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city of kalamunda

INDUSTRIAL DEVELOPMENT STRATEGY 2018

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EXECUTIVE SUMMARY

The Industrial Development Strategy (the Strategy) is intended to provide direction in regard to strategic and statutory planning decision making within the City of Kalamunda (the City) to facilitate and manage growth and changes to industrial estates within the municipal area.

The City's industrial areas are well situated for industrial activity given the proximity to major freight routes, established industrial estates and Perth Airport. High Wycombe, Forrestfield and Wattle Grove in particular have accommodated significant industrial expansion over the past 30 years and have areas suitable for further growth.

The Strategy builds on the City's Strategic Community Plan to facilitate diverse and sustainable industrial development to meet changing social and economic needs and support the success and growth of industry and business.

The vision of the Strategy is to enhance and expand upon our industrial precincts to accommodate future growth and diversity in industrial land uses and develop modern, efficient and attractive industrial estates that provide for the local and regional community.

Key development precincts identified within the Strategy are generally consistent with the sites identified in the Western Australian Planning Commission's (WAPC) Economic and Employment Land Strategy, and are broadly identified as follows:

1. **Forrestfield Marshalling Yards:** Representing the existing marshalling yards / intermodal freight facility between Perth Airport and Dundas Road;
2. **Forrestfield Industrial Area:** Representing the established Forrestfield industrial precinct west of Roe Highway in Forrestfield;
3. **Forrestfield / High Wycombe Light Industrial Area Stage 1:** Representing the growing industrial precinct to the north of the Forrestfield Industrial Area;
4. **Maddington Kenwick Strategic Employment Area (MKSEA):** Representing the north-eastern most section of the MKSEA precinct, colloquially known as the 'Kalamunda Wedge' area, an area planned for future industrial development;
5. **Wattle Grove South:** Representing an area identified for urban investigation, and considered to have strong potential for future industrial development;
6. **Walliston Industrial Area:** Representing the established industrial area within Walliston, which has potential for renewal and intensification; and
7. **Hatch Court / Stirling Crescent Light Industrial Area:** Representing an area identified for light industrial development abutting the City of Swan's Hazelmere Industrial Area and Perth Airport land, subject to further detailed planning.

The progression of key actions identified within this Strategy for each of these areas will be implemented via the preparation of new *Local Planning Scheme No.4* and the Local Planning Policy framework, and where necessary, amendments to the *Metropolitan Region Scheme.*

1.0 INTRODUCTION

The City currently has a total of approximately 351ha of industrial land, spread across five suburbs in Forrestfield, High Wycombe, Wattle Grove, Kewdale and Walliston.

The City's Local Planning Strategy (2010) drew on existing strategic documents at the time and resulted in a number of planning implications related to planning for industrial areas:

- Ongoing demand for industrial land due to freight rail facility in High Wycombe.
- The City's location is of strategic importance to transport-oriented industry as it is well located relative to major road and rail systems to and from the Eastern States and intra-state.
- Kewdale-Hazelmere Integrated Masterplan (KHIM) and Economic and Employment Lands Strategy (EELS) recommended that existing Rural and Special Rural land to the west of Roe Highway should be rezoned for industrial uses.
- Expanded industrial areas should help respond to the demand for truck parking activity throughout the City.
- Land located south of Welshpool Road East abutting the City of Gosnells to be rezoned to allow for industrial development as a result of the Maddington Kenwick Strategic Employment Area.

Importantly, there have been some key developments in regard to the above planning implications, as summarised below:

- Forrestfield/High Wycombe Industrial Area Stage 1 planning framework developed for freight and logistics based light industrial uses. Development is progressing in this precinct and progressing as is the delivery of key infrastructure projects.
- Wattle Grove South is being investigated for industrial development.
- Maddington Kenwick Strategic Employment Area (MKSEA) has been rezoned to industrial. Infrastructure upgrades and subdivision/development to commence in the near future.
- The State Government's announcement in 2014 confirming the Forrestfield-Airport Link project, resulted in a major shift in the strategic context envisaged by the KHIM and EELS plans for the provision of industrial land in High Wycombe. This resulted in the need to redefine the potential land uses surrounding the future station, focusing on mixed use development incorporating retail, commercial and higher density residential.

This Strategy seeks to build upon the strategic directions of the Local Planning Strategy 2010 and deliver a new set of objectives updated with the intentions of the latest State strategic documents, best practice examples, and incorporating updated statistical data. The Strategy will ultimately form a component of a new Local Planning Strategy for the City.

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1.1 GOAL

The Strategy builds on the priorities of the City's Strategic Community Plan by supporting our local economy and using our land and assets sustainably, diversely and effectively. The Strategy has the following overarching goal:

The City of Kalamunda will enhance and expand upon our industrial precincts to accommodate growth and diversity in industrial land uses and develop modern, efficient and attractive industrial estates that provide for the local and regional business community.

1.2 OBJECTIVES

The objectives of the Industrial Development Strategy are to:

- Develop an understanding of the key functions, attributes and needs of the City's industrial areas.
- Acknowledge the regional and local influences that determine the opportunities and constraints for the City's industrial areas.
- Outline strategies and actions that guide future strategic and statutory planning decision making in regard to industrial land use and development considerations in the City's industrial areas, with a particular focus on:
    - Attracting high quality industrial operators in strategic locations;
    - Establishing robust industrial areas that can withstand changing market conditions;
    - Improve local employment opportunities in industrial areas; and
    - Facilitate public realm improvements in industrial areas generally and improve the interface between industrial and sensitive land uses.

The above objectives are further expanded within the Strategic Directions and Actions section of the Strategy.

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2.0 STATE PLANNING FRAMEWORK

State Planning Strategy

The State Planning Strategy is a long-term strategic plan which provides a vision and broad strategic direction regarding land use and development for Western Australia. It recognises the importance of providing strategically identified industrial areas that are connected to suitable transport infrastructure and appropriately integrated with surrounding compatible land uses to ensure long term sustainability.

Economic and Employment Lands Strategy 2012 (EELS)

The aim of EELS is to ensure that adequate forward planning is undertaken to provide employment land in both the Perth and Peel regions to 2031. Employment land is defined as land that could be used for employment generating activities, including land zoned for industrial and commercial purposes.

EELS identifies the areas, type and locations of general and light industrial land required over the next 20 years. The Local Planning Strategy will generally be in accordance with the areas identified in EELS except where local issues arise and require alternative outcomes.

EELS identifies the Forrestfield Industrial Area stages 1, 2 and 3 as the City of Kalamunda's contribution towards the North-East Metropolitan Sub-region. Overall, the Sub-region is estimated to require an additional 424 hectares of industrial land by 2031. Of that, the City's contribution through the Forrestfield Industrial Area equates to 240 hectares, with the planning for Stage 1 (70 hectares) already finalised.

On 7 August 2014, the Western Australian Planning Commission (WAPC) advised the City that, due to the proposed Forrestfield Airport Link and Forrestfield train station, the proposed Forrestfield Industrial Area Stages 2 and 3, should no longer proceed. Instead, the WAPC requested the City to undertake District Structure Planning to identify new opportunities for office/commercial and residential land uses, which would make better use of the proposed train station.

Since Stages 2 and 3 of Forrestfield Industrial Area equate to approximately 170 hectares, the City cannot provide its original 240 hectare contribution of industrial land to the North-East Metropolitan Sub-region as envisaged under EELS, unless the Local Planning Strategy identifies additional or alternative locations for industrial land.

EELS also identifies the Maddington Kenwick Strategic Employment Area (MKSEA) as being located within the City of Gosnells with a small section referred to as the "Kalamunda wedge" being located within Kalamunda. MKSEA is characterised by fragmented landownership, high levels of access to Tonkin and Roe Highways, low-lying topography and in close proximity to an existing workforce population.

It should be noted that EELS is now 6 years old, and the economy has changed significantly since its adoption. Therefore some of the recommendations of EELS may no longer be relevant.

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North-East Sub-Regional Planning Framework

The final North-East Sub-Regional Framework (Framework) was released on 23 March 2018. The Framework is mostly in alignment with EELS but also takes into account all local government's Local Planning Strategies. In the City's case, the Local Planning Strategy 2010 identified MKSEA to be expanded from the City of Gosnells into Wattle Grove, south of Welshpool Road East. The Framework included this change and, in December of 2015, the Metropolitan Region Scheme was amended to rezone the City of Kalamunda's portion of MKSEA as Industrial.

The Framework also identifies the Forrestfield Train Station and shows the Forrestfield North area as Urban. This represents a loss of 170ha of industrial land from stages 2 and 3 of the Forrestfield / High Wycombe Industrial Area. The Framework only identifies an additional 50ha within the MKSEA area. This results in the City having lost a total of 124ha of potential industrial land given the shift in land use for Forrestfield North. Opportunities for additional industrial land may need to be borne by the rest of the sub-region unless this Strategy identifies additional or alternative locations for industrial land.

Not all industrial land is specifically identified for industrial purposes under the Framework or under the Metropolitan Region Scheme. For example the Framework identifies two (2) of the City's industrial areas within the Urban zone, Forrestfield/High Wycombe Industrial Area (Stage 1) and the Hatch Court / Stirling Crescent light industrial area. Both of these areas would permit light industrial uses which are generally compatible with urban land uses and are therefore able to be considered in the Urban zone.

The City has a dwelling target of an additional 11,452 dwellings and population target of an additional 25,194 by 2050. The majority of this growth is anticipated to occur in High Wycombe, Forrestfield, Wattle Grove and Maida Vale which is also in the area where the City's key industrial sites are located and where industrial development will predominantly occur. This is beneficial in terms of growing the City's employment self-sufficiency and creation of consolidated demand for service infrastructure, with associated potential congestion and land use conflict planning issues to address.

Industrial Land Needs Study (ILNS)

The ILNS was prepared in 2008 by Syme Marmion & Co for the Department for Planning and Infrastructure (now Department of Planning, Lands and Heritage). ILNS models the drivers of supply and demand to determine future requirements of industrial land by 2030. This included population and settlement growth, economic growth and decline, and location criteria and market preferences.

Many of the references made within ILNS relate to the strong, growing industrial market of 2005 – 2008. At that time, ILNS identified a supply shortage and interpreted that there would be a deficit of between 990 to 2,300 hectares of industrial land in the Perth and Peel regions by 2030.

While the more recent contraction in mining resources sector has seen a reduction in demand for industrial land, large tenants and investment groups are still seeking high quality industrial sites in strategic locations. This is reflected through recent sales of land in Forrestfield and Wattle Grove.

In addition to recent changes to the economic environment, it should be noted that this Study is now 10 years old and may no longer accurately represent the true industrial demand in the current market.

Kewdale-Hazelmere Integrated Masterplan (KHIM)

The KHIM was prepared 2006 by the WAPC. The Kewdale-Hazelmere area is a major strategic area for the freight industry in the Perth Region. The area has extensive road/rail intermodal freight infrastructure networks and overlaps three levels of government jurisdictions. There is also the challenge to facilitate the rapid expansion and change occurring in the freight industry and accommodate the existing population of residents within the area.

The KHIM makes a number of recommendations that impact the City. This includes revising the access strategy for Abernethy Road, structure planning for the Forrestfield North and Forrestfield/High Wycombe Industrial Area with appropriate land use interface designs for residential and industrial areas abutting land and upgrading the freight rail line within the Forrestfield Marshalling Yards.

It should be noted that the KHIM is now 12 years old, and certain aspects of the plan may be outdated and require review.

State Planning Policy 4.1 State Industrial Buffer / Draft State Planning Policy 4.1 Industrial Interface

State Planning Policy 4.1 (SPP 4.1) is a guiding document applicable to existing and new industrial areas and industrial uses. Its purpose is to protect industry from encroachment of sensitive land uses and, conversely, to protect sensitive land uses from potentially hazardous industrial activity. SPP 4.1 achieves this by recommending buffers be applied to industrial land where sufficient separation distances cannot be met on-site.

It is noted that this policy is currently under review, with a key component being the appropriate planning at the residential and industrial interface. Refer to Section 5.9 of the Strategy for detailed analysis of residential and industrial interface.

The measures contained in SPP 4.1 will be considered in this document for the purposes of managing and planning for existing and new industrial areas.

Development Control Policy 4.1 Industrial Subdivision

Adopted in 1988, Development Control Policy 4.1 (DC4.1) is still relatively contemporary in its operation. Lot sizes are not controlled in a strict manner; rather, it is suggested that lot sizes be determined later in the process to allow for a flexible design outcome that suits the function and purpose of each particular industrial area. The DC4.1 also has requirements around access, public open space and infrastructure servicing, which are further detailed at the structure planning or scheme amendment stages.

DCP 4.1 will be considered as a component of the creation of industrial policies and during the assessment of new industrial areas and activities.

Development Control Policy 4.2 Planning for Hazards and Safety

Adopted in 1991, Development Control Policy 4.2 (DC4.2) provides for location of industrial developments relative to more sensitive land uses. DC 4.2 also includes some guidance on buffer zones and separation distances similar to SPP 4.1.

All proposals within this Local Planning Strategy are consistent with DC 4.2.

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3.0 REGIONAL CONTEXT

The City's foothill suburbs have several characteristics that make them well located for industrial development. These characteristics include the following:

- The City's Industrial areas are centrally located within an extensive road and rail network.
- Connectivity to surrounding industrial estates; with Welshpool/Kewdale, Maddington, MKSEA, South Guildford and Hazelmere in close proximity.
- Key road connections Roe Highway, Tonkin Highway, Abernethy Road and Welshpool Road East provide easily accessible routes to key freight and industrial locations.
- Close proximity to the Perth Airport. Perth Airport borders the City to the west and is easily accessible via Tonkin Highway and Abernethy Road.
- The City has land available, particularly in Wattle Grove and Forrestfield for future industrial development which is well located due to the above points.
- Planned residential development (eg. Forrestfield North) provides increased demand for population driven industrial uses.

The following table provides a summary of other industrial areas in the region that influence the City's industrial areas.

Industrial Areas	Details	Relevance
City of Swan (CoS)		
Hazelmere Enterprise Area	The Hazelmere Enterprise Area (HEA) forms part of the Kewdale-Hazelmere Integrated Masterplan (KHIM) area. The area comprises approximately 210 hectares of land proposed to be rezoned to industrial. This area is well located for industrial development due to its close proximity to Roe Highway, Tonkin Highway, Great Eastern Highway, Perth Airport and existing industrial in	The HEA borders the northern parts of High Wycombe and Maida Vale. HEA provide an alternative industrial land supply and development opportunity outside of the City. The HEA will need to consider how to appropriately plan the residential/industrial interface due to the industrial of Hazelmere abutting residential of High Wycombe and Maida Vale.

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	Hazelmere and South Guildford. Most of the area was previously zoned rural and has been rezoned for industrial development. There is still a significant portion of the HEA that is yet to be developed. This precinct includes several areas of environmental importance including the Helena River and Hazelmere Lakes. The area also includes areas of residential.	
Malaga	A diverse industrial area with a range of lot sizes and land uses. Located in the north-west of the City of Swan, Malaga is well located at the head of the Tonkin Highway / Reid Highway intersection, serving important connections to the airport, Perth CBD and industrial areas to the south. Alexander Drive also borders the site to the west and Hepburn Avenue is located to the north of the site. Most of the site has been developed, with a few remaining land parcels the north and east of the site. The North Link project which incorporates a redesigned Reid Highway/Tonkin Highway/Hepburn Avenue intersection runs along the eastern boundary of the site.	Although not in close proximity to the City, Tonkin Highway and Reid Highway which becomes Roe Highway provide key linkages between Malaga and the City's industrial areas.
South Guildford	South Guildford is a small established industrial area to the south of the City of Swan. The site has reached full development. South Guildford's main key connection is via the Great Eastern Highway/Bypass which connects to the Perth Airport and Perth CBD to the west and industrial areas and other key connections to the east.	South Guildford has direct access to the City via Kalamunda Road. Connections to industrial areas within the City stem off Kalamunda Road and Great Eastern Bypass via Abernethy Road and Roe Highway.

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City of Canning (CoC)		
Welshpool / Kewdale	Located to the north-east of the City of Canning, Welshpool/Kewdale is a well-established industrial area that has key connections to the Perth CBD via Orrong Road and Albany Highway, Fremantle Port via Leach Highway, Kwinana Industrial Area and industrial areas to the north and south via Roe Highway, and the Airport via Abernethy Road and Horrie Miller Drive. The site has been fully developed with no future areas of expansion. The Kewdale Freight Terminal is a vital location for the movement of freight.	Located to the west of the City's suburb Wattle Grove, the Roe Highway / Welshpool Road East intersection provides a natural barrier between the residential of Wattle Grove and industrial of Welshpool. The industrial interface will have to continue to be considered at this location. Welshpool /Kewdale has direct access to the City's industrial areas via Roe Highway, Dundas Road and Abernethy Road.
Canning Vale	Located to the south-east of the City of Canning. Canning Vale also forms part of the City of Gosnells to the west. Canning Vale has almost reached its full development potential. Canning Vale's main connection is via Roe Highway which borders the site to the north and provides a key connection to the Kwinana Industrial Area and other industrial areas to the north and south.	Although not in close proximity to the City, Roe Highway provides a key linkage between Canning Vale and the City's industrial areas.
City of Gosnells (CoG)		
Maddington Kenwick Strategic Employment Area (MKSEA)	MKSEA was first identified by the State Government for industrial development in 1990. In August 2014, the City of Gosnells completed the necessary studies in support of the rezoning of the major portion of the Maddington-Kenwick Strategic Employment Area (MKSEA) within their boundaries, from Rural to Industrial. MKSEA is a large site recently rezoned from Rural	MKSEA is located to the south of the City, along the Wattle Grove border (incorporating a small wedge within Wattle Grove). The industrial interface with the Wattle Grove residential areas will be an important consideration for the planning of the site. MKSEA has direct connection to the City's industrial areas via Roe Highway.

	to industrial. The site incorporates a small area within Wattle Grove. MSKEA provides industrial infill between the existing industrial areas of Maddington and Welshpool. MKSEA is located between the key freight routes of Tonkin Highway, Roe Highway and Welshpool Road East which provide key connections to Perth Airport, Kwinana Industrial Area and the Perth CBD respectively. Development in MKSEA will commence over the coming years.	MKSEA in the City of Gosnells provides an alternative industrial land supply and development opportunity outside of the City.
Maddington	An established industrial area to the north of the City of Gosnells. The majority of the Maddington industrial area has been developed. Maddington has key connections to the Perth Airport via Tonkin Highway, and Perth CBD, strategic commercial centres to the west and industrial areas to the west via Albany Highway.	Maddington is in close proximity to the City to the south of Wattle Grove. The key connection for industrial traffic to the City from Maddington is via Tonkin Highway and then on to Roe Highway to access the industrial areas.
Perth Airport		
Perth Airport	Located on Australian Government land and leased and operated by the Westralia Airports Corporation. This land is reserved under the Metropolitan Region Scheme for 'public purposes'. Perth Airport is the hub of air freight operations in Pert. The industrial and freight component of Perth Airport is relatively small with significant future expansion anticipated. Perth Airport is well located to key industrial and freight locations via key connections Great Eastern Highway, Tonkin Highway, Horrie Miller Drive/Kewdale Road,	Located to the west of the City of Kalamunda. There is a significant interface to the Forrestfield industrial area. The City's Forrestfield Industrial Area is a 'spill-over' from the Perth Airport and has key connections to Perth Airport via Tonkin Highway and Abernethy Road. Perth Airport offers an alternative industrial land supply and development opportunity outside of the City. Sensitive land uses such as residential within close

	Abernethy Road and Leach Highway.	proximity to the Airport are considered via State Planning Policy 5.1 Land Use Planning in the Vicinity of Perth Airport.

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4.0 LOCAL PLANNING FRAMEWORK

City's Strategic Community Plan

Kalamunda Advancing 2027 is the City's Strategic Community Plan, which guides the strategic direction of the City.

The City's endorsed vision in Kalamunda Advancing is 'Connected communities, valuing nature and creating our future together'.

Priority 3 – Kalamunda develops to support our local economy and use our land and assets diversely and effectively. The relevant strategies that this Industrial Development Strategy will target are:

3.1.1 Plan for Diverse and Sustainable housing, community facilities and industrial development to meet changing social and economic needs.

3.2.1 Optimal management of all assets.

3.3.1 Facilitate and support the success and growth of industry and businesses.

These strategies were influenced by the results of the Community Perceptions Survey 2016. In the survey, our community identified a need for greater transparency, clear communication, job creation and forward thinking.

The City's Corporate Business Plan identifies the following actions that this Industrial Development Strategy will satisfy:

3.1.1.10 Review the Local Planning Strategy ensuring sustainable development and preservation of environmental values are recognised.

3.1.1.17 Prepare an Industrial Development Strategy to identify and justify future industrial land in the City as an input into the new Local Planning Strategy.

Local Planning Strategy 2010

The Local Planning Strategy 2010 (LPS) was prepared to set out the long term strategic planning directions in regard to land use planning for the City, based on relevant State and Regional planning policies. The 2010 LPS was ultimately endorsed by the WAPC in 2013. Local Planning Strategies are required to be reviewed every five (5) years; This Strategy is a component of the City's preparation to review the LPS.

The vision statements relating to industrial land use provided in the 2010 LPS includes:

- Expand industrial development and uses within the Shire (now City) taking advantage of the broader state industrial and transport policies, and the development related to Perth Airport.
- Develop industrial areas to maximise economic and employment opportunities without compromising the amenity of the adjacent land uses or the natural environment.

The 2010 LPS had the following strategies relating to industrial land use:

- Implement the recommendations of the Kewdale-Hazelmere integrated master plan (KHIMP), with the development of the Forrestfield/High Wycombe Industrial area.

- Consolidate industrial uses west of Roe Highway and east of Perth Airport to form a single industrial freight hub and provide additional employment opportunities.
- Implementation of recommendations contained in the Economic and Employment Lands Strategy.
- Review road and transport hierarchy around existing and planned industrial area to support freight movements and seek government financial assistance to address vehicle blackspots.
- Work with the City of Gosnells in respect to the planning implications of the Maddington Kenwick Strategic Employment Area for land owners in the Shire of Kalamunda.

The following table indicates the status of implementation of the abovementioned strategies through Scheme Amendments and Policy Initiatives:

Initiative	Progress	Comments
Incorporate relevant zoning changes as proposed in the Economic and Employment Lands Strategy – Non-Heavy Industry (2012).	Forrestfield/High Wycombe Industrial Area and MKSEA rezoned as recommended by the EELS. Forrestfield North not rezoned for industrial due to the train station located to the western border of the site, with a transit-oriented-development considered a more appropriate planning response.	Review required on whether there is a need to pursue additional land that was lost as a result of the Forrestfield North area not progressing for industrial development.
Prepare Environmentally Sensitive Design guidelines for industrial development and other controls to manage potential impact on the amenity of adjacent areas.	Forrestfield/High Wycombe Industrial Area design guidelines have been developed. No design guidelines for other industrial areas.	There continues to be a need to consider implementation of design guidelines to other industrial areas within the City.
Work with State Government and Landcorp to secure partnership to develop the Forrestfield/High Wycombe Industrial Area.	Partnership did not eventuate. The City has undertaken the structure planning and project management for the Forrestfield/High Wycombe Industrial Area.	No partnership required. Continue project management of the Structure Plan and Developer Contribution Scheme.
Undertake comprehensive planning and analysis of the Forrestfield/High Wycombe Industrial area.	Structure planning undertaken for the site with project infrastructure works ongoing.	Continue to roll out infrastructure works.
Identify land located to the south of Welshpool Road East abutting the City of Gosnells as future Industrial Development.	Land identified (MKSEA) has been rezoned to industrial.	Oversee the planning of the site and ensure the planning and development meets modern principles and adheres to the relevant planning frameworks.

The City has initiated some of the actions as mentioned above since the LPS 2010 was adopted. This Strategy and ultimately the future Local Planning Strategy will review actions that have not been fully implemented.

Local Planning Scheme No. 3

Local Planning Scheme No. 3 (LPS3) sets out the planning framework and requirements for land use planning within the City. More specifically the zoning table of LSP3 sets the permissibility of land uses in industrial zones. The Site Requirements Table sets out the site requirements in industrial zones. LPS3 also sets out the objectives and development requirements in industrial zones. LPS3 is planned to be superseded by the City's Local Planning Scheme No. 4 which is will be progressed as part of the preparation of a future Local Planning Strategy.

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5.0 LOCAL PROFILE

5.1 POPULATION DEMOGRAPHICS

Population Demographics obtained from Profile. Id (2017).

The City has a 2018 forecast population of 60,739 people. This is predicted to increase to 76,179 people by 2036. The suburbs of Forrestfield, High Wycombe and Wattle Grove are expected to experience some of the highest population rises within the City as well as the Forrestfield North development area. High Wycombe population is set to rise by 1373 people, 12,563 to 13,936 in the next 18 years (this is not including population rise from Forrestfield North). Forrestfield population is predicted to rise by 3465 people in the next 18 years, 13,614 to 17,079. Wattle Grove is predicted to rise by 643 people in the next 18 years, 6586 people to 7229. The Forrestfield North development area is set to add an additional 6303 people over the next 18 years, 310 to 6613. These localities are all in close proximity to the City's and neighbouring local government's industrial areas. The population increase from these suburbs will be able to increase the local industrial workforce and provide a challenge to cater for increased demand for population driven industrial uses. Given the increase and expansion in the residential population, the industrial interface will need to be considered with any future planning of industrial areas within close proximity to residential.

Refer to Appendix 1 for detailed table of the above data.

5.2 ECONOMY AND EMPLOYMENT

Economy and Employment obtained from Profile id (2016).

The City's residents' are considered to be predominantly in the 'medium income' bracket, with the City having higher percentages of people in the $650-$3499 weekly household income brackets compared to Greater Perth. The City has lower percentages of people in the $0-$649 and $3500 and greater weekly income brackets.

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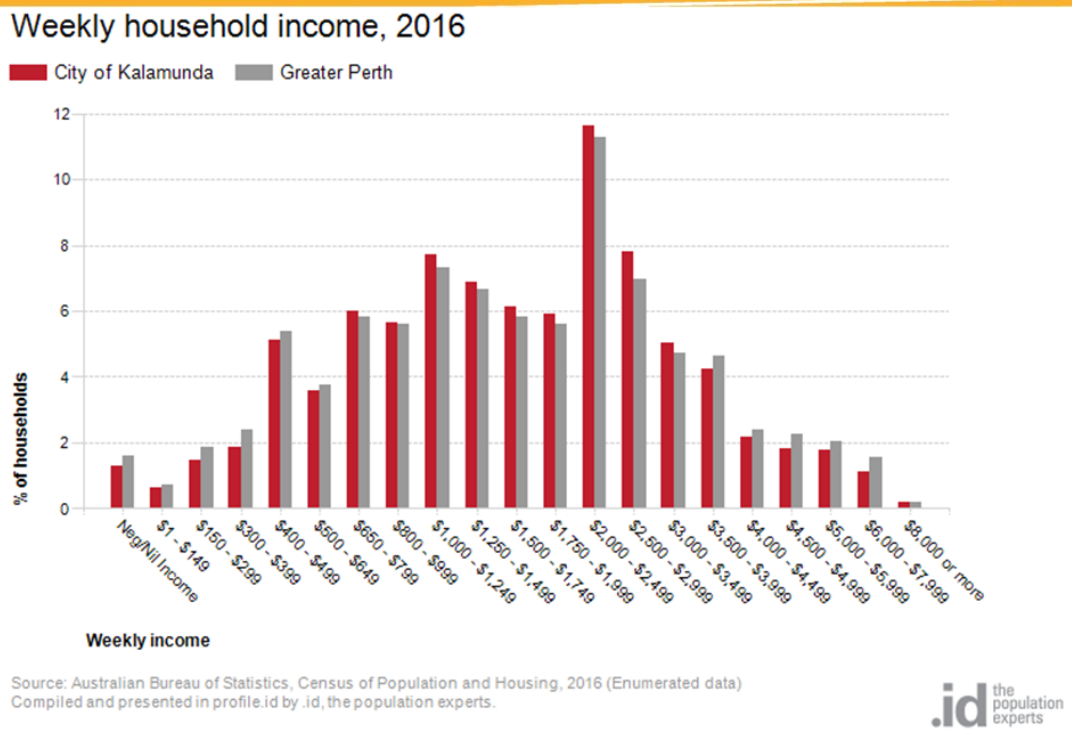

Source: Profile id 2016

The City's residents' five most common employment sectors are health care and social assistance, construction, retail trade, education and training, and transport, postal and warehousing. The majority of these industries are associated with industrial areas.

The City has higher percentages of people than Greater Perth employed in the following industries:

- agriculture, forestry and fishing;
- mining;
- manufacturing;
- electricity, gas, water and waste services;
- construction;
- wholesale trade; and
- transport, postal and warehousing

These industries all have association with industrial areas, demonstrating the significant workforce the City has employed in industrial areas. This demonstrates an importance to provide industrial land to enable residents to work close to home.

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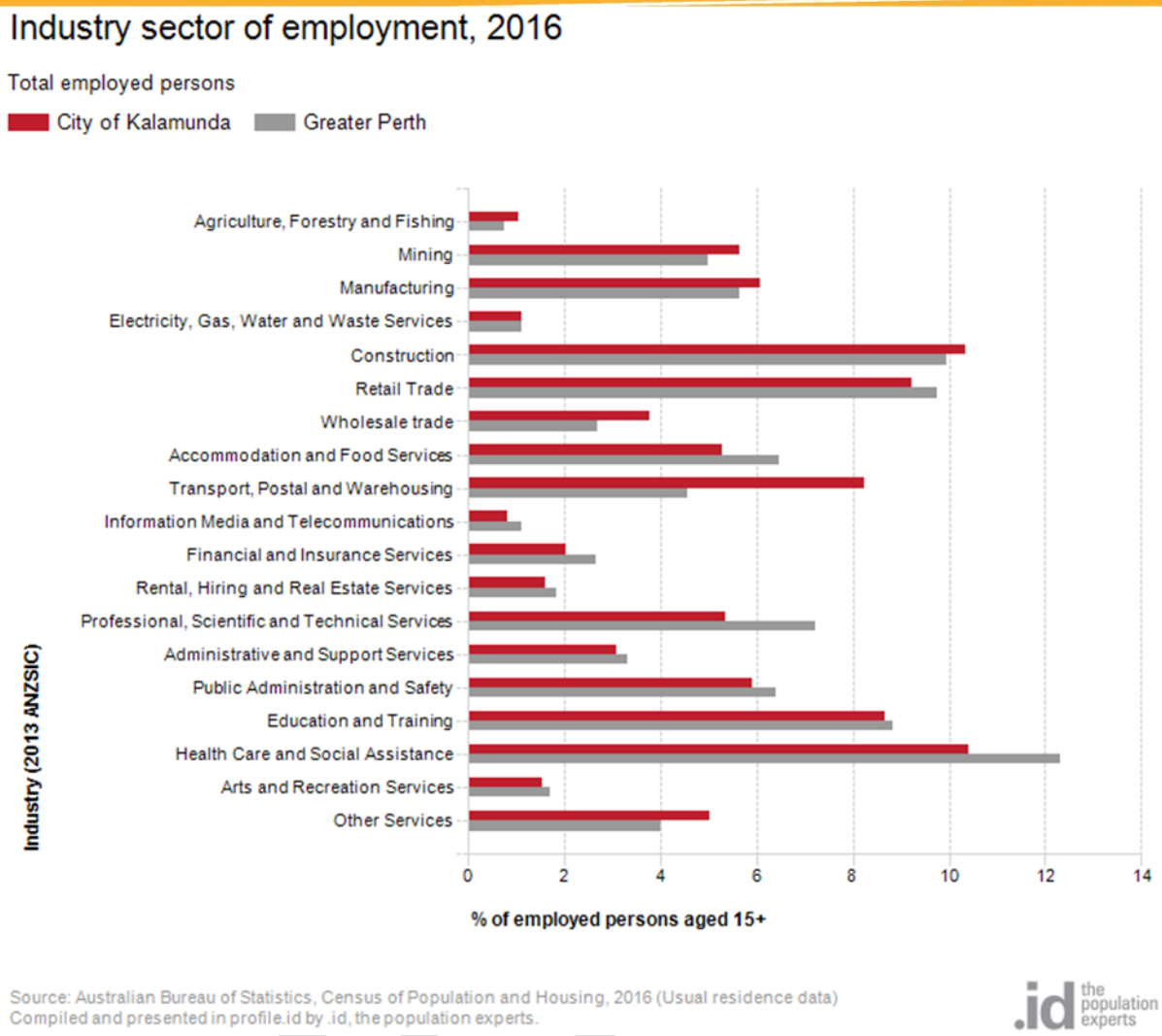


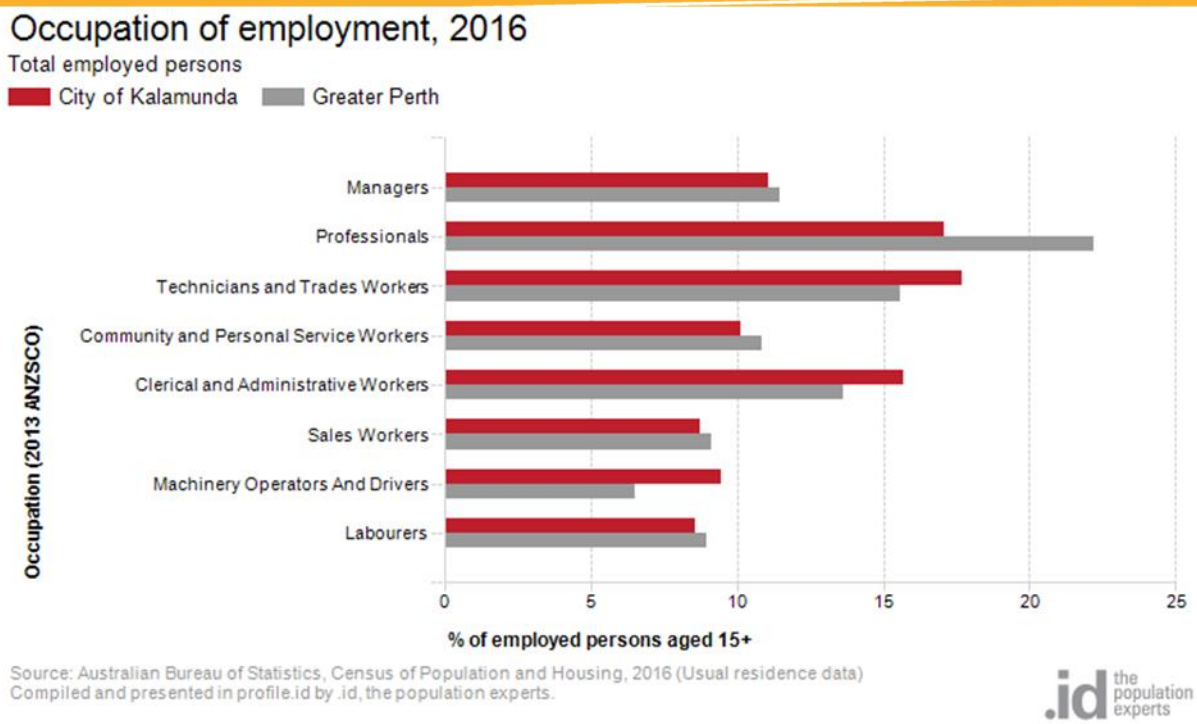
Source: Profile id 2016

The City's residents' three most common occupations of employment are technicians and trade workers, professionals and clerical and administrative workers. Technicians, trade workers and administrative workers in particular are associated with employment in industrial areas.

The City has higher percentages of people than Greater Perth with the following occupations:

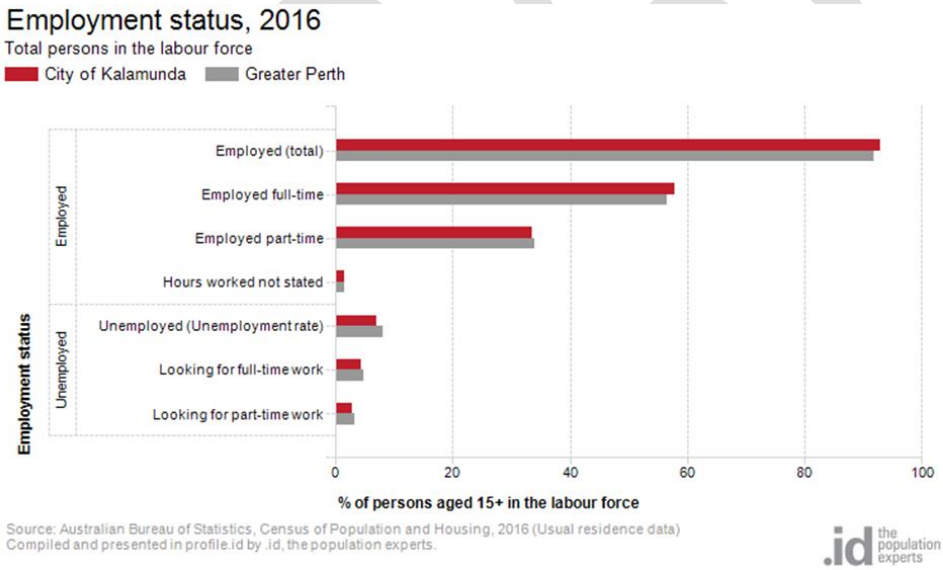
- technician and trade workers
- clerical and administrative workers
- machinery operators and drivers

These occupations all have association with industrial areas, demonstrating the importance of the City's industrial areas for creating local employment.



Source: Profile id 2016

The City has higher percentage of its population employed and employed full-time than Greater Perth and has a lower percentage of its population employed part-time and unemployed than Greater Perth.

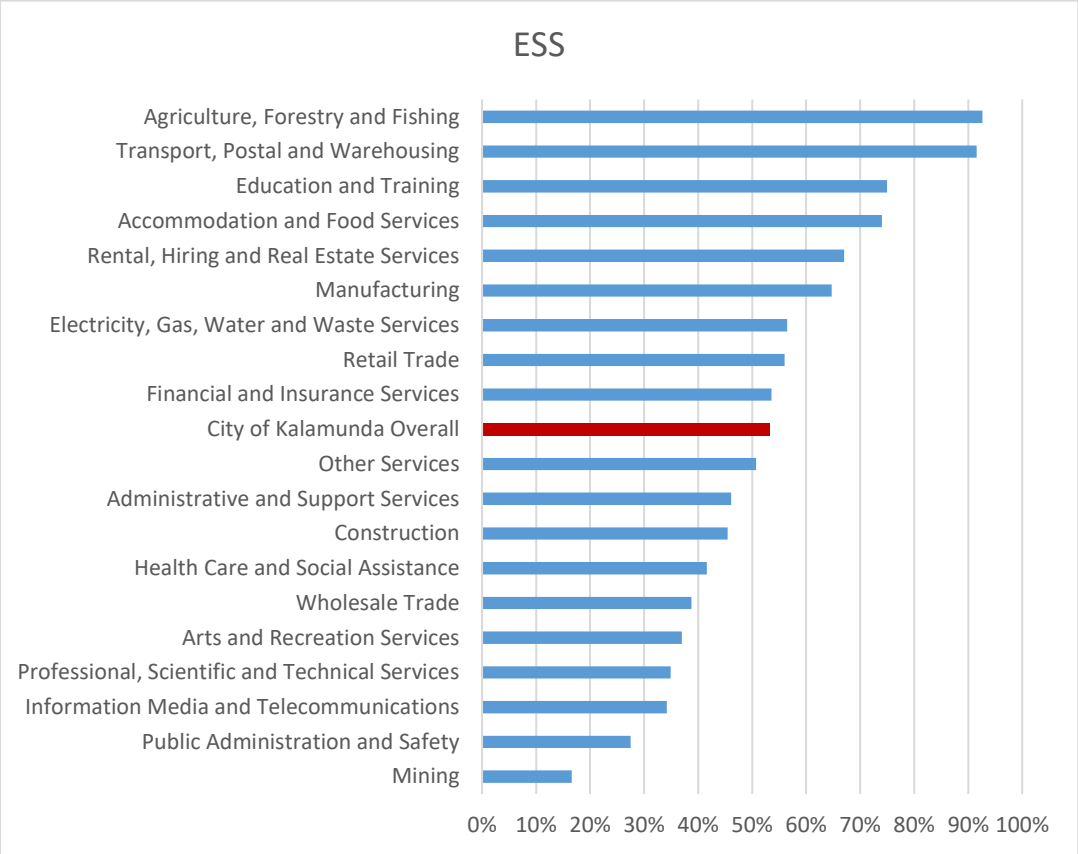


Source: Profile id 2016

Kalamunda has a relatively low rate of employment self-sufficiency (53%). Only the Agriculture Forestry and Fishing, Transport Postal and Warehousing, Education and Training and Accommodation and Food Services sectors have employment self-sufficiency rates at over 70%. This means that the majority of City resident workers travel outside of the City for employment. However, even though the City has low employment self-sufficiency, a

high proportion of the resident workforce work in the City of Belmont, City of Swan, and Perth Airport which have substantial industrial and commercial estates.

City of Kalamunda – Employment Self-Sufficiency by Industry, 2016



Source: ABS Census 2016 (Employment, Industry Sector by Place of Work and Place of Usual Residence)

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5.3 TRANSPORT LINKAGES

5.3.1 ROADS

The City has the following key transport linkages that service industrial traffic:

Name of Road	Direction of Travel	Key Destinations	Future Plans and Funding
Roe Highway	North/South	• Kwinana FWY • Jandakot Airport • Canning Vale industrial area • Willetton industrial area • Reid HWY • Great Eastern HWY • Great Eastern HWY Bypass • Great Northern HWY	Main Roads future plans to remove all at grade intersections and convert to grade-separated. Kalamunda Road/Roe Highway intersection will be affected by these plans.
Tonkin Highway	North/South	• Perth Airport • Malaga industrial area • Maddington industrial area • Great Eastern HWY – connection to Perth CBD	As part of Main Roads' future plans to remove all at grade intersections and convert to grade-separated roads, in April 2018 the State and Federal Governments have committed funding towards improving the Hale Road and Welshpool Road interchanges.
Abernethy Road	West/East North/South	• Perth Airport • Hazelmere Industrial area • Kewdale/Welshpool Industrial area	Future road upgrades planned for Abernethy Road. Future runway project for Perth Airport to consider Grogan Road connection to Abernethy Road.
Welshpool Road East	West/East	• Kewdale/Welshpool Industrial area • Orrong Road – Perth CBD	Welshpool Road/Tonkin Highway intersection planned to be grade separated. In April

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			2018 the State and Federal Governments have committed funding towards improving the Welshpool Road interchange.
Kalamunda Road	West/East	• Hazelmere Industrial area • Great Eastern HWY Bypass • Great Eastern HWY	Kalamunda Road/Roe Highway intersection planned to be grade separated.

The above key transport links, connect the City's industrial areas to other key industrial areas, freight links and activity centres.

5.3.2 PUBLIC TRANSPORT

Public transport access to existing industrial areas is currently limited and infrequent. There are currently no bus services to the Forrestfield Industrial Area and Forrestfield/High Wycombe Industrial Area. Access to these localities is expected to improve when the Forrestfield Train Station opens with the train station in close proximity and additional bus routes utilising Berkshire Road to link with the Train Station expected. There is an existing bus route that utilises Abernethy Road and provides access to the Forrestfield Marshalling Yard. The Walliston Bus Depot is located in the Walliston Industrial Area and is where buses servicing Kalamunda are stored and serviced by the Public Transport Authority. Most of the bus routes however terminate in Kalamunda, with bus routes starting or ending in Walliston infrequent. There is a bus route that services potential industrial area Wattle Grove South. To encourage modal shift to public transport the City will need to liaise with PTA to justify the addition of bus servicing to industrial areas.

5.3.3 CYCLING

The only existing cycle lanes currently servicing industrial areas in the City are along Abernethy Road providing cycle access to Forrestfield Marshalling Yards and along Dundas Road providing cycling access to the Forrestfield Industrial Area and Forrestfield/High Wycombe Industrial Area. Further expansion on this cycle infrastructure will be required to further encourage modal shift to cycling and connect with existing networks throughout the metropolitan area. Bicycle infrastructure improvements throughout the City, including within the City's industrial areas have been identified in the City's Bicycle Plan which is anticipated to be adopted in 2018.

5.4 INFRASTRUCTURE AVAILABILITY

Reticulated sewer in the City is limited to the industrial areas of Forrestfield, High Wycombe, Maida Vale and Wattle Grove. The central area surrounding the Kalamunda town centre is also serviced. Any future industrial development will occur in areas which are currently rural and not serviced by sewer. The majority of the City is serviced by reticulated water, apart from the parks and recreation areas and fringe Hills Rural areas.

The City will continue to work with landowners and the State Government to facilitate the extension of sewer to existing and future industrial estates, but recognise that interim solutions via on-site treatment of wastewater are potentially acceptable subject to land capability assessment.

All current and future industrial areas have access to electricity. All established industrial areas have above-ground power. The City to work with Western Power to investigate potential power upgrades such as underground power to established industrial areas and ensure that future industrial areas incorporate power infrastructure that is future proof and up to modern day standards.

See Appendix 2 for servicing map.

Existing National Broadband Network (NBN) currently services the Hills Rural Area, High Wycombe, Maida Vale and the Forrestfield Industrial Area. The remainder of the Hills Area (Kalamunda, Lesmurdie and Walliston) are currently in the process of build out and according to the NBN will be fully operational by April 2018. The remaining non-serviced NBN areas of Wattle Grove and Forrestfield are planned to receive the NBN rollout between mid-2018 to late-2019. This demonstrates that all industrial businesses will have access to the NBN network currently or in the near future.

See Appendix 3 for NBN roll out map.

5.5 QUANTITY OF INDUSTRIAL LAND

The availability of land is a key consideration for industrial operators in determining whether to establish an industrial development in the City.

The City currently has a total of approximately 351ha of industrial land, spread across five suburbs; Forrestfield, High Wycombe, Wattle Grove, Kewdale and Walliston.

Refer to Appendix Map 1

Forrestfield has the most amount of industrial land with approximately 212ha, equating to 61% of the City's total industrial land supply. All industrial land in the City is located on the foothills apart from Walliston which has approximately 12ha of industrial land.

The City has the following amount of existing land for each zone under the Local Planning Scheme:

Light Industry	37ha
General Industry	208ha
Industrial Development	82ha
Special Use	8ha
Railways	16.52ha

The City is expected to have an additional 36ha of land rezoned for industrial in the future, which takes the total amount of industrial land to 387ha. The 'Wattle Grove South area' is approximately 310ha and this has been identified for industrial and urban investigation. Initial feasibility investigations indicate that it is unlikely that the entire area will be suitable for future industrial therefore the industrial component is unlikely to exceed 140ha.

Approximately 314ha of the 387ha of industrial land within the City has already been developed. There is approximately 73ha remaining that is yet to be developed. This includes the land expected to be rezoned to industrial in the future, which is the second stage of MKSEA. Note that MKSEA already has been rezoned under the MRS.

There are a number of contaminated sites located in the City. The future use of many these sites is unknown pending detailed investigations and remediation. Depending on the results of detailed investigations and remediation requirements, the possibility of using these sites for alternative employment generating land uses associated with industry should be considered.

See Appendix 4 for suburb breakdown of industrial areas.

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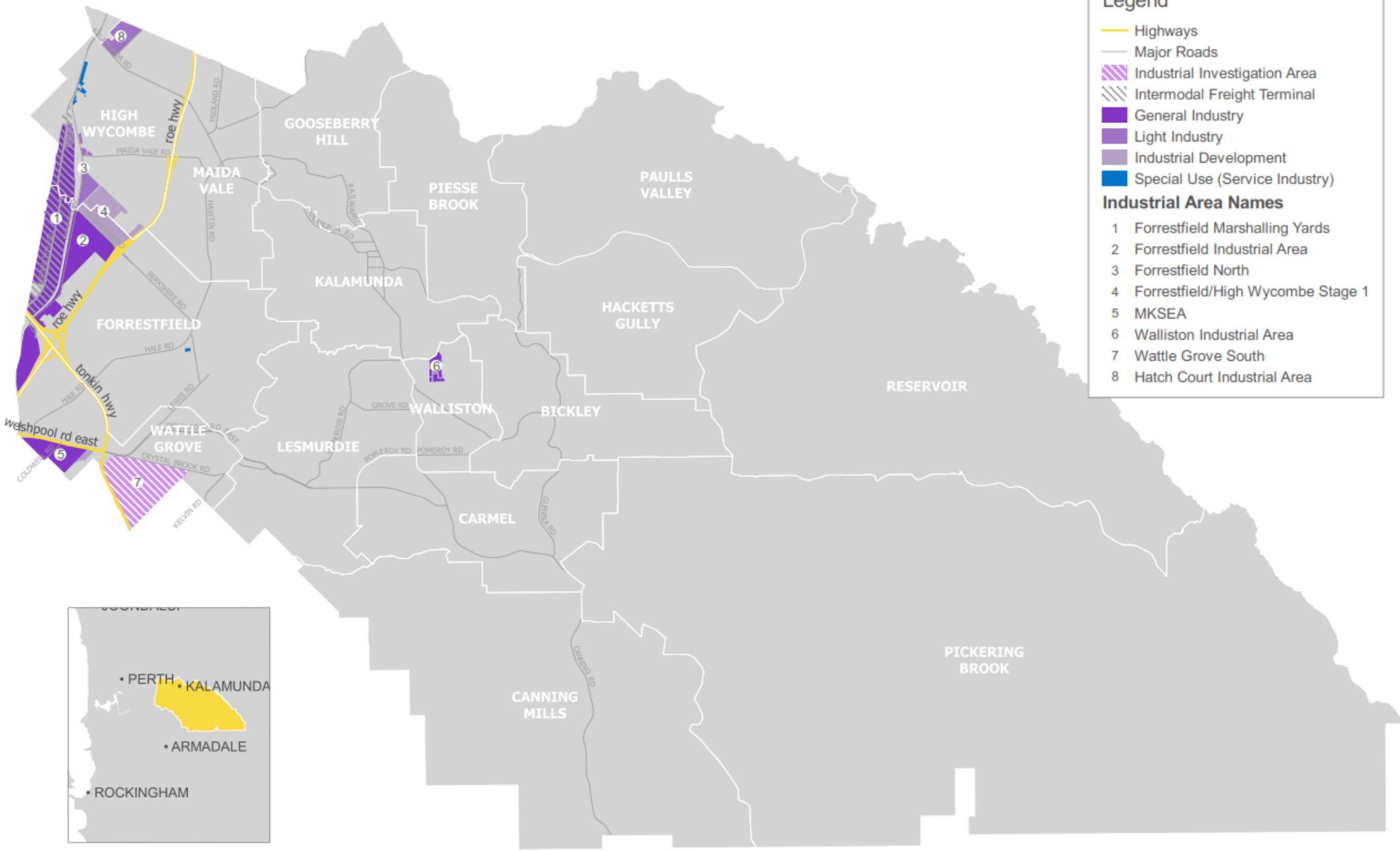
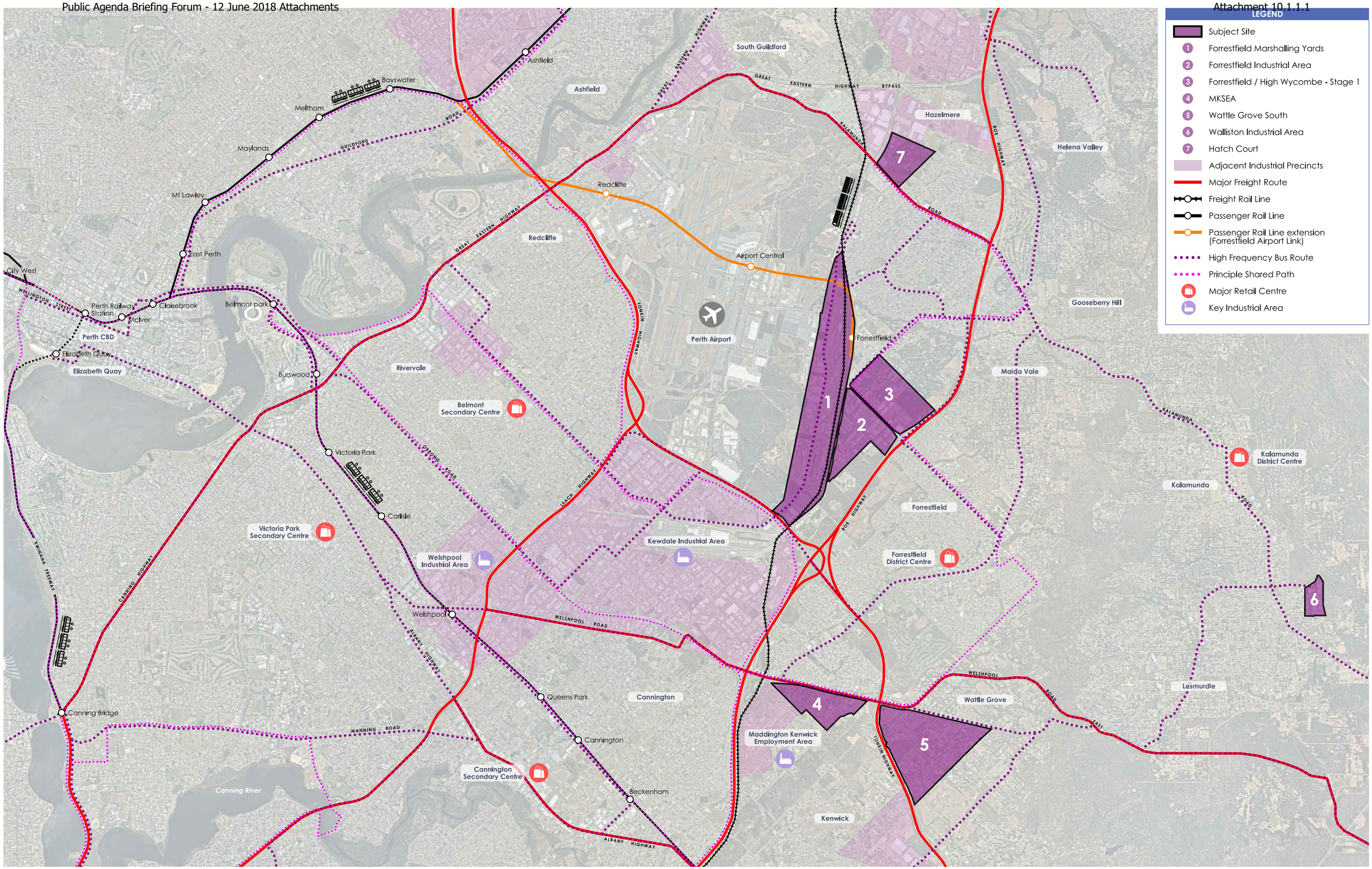
MAP 1: INDUSTRIAL AREAS - CITY OF KALAMUNDA

Industrial Development Strategy



MAP 2: INDUSTRIAL AREAS - REGIONAL CONTEXT



SUB-REGIONAL CONTEXT PLAN

City of Kalamunda Industrial Strategy

A City of Kalamunda Project

City of Kalamunda

0m 0.25 0.5 0.75 1km

s: 1:55,000@A3
d: 18 May 2018
p: 17/103/002B

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6.0 ANALYSIS OF KEY AREAS / ISSUES

6.1 FORRESTFIELD MARSHALLING YARDS

The Forrestfield Marshalling Yards encompass more than 190ha of land from which some of the largest distribution and transport companies in Australia operate. The marshalling yards are an intermodal freight for road and heavy rail, which also takes advantage of the adjacent airport.

The development of land within the marshalling yards precinct largely occurs without significant guidance from the City of Kalamunda. The Freight and Logistics Council of WA provides guidance to operators and policy makers about supply chain efficiencies, which affects development patterns within the marshalling yards.

Since the majority of the marshalling yards are built-out, there is little opportunity for development or redevelopment.

It is important to plan around this important strategic asset of state and regional significance. The residential development proposed at Forrestfield North will need to implement appropriate mitigation measures to prevent any adverse impacts on residents and businesses from the 24 hour operations at the Marshalling Yards. Noise and vibration are the key risks associated with development in close proximity to the Marshalling Yard, which will be investigated as part of the Forrestfield North Structure Planning process. Reducing the amount of residential development within the areas most affected by noise and vibration will be a key consideration. The development of large scale mixed use and commercial buildings and appropriate development requirements for buildings to reduce the impact of noise and vibration will be key strategies in the planning for Forrestfield North.

Draft State Planning Policy 5.4 Road and Rail Noise (SPP 5.4) has a trigger distance of 300m from the closest freight rail track whereby sensitive land uses should be avoided or where they do occur the appropriate interface management and development conditions are required to ensure adverse effects are minimised.

Forrestfield Marshalling Yards snapshot:

Criteria	**Existing**
Local Planning Scheme Zoning	Majority General Industry Small portion Light Industry
Predominant Land uses	• Transport Depot • Warehouse • Storage
Industrial Typology	Freight and Logistics
Lot Sizes	0-1ha: 8 lots 1-2ha: 16 lots 2-3ha: 1 lots 3-4ha: 6 lots 4-5ha: 1 lots 5ha+: 3 lots
Movement Network	• Abernethy Road, Other Regional Road, • Freight Rail Line

	• Dundas Road
Infrastructure and Utilities	• Water • Gas • Electricity – part aboveground and underground • Sewer provided

Strategies:

- **To protect the Forrestfield Marshalling Yards from encroaching urban development and mitigating noise and vibration issues in respect to future residential development.**
- **Maintain a high standard of landscaping and road maintenance.**

6.2 FORRESTFIELD INDUSTRIAL AREA

The Forrestfield Industrial Area is approximately 70 ha, zoned General Industry and home to some the City's more intense industrial activity. This area is subject to a 20 year old structure plan that addresses interface and general development requirements.

Local Planning Scheme No. 3 and the Forrestfield Industrial Area Structure Plan control development but do not account for modern building typologies and lot layouts.

Forrestfield Industrial Area snapshot:

Criteria	Existing
Local Planning Scheme Zoning	• General Industry • Light Industry (Berkshire Road interface and southern portion)
Predominant Land use	• Warehouse • Storage • Transport Depot • Local Services • Fabrication and Manufacturing
Industrial Typology	• Warehousing and Distribution • General • Transport and Logistics
Lot Sizes	0-1ha: 62 1-2ha: 7 2-3ha: 4 3-4ha: 4 4-5ha: 4 5ha+: 1
Movement Network	• Berkshire Road • Dundas Road • Milner Road • Roe Highway
Infrastructure and Utilities	• Water • Gas • Electricity – Aboveground along Berkshire Road and Dundas Road. Underground within estate • Sewer (Partial – northern portion of precinct)

Strategy:

- **Provide modern and flexible development guidance.**

6.3 FORRESTFIELD/HIGH WYCOMBE STAGE 1

Forrestfield/High Wycombe Stage 1 comprises an area of approximately 70 ha and provides for principally transport and logistics based industrial uses. The area is zoned Urban under the Metropolitan Region Scheme (MRS) and Industrial Development under the City's Local Planning Scheme No. 3. The North-East Sub-Regional Framework supports the urban classification of the land under the MRS.

The Industrial Development zone requires a Local Structure Plan be prepared for development guidance and permits land uses in accordance with transport- and logistics-based industries. The area is designed to accommodate Category 7 Restrict Access Vehicles (37.5m trucks) to take advantage of its proximity to Roe Highway and the significant upgrades by the state government in the Gateway project.

The Forrestfield/High Wycombe Stage 1 Local Structure Plan provides for future road connections, subdivision and design requirements. There is also a Development Contribution Plan (DCP) in place that collects funds from developing landowners to develop new roads, land acquisition for roads and other common infrastructure. Planning for this area has been had to take into consideration the proposed Forrestfield North urban development. The planning framework has recently been reviewed to address this interface and ensure it is contemporary, efficient, and in line with community aspirations.

A review of the planning framework investigated three key areas relating to the Forrestfield/High Wycombe Industrial Area Stage 1 Local Structure Plan:

- Land use permissibility and lot sizes;
- The proposed local road network; and
- The DCP.

Market analysis indicated that there would be no advantage for reducing or removing the minimum lot size for subdivision within the precinct generally, as the demand is highest for lots that exceed 2ha. However, the review indicated that Lots 50-52 Sultana Road West and Lots 5-6 Ashby Close would potentially benefit from a reduced lot size to facilitate subdivision and providing an alternative industrial product to the market. As a result a proposal was presented to the WAPC in early 2018 to enable the flexibility of reduced lot sizes to a minimum of 2000m² for these lots. In March 2018 the WAPC advised the City that there is insufficient justification for reduced lot sizes and that this proposal would not be supported.

The modifications also included changes to the movement network to allow for more efficient traffic movements within the site, with subsequent changes to the DCP in response to the modifications. A composite industrial zone has also be recommended to be introduced as a Scheme Amendment over Lot 50 which abuts the Forrestfield North development area. This will assist with appropriate industrial-residential interface management and the provision on an alternative lot product within the area.

Facilitating development in this area is key to delivering the proposed infrastructure and should be the focus of the planning framework.

Forrestfield/High Wycombe Stage 1 snapshot:

Criteria	Existing
Local Planning Scheme Zoning	Industrial Development
Predominant Land uses	• Rural • Transport Depot • Warehouse • Storage
Industrial Typology	Transport and Logistics
Lot Sizes	0-1ha: 27 1-2ha: 24 2-3ha: 0 3-4ha: 4 4-5ha: 1 5ha+: 1
Movement Network	• Berkshire Road • Dundas Road • Milner Road • Roe Highway
Infrastructure and Utilities	• Water • Gas • Electricity – Aboveground along Berkshire Road and Dundas Road. Underground within estate • Sewer – Berkshire Road and Milner Road

Strategies:

- **Keep development contributions relevant and within relevant frameworks;**
- **Maintain a high standard of landscaping where appropriate and road maintenance;**
- **Attract large businesses by protecting key land parcels from subdivision;**
- **Provide opportunity for small and medium sized businesses to benefit from, and co-locate with, larger industries where appropriate;**
- **Ensure there are logical transition zones between residential and industrial uses; and**
- **Capitalise on the close proximity to the airport, freight marshalling yards and highways.**

6.4 MADDINGTON-KENWICK STRATEGIC EMPLOYMENT AREA (MKSEA)

In August 2014, the City of Gosnells completed all the necessary studies in support of the rezoning of the major portion of the Maddington-Kenwick Strategic Employment Area (MKSEA) within their boundaries, from Rural to Industrial. 13% of MKSEA is within the City of Kalamunda's boundaries, which equates to approximately 20.4ha. MKSEA in the City of Kalamunda is bounded by Welshpool Road East and the City of Gosnells local government boundary. MKSEA is zoned General and Light Industry and has a specific policy to guide development and design. The area is not yet developed, but there are some leases and sales mainly to freight, logistics and warehousing operators. There is potential with MKSEA to accommodate ancillary services such as cafés, a gym, retail outlets and service stations.

The General Industry zone is intended for properties to accommodate industrial type uses as an extension to the freight and logistics precinct within the City of Gosnells. The Light Industry zone is intended for properties to accommodate service and light industrial uses as an interface to Welshpool Road East and a buffer to the residential land uses within Wattle Grove (Cell 9). The proposed provisions include a requirement for further bushfire, drainage and environmental assessments for future development in the entire amendment area. Design guidelines for lots fronting Welshpool Road East have also been required to be developed to ensure a sensitive and appropriate interface with existing residential development in Cell 9 in accordance with SPP 4.1. MKSEA also proposes to modify the permitted land uses in the Special Control Area.

Maddington-Kenwick Strategic Employment Area snapshot:

Criteria	**Existing**
Local Planning Scheme Zoning	• General Industry • Light Industry (Welshpool Road East interface)
Predominant Land uses	• Rural • Storage
Industrial Typology	No existing industrial
Lot Sizes	0-1ha: 0 1-2ha: 24 2-3ha: 1 3-4ha: 5 4-5ha: 0 5ha+: 0
Movement Network	• Welshpool Road East • Roe Highway
Infrastructure and Utilities	• Water • Gas • Electricity – Aboveground along Berkshire Road and Dundas Road. Underground within estate • Sewer (Partial – northern portion of precinct)

Strategies:

- **Keep development contributions relevant and within frameworks;**

- **Ensure there are logical transition zones between residential and industrial uses; and**
- **Provide modern and flexible development guidance.**

6.5 WATTLE GROVE SOUTH

Wattle Grove South is identified for urban investigation by the Local Planning Strategy 2010. The North-East Sub-Regional Structure Plan also identifies Wattle Grove South as an urban expansion area with a Medium-Long term (2022+) development horizon. The area for possible industrial is approximately 136ha with 170 existing lots. Feasibility investigations are required to determine what land uses are the most appropriate and feasible within the site. Given the site is bordered by key freight links, Tonkin Highway and Welshpool Road East and is in close proximity to Roe Highway and Perth Airport, industrial development maybe considered a feasible development option for a portion or entirety of the site. Any proposed industrial development would be freight and logistics oriented or light industrial. It is possible for Light Industrial to be classified over the Urban zone under the MRS, as has occurred in the Forrestfield / High Wycombe Stage 1 and the Hatch Court / Stirling Crescent industrial areas. In this regard, the Wattle Grove South area has been identified under the North-East Sub-Regional Framework as Urban expansion and there is potential for light industrial uses to be considered under this identification.

Aircraft noise needs to be considered as part of the development of Wattle Grove South. The provision of industrial uses may assist with mitigating impacts from Perth Airport.

Criteria	**Existing**
Local Planning Scheme Zoning	Special Rural
Predominant Land uses	Rural Lifestyle
Industrial Typology	No existing industrial typology
Lot Sizes	0-1ha: 61 1-2ha: 141 2-3ha: 32 3-4ha: 3 4-5ha: 7 5ha+: 3
Movement Network	• Tonkin Highway • Welshpool Road East • Kelvin Road
Infrastructure and Utilities	• Water • Electricity – aboveground
Industrial Typology	No existing industrial typology

Strategy:

- **Investigate sites for potential industrial development.**

6.6 WALLISTON INDUSTRIAL AREA

The Walliston Industrial Area was first established in the 1970s and is at full build out. The Walliston Industrial Area is a small industrial area, mostly providing the servicing needs of the Hills local residents. The City's Operations Centre is also located within the Walliston Industrial Area, providing an important operational location for the City. Many of the existing buildings date back to the 1970s, demonstrating a need to promote renewal within the area.

The Walliston Industrial Area abuts regional reserve to the north and east and low density residential to the west and south. The interface measures used are slithers of public open space and road reserves between the industrial area and residential area. Public realm opportunities should be investigated to improve the interface between the industrial and residential area.

Criteria	**Existing**
Local Planning Scheme Zoning	General Industry
Predominant Land uses	• Warehouse • Storage • Local Services • Fabrication and Manufacturing
Industrial Typology	General - Service
Lot Sizes	0-1ha: 51 1-2ha: 1 2-3ha: 1 3-4ha: 0 4-5ha: 0 5ha+: 0
Movement Network	• Canning Road • Lesmurdie Road
Infrastructure and Utilities	• Water • Electricity – (above ground)

Strategies:

- **Investigate public realm improvements in industrial areas to improve the industrial-residential interface; and**
- **Ensure there are logical transition zones between residential and industrial uses.**

6.7 HATCH COURT / STIRLING CRESCENT

Hatch Court Industrial Area is located in the north-west corner of High Wycombe, abutting the City of Swan and Perth Airport. The site is currently zoned urban development and is approximately 30 hectares. The site was originally rezoned from Rural to Urban under the MRS in 2010 and a Local Structure Plan to facilitate residential development was adopted by Council in 2013, however refused by the Department of Planning.

Subsequently it was decided that the location was more appropriate for industrial, given its location abutting the City of Swan's Hazelmere industrial development area and Perth Airport's industrial area, in addition to access to freight links such as Abernethy Road. Amendment 80 was initiated in 2015 to rezone the site from urban development to light industry. At Council's February 2017 OCM, Council adopted Amendment 80. In order to develop light industry within the site a Local Structure Plan must first be prepared. The site abuts urban development to the east, which will require an appropriate industrial – residential interface in accordance with SPP 4.1.

Item	**Existing**
Local Planning Scheme Zoning	General Industry
Predominant land uses	Rural Lifestyle
Industrial Typology	No existing industrial typology
Lot Sizes	0-1ha: 0 1-2ha: 12 2-3ha: 2 3-4ha: 0 4-5ha: 1 5ha+: 1
Movement Network	• Kalamunda Road • Abernethy Road • Stirling Crescent
Infrastructure and Utilities	• Water • Electricity – Aboveground • Gas (along Stirling Crescent) • Sewer (eastern side of Stirling Crescent)

Strategy:

- **Capitalise on the close proximity to the airport, freight marshalling yards and highways; and**
- **Ensure there are logical transition zones between residential and industrial uses.**

6.8 RESIDENTIAL AND INDUSTRIAL INTERFACE

Residential and Industrial interface is addressed through the requirements of SPP 4.1. The intention of SPP 4.1 is to prevent land use conflict between industrial areas and sensitive land uses such as residential areas. SPP 4.1 requires statutory buffers to be put in place where applicable. SPP 4.1 states that statutory buffers should take the form of a Special Control Area, or similar with related scheme provisions in the applicable local planning scheme. The size and extent of statutory buffers should be determined by potential off-site impacts and strategic planning considerations. The management of land use conflicts and preventing adverse impacts should ensure the co-location of industrial land uses in clusters or industrial areas. Sensitive land uses should not be considered in industrial areas. Strategic and General Industry zones should not have direct interface with sensitive zones. An interface of compatible land use zones should be identified in local planning schemes such as light industry, commercial zones, rural zones and public open space reserves.

The City will ensure that interface issues and land use conflicts are addressed by ensuring there are logical boundaries between residential and industrial uses and utilising transition zones (light industry, commercial, rural and public open space). An example where the City has considered a transition zone is in the Forrestfield/High Wycombe Industrial Area, where a composite zone has been proposed to be introduced. The residential component of the zone faces the future Forrestfield North development which will be urban and the industrial component faces the industrial area. The composite zone will provide an appropriate transition from residential to industrial.

Strategy:

- **Ensure there are logical transition zones between residential and industrial uses.**

7.0 OBSERVATIONS

There is limited opportunity for further development of large industrial areas within the City's boundaries. Future industrial development within the City will occur in the already identified locations of Forrestfield/High Wycombe Industrial Area, MKSEA Wattle Grove and Hatch Court. With Forrestfield North and Maida Vale South both identified for urban development there are few rural areas left in the foothills that could be rezoned to accommodate industrial development. Wattle Grove South has also been identified for urban development under the North-East Sub-Regional Framework, however it is potentially the last remaining area that could be identified for industrial development for the City. The area should be investigated for the potential development of industrial within the area, given its location with close proximity to key industrial links, Tonkin Highway and Welshpool Road East. In this regard, it is possible for Light Industrial to be classified over the Urban zone under the MRS, as has occurred in the Forrestfield / High Wycombe Stage 1 and the Hatch Court / Stirling Crescent industrial areas. The sub-regional framework does not identify any other areas within the City that haven't already been identified as part of this Strategy for industrial development, further limiting industrial expansion opportunities.

The focus of the Strategy should be ensuring that future industrial development is supported in the existing and future industrial areas. Supporting the local workforce by increasing the local population in close proximity to industrial areas should be supported. Attracting high quality businesses should be supported through effective planning measures such as reasonable developer contribution schemes, promoting quality design through design guidelines and quality landscaping, and ensuring transport links are provided to a high standard.

There is also a need for more up-to-date research at a regional scale on industrial demand for the region, with previous research undertaken as part of EELS, ILNS and KHIM possibly outdated and in need of review.

8.0 STRATEGIES AND ACTIONS

Short Term: 1-3 years

Medium Term: 4-8 years

Long Term: 9 years +

OBJECTIVES		
STRATEGIES	**ACTIONS**	**PRIORITY/RESPONSIBILITY**
ATTRACT HIGH QUALITY BUSINESSES THAT CAN WITHSTAND CHANGING MARKET CONDITIONS		
1.1 Provide modern and flexible development guidance.	1.1.1 Develop a Local Planning Policy for all industrial areas to guide design and address modern industrial development standards.	Short Term / City of Kalamunda
	1.1.2 Normalise Forrestfield Industrial Area Structure Plan into Local Planning Scheme No. 4	Short Term / City of Kalamunda
PROVIDE INCENTIVES TO DEVELOP AND INVEST IN EXISTING AND FUTURE INDUSTRIAL AREAS		
2.1 Maintain a high standard of landscaping and road maintenance.	2.1.1 Investigate options for inclusion in the City's future Capital Works Programs or other funding mechanisms.	Short Term / City of Kalamunda
2.2 Investigate public realm improvements in industrial areas to improve the industrial-residential interface.	2.2.1 Investigate options for inclusion in the City's future Capital Works Programs or other funding mechanisms.	
2.3 Keep development contributions relevant and consistent with the principles underlying development contributions in Western Australia.	2.3.1 Continue conducting annual reviews of all development contribution plans and maintain transparency and accountability in all workings.	Ongoing / City of Kalamunda
2.4 To protect the Forrestfield Marshalling Yards from encroaching urban development and mitigating any noise and vibration issues.	2.4.1 Ensure that any urban development within close proximity of the freight rail track are assessed in accordance with relevant State Planning Policy.	Ongoing / City of Kalamunda
GUIDE DEVELOPMENT TO ADDRESS A REGIONAL NEED		
3.1 Attract large industrial	3.1.1 Project specific brief to	Medium Term / City of

operators by protecting key land parcels from subdivision.	identify industrial land in appropriate locations that are suitable for increased lot sizes, and facilitate the protection of larger lots and minimum lot size requirements.	Kalamunda
3.2 Capitalise on the close proximity to the airport, freight marshalling yards and highways.	3.2.1 Zone land that permits freight and logistics based industries to locate near key services.	Medium Term / City of Kalamunda
3.3 Investigate sites for potential industrial development.	3.3.1 Undertake feasibility study on appropriate land uses within Wattle Grove South site.	Short Term / City of Kalamunda / Department of Planning, Lands and Heritage
	3.3.2 Consider alternative employment generating land uses associated with industry for contaminated sites.	Long Term / City of Kalamunda / Department of Water and Environmental Regulation
3.4 Ensure there are logical transition arrangements and interfaces between sensitive and industrial land uses.	3.4.1 Industrial areas and sensitive land uses in close proximity to industrial areas assessed and determined in accordance with State Planning Policy 4.1 Industrial Interface.	Ongoing / City of Kalamunda
3.5 Identify industrial regional demand.	3.5.1 Investigate and review the regional demand for industrial land.	Short Term / City of Kalamunda
IMPROVE LOCAL EMPLOYMENT OPPORTUNITIES IN INDUSTRIAL AREAS		
4.1 Provide opportunities for small and medium sized businesses to benefit from, and co-locate with, larger industries.	4.1.1 Prepare a project specific brief to identify industrial land in appropriate locations to allow smaller lot subdivision and a broader range of land uses compatible with industrial uses.	Medium Term / City of Kalamunda
4.2 Increase population of local workforce.	4.2.1 Rezone Forrestfield North and Maida Vale South to allow for higher density residential.	Short Term / City of Kalamunda

9.0 REVIEW

The Strategy will be required to be reviewed periodically as needed and at least every 5 years as a minimum. It is recommended that the base assessment methodology remains

unchanged during periodic review to retain the integrity of the existing Strategy. The City shall support the continual improvement to industrial policy (both State and local), strategic partnerships, and operational activities and procedures. In doing so, this will enable the City to deliver efficient and effective industrial outcomes.

10.0 IMPLEMENTATION

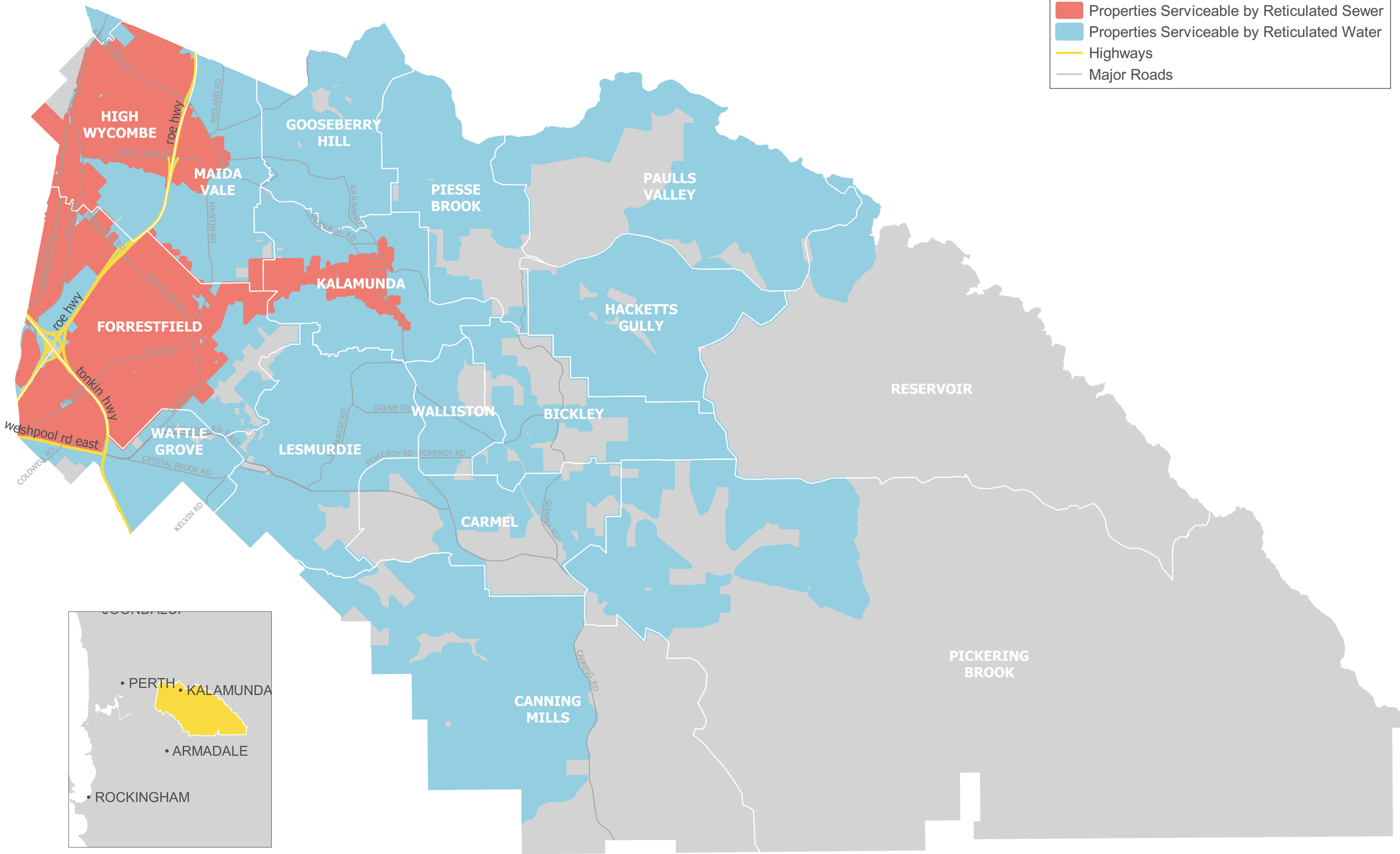
This Strategy is a long-term plan which outlines the future recommendations for industrial areas within the City. Within the implementation phase of the Strategy, the City will prioritise the Strategy's recommendations based on available resources, funding and Council priorities.

APPENDIX 1: POPULATION DEMOGRAPHICS

	Forecast 2018 pop.	Forecast 2036 pop.	Change 2018-36	Change 2018-36 Percentage	Land Area (ha)	Forecast Population Density 2018 (persons per hectare)	Forecast Population Density 2036 (persons per hectare)
City of Kalamunda	60,739	76,179	+15,440	25.42%	32,436	1.87	2.35
Hills	23,009	25,274	+2,265	9.84%	27,950	0.82	0.90
Kalamunda	7,517	8,969	+1452	19.31%	1,064	7.06	8.43
Lesmurdie	8,605	8,694	+89	1.03%	1,365	6.30	6.37
Gooseberry Hill	3,467	3,620	+153	4.41%	895	3.87	4.04
Rural East-Walliston	3,420	3,991	+571	16.69%	24,626	0.14	0.16
Foothills	37,730	50,905	+13,175	34.92%	4,485	8.41	11.35
Wattle Grove	6,586	7,229	+643	9.77%	867	7.60	8.34
Forrestfield	13,614	17,079	+3465	25.45%	1702 (+30ha in Forrestfield North)	7.99	10.03
Forrestfield North DSP	310	6,613	+6,303	2033.86%	264	1.17	25.05
High Wycombe	12,563	13,936	+1,373	10.92%	811 (+234ha in Forrestfield North)	15.49	17.18
Maida Vale	4,657	6,048	+1,391	29.88%	841	5.54	7.19

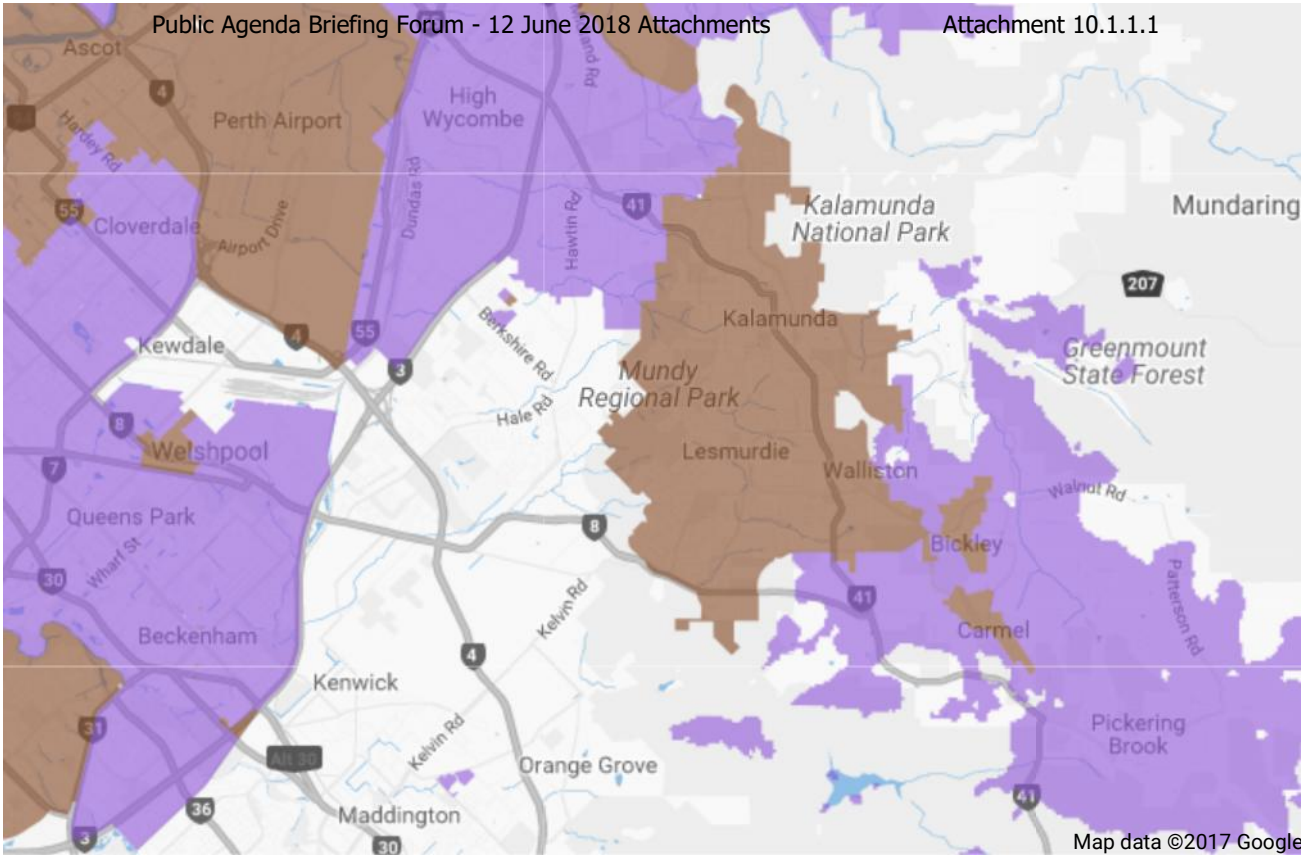
APPENDIX 2: INFRASTRUCTURE SERVICING

Local Infrastructure Servicing Strategy



City of Kalamunda

APPENDIX 3: NBN ROLLOUT



Service available

Other fibre provider

Build commenced

APPENDIX 4: INDUSTRIAL AREAS BREAKDOWN

Forrestfield	Existing Industrial Zoned Land (ha)	Future Industrial Zoned Land (ha)	Existing Industrial to be Rezoned to Urban (ha)
Light Industry	11.8		
Industrial Development	42.9		
General Industry	147.56		
Special Use	1.78		
Railways	8.26		
Total Overall Existing + Future	212.3 212.3	0	0
Industrial Investigation Area (ha)	0		

Wattle Grove	Existing Industrial Zoned Land (ha)	Future Industrial Zoned Land (ha)	Existing Industrial to be Rezoned to Urban (ha)
Light Industry	10.08		
Industrial Development	4.26		
General Industry	8.39	36.37	
Special Use			
Railways			
Total Overall Future + Existing	22.73 59.1	36.37	0
Industrial Investigation Area (ha)	50		

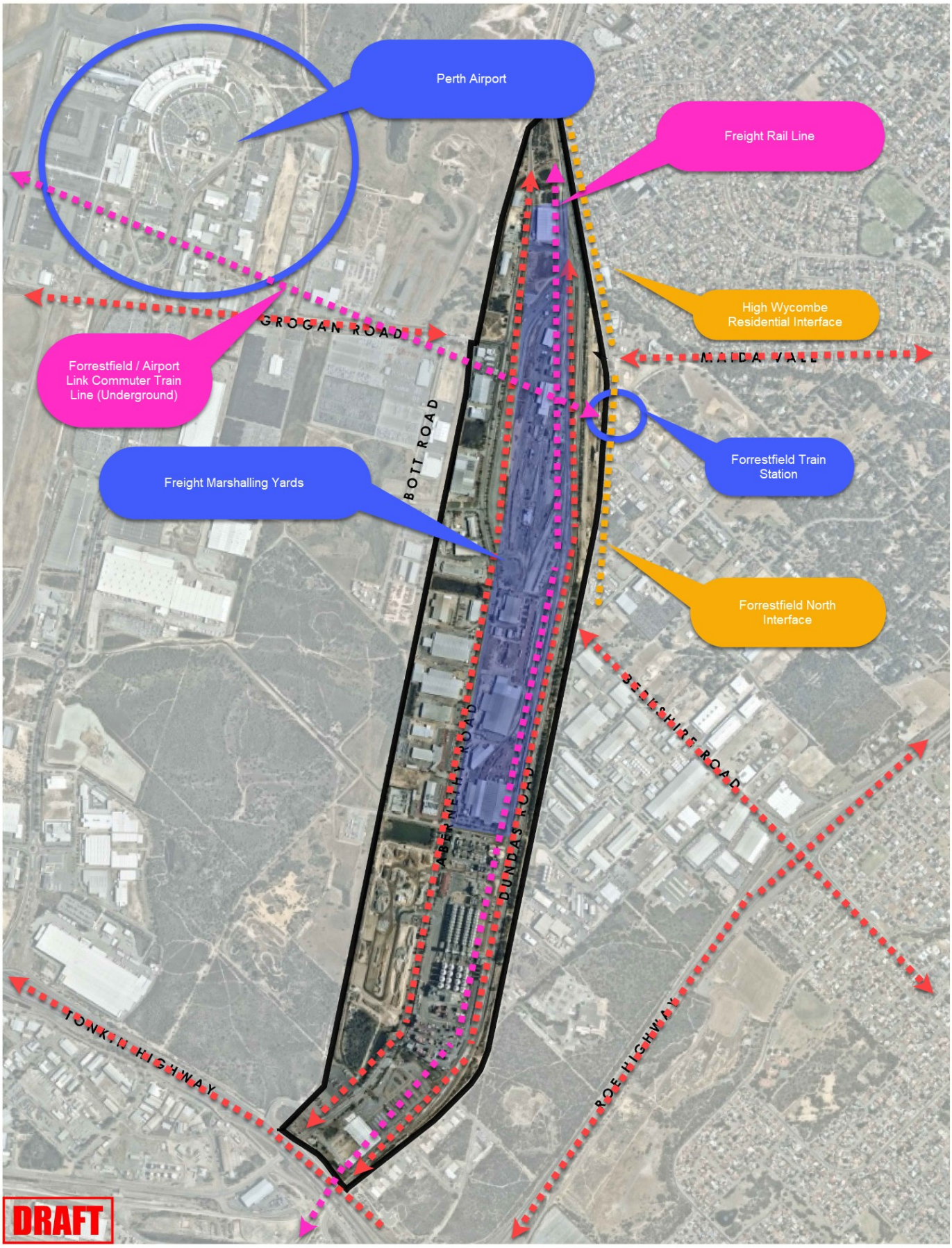
High Wycombe	Existing Industrial Zoned Land (ha)	Future Industrial Zoned Land (ha)	Existing Industrial to be Rezoned to Urban (ha)
Light Industry	14.74		4.18
Industrial Development	35.08		
General Industry	15.2		
Special Use	6.17		2.4
Railways	8.26		
Total Overall Future + Existing	79.45 72.87	0	6.58

Industrial Investigation Area (ha)	0		

Walliston	**Existing Industrial Zoned Land (ha)**	**Future Industrial Zoned Land (ha)**	**Existing Industrial to be Rezoned to Urban (ha)**
Light Industry			
Industrial Development			
General Industry	11.71		
Special Use			
Railways			
Total Overall Future + Existing	11.71 11.71	0	0
Industrial Investigation Area (ha)	0		

Kewdale	**Existing Industrial Zoned Land (ha)**	**Future Industrial Zoned Land (ha)**	**Existing Industrial to be Rezoned to Urban (ha)**
Light Industry			
Industrial Development			
General Industry	25		
Special Use			
Railways			
Total Overall Future + Existing	25 25	0	0
Industrial Investigation Area (ha)	0		

APPENDIX 5: SITE PLANS



FORRESTFIELD MARSHALLING YARDS - OPPORTUNITIES & ISSUES ANALYSIS

City of Kalamunda Industrial Strategy

A City of Kalamunda Project

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d: 21 Feb 2018
p: 17/103/005

Taylor Burrell Barnett Town Planning and Design
Level 7, 160 St Georges Terrace, Perth WA 6000
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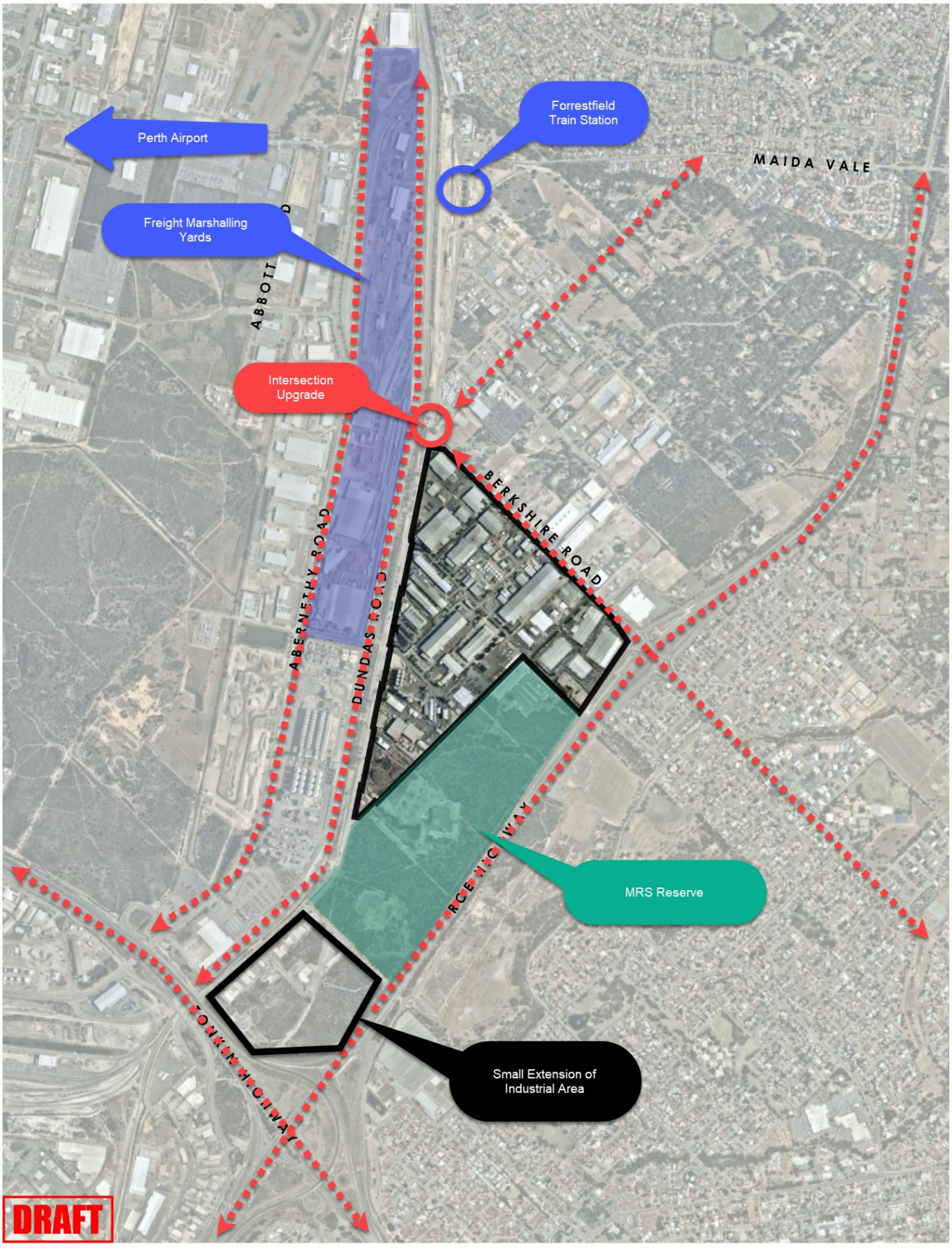

FORRESTFIELD INDUSTRIAL AREA - OPPORTUNITIES & ISSUES ANALYSIS
City of Kalamunda Industrial Strategy
A City of Kalamunda Project

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d: 21 Feb 2018
p: 17/103/005

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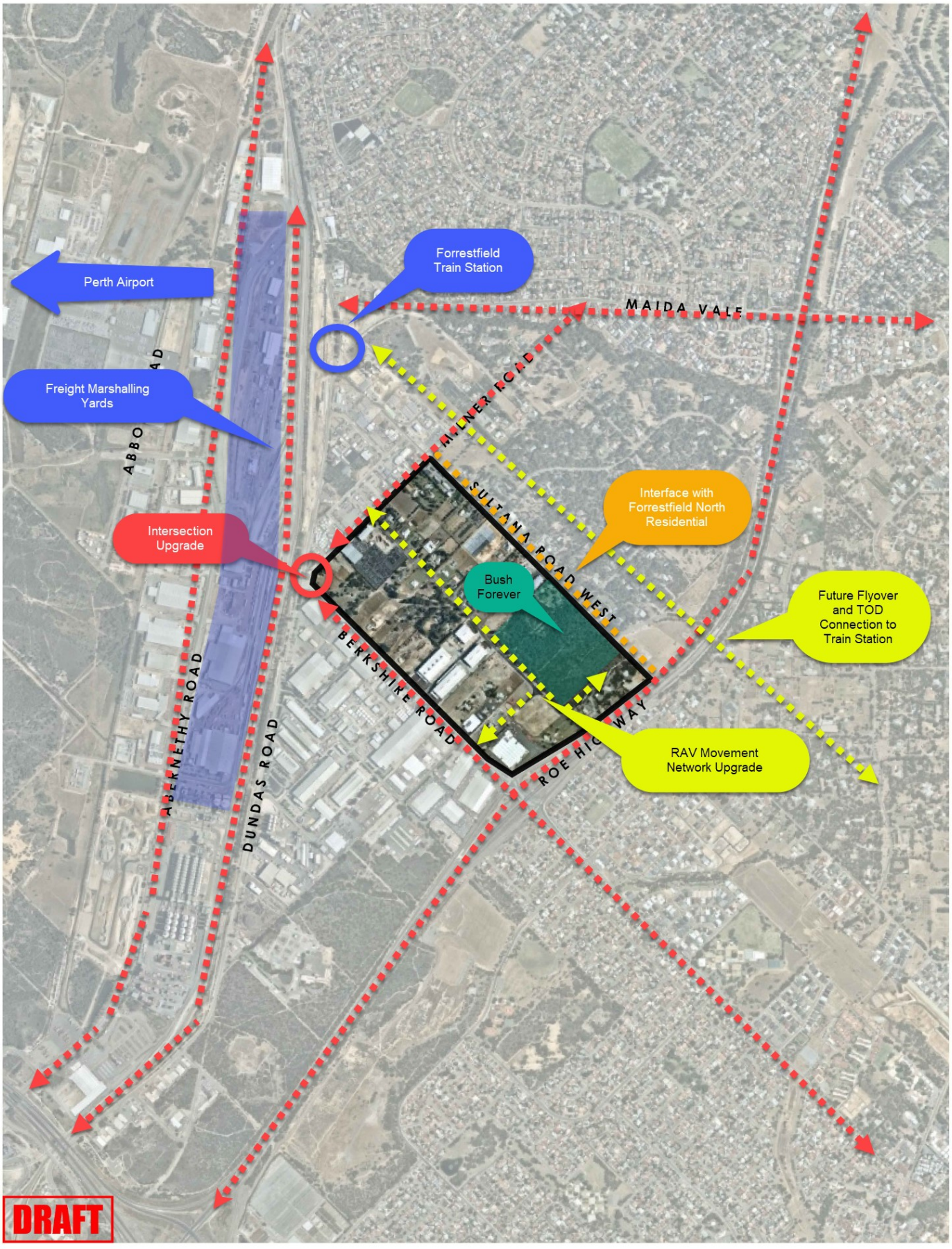

FORRESTFIELD HIGH WYCOMBE (STAGE 1) - OPPORTUNITIES & ISSUES ANALYSIS

City of Kalamunda Industrial Strategy

A City of Kalamunda Project

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p: 17/103/005

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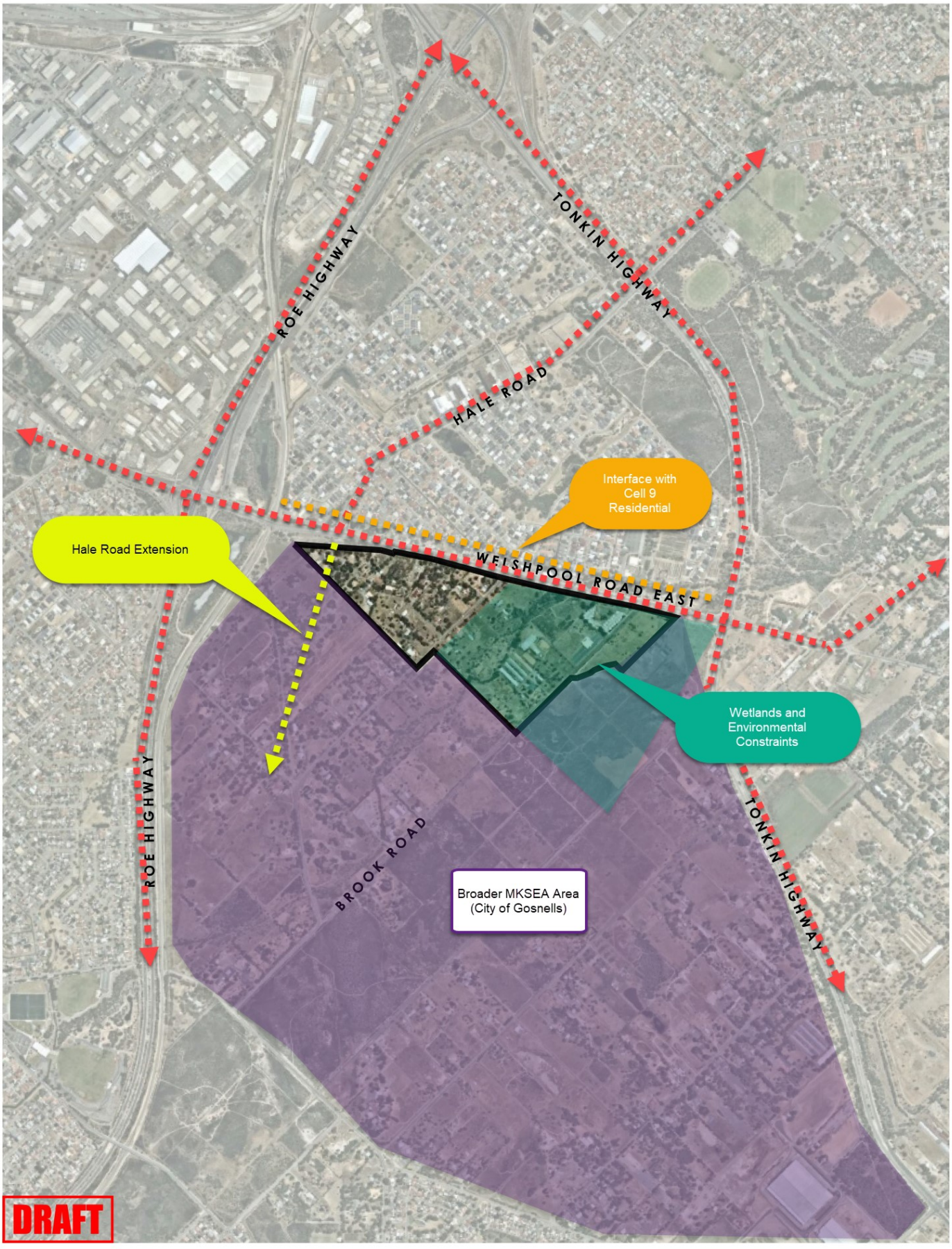

MKSEA - OPPORTUNITIES & ISSUES ANALYSIS
City of Kalamunda Industrial Strategy
A City of Kalamunda Project

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p: 17/103/005A

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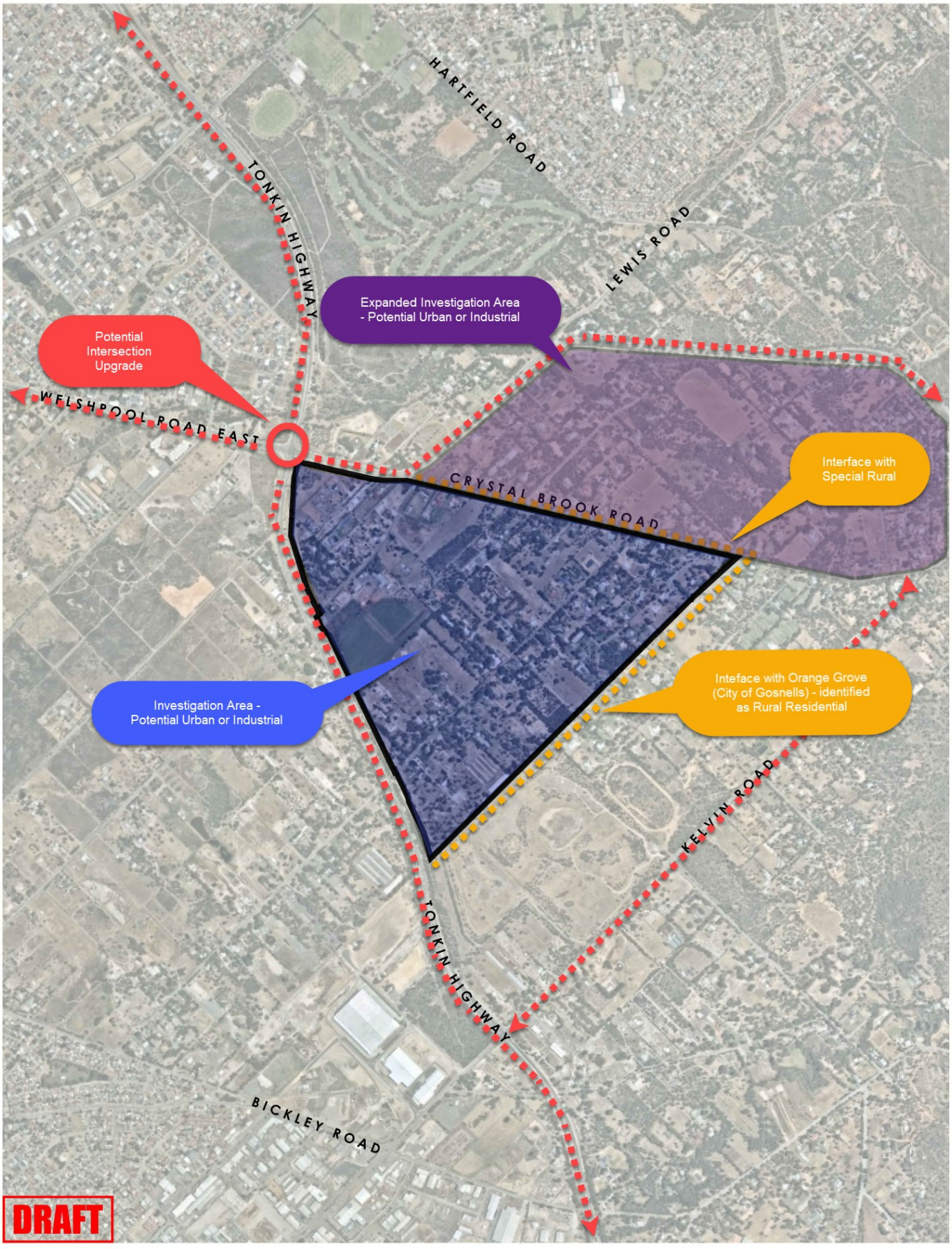

WATTLE GROVE SOUTH - OPPORTUNITIES & ISSUES ANALYSIS

City of Kalamunda Industrial Strategy

A City of Kalamunda Project

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d: 21 Feb 2018
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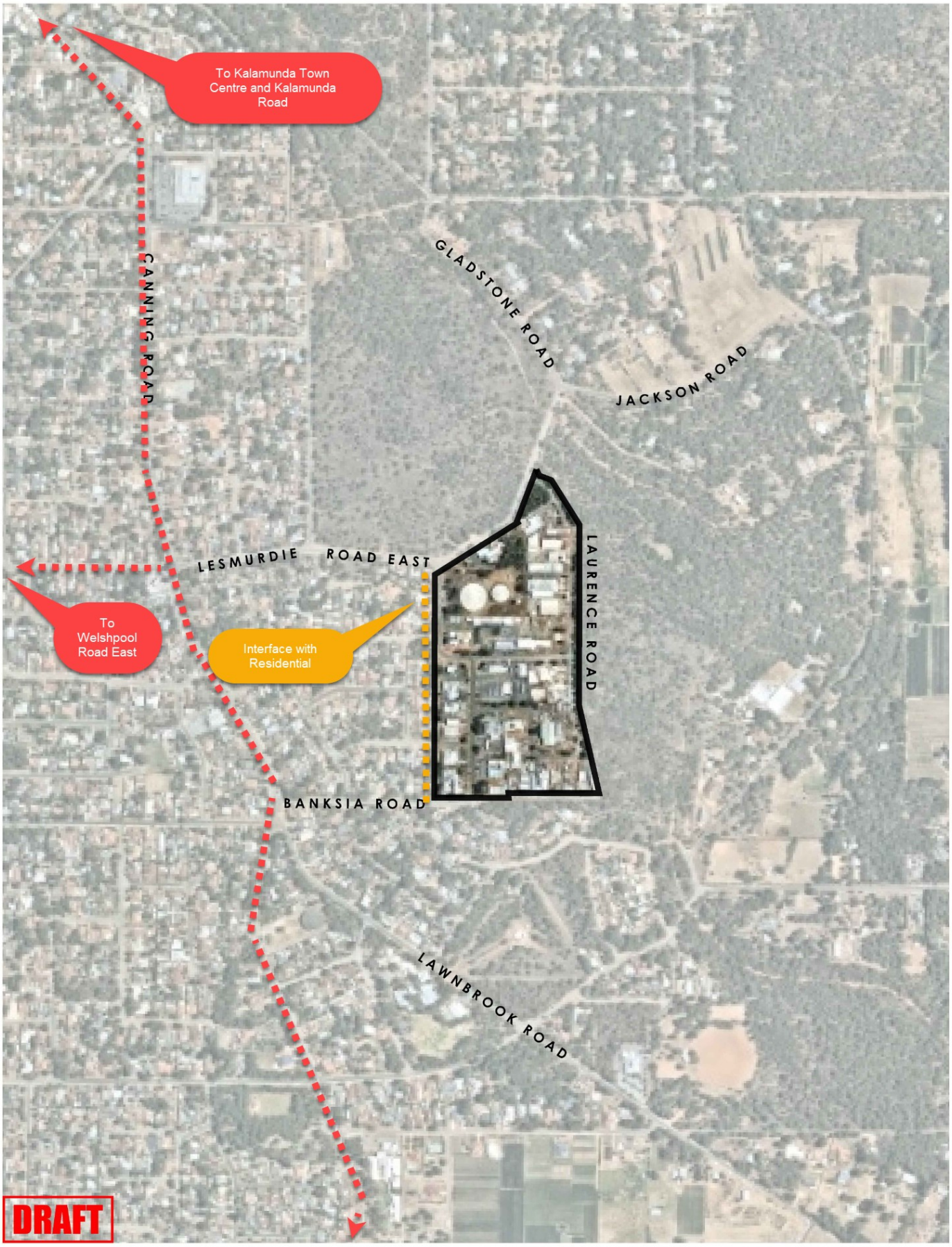

WALLISTON INDUSTRIAL AREA - OPPORTUNITIES & ISSUES ANALYSIS

City of Kalamunda Industrial Strategy

A City of Kalamunda Project

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d: 21 Feb 2018
p: 17/103/005

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HATCH COURT - OPPORTUNITIES & ISSUES ANALYSIS

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d: 21 Feb 2018
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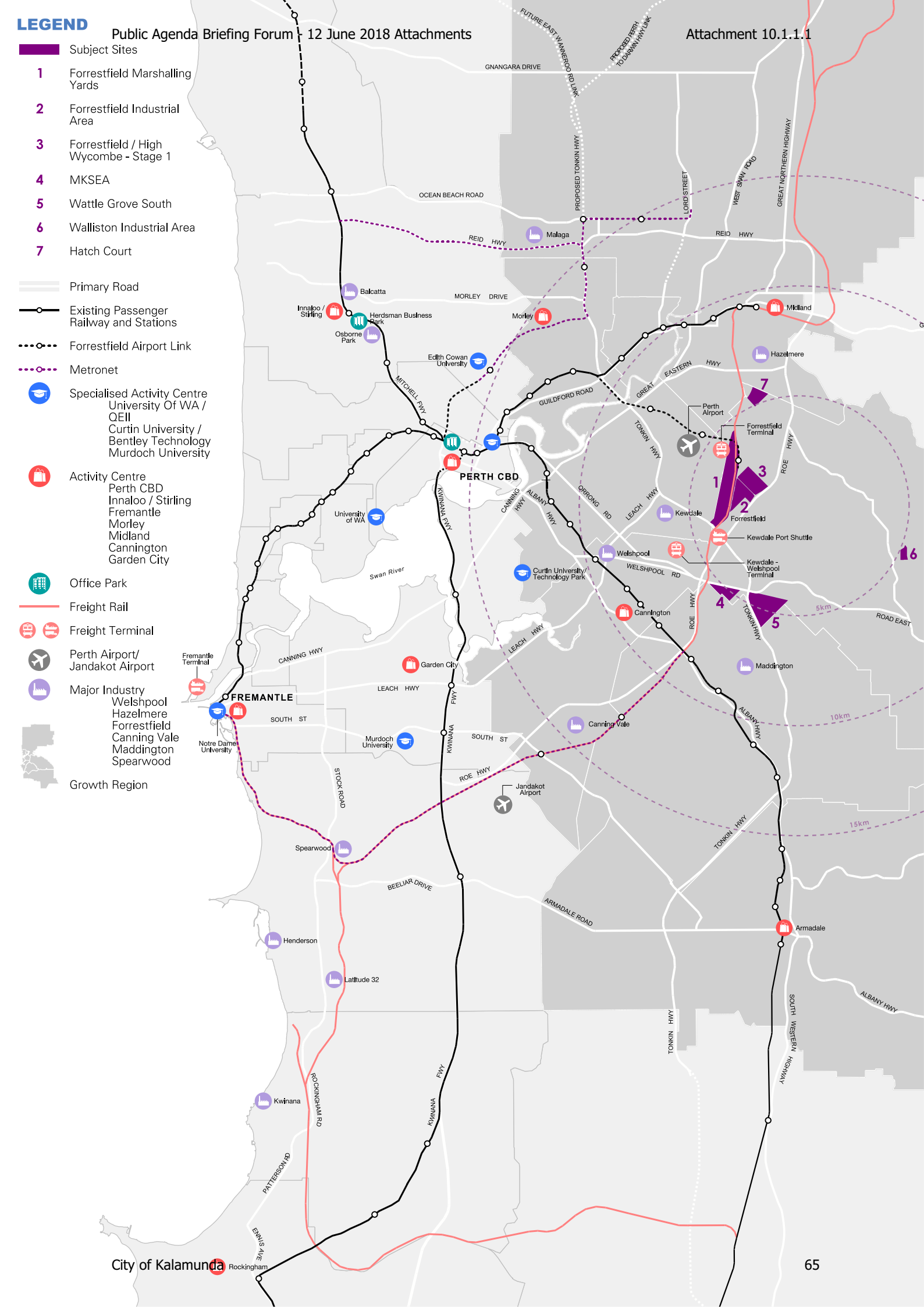
APPENDIX 6: METROPOLITAN CONTEXT PLAN


LEGEND
Subject Sites
1 Forrestfield Marshalling Yards
2 Forrestfield Industrial Area
3 Forrestfield / High Wycombe - Stage 1
4 MKSEA
5 Wattle Grove South
6 Walliston Industrial Area
7 Hatch Court
Primary Road
Existing Passenger Railway and Stations
Forrestfield Airport Link
Metronet
Specialised Activity Centre
University Of WA / QEII
Curtin University / Bentley Technology
Murdoch University
Activity Centre
Perth CBD
Innaloo / Stirling
Fremantle
Morley
Midland
Cannington
Garden City
Office Park
Freight Rail
Freight Terminal
Perth Airport/ Jandakot Airport
Major Industry
Welshpool
Hazelmere
Forrestfield
Canning Vale
Maddington
Spearwood
Growth Region
PERTH CBD
FREMANTLE
Malaga
Balcatta
Innaloo / Stirling
Herdsman Business Park
Osborne Park
Morley
Midland
Hazelmere
Edith Cowan University
University of WA
Curtin University/ Technology Park
Perth Airport
Forrestfield Terminal
Kewdale
Forrestfield
Kewdale Port Shuttle
Kewdale - Welshpool Terminal
Welshpool
Cannington
Fremantle Terminal
Notre Dame University
Murdoch University
Garden City
Maddington
Canning Vale
Jandakot Airport
Spearwood
Henderson
Latitude 32
Kwinana
Armadale
Swan River
GNANGARA DRIVE
FUTURE EAST WANNEROO RD LINK
PROPOSED PERTH TO DARWIN HWY LINK
PROPOSED TONKIN HWY
LORD STREET
WEST SWAN ROAD
GREAT NORTHERN HIGHWAY
OCEAN BEACH ROAD
REID HWY
MORLEY DRIVE
MITCHELL FWY
GUILDFORD ROAD
GREAT EASTERN HWY
TONKIN HWY
ROE HWY
KWINANA FWY
CANNING HWY
ALBANY HWY
QRRONG RD
LEACH HWY
WELSHPOOL RD
SOUTH ST
STOCK ROAD
BEELIAR DRIVE
ARMADALE ROAD
ROCKINGHAM RD
PATTERSON RD
ENNIS AVE
SOUTH WESTERN HIGHWAY
5km
10km
15km

APPENDIX 7: REFERENCES

Australian Bureau of Statistics (2016) ABS Census 2016 (Employment, Industry Sector by Place of Work and Place of Usual Residence), Retrieved from: http://www.abs.gov.au/

Forecast. id (2017) Population Forecast, City of Kalamunda, Retrieved from: http://forecast.id.com.au/kalamunda

Profile. id (2017) Community Profile, City of Kalamunda, Retrieved from: https://profile.id.com.au/kalamunda

Adopted		Next Review Date	

P-DEV 57 - Street Fencing, Walls and Gates

Management Procedure	Relevant Delegation

Purpose

1. Background and Introduction

1.1 Street fences and walls significantly contribute to the streetscape and amenity of an area and can influence pedestrian and motor vehicle safety and street surveillance.

1.2 On 27 June 2016, the City adopted *Fencing Local Law 2016*, which was published in the Government Gazette on 2 September 2016. The City's *Fencing Local Law 2016* sets provisions for '*sufficient*' dividing fences (as defined in the local law), for fencing throughout the City in residential, rural, commercial and industrial zones.

1.3 This Policy is prepared in accordance with Clause 3, Schedule 2 of the *Planning and Development Regulations 2015* (WA) and Part 7.3.1(a) of State Planning Policy 3.1 – Residential Design Codes (R-Codes).

1.4 The Policy:

clarifies when and how the City will consider a fence or wall variation within the front boundary set back of a property, or along the boundary between private and public property;

provides a table of recommended materials for fences and walls in these areas; and

clarifies assessment criteria for unauthorised fences, walls and gates.

2. Application of Policy

2.1 This Policy applies to all development proposing a fence, wall or gate throughout the City of Kalamunda.

DRAFT

3. Statutory Authority / Legal Status

3.1 This Policy has been prepared in accordance with *Planning and Development (Local Planning Scheme) Regulations 2015* (WA) (Regulations) and Part 7.3.2 of the R-Codes to supplement the R-Codes deemed-to-comply provisions, clause 5.2.4 and clause 6.2.2.

a) Relationship to LPS No. 3

i) This policy is a planning policy prepared, advertised and adopted pursuant to Part 2 of Local Planning Scheme No.3. The policy augments and is to be read in conjunction with the provisions of Local Planning Scheme No.3 relating to development.

ii) If there is a conflict between this local planning policy and the Scheme, then the Scheme shall prevail.

b) Relationship to Fencing Local Law 2016

If there is a conflict between the policy and the *Fencing Local Law 2016*, then the Policy shall prevail.

c) Relationship to other state planning/ development control policies and guidelines

i) This Policy has due regard to, and should be read in conjunction with, State planning policies and guidelines.

ii) Of particular relevance to this policy are:

A. State Planning Policy 1 – State Planning Framework.
B. State Planning Policy 3.1 – Residential Design Codes.
C. State Planning Policy - Liveable Neighbourhoods.
D. State Planning Guidelines - Designing out Crime.

iii) This Policy:

A. has due regard to, and should be read in conjunction with, the City of Kalamunda's other local planning policies;

B. has been prepared in accordance with Part 7.3.2 of the R-Codes and amends the deemed-to-comply provisions of '*Street Walls and Fences*' clause 5.2.4 and clause 6.2.2 including height limits; and

C. provides supplementary information regarding performance objectives for fencing above retaining, and performance objectives for clause 5.3.8 'Retaining Walls'.

d) Relationship to *Dividing Fences Act 1961* (WA) (*Dividing Fences Act*)

(i) Currently dividing fences are administered under the *Dividing Fences Act.*

(ii) If there is a conflict between this Policy and the *Dividing Fences Act*, then the Act shall prevail.

4. Policy objectives

4.1 To provide clarity and design guidance through a detailed framework to supplement the provisions of Clauses 5.2.4 and Clause 6.2.2 of the R-Codes.

4.2 Provide development standards for all street fence, wall and gate development within the City of Kalamunda.

Policy Statement

This Policy applies to all fences, walls and gates within the front setback area and on the boundary between public and private land.

All other dividing fences are to be in accordance with the *Dividing Fences Act* and the *Fencing Local Law 2016* (the Local Law).

Where a development for a fence, wall or gate is fully compliant with this Policy, development approval will not be required. A building permit may however be required.

A development application is required for unauthorised developments for fences and walls.

5. Residential Zoned Land

5.1 In addition to the requirements under Clause 5.2.4 and Clause 6.2.2 of the R-Codes, the provisions of this Policy should be applied when assessing applications for street fencing, walls and gates:

5.2 If a street fence complies with Table 1 and Table 2, a planning application is not required.

5.3 A building licence will still be required to be submitted and approved by the City.

5.4 Street fence materials must comply with Table 2- Acceptable Fencing Materials within the Front Setback as outlined in this policy.

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Table 1 – Heights of Sufficient Fences and Screening

The following heights criteria are applied in Residential zoned areas.

Fencing Wall and Gate Type	Acceptable Criteria
Front fence, wall or Gate. Site with an R Coding of R2 to R10	Subject to the same provisions as Rural fencing (see Part 8).
Front fence, wall or Gate. Site with an R Coding of R12.5 to R40	Solid portion permitted up to **1.2m**, and visually permeable (see Table 1.1) to a maximum height of **1.8m** within the front setback area or side otherwise identified as the primary access (refer Attachment 3 – Examples of Front Fencing) A street fence or wall may be varied to a solid height of 1.8m where the property faces any of the roads listed in Appendix 1 and the dwelling is subject to headlight glare or excess noise from traffic calming devices such as a chicane. This applies to all fences and walls within the front setback and on the boundary between public and private land. All other dividing fences are to be in accordance with the *Dividing Fences Act*.
Front fence, wall or Gate. Site with an R Coding of R40 to R80	Visually permeable to max height of **1.2m** as per part 6.2.2 of the R-Codes.
Dividing Fence (separating two privately owned properties)	As per the Dividing Fences Act 1961 and the Fencing Local Law. Dividing fence heights that exceed **1.8m** require a development application and approval by the City. **For materials refer to Schedule 1-3 of the Local Law.**
Hedging	Hedges are encouraged as an alternative to a fence or wall and should be maintained to a height of 1.2m to provide adequate street surveillance
Uniform fence (boundary of private property adjoining a public domain)	Solid portion permitted to **1.8m**.
Boundary fence (street or Public Open Space POS)	Solid portion to **1.2m** in height within the front setback and 50% visually permeable to a maximum height of 1.8m. Solid portion permitted to 1.8m behind the front setback line (refer Appendix 2 – Indicative Diagram of Fencing).

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Gates	All gates are to be visually permeable above 1.2m (see Definitions) and open inwards or sideways so as not to obstruct the road or footpath. Gates are to comply with total fence or wall heights as outlined in Table 1 unless otherwise approved by the City.
Sightlines	To maintain sightlines fences and walls shall be a maximum height of 0.75m within 1.5m of where a driveway meets a public street and where two streets intersect, and/or truncated at the conflict point (Part 5.2.5 and 6.2.3 R-Codes).

Table 2 – Acceptable Fencing Materials within the Front Setback

*Front fencing and walls in Residential zoned land, with the exception of **R2 - R10 residential zoned land, shall be in accordance with the materials as prescribed in Table 2.

Fencing Material	**Acceptable Criteria**
Masonry Limestone, brick, stone, slate	Permitted
Metal Wrought iron, decorative steel or aluminium of an open style	Permitted
Timber slats maintaining permeability up to a minimum of 50% of the surface area.	Permitted
Powder coated steel or aluminium	Permitted behind the front setback.
Chain link wire mesh	Permitted behind the front setback.
Fibre cement sheeting Brush type style fencing Asbestos containing material Star pickets and wire Post and wire Barbed wire fencing	**Not** permitted. **Not** permitted. **Not** permitted. **Not** permitted. **Not** permitted. **Not** permitted in residential zones.

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***Refer Appendix 3 for examples of appropriate front fencing in Residential Zoned areas.**
****For acceptable street fencing material, refer to Part 7 – R2-R10 and Rural zoned land.**

6. Retaining Walls and Fill

6.1 Where retaining walls or fill are proposed above 500mm above natural ground level within the front setback area, any fencing should be of an 'open style' and visually permeable.

6.2 A visually permeable fence may be permitted above the height of the retaining wall where it meets the following criteria:

a) Design for front fence retaining walls:

i) Retaining should be designed to be as close to natural ground level as practicable (refer Figure 2).
ii) The amount of fill brought onto the site should be minimised and must be 'clean' fill.
iii) Where retaining walls are greater than 500mm in height the fencing portion above the retaining wall shall be a minimum 50% visually permeable (as defined by the R-Codes) and be, up to a maximum total height of 1.5m above the height of the retaining wall portion (see Figure 1).
iv) Where, in the opinion of the assessing officer, the height of a retaining wall above 500mm with a 1.5m fence above may have an undesirable impact on the streetscape the design shall be modified to include terracing and vegetative screening where practicable (see Figure 2).
v) Street surveillance shall be maintained in accordance with the R-Codes regardless of permissible height requirements.
vi) Stormwater to be retained onsite.
vii) Where retaining walls exceed 500mm in height, landscaping shall be planted in front of the wall to minimise visual building bulk to the streetscape. Landscaping plans are to be submitted with all applications for retaining over 500mm and designed to maintain/maximise street surveillance with species of plants to be approved by the City.
viii) Where the retaining exceeds 500mm above natural ground level the City may require the applicant to mitigate the bulk by terracing the retaining and/or setting the wall back from the boundary to provide for permanent planter boxes facing the street (see Figure 2).

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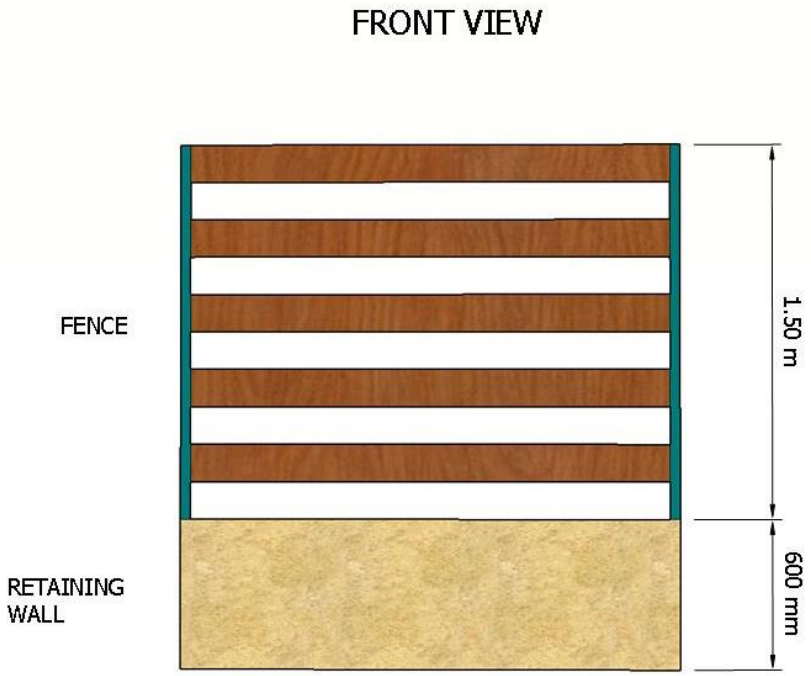

Figure 1. Elevation demonstrating 7.2(a)(iii) fence above retaining over 500mm. Fences above retaining should be a maximum of 1.5m in height and 50% visually permeable.

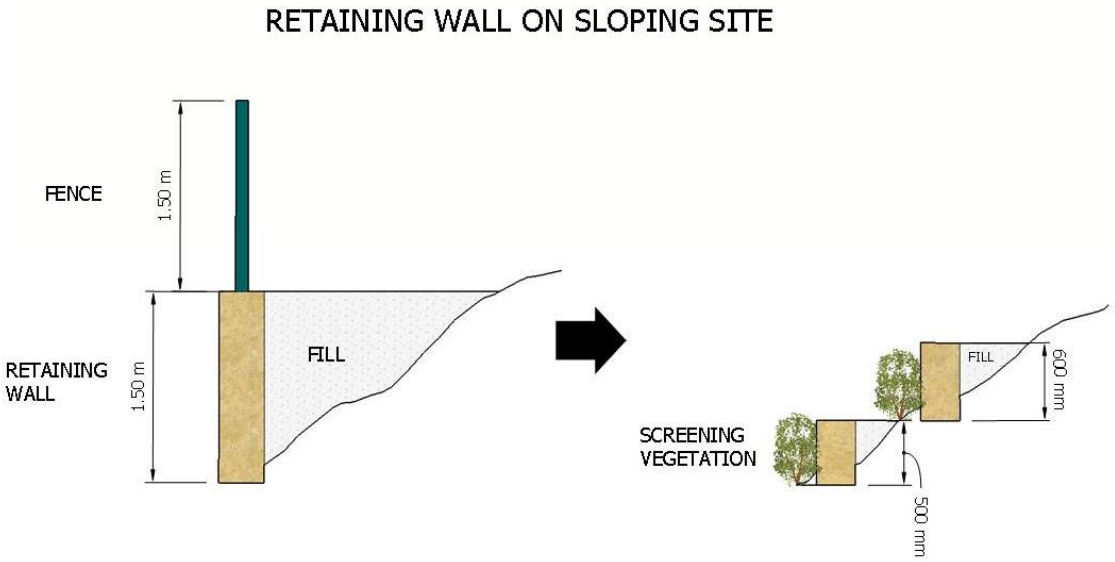

Figure 2. Design objective for retaining walls on a sloping site. High retaining with a fence above should be avoided. Design features such as terracing and landscaping planted in front of retaining walls minimises the visual impact on the streetscape.

7. R2 to R10 and Rural Zoned Land

7.1 Front fences, walls and gates should maintain high visual permeability to retain the rural aesthetic and character of an open streetscape (Refer to Appendix 3 for examples of appropriate fencing).

7.2 Front fencing and walls in rural zones may be solid to a maximum height of 1.2m and visually permeable to 1.8m.

7.3 Street fencing to comply with Schedule 3 of the Fencing Local Law.

7.4 Applications for variation may be applied where necessary for the containment of livestock/large animals and other agricultural uses, provided street surveillance is maintained, and adequate sightlines are provided at intersections and at crossovers.

8. Commercial, District Centre, Activity Centre, Service Station, Private Club and Institutions, and Mixed Use Zoned Land

8.1 The standard of fencing, walls and gates for commercial and institutional developments will be assessed on its own merits (refer Appendix 3 for examples of appropriate front fencing).

8.2 Generally, the standard of street fencing and walls will be assessed against the same criteria as Residential zoned land and taking into consideration the existing streetscape, sightlines, crime prevention through environmental design as well as minimising opportunities for blank walls and graffiti opportunity.

8.3 A fence or wall or gate shall not be approved if it is deemed to have a negative impact on visual amenity, safety, street surveillance, or anti-social behaviour in the area.

8.4 Fencing, gates and walls in non-residential areas will be assessed in accordance with Schedule 2 of the Local Law.

8.5 Where this Policy conflicts with a Structure Plan, Local Development Plan (LDP), or Design Guidelines for an industrial area, the adopted LDP/Design Guidelines shall prevail.

9. Front Fences and Walls in Industrial and Industrial Development Zoned Land

9.1 Fencing and gates shall be a maximum height of 2.1m and shall be visually permeable.

9.2 Solid front fences will not be permitted in an Industrial zoned area. Solid elements should be incorporated as pillars or posts (refer to Appendix 3 for examples of appropriate front fencing).

9.3 Fencing and gates shall be integrated (with complimentary colours, textures or materials) with the site planning and design of the building and details required to be submitted as a planning application.

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9.4 Sliding front gates are preferred. Where swinging gates are installed on boundary fencing they shall open inwards from the street.

9.5 Black is the preferred colour for metal tubing rail fences (including garrison fencing).

9.6 No chain link mesh fencing is permitted forward of the front setback line.

9.7 Where fencing or walls are proposed behind the front setback line, the minimum standard is black PVC galvanised link mesh fencing or palisade and welded mesh fencing.

9.8 Electrified fencing and barbed wire on top will only be permitted on a case by case basis at the discretion of the City.

9.9 For all dividing fences and walls behind the front setback see Schedule 2 of the Local Law.

9.10 Where this policy conflicts with a Structure Plan, Local Development Plan (LDP), or Design Guidelines for an industrial area the adopted LDP/Design Guidelines shall prevail.

10. Unauthorised Fence, Wall and Gate Applications

10.1 Where an unauthorised fence, wall or gate is deemed dangerous or a hazard the owner will be given notice to remove it immediately in accordance with Part 8.4.2 'Unauthorised Existing Developments' of the Local Planning Scheme.

10.2 The height and visual permeability may be required to be modified to be compliant without total demolition of the fence. Applications for non-compliant unauthorised fencing shall be remedied by the owner to be compliant with this policy. Where variation to the policy is sought justification for the variation must be provided and other materials or methods may be used to 'soften' the impact of the fence or wall. This may include the following measures;

a) Converting portions of fence above 1.2m to visually permeable material.

b) Adding colours or texture to 'break-up' the bulk, and/or

c) Adding vegetative screening. Species and size of planting to be approved by the City.

10.3 An unauthorised street fence, wall or gate can be approved where the justification is deemed reasonable, and the owner has proposed sufficient modifications in accordance with Part 11.2, and the proposal will not set an undesirable precedence for the area with consideration to Part 13 'Matters to be considered' of this policy.

10.4 An unauthorised street fence, wall or gate can be approved where the justification is deemed reasonable, and the owner has proposed sufficient modifications in accordance with Part 11.2, and the proposal will not set an undesirable precedence for the area with consideration to Part 13 'Matters to be considered' of this policy.

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10.5 All unauthorised street fence, wall, and gate applications that do not take action when issued with a notice to apply for a development approval, is considered to have contravened the provisions of the Local Planning Scheme and may be subject to compliance action.

11. Maintenance and Appearance

11.1 The landowner(s) shall maintain fencing, walls, and gates to the street to a maintenance condition so as to prevent it from becoming dangerous, damaged, dilapidated, unsightly, or otherwise detrimental to the safety of the community or visual amenity of the streetscape or neighbouring properties. Where a complaint is received in writing and in the opinion of the City of Kalamunda 25% of the structure (or more) is in disrepair the owner will be required to upgrade or make good the condition of the structure to the satisfaction of the City.

11.2 All fences, walls and gates should be durable and resistant to weather conditions and vandalism (refer to Appendix 3 for examples of appropriate front fencing).

11.3 The colours and materials for all street fencing, walls or gates should blend with existing fencing along the same boundary so as retain a consistent visual impact on the streetscape or public open space.

12. Matters to be considered

13.1 The impact of the proposed street fence or wall on the amenity and character of areas, as viewed from a street, public space or neighbouring property;

12.1 The impact of retaining 'bulk' (unbroken blank walls) on neighbouring properties;

12.2 Whether the proposed development will still achieve a desired streetscape where a variation is applied;

12.3 Whether street surveillance is maintained for the safety of residents, cyclists, and motor vehicle sightlines;

12.4 Whether solar access and ventilation is maintained within the development and on adjoining properties;

12.5 Any special limitation on the development of the land by virtue of its size, shape or environmental/geographical feature;

12.6 Whether support for the development application will set an undesirable precedent for similar sized surrounding lots;

12.7 Comments received from affected adjacent property owners/occupiers;

12.8 Where wall height exceeds 500mm the applicant must demonstrate the excess height is justified and steps have been taken to minimise earthworks and fill, and that high quality landscaping can be planted to screen the development (see Figure 2); and

12.9 Stormwater shall be disposed of onsite to the satisfaction of the City.

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13. Variations to the Policy

13.1 Any variation to development requirements will require the applicant to provide additional justification demonstrating how the proposal will not adversely affect adjoining property owners, the streetscape or the amenity of the locality, with particular reference to 'Matters to be Considered' of this policy. The City may undertake consultation with adjoining affected property owners/occupiers during assessment.

13.2 The following variations for fencing height requirements in Residential areas may be considered:

a) Where protection is needed from headlight glare and the road is not a primary or district distributor road, there may be a case to justify a solid portion of wall to block headlight glare to a primary outdoor living area or window to a habitable room (Refer to Appendix 1 – List of Primary or District Distributor Roads within the City).

A 1.8m height wall is deemed acceptable in these situations where the property may be subject to effects from traffic calming devices such as a chicane, can be screened with vegetation, and/or where it will not set an undesirable precedent for the street, and only where the portion of the wall required to protect from headlight glare is built solid to 1.8m with the remaining portion of the fence being designed in accordance with the requirements of the R Codes and this policy (1.2m solid, visually permeable between 1.2m-1.8m with solid pillars permitted).

b) Where the contours of the ground or the difference in levels between one side of the fence and the other side warrant consideration of an irregular or higher fence.

c) Where the applicant can demonstrate to the City that there is a need to provide visual screening to an outdoor living area.

d) In the case that a proposed solid fence or wall application may be varied, the City may consider conditions providing alternative options for example; vegetative screening, as a buffer for potential noise or light pollution and/or to reduce the impact of a solid fence or wall, and/or incorporate design features as in clause 8b) of this policy. In those instances, the street fence or wall shall not exceed a total solid height of 1.8m.

e) Where a site boundary slopes the front fence can be 'stepped' to meet an average height of 1.8m or 1.2m to the satisfaction of the City.

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Definitions

Boundary fence

A "boundary fence" is a fence that is installed along a lot boundary adjoining a street or public open space or reserve.

Chicane

An artificial feature creating extra turns in a road to slow traffic.

Dividing fence

A "dividing Fence" is a fence that separates the lands of different owners whether the fence is on the common boundary of adjoining lands or on a line other than the common boundary;
It does not include a fence running along the boundary of a road and it does not include a retaining wall.

Front fence

A "front fence" is a fence within the front setback area of the primary street or side otherwise identified as the primary access. Gates will be considered an extension of the fence and subject to the same conditions. Street fence and wall height is measured from natural ground level from the primary street side of the fence as viewed from the street.

Gate

A hinged barrier used to close an opening in a wall, fence or hedge.

Uniform Fence

A "uniform fence" is fencing which runs along the boundary of a private property which adjoins the public domain (i.e. a Road Reserve, public open space etc.).

Sufficient Fence

A "sufficient fence" is fencing which is considered acceptable under Schedule 1, 2 and 3 of the City's Fencing Local Law.

Visually Permeable

A "visually permeable" fence is defined in the R-Codes and is summarised as follows:

R-Code definition of visually permeable
Continuous vertical or horizontal gaps of 50mm or greater width occupying no less than one third of the total surface area;
Continuous vertical or horizontal gaps less than 50mm, occupying at least one half of the total surface area in aggregate
A surface offering equal or lesser obstruction to view

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All gaps should be evenly distributed across the total length of the wall unless otherwise approved.

Wall

A "wall" is defined as a continuous vertical structure made from masonry that encloses or divides an area of land.

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Details

Appendix 1 – List of Primary or District Distributor Roads within the City

CANNING ROAD	Distributor A/Regional Distributor
HALE ROAD	Distributor A/Distributor B
KALAMUNDA ROAD	Distributor A
ROE HIGHWAY	Primary Distributor
TONKIN HIGHWAY	Primary Distributor
WELSHPOOL ROAD EAST	Primary Distributor/Distributor A/Regional Distributor

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Appendix 2 – Indicative Diagram of Fencing

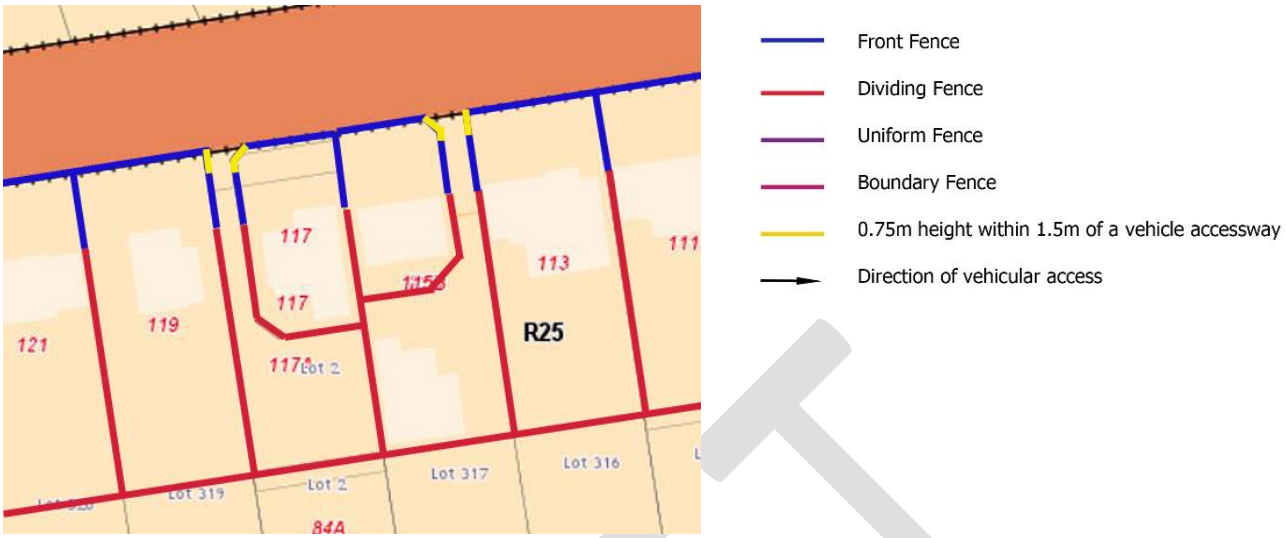

Figure 3 – Indicative diagram showing fencing detail for battle-axe type lots.

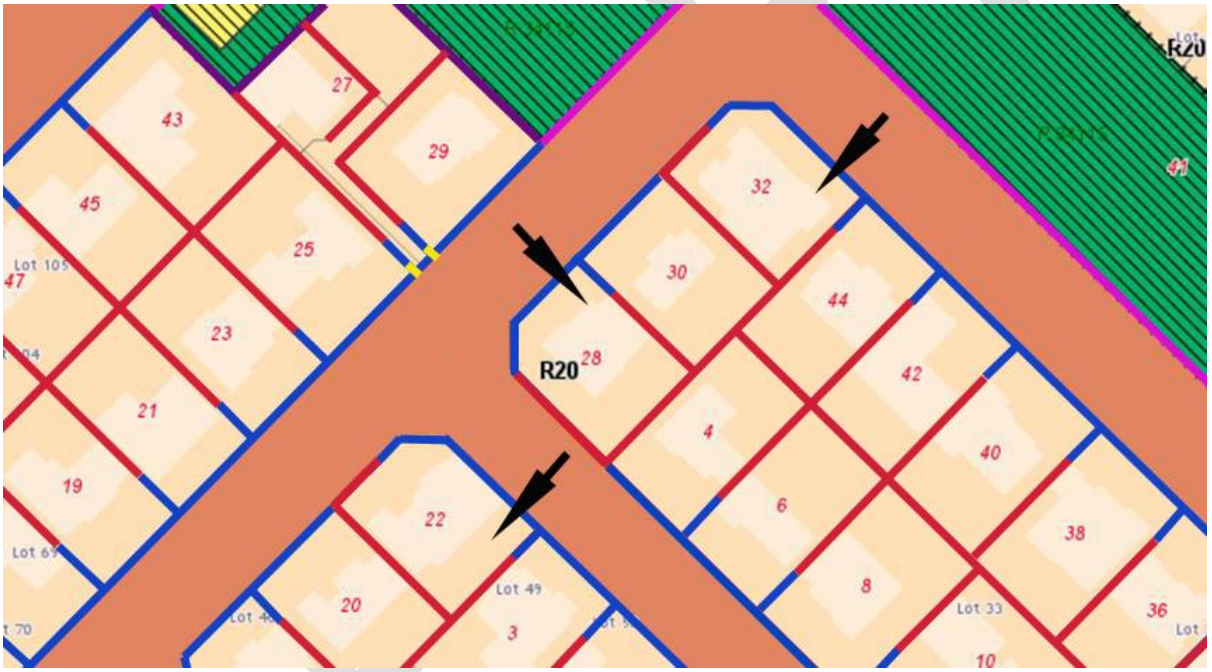

Figure 4 – Indicative diagram showing fencing for alternative residential circumstances

Note: For pedestrian safety and to maintain vehicle sightlines, all fences within 1.5m of an access way where it meets a public street shall be truncated or reduced to a height of 0.75m (yellow). This applies to all access ways where they adjoin a property boundary not just battle-axe type lots.

Appendix 3 - Examples of Front Fencing



<1.2m visually permeable with masonry elements.



> 1.2m street surveillance is not maintained.



Visually permeable on retaining to maximum height of 1.8m.



Not visually permeable, street surveillance is not maintained.



1.2m in front setback and 1.8m behind front setback. Fence follows natural ground level.



Powder coated steel or aluminium not permitted in front setback area.

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Appendix 3 - Examples of Front Fencing



Fencing on a sloping site with minor retaining.



Front fencing should be neutral tones and blend with the streetscape.



Front fence retaining wall on a sloped site softened with vegetation.



Retaining/fencing to follow ground level and maintain street surveillance.



Hedges encouraged provided they are maintained to 1.2m.



Fencing should be durable, hard wearing and resistant to vandalism.

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Appendix 3 - Examples of Front Fencing



Visual permeability extends within the front setback including sides.



No powder coated steel or aluminium sheeting permitted in front setback.



Rural style fencing to be open style and blend with the surrounding landscape.



Chain link fencing, star pickets and barbed wire not permitted in front setback.



Where a 1.8m side fence abuts a public street or ROW high quality landscaping features shall be planted.



Large expanses of blank wall should be broken up with colour/texture, or screened with landscaping.

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Appendix 3 - Examples of Front Fencing



Industrial fencing should have high visual permeability and incorporate landscaping including advanced trees.



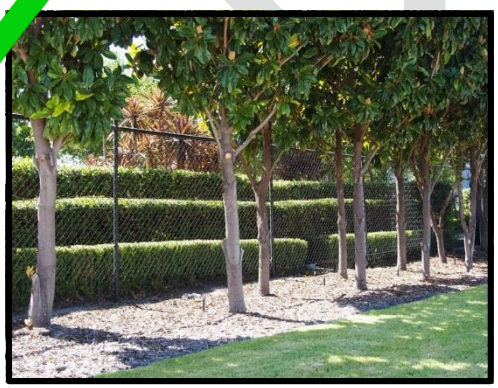
No powder coated steel or aluminium sheeting permitted in front setbacks. Fencing should be graffiti resistant.



Black tube metal style fencing is commonly used in industrial areas.



Barbed wire not permitted unless approved by the Shire.



Where a 1.8m side fence abuts a public street high quality landscaping features shall be planted.



Chain link mesh fencing not permitted in front setback.

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Explanatory Notes

All fences in zones R2-R10 to be considered 'rural fencing' as per Part 8 due to the larger lot sizes and generally more open streetscapes.

All fences in zones R10-R40 within the front setback are to be consistent with the heights as outlined in the Residential Design Codes (R-Codes) Part 5.2.4 'Street Walls and Fences' as solid to 1.2m and visually permeable to a maximum height of 1.8m. Front fences may only be varied where there is reasonable justification and meets one or more of the criteria outlined in Part 14 -'Variations to this Policy', or the property abuts a road as outlined in Appendix 1.

All street walls and fences R40-R80 are subject to the R-Codes Part 6.2.2 'Street Walls and Fences' which are to be visually permeable from natural ground level with masonry elements to a maximum height of 1.2m.

The City's fencing Local Law outlines minimum standards for a sufficient fence in residential, commercial, industrial, and rural lots. The Local Law applies to all fencing behind the front setback which is subject to the *Dividing Fences Act* while this policy outlines select materials which are not permitted within the front setback and deemed to detract from the character and amenity of the area.

Appendix 2 Indicative Diagram of Fencing is a representation of where front fencing and boundary fencing applies. Diagram 3 and 4 are a guide only and may not apply in all situations, particularly on unconventional shaped lots. Circumstances may vary and are subject to the discretion of the assessing officer.

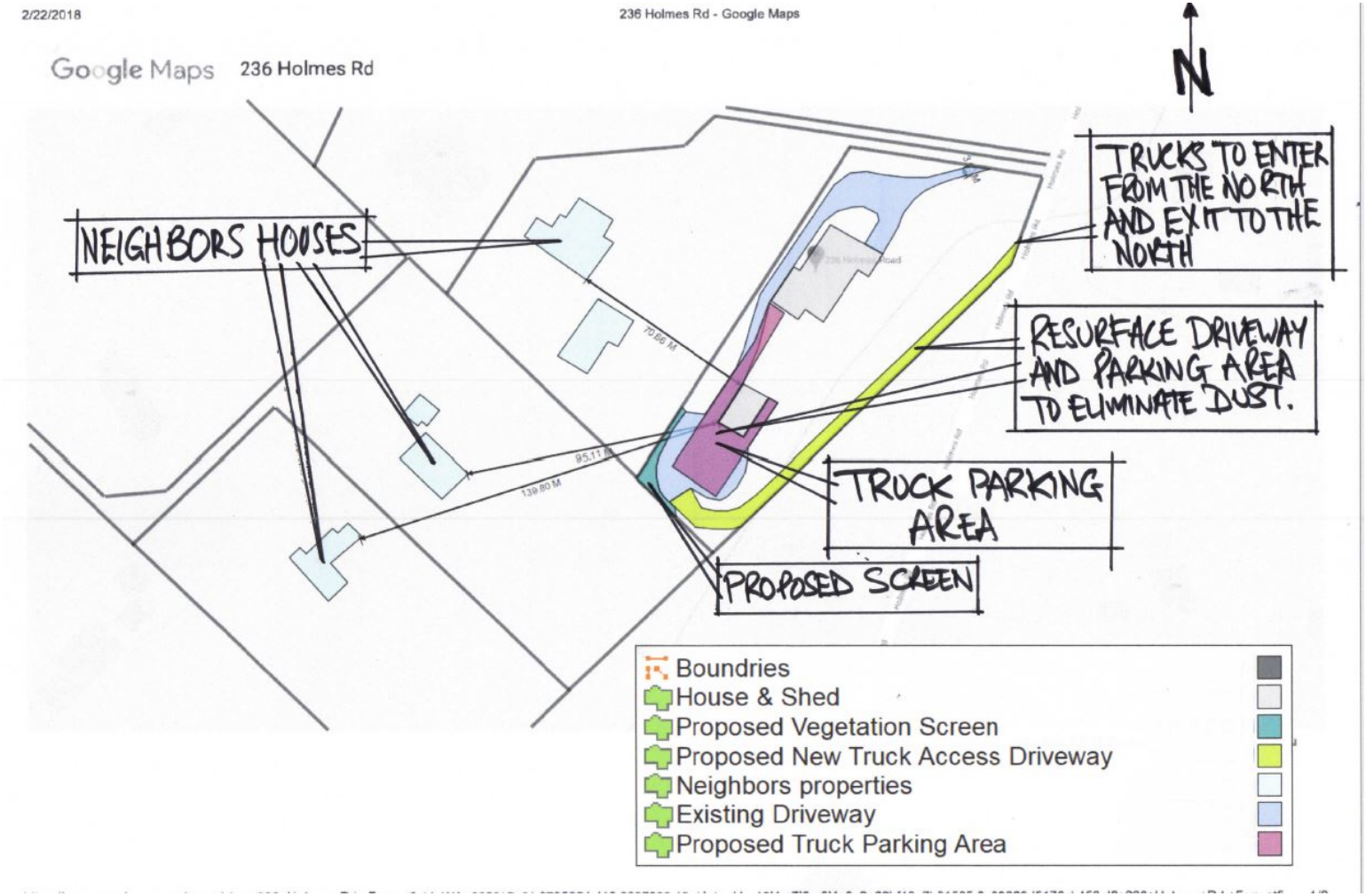
Appendix 3 - The Fence and Wall Examples Information Sheet provides a visual guide to a sufficient front fence in different zones. This is to be used as a guide only. The City can consider a variety of other materials and designs provided they meet the criteria and objectives of this policy and the R-Codes.

Retrospective applications or development applications proposing variation to the deemed-to-comply provisions should be assessed based on individual merit and give consideration to the Scheme and Part 13 'Matters to be considered' and Part 14 'Variations to this policy'.

Submission Table

Submitter Assess No.	Nature of Submission	Applicant/Owner Response	Response/Recommended Modifications
1	**Non-Objection** I fully support the policy limiting the height of the solid portion of street fencing to 1.2m. I have lived in countries where high walls are used to surround residential properties and it is ugly, impersonal and quite frankly, horrible. Please don't ever allow this to happen.	N/A	Noted.
2	**Non-Objection** How does this change impact residents with existing fencing not meeting the criteria? Could make for a very expensive exercise for people already under financial strain.	N/A	The new policy would only apply from the date in which Council adopts it and cannot be applied retrospectively to already established development.

Lot 27 (236) Holmes Road, Forrestfield – Site Plan



Lot 27 (236) Holmes Road, Forrestfield - Commercial Vehicle and Site Photos

Commercial Vehicle Photos- photos provided by the applicant



Commercial Vehicle 1



Commercial Vehicle 1



Commercial Vehicle 2



Commercial Vehicle 2

Site Photos:



Area where the commercial vehicles are proposed to be parked. One is proposed behind the shed.



Area where one of the commercial vehicles is proposed to be parked. One is proposed behind the shed.



Photo is taken from the area where the commercial vehicle is proposed looking towards the neighbouring properties.



Area where the second commercial vehicles is proposed to be parked. It is proposed to be parked between the shed and the side boundary.



Area as viewed from the rear boundary where the commercial vehicles will be parked.



Firebreak to be used as the new proposed driveway.



Creek at the property and the vegetation around it.



Front of the property and the vegetation around the building

Lot 27 (236) Holmes Road, Forrestfield – Submission Table

	Comment	Staff Comment
1.	No objection to the proposal. "Being a near neighbour the impact on our property is minimal. There for our family has no objections what so ever".	Noted.
2.	No objection to the proposal. "Does the Shire and other parties realise that there is a 3 metre main sewer pipe running along the boundary with a 6 metre easement. The main sewer line comes from central Kalamunda through to Forrestfield pump station (sic). There was, or is future plans to connect residents to this particular pile line on either side of Holmes Road and Whistlepipe Court (sic). My question is, is there enough coverage over existing main to carry anticipated weight of the trucks. I have no objection to the proposal".	Noted • The crossover will be designed and approved as per the City's requirements. The City's will ensure appropriate clearances from the sewer pipe.
3.	Objection to the proposal. "Commercial business operating from 'zoned Special Rural'? (New drive over sewer function?)"	Noted. • The proposal is in accordance with the uses that can be considered on the land zoned 'Special Rural' and is compliant with the Policy. • The crossover will be designed and approved as

		per the City's requirements. The City's asset services will look into the necessary clearances from the sewer pipe.
4.	Objection to the proposal. "The use of the special rural zoned property at 236 Holmes Road Forrestfield for storage and maintenance of two heavy haulage semi-trailers does not meet the guidelines for the use of special rural land. It appears to us that the proponent is using the land as a business for commercial gain, which is clearly not within the guidelines for the use of special rural land. The previous owners of this property destroyed the rural amenity of the property to the point that the property was advertised as a "truckies delight". Further clearing and destruction of this special rural property has been carried out by the new owners to enable them to store the heavy haulage semi-trailers and operate their business. In the proponents application to the Council there is no mention of other machinery or vehicles that will be carried on the back of the low-loaders and trucks that will be moved on and off to be serviced, this is in direct contrast to the information that the proponent stated at the Council Meeting on 13 February 2018. We are very concerned by comments made by the Councils Planning Officer, who visited our property in late February to determine the impact of this application. The Planning Officer indicated to us that if this application went to the SAT Council we would probable lose the case. We cannot see how it is possible for two semi-trailers to manoeuvre around the property to enter and leave on same green route as per map included with their application to Council. We also put the following questions to Council: • What is the Council's definition to screening special rural land from loss of amenity, noise, dust caused by heavy haulage trucks and other associated machinery?	Noted. • The proposal is in accordance with the uses that can be considered on the land zoned 'Special Rural' and is compliant with the Policy. • Under the provisions of the Scheme and Policy, a maximum of two commercial vehicles can, with development approval, be parked in Special Rural zoned areas. • The movement of trucks will be conditioned to comply with the Policy. • The crossover will be designed and approved by the City to ensure traffic safety when the

	• Have all ratepayers of special rural land been notified of the changed of the rules regarding special rural land uses. I know I have not been. • Have all surrounding residents of this property been advised of new submission or just those who opposed the original submission? If it wasn't for a concern on previous submission we would now be in conflict with council regarding this property as the applicants did not submit their full intention and to this point information is still missing on what else will be stored and carried out on this property. Please also refer to our initial concerns on our first submission on 6/11/2017. We would also like to highlight the loss of value to ours and other nearby properties due to the impact of this proposal at the expense of the proponent's commercial gain. We have lived at our Forrestfield property for 37 years and have been ratepayers within the Shire of Kalamunda for 45 years. We are very concerned regarding the direction of Council decisions". Comments from the initial proposal: "I can only assume that the Prime Movers are owned by the proposed purchaser of the Holmes Road property and as such is a private business operation if not these vehicles should be parked on company land when not in use and not on Special Rural land as proposed. No matter what the proposed owner says on his application regarding onsite/offsite, Xmas holidays, (sic), Part time use can quickly develop into full time use. Special Rural land in Forrestfield is fast becoming a rarity and should be maintained as such, not become a truck depot which ruins the rural amenity. Noise and dust are also a big issue. We have lived on our property for 36 years and value the rural ambiance and definitely do not agree with any business that operates and effects neighbours in this unique environment. Looking at the plans for parking of trucks, the location of the shed is a lot closer to boundary or properties than shown as we have been extremely effected by current owner and his business enterprise.	commercial vehicles are entering and leaving the site. • Since the proposal complies with the Scheme and the Policy, if the Council refuses the application, the applicant may take the matter to SAT, which can change the decision of the Council. • The advertising of the amended proposal has been undertaken in accordance with the requirements of the Scheme. All the effected and nearby landowners were given an opportunity to make a submission on the amended proposal. • The proposal is compliant with the Policy and if approved will be conditioned to reduce the impact on the neighbouring areas.

	I feel that if this is approved it will give the green light to other truck owners and these properties will become nothing more than truck depots. Unfortunately these decisions impact on ratepayers wellbeing and health as they are the ones effected and have to police Council policy. *If approved could truck 2 be parked out of site in front of Shed".	Vegetative screening has been proposed at the rear end of the boundary by the applicant to reduce amenity impacts. • The applicant proposes that the vehicles will parked on the property only one week in a month or during the Christmas period. For the balance of the time the vehicles will be parked off-site. • The trucks are proposed to be parked 16.5m from the nearest boundary and the area has some natural vegetation on the boundary. • Every proposal is assessed in accordance with the information provided. The location of the parking is compliant with the requirements under the Policy.

5.	Objection to the proposal. "I understand that 236 Holmes Road, Forrestfield is special rural land and as such certain rules apply to the use of this land. The Council needs to make clear to us what rules do and do not apply to the use of Special Rural land. I have never been informed of any changes to the use of Special Rural land. This proposal has the potential to devalue my property if allowed to go ahead. Proposed vegetation screen. This screen needs to be a 2-2.5 metre colourbond fence with vegetation planted inside this fence to screen off this property. The colourbond fence and vegetation needs to be extended to the full length of the back of 236 Holmes Road to totally screen off the trucks and machinery from my property. This would go someway to reducing the noise and dust and visual impact". Comments on the initial proposal: " We will suffer a loss of our rural amenity. Having trucks on the boundary of our property will devalue our property. Special Rural land should not be turned into a truck depot. Our home is located very close to the proposed truck parking. The map proportions are incorrect and not a true reflection on how close the trucks are to our house. There will be noise and dust issues, which are magnified by prevailing easterly and gully winds. What exactly does 1 week a month mean? One week for one truck or two weeks a month for two trucks? How is the Christmas period defined? Is it for four week or eight weeks or 12 weeks? We need exact dates. We understand these commercial vehicles are prime movers and parking is available for them in appropriately zoned industrial areas. It is unfair for us to be disturbed by prime movers during the hours stated. E.g early mornings ect".	Noted. • Under the provisions of the Scheme and Policy, a maximum of two commercial vehicles can, with the approval of the City or Council, be parked in Special Rural zoned areas. • If approved, the proposed screening will be assessed and approved by the City. • The proposal is compliant with the Policy and the proposed land use can be considered on the land zoned 'Special Rural'. If approved, it will be conditioned to reduce the impact on the neighbouring properties. • The trucks are proposed to be parked 16m from the nearest side boundary and the area has natural vegetation that helps in screening the truck.

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Planning Solutions (Aust) Pty Ltd

PSA Ref: 5328

23 March 2018

Chief Executive Officer
City of Kalamunda
PO BOX 42
Kalamunda WA 6926

Attention: Planning Services

Dear Madam,

PROPOSED AMENDMENT TO LOCAL PLANNING SCHEME NO. 3
LOT 36 (655) WELSHPOOL ROAD EAST AND LOT 810 (31) BROOK ROAD, WATTLE GROVE

Planning Solutions acts on behalf of Evangelos Litis Nominees, the proponent of the proposed scheme amendment relating to Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove (**subject site**).

We are pleased to provide the enclosed scheme amendment request for the City of Kalamunda's consideration. Please find enclosed the following:

1. One copy of the scheme amendment request and supporting technical appendices.
2. One USB containing the scheme amendment documents.

We look forward to the City's confirmation of receipt of this request, and confirmation of the costs associated with the City's assessment of the scheme amendment request.

Should you have any queries or require further clarification in regard to the above matter please do not hesitate to contact the undersigned.

Yours faithfully,

pp_____
JESSE DUNBAR
SENIOR PLANNER

180319 5328 Cover letter - scheme amendment

PLANNING SOLUTIONS
URBAN & REGIONAL PLANNING
PS

Proposed Amendment to Local Planning Scheme No. 3

Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road Wattle Grove, Western Australia



PART A

Prepared for
Evangelos Litis Nominees Pty Ltd

March 2018

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Project details

Job number	5328	
Client	Evangelos Litis Nominees Pty Ltd	
Prepared by	Planning Solutions	
Consultant Team	Town Planning	Planning Solutions
	Architect	Meyer Shircore & Associates
	Traffic Engineering	Transcore
	Civil Engineering	McDowell Affleck
	Bushfire	Eco Logical Australia

Document control

Revision number	File name	Document date
Rev 0	180321 5328 Scheme amendment request (final)	22 March 2018

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1 Preliminary

1.1 Introduction

This Scheme Amendment Report has been prepared by Planning Solutions on behalf of Evangelos Litis Nominees, the proponent of the proposed scheme amendment relating to Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove (**subject site**). Planning Solutions has prepared the following report in support of an amendment to the City of Kalamunda Local Planning Scheme No. 3 (**LPS3**).

This report will discuss various issues pertinent to the proposal, including:

- Site details.
- Proposed scheme amendment.
- Strategic planning framework.
- Statutory planning framework.
- Site considerations.
- Amendment justification.

1.2 Background

The subject site comprises Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove. Lot 31 previously formed part of a larger Lot 32, which included the land immediately south of the site (now Lot 811 (37) Brook Road). This land contains remnant vegetation and forms part of a Conservation Category Wetland (**CCW**).

In April 2012, the WAPC entered into a Deed of Agreement with the owner of former Lot 32 and Lot 36 to ensure that the portion of Lot 32 which contains the CCW, and up to a 25m buffer, would be ceded to the Crown free of cost for conservation purposes. An additional 25m buffer (to form a 50m buffer) was purchased by the WAPC for conservation purposes.

The subject site was previously reserved Parks and Recreation under the Metropolitan Region Scheme (**MRS**), and was rezoned to Urban via MRS Amendment 1235/57, gazetted on 17 May 2013. The amendment also removed the Bush Forever Area notification (site 387) over the subject site. The purpose of the MRS amendment was to facilitate the commercial/light industrial development of the land. The MRS amendment excluded the CCW area and a 50m buffer from the wetland. This area remains in the Parks and Recreation reservation and Bush Forever Area notification.

Pursuant to section 226(3) of the *Planning and Development Act 2005*, the (then) Shire of Kalamunda requested the WAPC amend its (then) Town Planning Scheme No. 3 as it related to the subject site. This was agreed to by the WAPC and the subject site was transferred to the Industrial Development zone under Town Planning Scheme No. 3.

A meeting was held with the City's officers on 28 July 2017 to discuss the proposed amendment to Local Planning Scheme No. 3 to accommodate a mixed commercial development on the subject site. In discussions with the City's officers, it has been generally agreed that a scheme amendment request for a Light Industry zoning for the subject site can be considered, subject to a range of matters being addressed through the amendment process, including bushfire hazard, water management, environmental impacts, traffic and servicing considerations. These matters have been addressed through this amendment request and accompanying technical reports.

2 Site context

2.1 Land description

Refer to **Table 1** below for a description of the land subject to this development application.

Table 1 – Lot details

Lot	Plan	Volume	Folio	Area (ha)
36	4647	1228	739	3.4718
810	69210	2880	7	0.7868
			Total	**4.2586**

Refer **Appendix 1** for copies of the Certificates of Title and Deposited Plans.

2.2 Location

The subject site is located in the suburb of Wattle Grove, within the municipality of the City of Kalamunda. The site is located approximately 14 kilometres south-east of the Perth Central Business District, approximately 5 kilometres east of the Cannington city centre, and approximately 4.6 kilometres north of the Maddington secondary centre. The Perth Airport, Kewdale industrial area and intermodal freight terminal are located approximately 5 kilometres north of the site.

The subject site has frontage to Brook Road to the north-west and Welshpool Road East to the north-east, and is located in close proximity to Welshpool Road and Tonkin Highway, both of which are major arterial roads providing convenient access from the site to Perth's northern, southern and eastern suburbs.

The subject site is surrounded by a range of environmental features. The Greater Brixton Street Wetland complex is located to the south of the subject site, which covers approximately 90 hectares and contains over 320 plant species, representing more than 20% of Perth's floristic biodiversity. The wetland system is considered one of the most floristically diverse areas of the Swan Coastal Plain. Yule Brook is located approximately 100m north of the subject site, and is a major drainage system running from the north-east to the north-west through the locality.

The site forms part of the broader Maddington Kenwick Strategic Employment Area, which will ultimately be developed for a mix of general industrial/business and light industrial/composite uses.

2.3 Land use and topography

The subject site comprises an area of approximately 4.2 hectares, and is currently vacant. The site is predominantly cleared and contains little remnant vegetation, with the exception of a few sparse trees. The subject site is not considered to possess any specific environmental features worthy of retention, such as waterways/seasonal drainage lines, etc. The environmentally significant features to the south, which previously formed part of the subject site, have been excised and ceded to the Crown for conservation purposes.

The subject site is surrounded by a mix of land uses, being predominantly residential to the north, and rural to the south and west.

Wattle Grove Urban Cell 9 is located immediately north of the subject site on Welshpool Road East, and comprises a range of low to medium density residential development, public open space, community and commercial/mixed use development.

The surrounding land to the west and further south forms part of the Maddington Kenwick Strategic Employment Area, and is earmarked for future industrial and mixed business development.

The immediately surrounding properties comprise the following mix of uses:

- 639 Welshpool Road East at the opposite corner of Brook Road and Welshpool Road East previously contained the Wattle Grove Primary School, and is now a construction site containing a number of transportable structures.
- 665 Welshpool Road East, abutting the site to the south-east contains a heavy vehicle transport depot / logistics centre.
- 30 Brook Road opposite the site to the west contains the Abruzzo & Molise Sporting Club WA, a cultural association for Italian-Australians.
- 44 & 56 Brook Road further west contain the Foxwood Farm Equestrian Centre.
- 12 Bruce Road to the north of the subject site contains Grasstrees Australia sales centre and nursery.
- 7 Bruce Road on the northern side of Welshpool Road East contains the Assembly Hall of Jehovah's Witnesses.

The subject site is generally flat, with a gentle slope down from east to west. An open drain runs along the Brook Road frontage of the subject site.

Refer **Figure 1**, aerial photograph, and **Photographs 1 to 7** which depict the subject site and surrounds.



Photograph 1 – View of the subject site from Brook Road.



Photograph 2 – View north along Brook Road towards the Welshpool Road East full-movement intersection.



Photograph 3 – View south along Brook Road adjacent to the subject site.



Photograph 4 – View of the subject site and neighbouring transport depot / logistics centre facility.



Photograph 5 – Abruzzo & Molise Sporting Club WA opposite the subject site.



Photograph 6 – Construction site with transportable structures opposite the subject site on Brook Road (former Wattle Grove Primary School).



Photograph 7 – Existing drainage infrastructure within the Brook Road reserve adjacent to the subject site.



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DATE	08 January 2018
FILE	01 180108 5328 Aerial Photograph.dwg
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Scale Bar (m) 0 75

AERIAL PHOTOGRAPH

LOT 36 (655) WELSHPOOL ROAD EAST AND
LOT 810 (31) BROOK ROAD
WATTLE GROVE, WESTERN AUSTRALIA

FIGURE 01

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3 Scheme amendment

3.1 Proposed scheme amendment

The proposed scheme amendment seeks to amend LPS3 to rezone Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove to facilitate the development of a mixed commercial centre on the subject site, consistent with the vision established under the applicable strategic planning framework.

It is proposed to rezone the subject site from 'Industrial Development' to 'Light Industry'. The rezoning will allow for the subject site to be developed for light and service industrial and mixed commercial purposes. Refer to the proposed Scheme Amendment Map contained in **Appendix 2**.

3.2 Proposed Special Control Area

To ensure the proposed development of the subject site in accordance with the Light Industry zoning does not conflict with the principles of orderly and proper planning, it is proposed to incorporate a set of special control area provisions which requires the necessary planning and environmental considerations to be addressed. A Special Control Area for the subject site will be included as a new clause 6.9 under LPS3, referred to as the 'Brook Road Light Industrial Precinct', as follows:

6.9.1 Subdivision and/or development proposals within the Special Control Area shall be supported by:

i. A BAL assessment or Contour Map, prepared in accordance with the Guidelines for Planning in Bushfire Prone Areas (as amended), demonstrating how any bushfire hazards identified can be appropriately managed within the context of the proposal to the satisfaction of the City of Kalamunda.

ii. A Local Water Management Strategy, prepare in accordance with Better Urban Water Management on the advice of the Shire of Kalamunda, to the satisfaction of the Department of Water.

iii. A Local Development Plan approved by the City of Kalamunda under Part 6 of the Deemed Provisions for development of land directly fronting Welshpool Road East.

The proposed Special Control Area requirements ensure all future subdivision and development applications are supported by the necessary expert advice demonstrating the suitability of the proposed subdivision and/or development.

In addition to the necessary bushfire and hydrological inputs, the City requires design guidelines to be prepared to ensure an appropriate development outcome is achieved for the land fronting Welshpool Road East. The design guidelines will be specific to the subject site, and will be prepared in the form of a Local Development Plan (**LDP**), approved by the City under Part 6 of the Deemed Provisions.

3.2.1 Use restrictions

Due to the context of the subject site in close proximity to existing residential zoned land to the north of Welshpool Road East, it is appropriate to restrict the permissibility of high impact industrial land uses within the subject site to minimise any potentially adverse impacts on nearby residents.

The following provision is proposed to be inserted under clause 6.9 of LPS3:

6.8.2 Notwithstanding Table 1, the permissibility of the following use classes within the 'Light Industry' zone within the Special Control Area is to be in accordance with the designation listed below for the purpose of clause 4.3:

- *Motor Vehicle Wrecking – 'X' use*
- *Resource Recovery Centre – 'X' use*

- *Salvage Yard – 'X' use*
- *Storage – 'X' use*

3.2.2 Special Control Area 4 – 300m Poultry Farm Buffer

The existing LPS3 mapping identifies Special Control Area 4 – Poultry Buffer (**SCA4**) as partially affecting the south-west portion of the subject site. SCA4 identifies the land within a 300m radius of a poultry farm on Lot 64 Brook Road, however, no further guidance on development control is provided within LPS3. It is understood the purpose of SCA4 is to control subdivision and development to ensure any sensitive uses are restricted or limited within the buffer area.

It is understood the poultry farm has since been removed, and the site is now used as the Foxwood Farm Equestrian Centre, and the SCA4 buffer area may now be redundant. Furthermore, the proposed Light Industrial zoning of the subject site does not allow for sensitive land uses to be developed within the subject site. It is therefore proposed to modify the extent of SCA4 to exclude the subject site, as depicted on the Scheme Amendment Map contained in **Appendix 2**.

3.3 Proposed scheme provisions

Based on the above, it is proposed to formally amend LPS3 as it applies to the subject site, as follows:

- Rezone Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove from 'Industrial Development' to 'Light Industry', as shown on the proposed Scheme Amendment Map (**Appendix 2**);
- Amend the boundary of Special Control Area 4 – Poultry Buffer to exclude the subject site.
- Insert a new provision (k) into clause 6.1.1, as follows:

  (k) Brook Road Light Industrial Precinct, for which subdivision and development shall be in accordance with clause 6.9 shown on the Scheme map as SCA 7.

- Amend the scheme map to include a new Special Control Area 7 boundary around the subject site.
- Insert a new clause 6.9 into Part 6, as follows:

  6.9 BROOK ROAD LIGHT INDUSTRIAL PRECINCT

  6.9.1 Subdivision and/or development proposals within the Special Control Area shall be supported by:

  i. A BAL assessment or Contour Map, prepared in accordance with the Guidelines for Planning in Bushfire Prone Areas (as amended), demonstrating how any bushfire hazards identified can be appropriately managed within the context of the proposal to the satisfaction of the City of Kalamunda.

  ii. A Local Water Management Strategy, prepare in accordance with Better Urban Water Management on the advice of the Shire of Kalamunda, to the satisfaction of the Department of Water.

  iii. A Local Development Plan approved by the City of Kalamunda under Part 6 of the Deemed Provisions for development of land directly fronting Welshpool Road East.

  6.8.2 Notwithstanding Table 1, the permissibility of the following use classes within the 'Light Industry' zone within the Special Control Area is to be in accordance with the designation listed below for the purpose of clause 4.3:

  - *Motor Vehicle Wrecking – 'X' use*
  - *Resource Recovery Centre – 'X' use*
  - *Salvage Yard – 'X' use*
  - *Storage – 'X' use*

A concept development plan has been prepared to demonstrate one way in which the site may be developed. This plan has been prepared for information only, to indicate how the development of the land might occur in the future. The concept plan does not form part of the proposed amendment, and separate approval will be required for the development of the land which may result in changes to the enclosed concept plan.

Refer **Appendix 2**, Scheme Amendment Map, and **Appendix 3**, Concept Development Plan.

4 Strategic planning framework

4.1 Draft Perth and Peel @ 3.5million

The draft Perth and Peel @ 3.5 million provides the overarching strategic framework for the Perth and Peel region for the next 35 years. The document provides guidance on where development should occur to ensure sustainable urban growth, protecting the environment and heritage, and making the most effective use of existing infrastructure. The draft Perth and Peel @ 3.5 million document sets the context for four draft sub-regional planning frameworks, including the draft South Metropolitan Peel Sub-Regional Planning Framework relevant to the subject site (refer section 4.2 below). The framework sets out proposals to strengthen key activity centres and employment nodes to meet the future needs of industry, commerce and the community.

The document encourages a connected city model, which will enable more effective use of urban and employment-generating industrial and commercial land to accommodate sustainable population growth across Perth and Peel. The purpose of the scheme amendment is to allow for the development of the subject site as a mixed commercial and light industrial precinct. The proposed employment-generating industrial and commercial land uses will assist in achieving the objectives of the draft Perth and Peel @ 3.5 million document, providing employment opportunities for existing and future residents in the surrounding residential areas.

4.2 Draft South Metropolitan Peel Sub-Regional Planning Framework

As outlined in the draft South Metropolitan Peel Sub-Regional Planning Framework, the south metropolitan sub-region is projected to require 5,924 hectares of industrial land to 2050. The staged delivery of infrastructure and public and private sector investment to maximise economic development and employment potential will be critical to the successful development of priority employment lands.

The identified growth sectors in the South Metropolitan Peel sub-region are in Armadale and Maddington, and will require a steady supply of developable land including into the Forrestfield Industrial area and Maddington Kenwick Strategic Employment Area.

The framework identifies the Maddington Kenwick Strategic Employment Area as 'Industrial Investigation', which will form an expansion of the existing industrial area in proximity to the Kewdale intermodal transfer facilities and freight routes linking with Fremantle, Kwinana and Perth Airport. The framework promotes employment opportunities and increasing the number of people who live and work within the sub-regions, with a focus on employment within the strategy metropolitan centres and strategic industrial centres, while maximising use of existing infrastructure.

4.3 Directions 2031

Directions 2031 and Beyond (**Directions 2031**) is the overarching spatial framework and strategic plan that establishes a vision for the future growth of the Perth and Peel region. It provides the framework to guide detailed planning and delivery of housing, infrastructure and services for a variety of growth scenarios. A medium density 'Connected City' model is put forward as the preferred means to achieve a liveable, prosperous, accessible, sustainable and responsible city, ensuring economic development and accessibility to employment inform urban expansion.

Directions 2031 seeks to address the relationship between where people live and where they work with the aim of reducing commuting time and cost through the delivery of improve employment self-sufficiency across the outer sub-regions. The document includes a range of strategies to achieve a prosperous city, including facilitating and retaining employment land to support economic growth and a balanced distribution of employment across the metropolitan Perth and Peel regions.
The proposed scheme amendment will facilitate the development of the subject site for mixed commercial and light industrial purposes, adding to the employment land and improving employment self-sufficiency within the Wattle Grove locality.

4.4 Outer-Metropolitan Perth and Peel Sub-Regional Strategy

The draft Outer-Metropolitan Perth and Peel Sub-Regional Strategy (**Sub-Regional Strategy**) provides more in-depth strategic planning for the growth of the Outer-Metropolitan Perth and Peel region in order to deliver the outcomes sought by Directions 2031.

Under the Sub-Regional Strategy, the Madding-Kenwick and Forrestdale industrial centres are identified to be progressively developed to cater for a range of manufacturing, processing, warehousing and bulk goods handling activities. These centres (including the subject site) are well connected to intermodal freight facilities at the Welshpool-Kewdale industrial centre, and are ideally located to develop synergies with major export-oriented industrial centres at Kwinana and Hope Valley-Wattleup. The Sub-Regional Strategy notes that all future industrial areas will be subject to investigation to evaluate their suitability and ensure that any environmental impacts can be appropriately managed.

4.5 Economic and Employment Lands Strategy: Non-Heavy Industrial

The Economic and Employment Lands Strategy: non-heavy industrial (**EELS**) is a key initiative in the ongoing development of Western Australia, and focuses on the identification and de-constraining of land suitable for industrial activity for the long term, allowing for an industrial land bank for the future. The document provides a coordinated and proactive approach to assisting in the facilitation of industrial land use development.

The EELS document identifies the Maddington Kenwick Strategic Employment Area as a potential industrial area, with Precinct 1 as a short-term priority, Precinct 3A as a medium-term priority and Precincts 2 and 3B as long-term priorities.

The proposed scheme amendment will allow for the release and development of industrial land within the Maddington Kenwick Strategic Employment Area, consistent with the initiatives of the EELS document.

4.6 Shire of Kalamunda Local Planning Strategy

The City's Local Planning Strategy (**LPS**) was adopted by Council on 3 October 2011 and endorsed by the WAPC in February 2013. The purpose of the LPS is to enable Council to determine the vision and strategic planning direction for the City of Kalamunda for the next 20 years, to coincide with Directions 2031.

A key action of the LPS is to encourage the expansion of new urban areas in a sustainable manner, providing increased housing and lifestyle opportunities; local employment opportunities and protection of biodiversity and the natural environment.

The LPS sets out the strategies and actions that will deliver the desired outcomes for the key action areas. In relation to industry, the City proposed to work with the City of Gosnells in respect to the planning implications of the Maddington Kenwick Strategic Employment Area. To ensure consistency with the City of Gosnell's vision for the development of the area for industrial purposes, the LPS identifies land to the south of Welshpool Road East as an investigation area for future industrial development.

4.7 Maddington Kenwick Strategic Employment Area

The Maddington Kenwick Strategic Employment Area (**MKSEA**) encompasses the area bound by Bickley Road, Roe Highway and Tonkin Highway, and was originally identified in Metroplan (1990) by the State Government as a future strategic industrial area, recognising that more detailed planning, including amendments to the MRS, would be required to enable subdivision and development to occur. The majority of the MKSEA is within the City of Gosnells' boundaries, with 13% of the area located within the City of Kalamunda's boundaries.

Planning for the area was initiated by the City of Gosnells through the commission of the Maddington Industrial Land Market Demand Study in 2003. The land within the area has since been progressively rezoned to Industrial under the MRS, and further detailed planning and technical studies have been undertaken to guide the subdivision and development of the land.

The MKSEA indicative Local Structure Plan identifies the subject site as being developed for General Industrial/Business Uses. Given the small, isolated nature of the subject site, no new or modified roads are proposed through the site, however, the plan acknowledges that a review of the intersection requirements at Brook Road / Welshpool Road East is needed. The proposed scheme amendment is entirely consistent with the vision established for the subject site under the MKSEA suite of documents.

5 Statutory planning framework

5.1 Planning and Development Act 2005

This Scheme Amendment Report has been prepared by the owner of the subject site, in accordance with section 75(b) of the *Planning and Development Act 2005*.

5.2 Planning and Development (Local Planning Schemes) Regulations 2015

Part 5 of the *Planning and Development (Local Planning Schemes) Regulations 2015* (**the Regulations**) sets out the requirements and process for amending a local planning scheme. This scheme amendment is to be processed in accordance with the requirements of the Regulations, which sets out three streams of scheme amendment types, namely:

- Basic amendment;
- Standard amendment; and
- Complex amendment.

The proposed amendment is considered to be a **standard amendment**, as the proposed rezoning is consistent with the MRS zoning that applies to the site, and the applicable strategic planning framework, including City's endorsed Local Planning Strategy, draft Perth and Peel @ 3.5 million, draft South Metropolitan Peel Sub-Regional Planning Framework and the Maddington Kenwick Strategic Employment Area documents.

The proposed amendment will have minimal impact on the surrounding land, which is also identified for future industrial development. As demonstrated through this scheme amendment request and supporting technical advice, the amendment will not result in any significant environmental, social, economic or governance impacts on the land in the scheme area.

5.3 Metropolitan Region Scheme

The subject site is zoned Urban under the provisions of the MRS. Lot 36 fronts the Welshpool Road East Primary Regional Roads reservation. Refer **Figure 2**, Metropolitan Region Scheme zoning map.

The MRS Clause 42 Certificate contained in **Appendix 4** confirms the whole of the subject site is contained within the Urban zone. The proposed Scheme Amendment is consistent with the relevant provisions of the MRS, and may be supported as proposed.

5.4 State planning policies

Pursuant to section 77(1)(a) of the *Planning and Development Act 2005*, every local government in amending a local planning scheme is to have due regard to any State planning policy which affects its district. The following State planning policies are relevant to this proposal and have been given due regard.

5.4.1 SPP 3.6 Development Contributions for Infrastructure

State Planning Policy 3.6 – Development Contributions for Infrastructure (**SPP 3.6**) outlines the relevant considerations and principles for developer contributions for infrastructure, and the preparation of development contribution plans.

Due to the isolated nature of the subject site, and the fact it remains within single ownership, development contribution arrangements are unlikely to be required to facilitate the development of the land for industrial purposes.

Any developer contribution arrangements for district level infrastructure are the responsibility of the local authority.

5.4.2 SPP 3.7 Planning in Bushfire Prone Areas

State Planning Policy 3.7 – Planning in Bushfire Prone Area (**SPP 3.7**) seeks to implement effective, risk-based land use planning and development to preserve life and reduce the impact of bushfires on property and infrastructure. The policy applies to all higher order strategic planning documents, strategic planning proposals, subdivision and development applications located in designated bushfire prone areas. The subject site is identified as being within an area that has been identified and designated by the Fire and Emergency Services Commissioner, as identified on the *Map of Bush Fire Prone Areas*. Refer to section 6.3 of this report for further detail in relation to bushfire risk management applicable to the subject site.

5.4.3 SPP 4.1 State Industrial Buffer

The purpose of State Planning Policy 4.1 – State Industrial Buffer (**SPP 4.1**) is to provide a consistent Statewide approach for the protection and long-term security of industrial zones, transport terminals (including ports) and other utilities and special uses.

The policy acknowledges that in the case of industries of a light/service nature, the impacts can usually be retained on-site or within the industrial area boundaries as the buildings in effect form the buffer area. The use of setbacks in this instance is most effective, particularly when combined with landscaping, for reducing impacts to acceptable levels (e.g. building bulk, noise and light overspill from storage areas, car parking and servicing areas, etc). Future development application/s for the subject site will ensure any potential impacts are able to be adequately mitigated through appropriate site design and layout.

5.5 City of Kalamunda Local Planning Scheme No. 3

Under the provisions of the City's LPS3, the subject site is zoned Industrial Development. Portions of the subject site are also located within various special control areas, including a Bushfire Prone Area (**BPA**) and Special Control Area 4 – Poultry Buffer (**SCA4**), as identified on the scheme map. The provisions of the BPA and SCA4 apply in addition to the provisions applying to the underlying zone. Refer **Figure 3**, Local Planning Scheme No. 3 zoning map

The objectives of the Industrial Development zone are set out in clause 4.2.4 of LPS3, as follows:

- *To provide for orderly and proper planning through the preparation and adoption of a Structure Plan establishing the overall design principles for the area.*
- *To permit the development of the land for industrial purposes and for commercial and other uses normally associated with industrial development.*

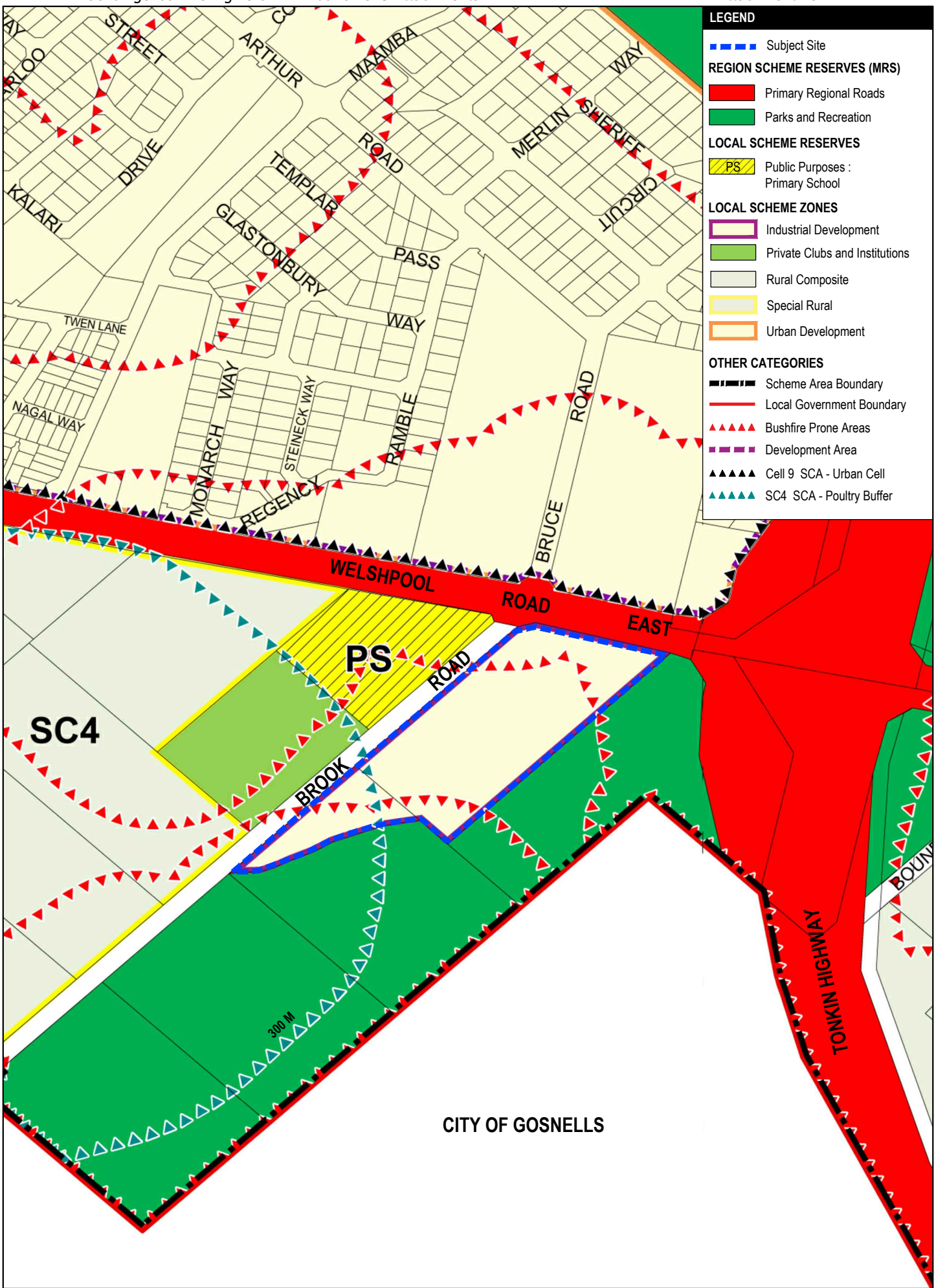
Under the current zoning, a Structure Plan is required to be adopted to provide for the orderly and proper planning of the land, prior to subdivision and/or development.

The purpose of the BPA special control area is to identify land that is bushfire prone, ensuring that development within a BPA is effectively designed in accordance with AS3959 to address the level of bushfire hazard applying to the land, and facilitate improved strategic planning for bushfires and more effective bushfire risk management.

As outlined in section 3.2.2 of this report, SCA4 identifies the land within a 300m radius of a poultry farm within Lot 64 Brook Road. Given the proposed Light Industrial zoning of the subject site does not allow for sensitive land uses to be developed within the subject site, it is proposed to modify the extent of SCA4 to exclude the subject site.

The current zoning and SCA provisions relating to the subject site restricts development to a limited range of uses capable of approval within the Industrial Development zone. Given the provisions of LPS3 require the adoption of a Structure Plan prior to the subdivision and development of the subject site, this is yet to occur, therefore the site remains undeveloped.

The proposed scheme amendment seeks to rezone the subject site to Light Industry under LPS3, introduce a new Special Control Area applicable to the subject site, and exclude the subject site from SCA4. The provisions of LPS3 relating to BPA's will continue to apply to the subject site. The proposed scheme amendment will facilitate the development of the land for mixed commercial and light industrial purposes, without the requirement for a separate Structure Plan prior to development.



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SCALE	1: 5,000 @ A4
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Scale Bar (m) 0 50 100

LOCAL PLANNING SCHEME NO.3
LOT 36 (655) WELSHPOOL ROAD EAST AND
LOT 810 (31) BROOK ROAD
WATTLE GROVE, WESTERN AUSTRALIA

FIGURE 02

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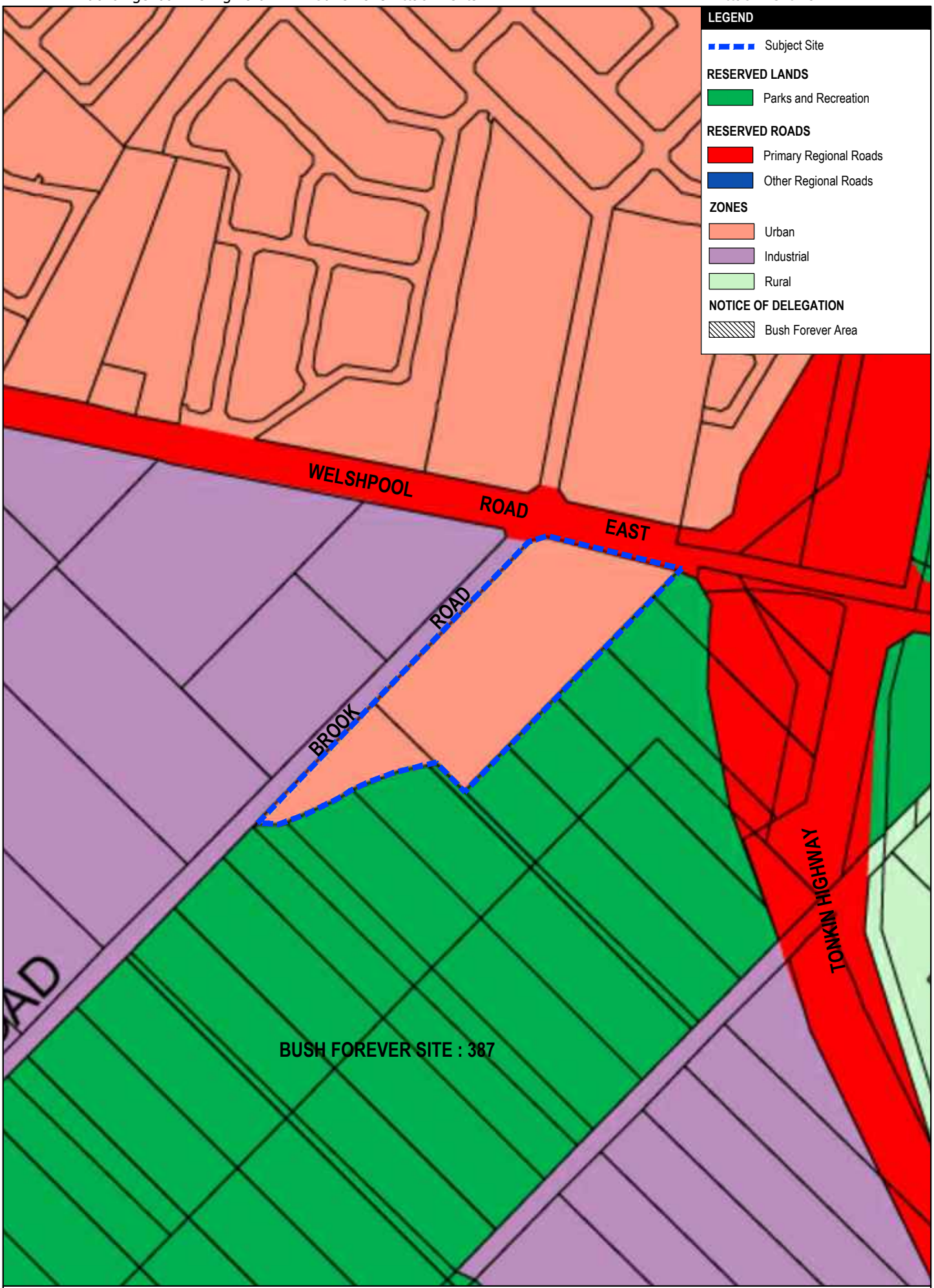

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Scale Bar (m) 0 50 100

METROPOLITAN REGION SCHEME ZONING MAP
LOT 36 (655) WELSHPOOL ROAD EAST AND
LOT 810 (31) BROOK ROAD
WATTLE GROVE, WESTERN AUSTRALIA

FIGURE 03

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6 Site considerations

6.1 Traffic and transport

A transport impact assessment (**TIA**) has been prepared by Transcore to provide an overview of the trip generation and distribution from the land uses resulting from the proposed rezoning, and assesses the impact of the assumed development traffic on surrounding roads and intersections. The TIA is based on the land uses and floor areas indicated on the concept development plan.

Based on an assessment of the proposed land uses and floor areas indicated on the concept development plan, the total external traffic generation from the subject site is expected to be about 2,460 vehicles per day or 288 vehicles per hour, which will be accommodated by a left-in/left-out crossover on Welshpool Road East and a number of full movement crossovers on Brook Road.

According to the MKSEA Precinct 3 Access Strategy, the Brook Road intersection with Welshpool Road East will be downgraded to a left-in/left-out intersection in the future. This is due to the proximity of the Brook Road / Welshpool Road East intersection to the proposed future interchange at Tonkin Highway / Welshpool Road East, and safety issues associated with the existing intersection arrangement.

Traffic analysis undertaken indicates that development crossovers on Brook Road will operate satisfactorily and well within capacity. For the Welshpool Road East crossover, a left turn land in accordance with Austroads Guidelines is proposed, to minimise impact on through traffic and improve safety.

Refer to **Appendix 5**, Transport Impact Assessment.

6.2 Water management

A District Water Management Strategy (**DWMS**) was prepared to support the rezoning of MKSEA Precincts 2 and 3 to 'Industrial' under the MRS, and incorporated portion of the subject site. The DWMS sets out the key water management objectives for the broader MKSEA district.

A Local Water Management Strategy (**LWMS**) has been prepared by McDowell Affleck Consulting Engineers in support of the proposed scheme amendment for the subject site. The LWMS has been developed in accordance with Better Urban Water Management, relevant policies and guidelines, with consideration given to the objectives and principles detailed in the overarching DWMS. The LWMS covers stormwater management, groundwater management and water consumption, and is based on the following major objectives:

- Provide a broad level stormwater management framework to support future industrial development.
- Minimise the amount of fill that needs to be imported to the subject site.
- Incorporate appropriate best management practices into the drainage system that address the environmental and stormwater management issues identified.
- Minimise ongoing operation and maintenance costs for the land owners and local government.
- Develop a water conservation strategy for the site that will ensure the efficient use of all water resources.
- Gain support from the Department of Water and local government for the proposed method to manage stormwater within the site.

Water will be managed using an integrated water cycle management approach, which has been developed using the philosophies and design approaches described in the Stormwater Management Manual for Western Australia. The LWMS has been prepared with the intention of providing a structure within which subsequent development can occur, and is based on the approved DWMS, the characteristics of the existing environment, and a contemporary approach to best-practice approach to integrated water cycle management.

Refer to **Appendix 6**, Local Water Management Plan.

6.3 Bushfire hazard

As outlined above, the subject site is within a designated bushfire prone area as per the Department of Fire and Emergency Services *Map of Bushfire Prone Areas*, which triggers bushfire planning requirements under SPP 3.7 and reporting to accompany submission of the scheme amendment request in accordance with the associated *Guidelines for Planning in Bushfire Prone Areas* (**Guidelines**).

A bushfire management plan (**BMP**) for the subject site has been prepared by Eco Logical Australia to act as a technical supporting document to inform planning assessment of the scheme amendment, and to provide guidance on how to plan for and manage the bushfire risk to the subject site through implementation of a range of bushfire management measures in accordance with the Guidelines.

The vegetation assessment for the subject site and surrounding 150m comprises the following vegetation classes and exclusions:

- Class A forest;
- Class B woodland;
- Class C shrubland;
- Class G grassland; and
- Exclusions as per clause 2.2.3.2 (e) and (f) of AS3959-2009 (i.e. non-vegetated areas and low-threat vegetation).

The existing vegetation within the subject site is proposed to be cleared to enable development. The current on-site vegetation is therefore not considered to be a bushfire hazard post-development, as these hazards can be managed through a staged clearing process, adequate separation of future built assets from classified vegetation, and ongoing fuel management that can be undertaken in and around individual development stages.

On this basis, the bushfire hazards within and adjacent to the subject site and the associated bushfire risk is readily manageable through standard management responses and compliance with acceptable solutions outlined in the Guidelines and AS3959-2009. These management measures will need to be factored into subdivision and/or development design as early as possible to ensure a suitable, compliant and effective bushfire management outcome is achieved to ensure protection of future life and property assets.

Refer to **Appendix 7**, Bushfire Management Plan.

6.4 Servicing

A preliminary assessment of the engineering works and civil infrastructure required to develop the subject site has been undertaken by McDowell Affleck Consulting Engineers. The report concludes that the site can ultimately be serviced with reticulated water, gas, power and communications. Refer to **Appendix 8** for the Engineering Servicing Report.

6.4.1 Waste water reticulation

The Water Corporation ESInet system indicates there is no nearby existing sewer main that is adequate to support the development of the subject site. The Water Corporation long term planning for the area indicates that the site will be serviced from the existing sewer main along Bickley Road, west of Roe Highway, approximately 2.7km to the west of the site via a DN150 sewer main. There are no current plans by the Water Corporation to construct the proposed reticulated sewer main to enable the site to be serviced by reticulated sewer.

The Water Corporation has indicated that a private pump station may be constructed onsite to service the development. Alternatively, an onsite effluent system can be used in accordance with the Government Sewerage policy.

6.4.2 Water supply

The Water Corporation Dial Before You Dig (**DBYD**) information shows an existing 150CI water main along Welshpool Road East fronting the site and an existing 200P-12 along Brook Road on the other side of the road reserve. The Water Corporation have confirmed there is adequate network capacity for the proposed commercial development of the subject site. In addition, there is no water upgrade required for a 20 L/s for firefighting purposes. The site can therefore be serviced with reticulated water.

6.4.3 Power supply

The subject site is not currently serviced by Western Power. Based on an initial assessment, a minimum of a 1MVA site supply will be required to service Stage 1, however, this is likely to increase once further information is provided on the use of the site and detailed electrical equipment details. The minimum load requirement for Stages 2 and 3 is estimated to be a total of approximately 700kVA, and likely to increase once further information is provided on the use of the Factory/Warehouse Units and detailed electrical equipment details. Based on organic load growth in the area, capacity does not appear to be constrained for the duration of the 10-year forecast.

6.4.4 Communications

As per the Federal Government's Telecommunications In New Developments policy the Developer is now responsible for the cost of delivering communications infrastructure in new developments (i.e. new pit & pipe and cables & equipment). DBYD plans indicate Telstra Pit and Pipe network running along Brook Road and Welshpool Road East, with the subject site being serviced by a 5-Pit on Brook Road. NBN Fibre to the Node (**FTTN**) infrastructure is currently planned to be made available for the subject site by October – December 2018. Given the area is going to be serviced by FTTN technology, it is likely that NBN will be made available through Telstra's Pit and Pipe network.

6.4.5 Natural gas supply

The DBYD information shows an existing 155PVC gas main along Welshpool Road East at the corner of Brook Road fronting the site. The site can therefore be serviced with natural gas.

6.5 Environmental

6.5.1 Native Vegetation

Environmental studies have been undertaken which indicate that the subject site does not contain vegetation of significance such as Declared Rare Flora or Endangered Ecological Communities.

The subject site was formerly located within Bush Forever site 387 (Greater Brixton Street Wetlands). Through the MRS rezoning process (MRS Amendment 1235/57), the former Department of Planning's Resource Protection branch raised no objection to the exclusion of the subject site and rationalisation of Bush Forever site 387.

The land to the south of the subject site contains remnant vegetation and forms part of a Conservation Category Wetland (**CCW**). The CCW area and 50m buffer are located outside of the subject site, and are reserved for Parks and Recreation under the MRS. This ensures the environmentally sensitive area remains in public ownership for conservation purposes.

A flora, vegetation and wetland assessment was undertaken by 360 Environmental in Spring 2008. There was no conservation significant flora located within the subject site. The vegetation units within the adjoining wetland area are part of the Guildford Vegetation complex. The vegetation at the wetland is predominantly *Melaleuca woodland* over low open shrubs or naturalised alien grasses. There were no conservation significant vegetation communities present in the wetland.

Using the vegetation condition assessment scale found in Bush Forever, the subject site was mostly considered 'completely degraded', with some areas of 'completely degraded to degraded'.

The CCW has previously been identified as potentially providing habitat for a range of fauna, however, is not a habitat for rare or endangered fauna. The 50m buffer between the CCW and the subject site provides an adequate separation for any fauna that may utilise the CCW as habitat.

6.5.2 Wetlands

There are no Ramsar wetlands or Directory Important Wetlands within the subject site. The subject site is located within a Resource Enhancement Wetland. The land immediately south of the subject site (Lot 811 (37) Brook Road) forms part of a CCW. A 50m buffer is provided between the southern boundary of the subject site and the CCW. Both the CCW and associated buffer are in public ownership, and remain within the Parks and Recreation reserve and Bush Forever Area notification under the MRS to ensure the land is protected for conservation purposes.

The Greater Brixton Street Wetland complex is located to the south of the subject site, covering approximately 90 hectares and containing over 320 plant species, representing more than 20% of Perth's floristic biodiversity. The Brixton Street Wetland was entered into the Directory of Important Wetlands in Australia in 1992 and placed on the Register of the National Estate of the Australian Heritage Commission in 2000. The wetland system is protected under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) and has been identified for conservation within Bush Forever Site 387. The Bush Forever Site is considered one of the most floristically diverse areas of the Swan Coastal Plain.

6.5.3 Contamination

A search of the Department of Water and Environmental Regulation's (**DWER**) Contaminated Sites Database indicates that the subject site is not registered as a contaminated site.

6.5.4 Acid Sulfate Soils

The DWER acid sulfate soils (**ASS**) risk map identifies the subject site as having moderate to low risk of ASS occurring within 3m of natural soil surface, but high to moderate risk of ASS beyond 3m of natural soil surface.

Given the site does not fall within an area of high to moderate acid sulfate soils occurring within 3m of natural soil surface, further acid sulfate soils investigations is not considered necessary for the proposed scheme amendment, consistent with the guidance provided in the WAPC's Acid Sulfate Soils Planning Guidelines.

6.6 Heritage

6.6.1 Indigenous heritage

A search of the DPLH's Aboriginal Heritage Inquiry System provides details on the location and extent of Registered Aboriginal Sites and Other Heritage Places in a given area, as well as providing information about previous surveys. The subject site has formed part of previous heritage surveys, however does not contain any registered aboriginal sites or other heritage places.

6.6.2 European heritage

The subject site does not contain any European heritage sites listed on the State Register of Heritage Places, local government inventory or other lists.

7 Amendment justification

7.1 Strategic planning framework

The proposal is consistent with the intent of the State Government's key strategic planning documents, including Directions 2031 and the Employment and Economic Lands Strategy, and endorsed local strategic planning documents, including the City's Local Planning Strategy and planning for the Maddington Kenwick Strategic Employment Area; all of which identify the subject site for light industrial development.

The proposed scheme amendment will facilitate the development of the subject site for a mixed commercial and light industrial centre. This will assist in achieving the City's target for increased local employment opportunities. The site is appropriately located to accommodate the proposed mixed commercial and light industrial development, given its location along the Wattle Grove industrial / residential interface. The proposed form of development ensures an appropriate transition between existing residential development to the north of Welshpool Road East and progressing industrial development to the south and west of the subject site.

The Special Control Area provisions proposed as part of this scheme amendment ensure all planning and environmental considerations are addressed through the subdivision and development of the land.

7.2 Statutory planning framework

The subject site is currently zoned Industrial Development under the City's LPS3. In accordance with clause 4.2 of LPS3, the objective of the Industrial Development zone is to provide for the orderly and proper planning through the preparation and adoption of a Structure Plan establishing the overall design principles for the area. In addition, the zone seeks to permit the development of the land for industrial purposes and for commercial and other uses normally associated with industrial development.

Where a Structure Plan was previously a statutory planning document, upon the gazettal of the Regulations in October 2015, Structure Plans were modified to be planning instruments of 'due regard'. To this end, a decision-maker for development or subdivision approval in an area that is covered by a Structure Plan that has been approved by the WAPC is to have due regard to, but is not bound by, the Structure Plan when deciding the application.

Furthermore, given a Structure Plan is no longer statutory document, land use permissibility is unable to be altered through a Structure Plan. As such, should a Structure Plan be prepared and approved for the subject site, a rezoning would still be required to allow for any land uses to be approved, which aren't currently capable of approval within the Industrial Development zone. This would be a duplication in process and would only add another layer to the planning framework which is not required. In this instance, there are no matters which would require resolution through a structure plan, that could not be appropriately addressed through the scheme amendment and proposed Special Control Area provisions for the subject site.

Given the above, the proposed rezoning of the subject site to Light Industry in the absence of a Structure Plan is considered appropriate, and will facilitate the future development of the site for mixed commercial and light industrial purposes.

7.3 Local development plan

Schedule 2 of the Regulations sets out the Deemed Provisions for all local planning schemes. These include provisions relating to LDP's, which now form part of LPS3.

Following preliminary engagement with the City, it was noted that Design Guidelines would be required to address the interface of the subject site to Welshpool Road East. An LDP is the most appropriate instrument to achieve this intent.

Schedule 2, Part 6, clause 47 of the Regulations sets out the instances where a LDP may be prepared. For the subject site, clause 47(d) applies, which states:

1. *the Commission and the local government considers that a local development plan is required for the purposes of orderly and proper planning.*

Given the above, it will be necessary to seek the agreement of the Commission and City to prepare LDP for the subject site, for the purposes of orderly and proper planning.

The Framework for Local Development Plans (August 2015) expands on clause 47 of the Regulations, detailing more specific circumstances where an LDP may be considered appropriate, including:

- *lots where specific vehicle access and egress control is required;*

The subject site abuts the Welshpool Road East Primary Regional Roads reservation to the north. It is important that any future development within the site appropriately addresses this interface.

Welshpool Road East is classified by Main Roads WA as a Category 2 road, meaning frontage access may be allowed subject to approval. Any proposed direct access to/from Welshpool Road East will need to consider a range of matters, including the effects of the development on traffic flow and safety, the ultimate volume and type of traffic generated by the development, and compliance with Main Roads WA and Austroads guidelines and standards.

Given the above, it is recommended that a LDP is prepared and lodged with the City for approval, prior to the development of the subject site.

8 Conclusion

It is considered the proposed amendment to LPS3 should be supported, recognising the proposed amendments are consistent with the applicable strategic and statutory planning framework, and will facilitate the development of the subject site for a high quality mixed commercial and light industrial centre.

In summary, the proposed amendment to LPS3 warrants initiation for the following reasons:

1. The proposal is entirely consistent with the relevant State and local level strategic planning framework, which encourages the development of the subject site and surrounding area for light and general industrial purposes.
2. The proposal will allow for the continued development of the land within the Maddington Kenwick Strategic Employment Area for a mix of General Industrial/Business and Light Industrial/Composite uses.
3. The proposal includes suitable mechanisms to ensure an appropriate interface between future development on the subject site and Welshpool Road East is achieved.
4. The proposal is supported by expert reporting, demonstrating the subject site is able to suitably accommodate the proposed mixed commercial and light industrial development.
5. The proposal will allow the land to be developed in a manner that will contribute positively to the locality.

In light of the information presented within this report, the City of Kalamunda is respectfully requested to initiate the proposed Scheme Amendment for the purposes of public advertising and to subsequently support the proposal, without modification.

Appendix 1
Certificates of Title and Deposited Plans

WESTERN AUSTRALIA

REGISTER NUMBER	
810/DP69210	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	15/7/2015

VOLUME 2880 FOLIO 7

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 810 ON DEPOSITED PLAN 69210

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

E & D LITIS PTY LTD OF SUITE 2, 137 BURSWOOD ROAD, BURSWOOD

(AF N047140) REGISTERED 30/6/2015

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. L309177 MORTGAGE TO BENDIGO AND ADELAIDE BANK LTD REGISTERED 17/6/2010.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

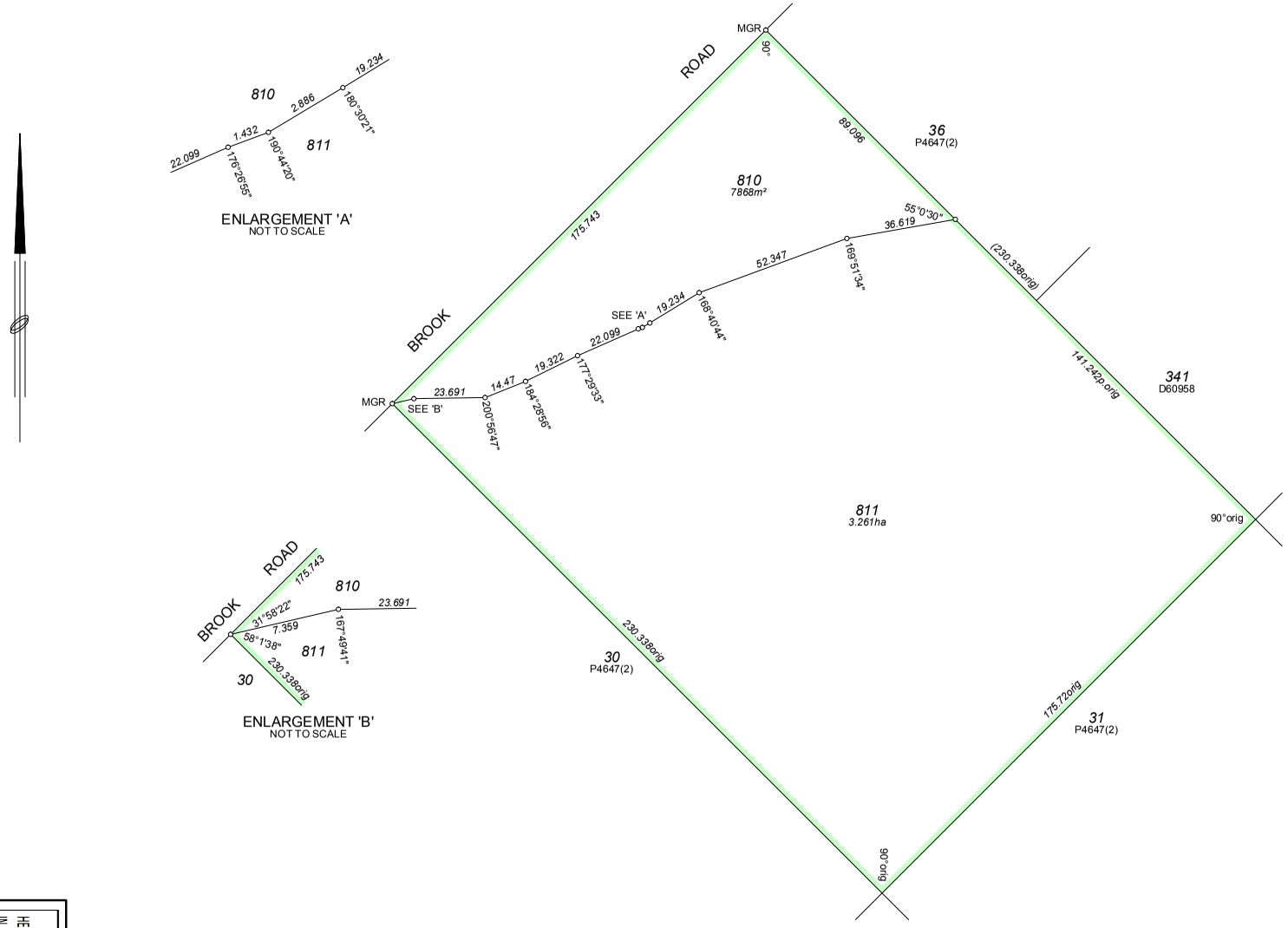
STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP69210
PREVIOUS TITLE:	1276-978
PROPERTY STREET ADDRESS:	31 BROOK RD, WATTLE GROVE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF KALAMUNDA

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Jul 21 11:08:36 2017 JOB 54428517
City of Kalamunda
www.landgate.wa.gov.au
Public Agenda Briefing Forum - 12 June 2018 Attachments
Attachment 10.1.4.1

VER.	AMENDMENT	AUTHORISED BY	DATE



TYPE: FREEHOLD

PURPOSE: SUBDIVISION

PLAN OF

LOTS 810 & 811

DISTRICT: CANNING	SSA: NO
TOWNSITE:	FORMER TENURE: LOT 32 P4647(2) C/T 1276-978
FILE:	
LOCAL AUTHORITY: SHIRE OF KALAMUNDA	
LOCALITY: WATTLE GROVE	FIELD BOOK: 129100
INDEX ON: SEE SMARTPLAN	

SCALE: @ A2 1:1000 (0 10 20 30 40 50)
ALL DISTANCES ARE IN METRES

SURVEYOR'S CERTIFICATE - Reg 54

I STUART WILCOX hereby certify that this plan is accurate and is a correct representation of the -
(a) *survey; and/or
(b) *calculations from measurements recorded in field records,
[*delete if inapplicable]
undertaken for the purposes of this plan and that it complies with the relevant written law(s) in relation to which it is lodged.

Licensed Surveyor — Date

SURVEYORS CERTIFICATE - Compiled

I ... hereby certify that this compiled plan
(a) is a correct and accurate representation of the survey(s) of the subject land; and
(b) is in accordance with the relevant law(s) in relation to which it is lodged.

Licensed Surveyor — Date

SURVEY FIRM: JBA SURVEYS

LODGED		APPROVED BY WESTERN AUSTRALIAN PLANNING COMMISSION
DATE: 2-FEB-2015	EXAMINED: E. Milewska 4.02.2015	FILE: WAPC/13/0143
FEE PAID: $400.00		17-Feb-2015 DATE
ASSESS No.: 16696250		Delegated Under S.16 P & D Act 2005

IN ORDER FOR DEALINGS

SUBJECT TO

19.02.2015

FOR INSPECTOR OF PLANS & SURVEYS / AUTHORIZED LAND OFFICER — DATE

APPROVED

30 JUNE 2015

INSPECTOR OF PLANS & SURVEYS / AUTHORIZED LAND OFFICER — DATE

Landgate
Western Australian Land Information Authority

DEPOSITED PLAN

69210

SHEET 1 OF 1
VERSION 1

HELD BY LANDGATE IN DIGITAL FORM ONLY.

JBA SURVEYS
12B Pepler Ave, Salter Point WA 6152
Ph: 9450 7188 Fax: 9450 7199
email: admin@jbasurveys.com.au
web: www.jbasurveys.com.au

INTERESTS AND NOTIFICATIONS

SUBJECT	PURPOSE	STATUTORY REFERENCE	ORIGIN	LAND BURDENED	BENEFIT TO	COMMENTS

Our Ref: 14226 69210.CSD

WESTERN AUSTRALIA

REGISTER NUMBER	
36/P4647	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	18/5/2010

VOLUME 1228 FOLIO 739

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 36 ON PLAN 4647

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

EVANGELOS LITIS NOMINEES PTY LTD OF 4A MAJESTIC CLOSE, APPLECROSS
(T C978291) REGISTERED 15/3/1985

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. L309172 MORTGAGE TO BENDIGO AND ADELAIDE BANK LTD REGISTERED 7/5/2010.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

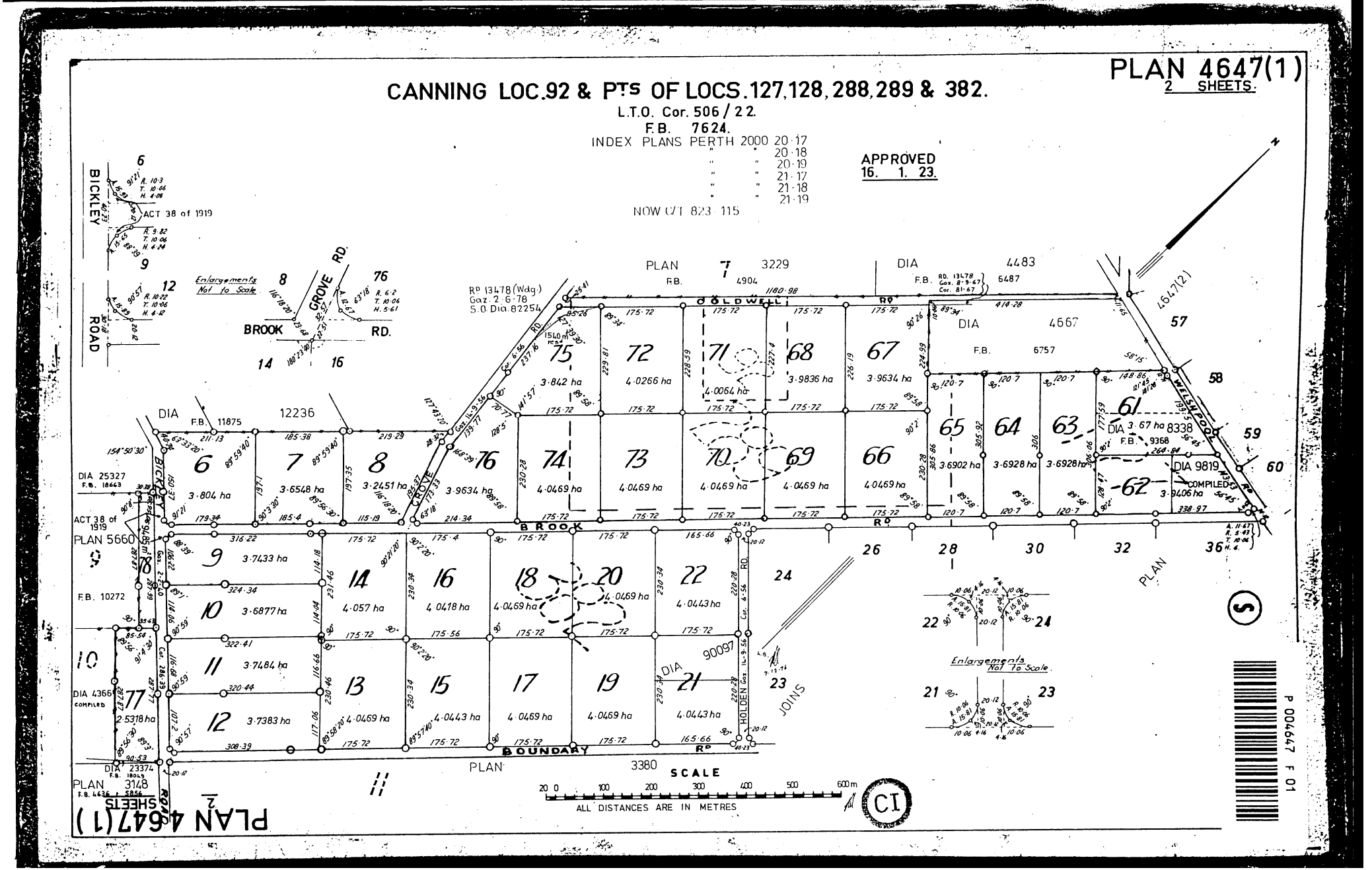
----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	1228-739 (36/P4647)
PREVIOUS TITLE:	1094-846
PROPERTY STREET ADDRESS:	655 WELSHPOOL RD EAST, WATTLE GROVE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF KALAMUNDA

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Jul 21 11:13:12 2017 JOB 54428635
City of Kalamunda



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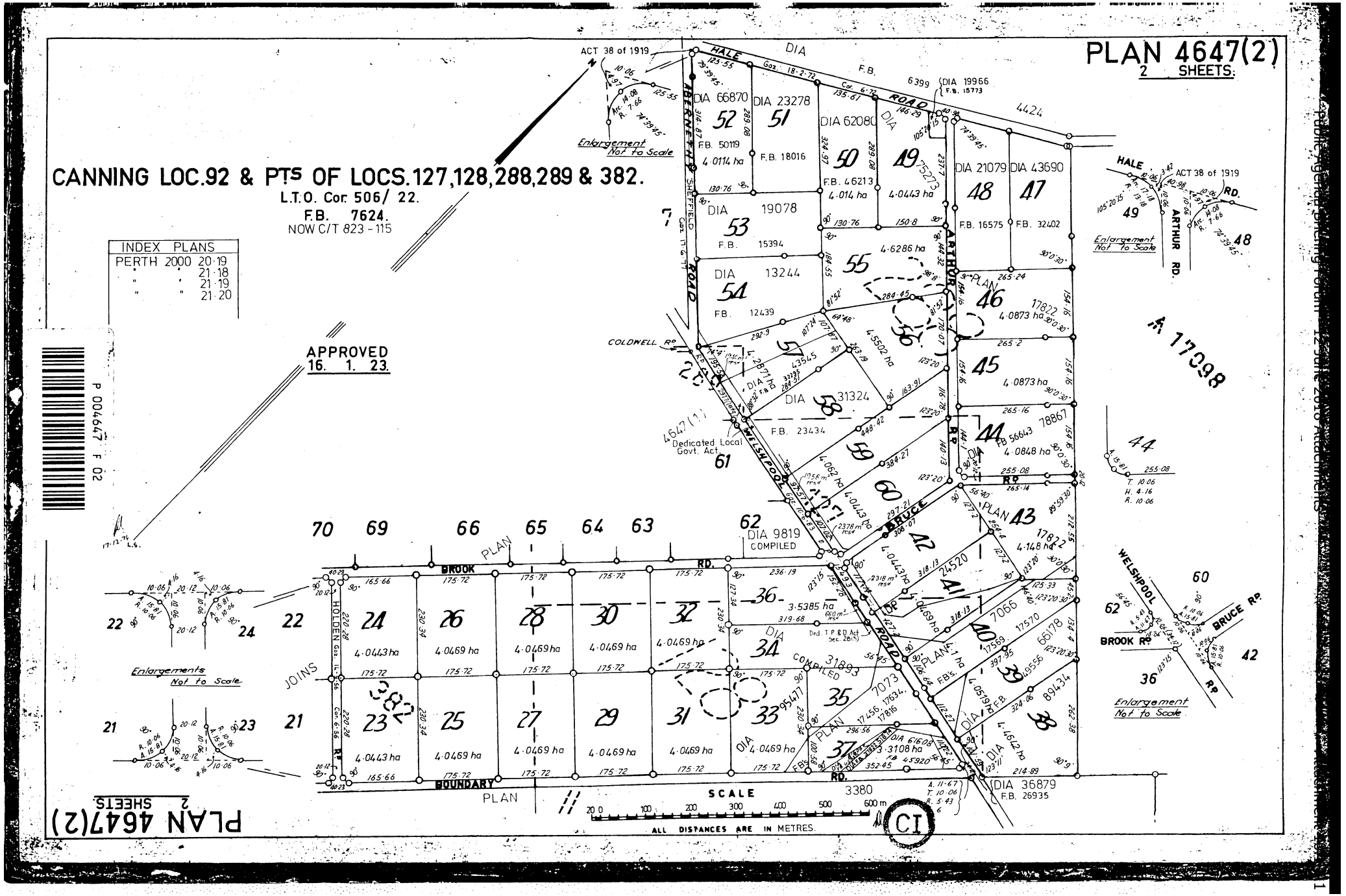
City of Kalamunda



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41781/59 Transfer 13769/1959 (12946)
Volume 1094 Folio 846

INDEXED.

REGISTER BOOK.

Vol. 1228 *Fol.* No. 739

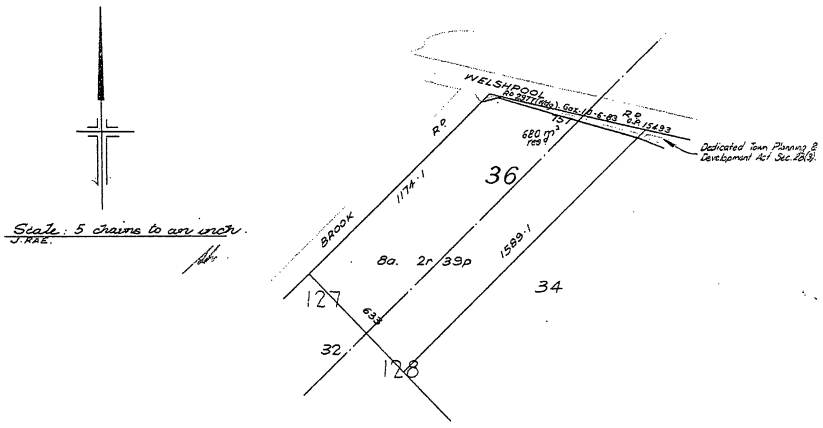
WESTERN AUSTRALIA.

Certificate of Title

CT 1228 0739 F

under "The Transfer of Land Act, 1893" (56 Vic., 14. Sch. 5).

Joseph Bertram Thomas Caterer, Poultry Farmer, and Edith Pretoria Caterer, his wife, both of Welshpool Road, Wattle Grove, are now the proprietors as joint tenants of an estate in fee simple subject to the easements and encumbrances notified hereunder in all that piece of land delineated and coloured green on the map hereon containing eight acres two roods and thirty-nine perches or thereabouts, being portion of each of Canning Locations 127 and 128 and being Lot 36 on Plan 4647.



Dated the eleventh day of September One thousand nine hundred and fifty-nine.

Registrar of Titles.

Application 39709/66 On the 1st April 1964 Edith Pretoria Caterer died and thereupon Joseph Bertram Thomas Caterer became the sole proprietor of the within described land by survivorship

17th June 1966 Asst. Registrar of Titles.

Transfer A 186463 to E + D Litis Pty Ltd of 1013 Albany Highway, East Victoria Park. Registered 1st July 1969 at 9.22 o'c.

Transfer C978291 to Evangelos Litis Nominees Pty. Ltd. of care of Barrett & Partners 23 Richardson Street, South Perth. Registered 15th March, 1985 at 10.33 o'c.

OFFICE OF TITLES Western Australia

The correct address of the registered proprietor is now 1013 Albany Highway, East Victoria Park. By G27335. Dated 13th November 1995 at 8.20 hrs.

OFFICE OF TITLES Western Australia

5339/5/57—24,402—tt/c

For encumbrances and other matters affecting the land see back.

Superseded - Copy for Sketch Only

Landgate
www.landgate.wa.gov.au

EASEMENTS AND ENCUMBRANCES REFERRED TO

Mortgage A108968 to Albert Percival Knowlton of 15 Alexander Drive Mount Lawley Farmer Registered 3rd December 1958 at 11.00 o'c

Discharge A146215 of Mortgage A108968. Registered 24th March 1969 at 9.42 o'c.

Mortgage B601995 to The Commercial Bank of Australia Limited Registered 13th October 1978 at 9.30 o'c

DISCHARGED

Discharge B873863 of Mortgage B601995. Registered 4th March, 1980 at 9.14 o'c.

Mortgage C3605 to The Commercial Bank of Australia Limited. Registered 7th October, 1980 at 9.07 o'c.

DISCHARGED

Discharge C62832 of Mortgage C3605. Registered 19th January, 1981 at 9.14 o'c.

Mortgage C62833 to The Commercial Bank of Australia Limited. Registered 19th January, 1981 at 9.15 o'c.

DISCHARGED

Discharge C727614 of Mortgage C62833. Registered 13th March, 1984 at 9.05 o'c.

Mortgage G27335 to National Australia Bank Ltd. Registered 13th November 1995 at 8.20 hrs.

DISCHARGED

Discharge G218793 of Mortgage G27335. Registered 2nd July, 1996 at 11.02 hrs.

Mortgage G298810 to The National Mutual Life Association of Australasia Ltd. Registered 8th October, 1996 at 15.02 hrs.

DISCHARGED

Discharge H252759 of Mortgage G298810. Registered 18th October 1999 at 8.17 hrs.

Mortgage H252760 to Bank of Western Australia Ltd. Registered 18th October 1999 at 8.17 hrs.

Superseded - Copy for Sketch Only

CT 1228 0739 B

CERTIFICATE OF TITLE

Vol. 1228 Fol. 739

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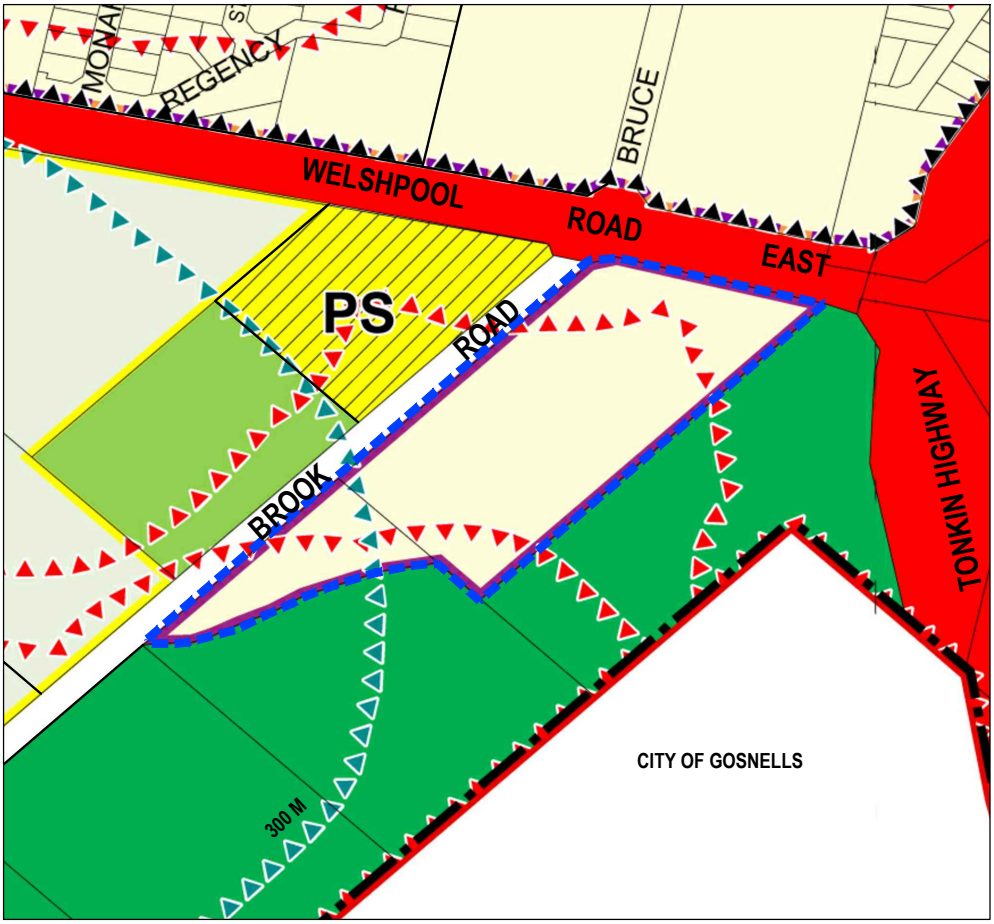
Appendix 2
Scheme Amendment Map



LEGEND

- Subject Site

REGION SCHEME RESERVES (MRS)

- Primary Regional Roads
- Parks and Recreation

LOCAL SCHEME RESERVES

- PS — Public Purposes : Primary School

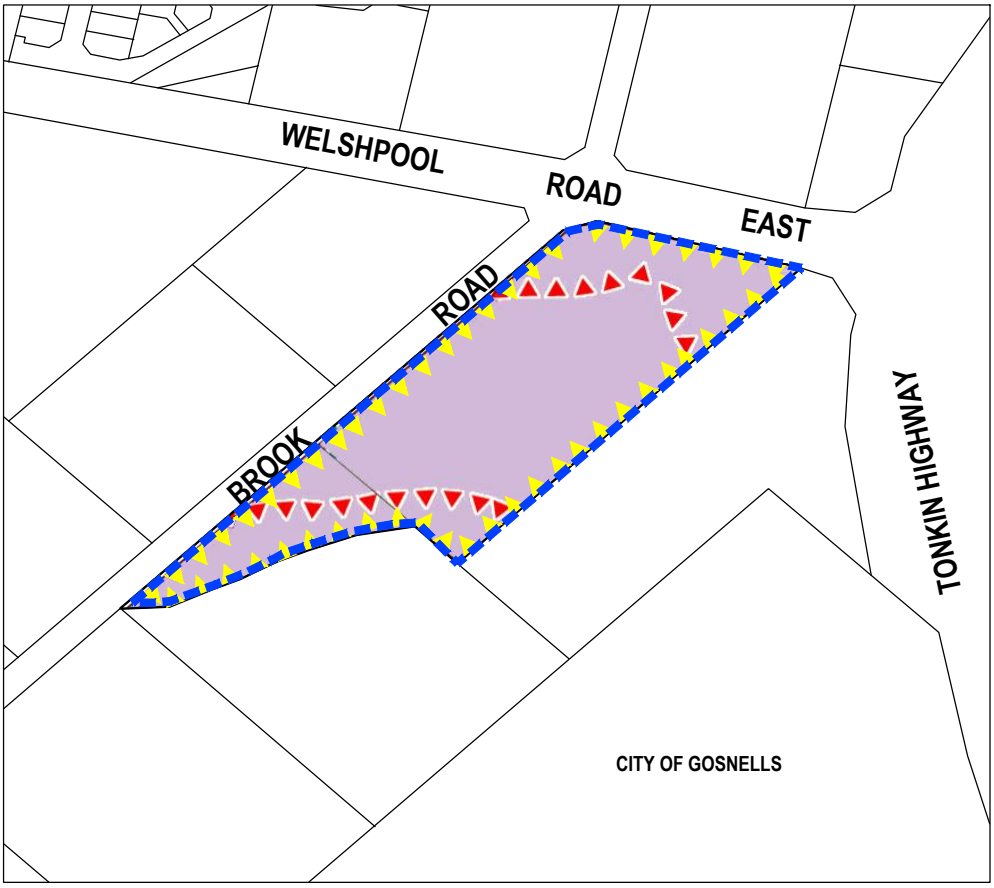
LOCAL SCHEME ZONES

- Industrial Development
- Private Clubs and Institutions
- Special Rural
- Urban Development

OTHER CATEGORIES

- Scheme Area Boundary
- Local Government Boundary
- Bushfire Prone Areas
- Development Area
- Cell 9 SCA - Urban Cell
- SC4 SCA - Poultry Buffer

EXISTING ZONING



LEGEND

- Subject Site

LOCAL SCHEME ZONES

- Light Industry

OTHER

- Bushfire Prone Area
- SCA7 - Special Control Area

PROPOSED ZONING

PLANNING SOLUTIONS | PS
URBAN & REGIONAL PLANNING

SCALE	1: 5,000 @ A4
DATE	19 March 2018
FILE	02 180319 5328 Zoning Map.dwg
REVISION	4/DR/3Rev/19.03.2018 3/OW/2Rev/11.01.2018 2/OW/1Rev/08.01.2018

Scale Bar (m) 0 50 100

SCHEME AMENDMENT MAP - CITY OF KALAMUNDA LOCAL PLANNING SCHEME NO.3

LOT 36 (655) WELSHPOOL ROAD EAST AND LOT 810 (31) BROOK ROAD WATTLE GROVE, WESTERN AUSTRALIA

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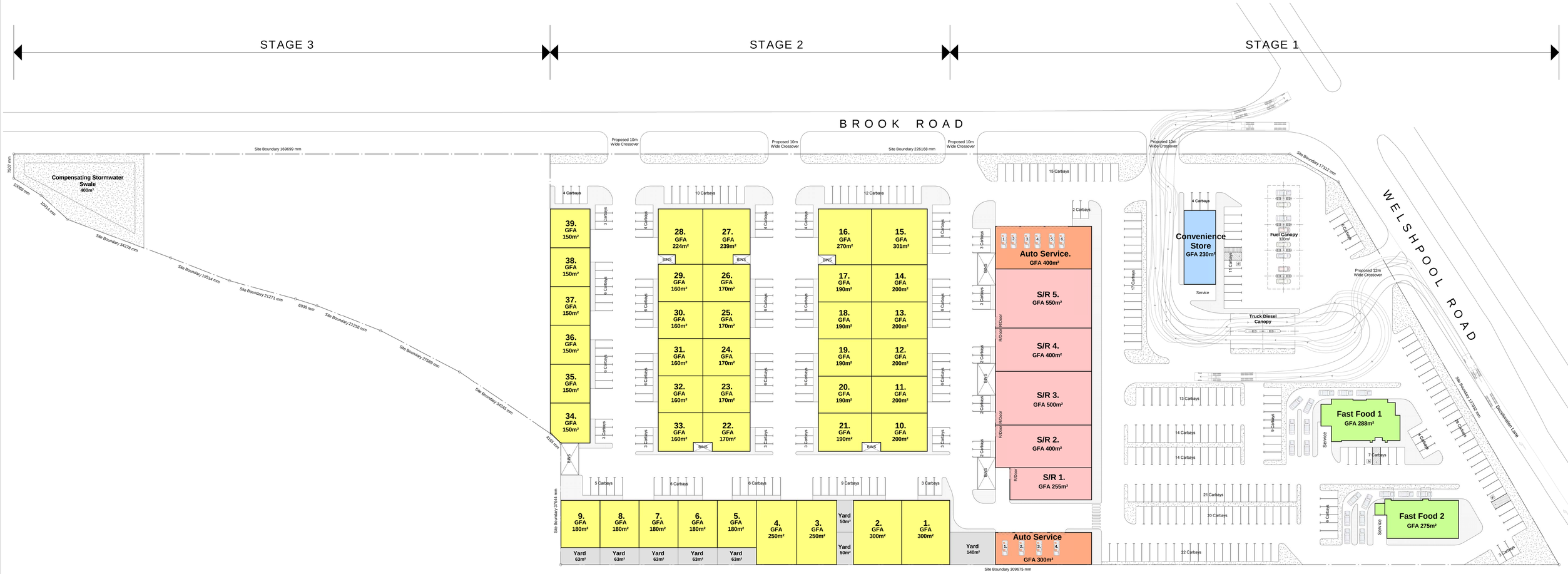
Appendix 3
Concept Development Plan



STAGE 1 - SITE CRITERIA

1. Overall Site Area		42,551.7m²
Stage 1		19,331.3m²
2. Floor Area		
a. Convenience Store		230m²
b. Fast Food		563m²
c. Showroom		2,105m²
d. Car Service		300m²
e. Auto Service		400m²
Total		**3,598m²**
3. Carparking		
i. Required		
a. Convenienve Store	230m² @ 6/100m²	13.8
	+ 1 per bowser	5.0
b. Fast Food	563m² @ 10/100m²	56.3
c. Showroom	2,105m² @ 4/100m²	84.2
d. Auto Service	@ 4 Bays to Working Bay	16.0
	+ 1 per employee	6.0
e. Auto Service	@ 4 Bays to Working Bay	24.0
	+ 1 per employee	8.0
Total		**213.3 Carbays**
ii. Provided		
a. On Site		228
b. Drive Thru		18
Total		**246 Carbays**

STAGE 2 - SITE CRITERIA

1. Overall Site Area		42,551.7m²
Stage 2		15,796.2m²
2. Floor Area		
a. Industrial		7,534m²
b. Yard		500m²
Total		**8,034m²**
3. Carparking		
i. Required		
a. Industrial	7,534m² @ 2/100m²	150.7
	500m² @ 2/100m²	10.0
Total		**160.7 Carbays**
ii. Provided		
a. On Site		151
Overall Site Carparking		
i. Required		
a. Stage 1		213.3
b. Stage 2		160.7
Total		**374 Carbays**
ii. Provided		
a. Stage 1		246
b. Stage 2		151
Total		**397 Carbays**

SITE PLAN

SCALE: 1 : 500

Landscaping
A. Hard Landscaping
Defined as paved walkways either open or covered.
B. Soft Landscaping
Defined as vegetative landscaping.

Gross Floor Area : GFA
A. All Floor Areas on this plan are shown as GROSS FLOOR AREA.
Unless otherwise noted as Nett Floor Area.
B. Definition of Gross Floor Area is defined as:
i/ GROSS FLOOR AREA OF TENANCY:
Gross Floor Area of an individual Tenancy is defined as the area contained between the centre line of common tenancy walls and the outside edge of external walls.
ii/ GROSS FLOOR AREA OF A BUILDING:
Gross Floor Area of a Building is defined as the total area contained between the outside edge of external walls

Nett Floor Area : NFA
A. Nett Floor Area of a Tenancy on this plan is defined as the area between external or tenancy dividing walls.
B. This area is inclusive of toilets if the toilets are exclusive to the Tenancy.

PROPOSED LIGHT INDUSTRIAL DEVELOPMENT
LOCATION:LOT 32 & 36, BROOK ROAD, WATTLE GROVE WA
FOR:Mr. J. LITIS

SK006
FEB 2018
1
As indicated @ B1

7795

5 10 15 20 25 50

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PO Box 1294 Subiaco WA 6904
t: 08 9381 8511 f: 08 9388 1339



N

SITE PLAN

SCALE: 1 : 1,500

PROPOSED LIGHT INDUSTRIAL DEVELOPMENT
LOCATION:LOT 32 & 36, BROOK ROAD, WATTLE GROVE WA
FOR:Mr. J. LITIS

SK006
FEB 2018
1
As indicated @ B1

7795

Appendix 4
MRS Clause 42 Certificate

Western Australian Planning Commission

Enquiries: Trevor Servaas (08) 6551 9110
Our Ref: 42 / 55700974
Your Ref: 5328

PLANNING SOLUTIONS (AUST) PTY LTD
LVL 1, 251 ST GEORGES TCE
PERTH
6000 WA

Dear Sir/Madam

CERTIFICATE UNDER CLAUSE 42 OF THE METROPOLITAN REGION SCHEME ISSUED BY THE WESTERN AUSTRALIAN PLANNING COMMISSION

In reply to your request, please find enclosed
Certificate Number: 55700974

It is advised that the enclosed Certificate has been prepared to conform with the current Statutory requirements (as at the date of signature) of the Metropolitan Region Scheme

Yours faithfully,

K M Blenkinsop

Kerrine Blenkinsop
Secretary
Western Australian Planning Commission

8 January 2018

wa.gov.au

Postal address: Locked Bag 2506 Perth WA Street address: 140 William Street Perth WA 6000
Tel: (08) 6551 8002 Fax: (08) 6551 9001 TTY: 6551 9007 Infoline: 1800 626 477
info@dplh.wa.gov.au www.dplh.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

Metropolitan Region Scheme

Form 5

Scheme Certificate

In accordance with clause 42 of the

Metropolitan Region Scheme the following information relates to:

Certificate: 55700974

Receipt: None

Date: 8/01/2018

Location: Welshpool Rd, Wattle Grove

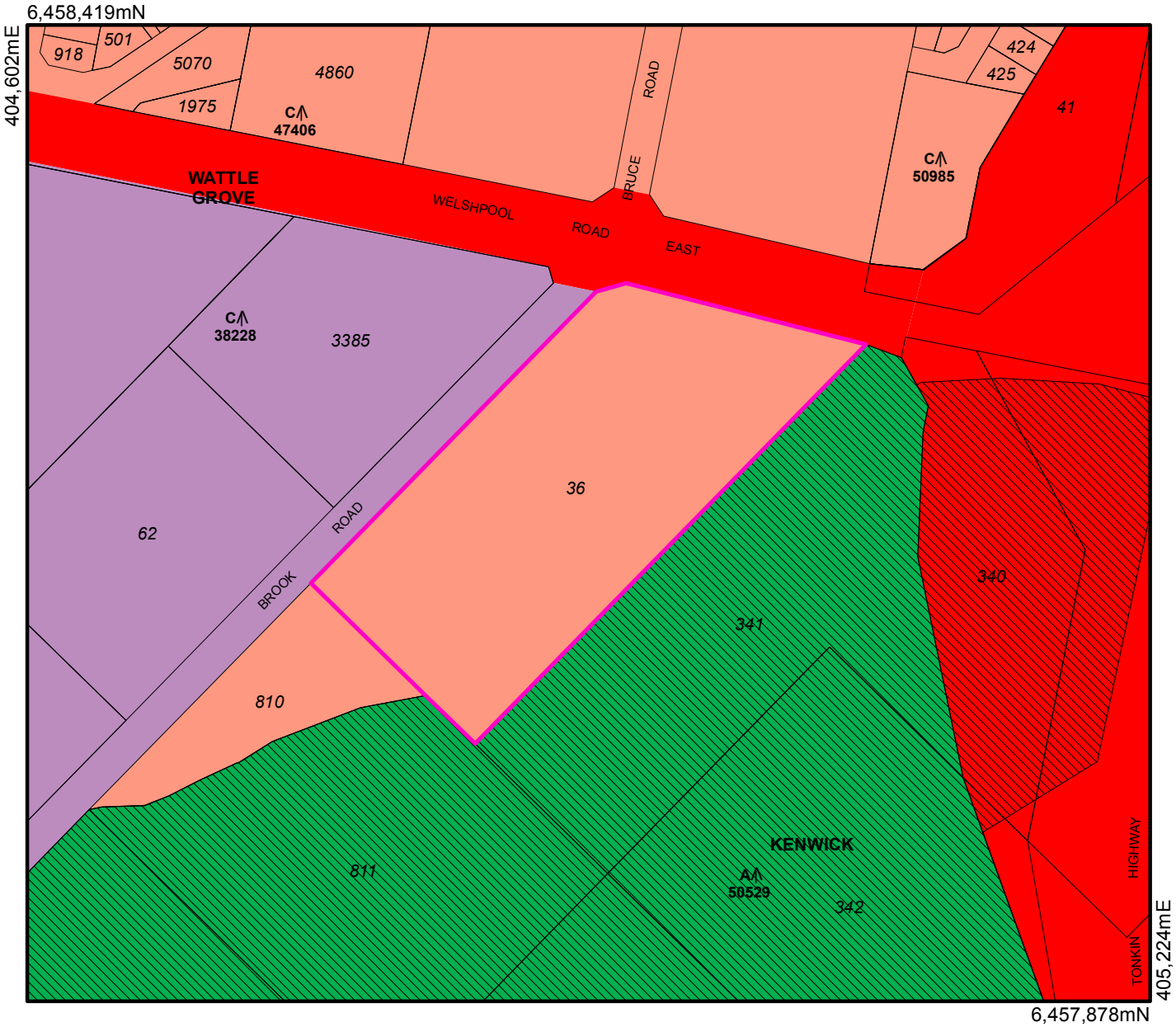
Certificate of Title: Vol: 1228 Folio:739

Plan: 4647

Legend for reserved land and zones

Bush forever areas | Parks and recreation | Urban

Industrial | Primary regional roads



This certificate relates only to the provisions of the:

Metropolitan Region Scheme

and does not claim to indicate the land use allocation under any local government provision.

Produced by Geospatial Research and Modelling, Department of Planning, Lands and Heritage, Perth WA.

Base information supplied by:
Western Australian Land Information Authority LI 862-2016-1

N

0 30 60 90 120

metres

Coordinates based on MGA Zone 50 (GDA 94)
All dimensions are in metres
Subject to survey

Kerrine Blenkinsop
Secretary
Western Australian Planning Commission

Appendix 5
Transport Impact Assessment

Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove

Proposed Scheme Amendment

Transport Impact Assessment

PREPARED FOR:
Evangelos Litis Nominees Pty Ltd

March 2018

Document history and status

Author	Revision	Approved by	Date approved	Revision type
M Rasouli	r01a	B Bordbar	06/03/2018	Draft
M Rasouli	r01b	B Bordbar	19/03/2018	Final

File name: t17.253.mr.r01b

Author: Mohammad Rasouli

Project manager: Mohammad Rasouli

Client: Evangelos Litis Nominees Pty Ltd

Project: Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove

Document revision: r01b

Project number: t17.253

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1.0 Introduction

This Transport Impact Assessment (TIA) report has been prepared by Transcore on behalf of Evangelos Litis Nominees Pty Ltd. The subject of this transport assessment is the proposed rezoning for Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, in Wattle Grove.

The site is currently vacant and zoned “Urban” in Metropolitan Region Scheme (MRS) and zoned “industrial” development under the City of Kalamunda Local Planning Scheme No.3 (LPS3). It is proposed to undergo a rezoning process to achieve “Light Industry” zoning under LPS3. **Figure 1** shows the subject site in relation to the different zones and reservations of the Metropolitan Region Scheme.



Figure 1: Location of the subject site

This TIA provides an overview of the trip generation and distribution of the land uses resulting from the proposed rezoning and will assess the impact of the assumed development traffic on surrounding roads and intersections. For the preparation of this TIA the following relevant document has been reviewed and considered:

- MKSEA Precinct 3, Transport Assessment, Cardno July 2016.

2.0 Proposed Development Plan

The proposed Development Plan prepared for the area subject to the rezoning application is shown in **Figure 2**. The proposal is for mix of commercial and light industrial uses, which is proposed to be constructed in three stages. The land use data for the first two stages of the development is shown in Figure 2. Stage 3 is expected to be industrial/ warehouse uses (about 3,300m^2 GFA) and will be constructed within the western portion of the Subject site.

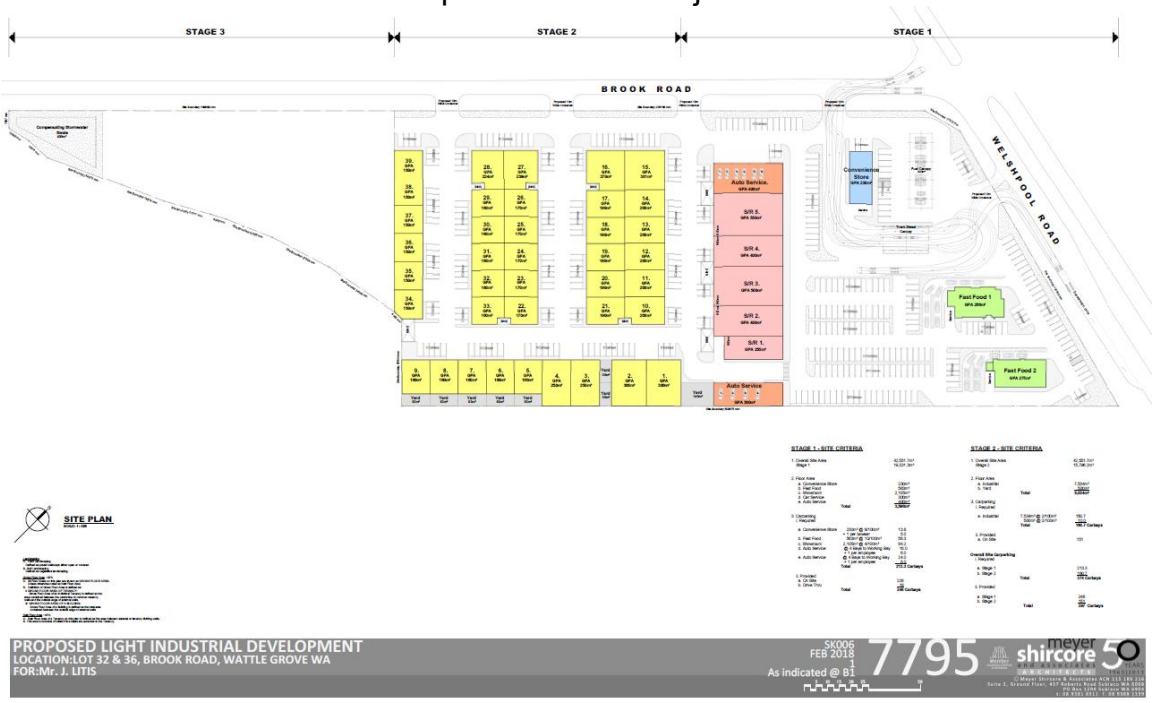

Figure 2: Proposed Development

The proposed land uses and car park provision for the first two stages of the development are summarised in **Table 1**.

Table 1: Proposed Land uses and car parking requirements

Stage 1			Stage 2	
Land use	GFA (m2)	Car parking required	GFA (m2)	Car parking required
Convenience Store	230	24		
Fast Food	563	56		
Showroom	2,105	84		
Motor vehicle repair	700	50		
Warehouse			7,534	125
Total		214	Total	125

Note: Parking calculations approximate based on preliminary concept plan.

The parking provision for the Stage 1 and Stage 2 is 238 (including 10 bowser bays) and 151 respectively which results in 389 parking bays in total. Therefore the development entails a parking surplus of approximately 50 bays.

The access/egress arrangement for the proposed development entails a left in/ left out crossover on Welshpool Road East and four full movement crossovers on Brook Road. The proposed development plan in figure 2 does not show the potential crossover/s on Brook Road for Stage 3. However it is expected that at least one additional crossover would be provided on Brook Road for Stage 3.

The proposed left in/ left out crossover on Welshpool Road entails a 100m left turn deceleration lane on Welshpool Road East in line with Austroads requirements for the posted speed limit of 70km/h on this section of Welshpool Road East.

The proposed left in/ left out crossover on Welshpool Road is in line with the Main Roads WA Driveway Policy for service stations on a State road and on a corner lot and will improve accessibility and permeability of the proposed development. It is also necessary for satisfactory and efficient traffic circulation and operation of the service vehicles, particularly fuel tankers.

Considering that an appropriate deceleration lane of 100m is proposed for the proposed left in/ left out crossover intersection at this location no traffic operation or safety issues are expected at this crossover.

3.0 Existing Situation

3.1 Existing Land Use

The subject site currently is vacant. As shown in Figure 1, the land to the west of the subject site is currently zoned “Industrial” under MRS and the area to the south and east zoned ‘Parks and Recreation’ and designated as a ‘Bush Forever area’.

3.2 Existing Road Network

Welshpool Road East is a Primary Distributor road in accordance with Main Roads WA Functional Road Hierarchy and a classified as a Primary Regional Road in the Metropolitan Region Scheme. Welshpool Road East is of dual divided carriageway standard with a speed limit of 70 km/h in the vicinity of the subject site. According to traffic counts published by Main Roads WA Welshpool Road East in this vicinity (west of Tonkin Highway) carried 22,700vpd with 10% heavy vehicles in June 2016.



Figure 3: Welshpool Road East, looking west

Brook Road is of single carriageway standard with a speed limit of 60km/h in the vicinity of the subject site. According to Main Roads WA Functional Roads Hierarchy, Brook Road is an Access Road. According to traffic counts undertaken by Transcore on 28 November 2017 Brook Road carried about 94 and 120 vehicles during the AM (7:00-8:00) and PM (4:00-5:00) peak hours.



Figure 4: Brook Road, looking south

3.3 Public Transport

The closest bus services in the vicinity of the subject site are the existing bus routes 282 and 283 running along Welshpool Road East (refer **Figure 5**). The nearest bus stops are located about 200m to the west of the proposed development.

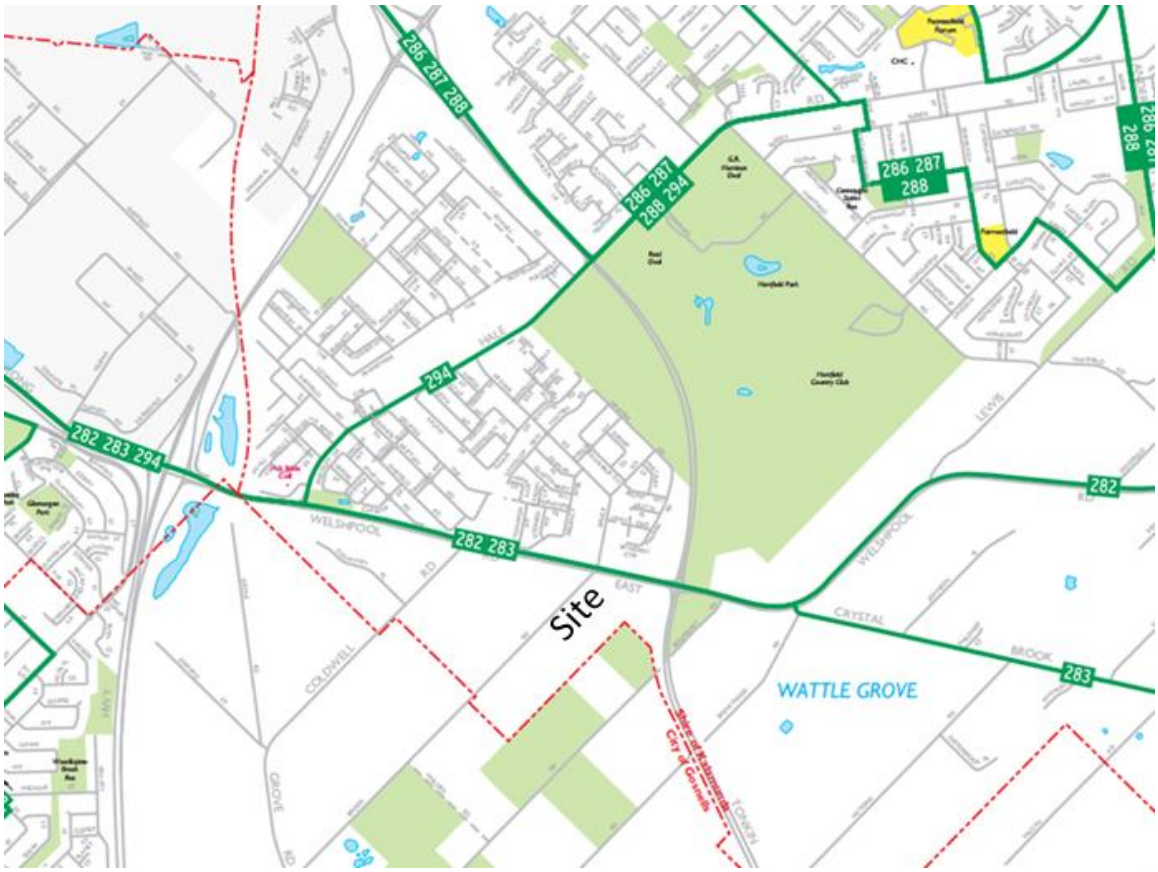

Figure 5: Existing bus routes

3.4 Pedestrian and Cyclist Facilities

The Department of Transport's Perth Bike Map series (see **Figure 6**) shows that a high quality shared path is in place along the south side of Welshpool Road East.

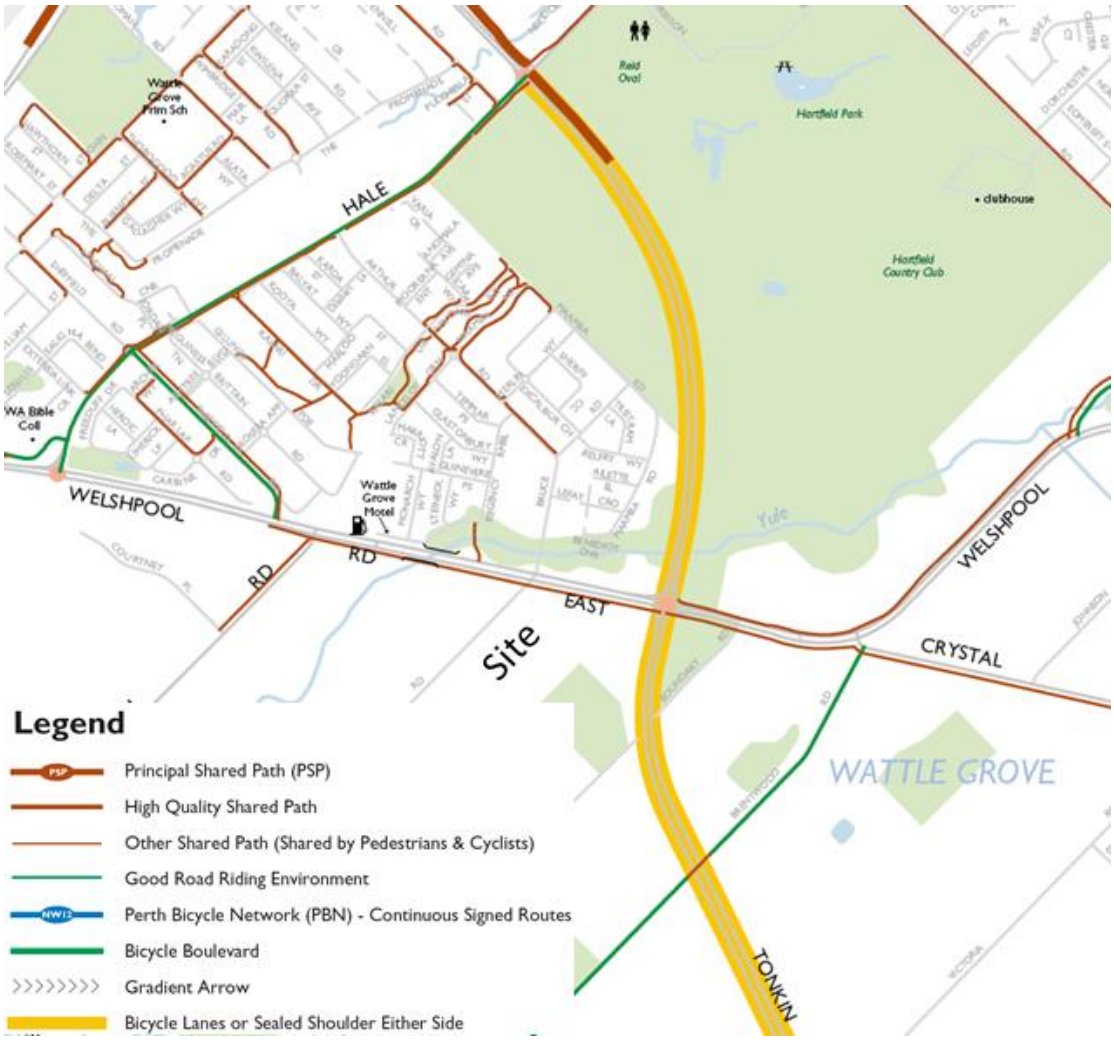

Figure 6: Bike map

3.5 Changes to the Surrounding Road Network

According to the information obtained from Main Roads WA, as part of the "Maddington Kenwick Strategic Employment Area (MKSEA) Precinct 3 Access Strategy" the following arrangements are proposed for the existing intersections along Welshpool Road East between Roe Highway and Tonkin Highway (as shown in **Figure 7**):

- Brook Road intersection will be downgraded to left in/ left out intersection;
- Traffic lights would be installed at the intersection of Coldwell Road and Welshpool Road East; and
- The intersection of realigned Grove Road and Welshpool Road East would be in the form of a left in/ left out intersection.



Figure 7: Proposed changes to the surrounding road network

3.6 Public Transport Network Planning

Currently there are bus services running along Welshpool Road East with bus stops within walking distance to the proposed development.

The subject site and the surrounding areas to the east and west are mainly industrial and due to the relatively low employment density associated with industrial land uses, it is highly unlikely that PTA would justify the provision of additional public transport services to service the area including the proposed development.

4.0 Analysis of the Transport Network

4.1 Assessment Period

The assessment year that has been adopted for this analysis is 2031, with full development of the rezoning area.

4.2 Traffic generation and distribution

The "Guide to Traffic Generating Developments, Roads and Traffic Authority (RTA) of New South Wales" document was used to establish the applicable traffic generation rates for various land uses within the development. For the land uses that their trip rates were not available within RTA guidelines, the trip rates have been sourced from the document "Land Use Traffic Generation Guidelines, Director-General of Transport, South Australia" and "Institute of Transportation Engineers" (ITE) document.

Table 2 summarises the trip generation estimation for the various land uses within the proposed rezoning area.

Table 2: Trip Generation

Land use	GFA (m2)	Trip rate (vpd)	PM Trip rate (vph)	Trip generation (vpd)	PM Trip generation (vph)
Service Station with Convenience Store	10 bowser	113.5 per bowser	11.93 per bowser	567*	60*
Fast Food	563	500/ 100sqm	50/ 100sqm	1,407*	140*
Showroom	2105	32/ 100sqm	3.6/ 100sqm	674	76
Auto Service	4 service channel	16/ service channel	2/ service channel	64	8
Auto Service	6 service channel	16/ service channel	2/ service channel	96	12
Industrial	7,534 (Stage 2)+3,330(Stage 3)	5/ 100sqm	1/ 100sqm	543	109
Total				3,351	405

**** 50% pass by trip is assumed***

It is expected that about 30% of the total trips would be internal to the development (cross trade or multipurpose trips) and about 70% of the trips would be external. Therefore, the total external traffic is expected to be about 2,345vpd or 284vph.

With respect to the location of the subject site, access/egress system and the permeability and layout of the surrounding road network it is assumed that the development traffic would be split as follows:

- 30% north-west from Welshpool Road East;
- 15% south-east from Welshpool Road East;
- 55% south-west from Brook Road; and,

It should be noted that by the time that the rezoning of the site is completed and the site is fully developed (assumed to be 2031), the intersection of Brook Road and Welshpool Road East is assumed to have been downgraded to Left in/ Left out.

4.3 Traffic Flow Forecasts

The development traffic volumes on surrounding road network are shown in **Figure 8** assuming that the intersection of Welshpool Road East/ Brook Road would operate as a left in/ left out intersection.



Figure 8: Development traffic assuming a left in/ left out intersection at Brook Rd/ Welshpool Rd East, daily (PM peak hour)

Figure 9 illustrates the PM peak hour trips which are distributed to the development crossovers. This figure also shows the pass by trips along Welshpool Road East.

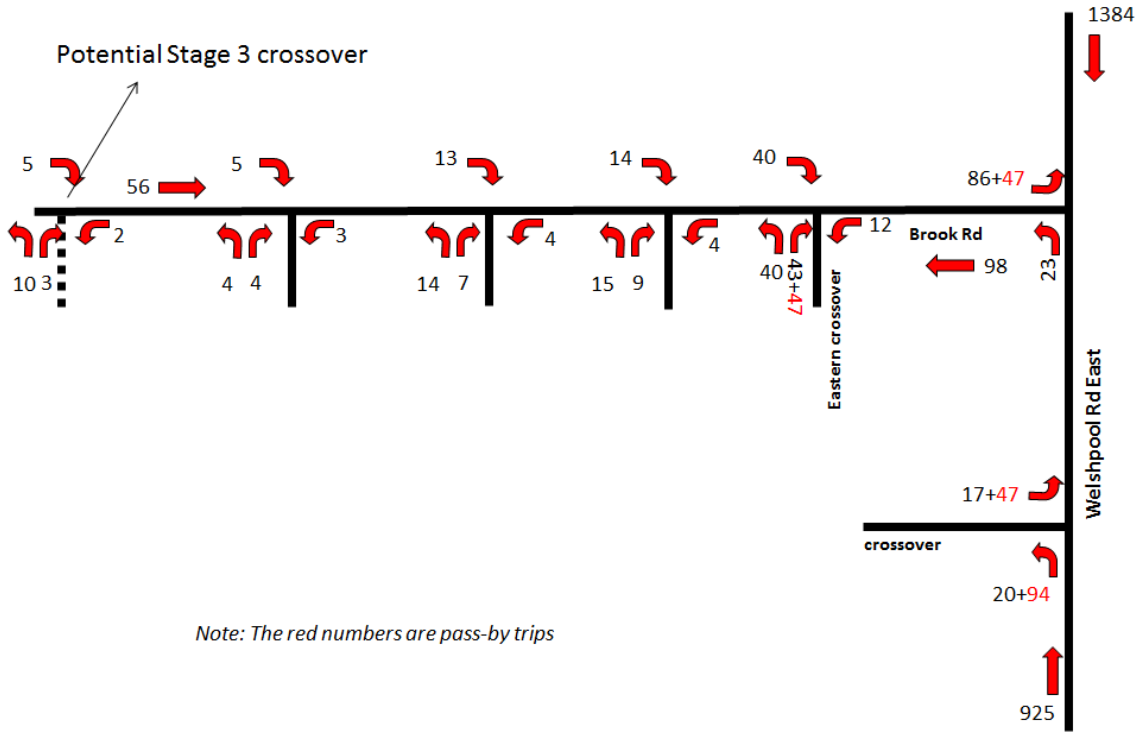

Figure 9: Development traffic (PM peak hour)

4.4 Roads and Intersections

Figure 10 shows the proposed intersection controls for the development crossovers and the intersection of Welshpool Road East/ Brook Road.

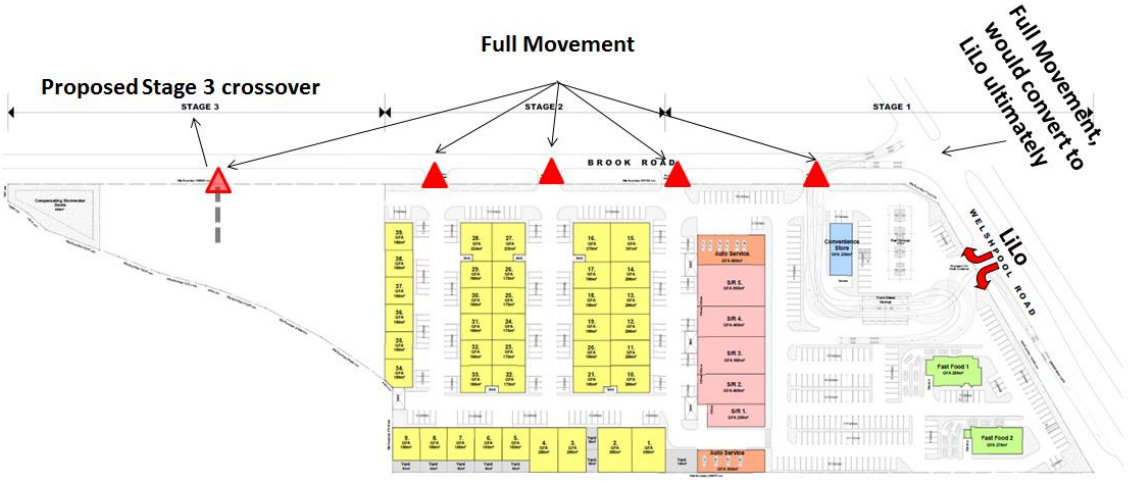

Figure 10: Intersection and crossover treatments

The proposed developments crossovers on Brook Road would operate as a basic priority controlled T-intersections without any turn lanes on Brook Road. The proposed left in/ left out intersection on Welshpool Road East provides a 100m left turn deceleration lane on Welshpool Road East to satisfy Austroads requirements and to improve safety.

4.5 Intersection Analysis

Intersection analysis was undertaken for the development eastern crossover on Brook Road. This crossover is expected to take most traffic compared to other development crossovers on Brook Road.

Capacity analysis has been undertaken using the SIDRA computer software package for the weekday PM peak hour which is expected to represent the highest combination of development and background traffic. SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- Degree of Saturation is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for infrequent traffic flow up to one for saturated flow or capacity.
- Level of Service is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- Average Delay is the average of all travel time delays for vehicles through the intersection.
- 95% Queue is the queue length below which 95% of all observed queue lengths fall.

The results of the SIDRA analysis are summarised in **Appendix A**.

The SIDRA analysis indicates that the proposed development eastern crossover on Brook Road will operate satisfactorily with overall level of service A during the weekday PM peak hour.

5.0 Conclusions

The subject of this TIA is the proposed rezoning of 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, in Wattle Grove. The site is currently zoned “Urban” in Metropolitan Region Scheme (MRS). It is proposed to undergo a rezoning process to achieve “Light Industry” zoning under LPS3.

The proposed development expected to result from the proposed rezoning is a mix of commercial and light industrial land uses which expected to be developed in several stages.

The total external traffic generation of the proposed development is expected to be about 2,460vpd or 288vph which will be accommodated by a left in/ left out crossover on Welshpool Road East and number of full movement crossovers on Brook Road.

According to the “Maddington Kenwick Strategic Employment Area (MKSEA) Precinct 3 Access Strategy”, Brook Road intersection will be downgraded to left in/ left out intersection in future.

Traffic analysis undertaken indicates that development crossovers on Brook Road will operate satisfactorily and well within capacity. For the Welshpool Road East crossover, a left turn lane in accordance with Austroads guidelines is proposed on Welshpool Road East to minimise impact on through traffic and improve safety.

The proposed left in/ left out crossover intersection on Welshpool Road, supplemented with an appropriate left turn slip lane on Welshpool Road, is in line with Main Roads WA Driveway Policy for service stations on a state road and on a corner lot and will improve accessibility and permeability of the proposed development without compromising traffic operations and safety.

Appendix A

INTERSECTION ANALYSIS

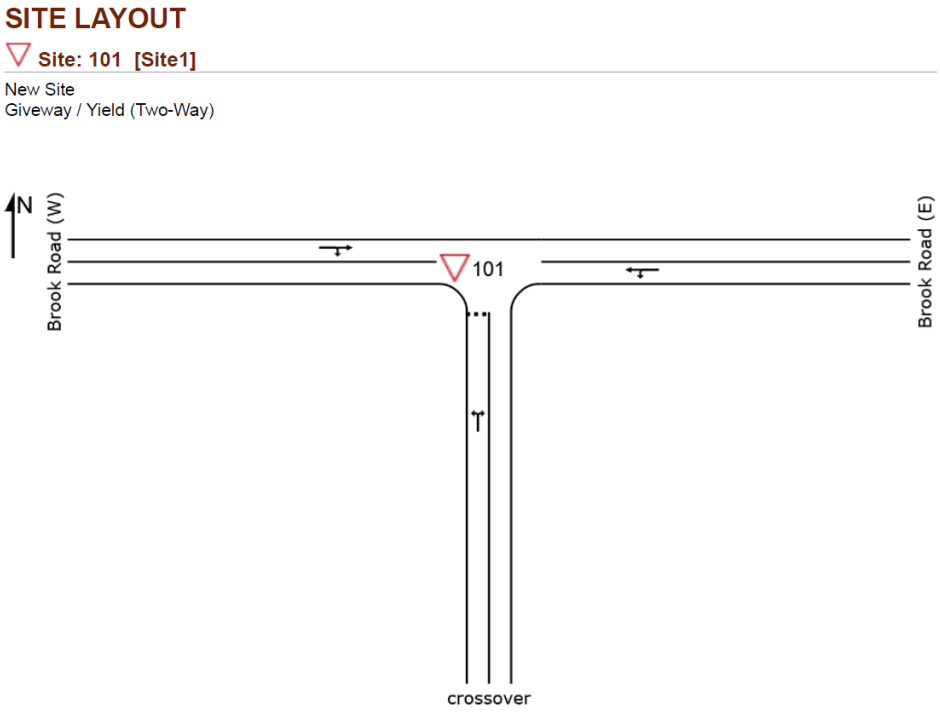

Figure A1: Proposed crossover layout

Table A1. SIDRA results – 2031 weekday PM peak hour with full development

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: crossover											
1	L2	42	0.0	0.067	5.7	LOS A	0.2	1.6	0.17	0.57	53.2
3	R2	95	0.0	0.067	5.7	LOS A	0.2	1.6	0.17	0.57	52.6
Approach		137	0.0	0.067	5.7	LOS A	0.2	1.6	0.17	0.57	52.8
East: Brook Road (E)											
4	L2	13	0.0	0.062	5.5	LOS A	0.0	0.0	0.00	0.07	57.8
5	T1	103	6.0	0.062	0.0	LOS A	0.0	0.0	0.00	0.07	59.4
Approach		116	5.3	0.062	0.6	NA	0.0	0.0	0.00	0.07	59.2
West: Brook Road (W)											
11	T1	84	6.0	0.071	0.2	LOS A	0.2	1.7	0.15	0.20	57.6
12	R2	42	0.0	0.071	5.8	LOS A	0.2	1.7	0.15	0.20	55.5
Approach		126	4.0	0.071	2.1	NA	0.2	1.7	0.15	0.20	56.9
All Vehicles		379	3.0	0.071	2.9	NA	0.2	1.7	0.11	0.29	56.0

Appendix 6
Local Water Management Strategy

McDowall Affleck
CONSULTING ENGINEERS | PROJECT MANAGERS
Responsive. Reliable. Results.

LOCAL WATER MANAGEMENT STRATEGY

FOR LOTS 36 (655) WELSHPOOL ROAD AND LOT 810 (31) BROOK ROAD, WATTLE GROVE

PROJECT NUMBER #15574

REVISION 0, DATE 27TH FEBRUARY 2018

McDowall Affleck
CONSULTING ENGINEERS | PROJECT MANAGERS
Responsive. Reliable. Results.

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EXECUTIVE SUMMARY

Evangelos Litis Nominees Pty Ltd propose to develop Lot 36 (655) Welshpool Road and Lot 810 (31) Brook Road within the *Maddington Kenwick Strategic Employment Area* (MKSEA) for industrial land uses. These landholdings (herein referred to as "the site") are located within the City of Kalamunda (CoK).

The proposed development area covers approximately 4.2 ha, the proposed development area is bound to the northwest by Brook Road, to the northeast by Welshpool Road East, other rural lots to the east and south. The development site is predominately cleared and generally appears to drain towards Brook Roads.

The subject site is zoned Urban under the Metropolitan Region Scheme and Industrial Development under the City of Kalamunda Local Planning Scheme No. 3 (**LPS3**). The site is located within the Maddington Kenwick Strategic Industrial Area, and is identified as an 'Industrial Investigation area'.

The LWMS is prepared in support of a proposed amendment to the City's LPS3. The proposed amendment seeks to rezone the subject site from Industrial Development to Light Industry, to facilitate the development of a mixed commercial centre on the site. The proposed amendment will allow for the site to be developed in a manner which is consistent with the MRS zoning that applies to the site, and the State and local strategic planning framework applicable to the site.

A concept development plan has been prepared to demonstrate one way in which the site may be developed, following the rezoning of the site. Any future development of the land will be subject to further development approval/s from the relevant authorities.

This Local Water Management Strategy (LWMS) has been developed in accordance with Better Urban Water Management, State Planning Policy 2.9 Water Resources, Planning Bulletin 92 Urban Water Management and Interim: Developing a Local Water Management Strategy. Water will be managed using an integrated water cycle management approach, which has been developed using the philosophies and design approaches described in the Stormwater Management Manual for Western Australia.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems. Characteristics of both the existing and past environment within the site have been investigated. In summary, the environmental investigations conducted to date indicate that:

- The site receives 825 mm of average annual rainfall with the majority of rainfall received in June and July.
- Topography of the site ranges from 20 m Australian height datum (AHD) in the south east to 17 m AHD in the north west.
- The site consists of white to pale grey at at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin over sandy clay to clayey sand of the Guildford Formation according to the Geological Survey Maps of Perth.
- The whole site is mapped as having a moderate to low risk of encountering acid sulfate soils (ASS) within 3 m of the surface.
- The land to the south is categorised as Conservation category wetland, with the site categorised as resource enhancement.
- 360 Environmental completed a Spring Flora and Vegetation Survey and Wetland Assessment, Delineation and Classification report and Wetland Buffer Assessment and Determination in July 2010 to better understand the developable potential of the site.
- The current development plans take into account the environmental advice provided by 360

Environmental to ensure protection of the wetlands.

- Hydrological modelling based on Australian Rainfall and Runoff (AR&R) and in further detail to the modelling of the greater MKSEA documented in the District Water Management Strategy (DWMS).
- Yule Brook is located approximately 100m North of the site.
- Emerge completed the LWMS for MKSEA 3A which located Surface water quality within Yule Brook in the locality of the site has low TN and TP concentrations upstream and downstream.
- Maximum groundwater levels (MGL) across the site range between 10 m AHD near the western boundary and 11 m AHD near Welshpool Road, and are either at the surface or very shallow beneath most of the site. Given the low permeability soils the MGL is more likely a reflection of seasonally perched groundwater rather than a permanent superficial aquifer.
- 360 Environmental noted a perch groundwater table during the winter months and moisture 150mm-280mm below the surface in the month of November.

The overall objective for integrated water cycle management for industrial developments is to minimise pollution and maintain an appropriate water balance. The LWMS design objectives seek to deliver best practice outcomes using a Water Sensitive Urban Design (WSUD) approach, including detailed management approaches for:

- Potable water consumption
- Flood mitigation
- Stormwater quantity and quality management
- Groundwater management.

The criteria proposed within this LWMS are based on the approved DWMS, the characteristics of the existing environment and a contemporary best-practice approach to integrated water cycle management.

The overall approach to water conservation is to minimise water requirements for the establishment and maintenance of swales and landscaped areas within the development. This will be achieved through the use of waterwise landscaping practices, including use of native vegetation where possible, and use of an average irrigation rate of 6,750 kL/ha/year.
Stormwater management focusses on two key aspects:

1. Stormwater peak flow rates will not exceed predevelopment flow rates
2. Stormwater runoff quality.

The principle behind the stormwater management strategy for the site is to maintain the existing hydrology by matching pre-development discharge rates. There are no existing upstream catchments flowing through this site. Lot detention is proposed through open swales along the boundary of Brook Road which will be landscaped to improve the aesthetics of the site. Predevelopment flows will leave the site through the Brook Road conveyance swales.

These swales will be designed such that outflows from the site match pre-development flow rates.

Stormwater quality will be addressed using a treatment train approach. Initial treatment will be adopted as appropriate for the site geotechnical conditions site usage. This will occur within the lot and therefore as close to source as possible using bio-retention areas within the site (or suitable alternative retention measures). Runoff from the road network will be conveyed within roadside conveyance swales. The grades of these swales are variable and generally very flat (1:650), which will allow in-line water quality treatment via extended detention during which time contact with vegetation and soils will be achieved. Further water quality treatment will be provided at the end of catchment, prior to discharge from the site.

Groundwater level management focusses on protecting properties from flooding due to inundation by groundwater. Fill will be used where the natural surface levels do not provide adequate clearance to groundwater.

The main objective of the management of groundwater quality is to maintain or improve runoff that could either be infiltrated to groundwater or that could be discharged from the site. This will be achieved by reducing the total nutrient load that originates from the development through treatment of surface water runoff from frequent events prior to infiltration to groundwater and through implementation of nutrient minimising landscape management practices.

The proposed design criteria and the manner in which they are proposed to be achieved are presented in **Table 1**. This table provides a readily auditable summary of the required outcomes which can be used in the future detailed design stage to demonstrate that the agreed objectives for water management at the site have actually been achieved.

This LWMS demonstrates that, by following the recommendations detailed in the report, the site is capable of being developed.

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Table 1 Water management criteria and compliance summary

Management Aspect	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Water Conservation	Minimise water requirements for the establishment and maintenance of swales and other landscaped areas	Use an average irrigation rate of 6,750 kL/ha/year to irrigate landscaped areas	Proponent	Landscape implementation
		Utilisation of WWG within road verges, drainage swales and landscaped areas	Proponent	Landscape design
	Minimise water use within lots	Use of water efficient fittings within lots	Lot owner	Building construction
		Finished floor levels will be provided a minimum 500 mm clearance from MGL with fill used where necessary	Proponent/lot owner	Detailed design
		Conveyance swales have been set consistent with existing drain inverts. Subsoil drains will be set above existing drain inverts, and these will therefore be above the MGL.	Proponent	Detailed design
Groundwater management	Finished floor levels of buildings should have a minimum 500mm clearance from MGL.	Inverts of flood detention structures will be set approximately at or above MGL, the underlying clay layer or the inverts of immediately adjacent existing drain inverts.	Proponent	Detailed design
	Inverts of flood detention structures to be set at or above MGL, the underlying clay layer or existing drain inverts	Minimise use of fertilisers within landscaped areas	Proponent	Landscape implementation
	Maintain or improve groundwater quality leaving the site	Use drought tolerant roll on turf species	Proponent	Landscape implementation

Management Aspect	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Surface water management	Runoff from lots will be treated at source, within each lot	Appropriate treatment measures will be required on lot	Proponent	Detailed design
	Detain flows up to the 100 year ARI storm event within the boundary of each lot.	Shire of Kalamunda will be required on lot to detain flows up to the 100 year ARI event	Lot developer	Lot development approvals
	Detain flows up to the 100 year ARI storm event to maintain pre-development peak flow rates at key discharge locations	Runoff will be detained in flood detention areas designed to detain the 100 year ARI event with a discharge	Proponent	Detailed design

Management Aspect	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
	Finished floor levels should have a 300 mm clearance from the 100 year ARI water level within conveyance swales and the flood detention structure	Finished floor levels will have a minimum clearance of 300 mm from the 100 year ARI top water level within swales with fill used where necessary	Proponent	Detailed design
	Apply appropriate non-structural measures to reduce pollutant loads	Minimise fertiliser use to establish and maintain vegetation within drainage reserves and road verges	Proponent	Landscape implementation
		Use drought tolerant turf species that require minimal water and nutrients	Proponent	Landscape implementation
		Education of lot owners regarding fertiliser use and nutrient absorbing vegetation species within lots	Proponent	Point of sale

1 INTRODUCTION

1.1 BACKGROUND

Evangelos Litis Nominees Pty Ltd propose to develop Lots 36 (655) Welshpool Road and Lot 810 (31) Brook Road, Wattle Grove within the *Maddington Kenwick Strategic Employment Area* (MKSEA) for industrial land uses. These landholdings (herein referred to as "the site") are located within the City of Kalamunda (CoK).

The proposed development area covers approximately 4.2 ha, the proposed development area is bound to the west by Brook Road, to the north by Welshpool Road East, other rural lots to the east and south. The development site is predominately cleared and generally appears to drain towards Brook Road.

The proposed development is for light industrial to facilitate the development of a mixed commercial centre on the site.

Proposed Layout Plan



1.2 TOWN PLANNING CONTEXT

The subject site is zoned Urban under the Metropolitan Region Scheme and Industrial Development under the City of Kalamunda Local Planning Scheme No. 3 (**LPS3**). The site is located within the Maddington Kenwick Strategic Industrial Area, and is identified as an 'Industrial Investigation area'.

The LWMS is prepared in support of a proposed amendment to the City's LPS3. The proposed amendment seeks to rezone the subject site from Industrial Development to Light Industry, to facilitate the development of a mixed commercial centre on the site. The proposed amendment will allow for the site to be developed in a manner which is consistent with the MRS zoning that applies to the site, and the State and local strategic planning framework applicable to the site.

A concept development plan has been prepared to demonstrate one way in which the site may be developed, following the rezoning of the site. Any future development of the land will be subject to further development approval/s from the relevant authorities.

1.3 POLICY FRAMEWORK

There are a number of State Government policies of relevance to the site. These policies include:

- State Water Strategy (Government of WA 2003)
- State Water Plan (Government of WA 2007)
- State Planning Policy 2.9 Water Resources (WAPC 2006a)
- Guidance Statement No. 33: Environmental Guidance for Planning and Development (EPA 2008)
- Liveable Neighbourhoods Edition 4 (WAPC 2007)
- Planning Bulletin No. 64: Acid Sulfate Soils (WAPC 2009)
- State Planning Policy 2.10: Swan and Canning River System (WAPC 2006b)
- Local Planning Scheme No. 3 (CoK 2007)
- Local Planning Policy 5.8: Maddington Kenwick Strategic Employment Area Planning Framework
- (CoG 2014).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that urban developments should aim to achieve.

These are key inputs that relate either directly or indirectly to the site and include:

- Better Urban Water Management (WAPC 2008)
- Australian Runoff Quality (Engineers Australia 2006)
- Australian Rainfall and Runoff (Engineers Australia 1987)
- Decision Process for Stormwater Management in Western Australia (DoW 2009)
- Developing a Local Water Management Strategy (DoW 2008a)
- Stormwater Management Manual for Western Australia (DoW 2007)
- National Water Quality Management Strategy (NWQMS) (ANZECC 2000)
- Swan and Canning Water Quality Improvement Plan (SCWQIP) (SRT 2009).

The guidance documents listed indicate a need for accurate water quality baseline data prior to urban development. This will ensure that any future development is able to fulfil the stormwater management requirements of DoW and engineering standards specified by local government, but will also ensure that realistic water management criteria that are practically achievable are adopted.

1.4 PREVIOUS STUDIES

1.4.1 DISTRICT WATER MANAGEMENT STRATEGY

The Maddington Kenwick Strategic Employment Area Precincts 2 and 3 District Water Management Strategy (DWMS) (TME 2014) was prepared to support the rezoning of MKSEA Precincts 2 and 3 to 'industrial'.

The key management objectives detailed in the DWMS and relevant to this LWMS include:

- **Water quality and environmental protection**
  - Utilisation of water sensitive urban design (WSUD), including bio-retention gardens, basins, swales and flow spreader devices to capture, detain, treat and convey all development runoff.
  - Investigation of building design guidelines that encourage structural separation of potentially polluted runoff in work areas from the stormwater runoff pathways.
  - Provision of lot owners with information relating to the establishment and maintenance of waterwise and nutrient wise gardens in their required landscape areas on each development.
  - Monitoring of storm water outflow rates and quality post-development.
- **Flood protection**

- All habitable floor levels on lots to be designed to maintain a minimum separation clearance of 300mm to the internal 100 year ARI flood levels.
- Protection of buildings and infrastructure with conveyance and storage of flood waters via the open and piped drainage network and road reserves.
- Discharge of the 10 year ARI flows from the site does not exceed predevelopment flows
- Discharge of controlled 100 year ARI flood flows to Brook Road does not exceed predevelopment flows.
- Designated 100 year ARI flow paths to protect infrastructure from flood risks.

- **Stormwater management**
  - Utilisation of WSUD to treat, store, convey, control and discharge stormwater runoff.
  - Ensure pre-development flows continue to maintain water dependent ecosystems, or other agreed flow regimes deemed necessary to support key ecological functions.
  - Investigation of building design guidelines that encourage structural separation of potentially polluted runoff in work areas from the stormwater runoff pathways.
  - Encourage non-structural best management practices (BMPs) to reduce flow rates/potential contamination.
  - Utilise drainage pipes and swales to convey flows through the development.
  - Lot storage and treatment of all runoff from the 1 year 1 hour ARI event on lot.
  - Storage and treatment of the 1 year 1 hour ARI event in road reserves.
  - Monitoring of water quality during construction and post-development.
- **Groundwater Management**
  - Ensure development has no negative impact on the groundwater resource or ecosystems dependent on the resource.
  - A controlled groundwater level (CGL) is to be set at the average annual maximum groundwater (MGL) across the site, unless further studies demonstrate that an alternative level satisfies infrastructure and environmental considerations. The CGL and MGL may be refined as part of the UWMP process.
  - The City of Kalamunda requires a minimum 500 mm separation from the CGL (or critical groundwater level) to physical infrastructure, building footings and to the invert level of the stormwater management measures.
  - Installation of a sub-soil drainage pipe network and swale systems at the proposed CGL to control groundwater from rising above the level set.
  - Treatment of controlled groundwater and the stormwater runoff infiltration via bio-retention and potentially wetland systems.
  - Monitoring of the groundwater quality and levels across the subject land post-development to identify any future detrimental impacts on the groundwater resource.
  - Managed use of groundwater resources within acceptable allocation limits.
- **Water conservation and servicing**
  - Development to be connected to a potable reticulated water supply.
  - Encouragement of water efficient fixtures and fittings for all buildings constructed.

1.5 LWMS OBJECTIVES

This LWMS has been developed in consideration of the objectives and principles detailed in the overarching DWMS, detailed in **Section 1.4** and Better Urban Water Management (WAPC 2008). It is intended to support the rezoning of the site, and is further based on the following major objectives:

- Provide a broad level stormwater management framework to support future industrial development.
- Minimise the amount of fill that needs to be imported to develop the land, which will result in reduced land costs for future lot owners.

- Incorporate appropriate BMPs into the drainage system that address the environmental and stormwater management issues identified.
- Minimise ongoing operation and maintenance costs for the land owners and local government.
- Develop a water conservation strategy for the site that will ensure the efficient use of all water resources.
- Gain support from DoW and local government for the proposed method to manage stormwater within the site.

Detailed objectives for water management within the site are further discussed in **Section 4**.

2 PROPOSED DEVELOPMENT

Planning Solutions have prepared a LPS amendment for the site which covers an area of 4.2 hectares (ha), and outlines the future industrial land use across the site, including:

- Areas to be developed for light industrial land uses.
- Carparking Requirements in accordance with the TPS.
- The provision and location of areas to accommodate stormwater drainage requirements.

The proposed landuses are in line with the proposed light industrial zoning.

The key elements of the water management approach are:

- Lots detain runoff from up to the 100 year ARI and provide treatment specific to land use.
- Outflows from the site to not exceed predevelopment flows.

3 PRE-DEVELOPMENT ENVIRONMENT

3.1 SOURCES OF INFORMATION

The following sources of information were used to provide a broad regional environmental context for the site:

- National Water Quality Management Strategy (ANZECC 2000)
- Regional 1:50 000 Geology Map Sheet (Jordan 1986)
- WA Atlas (Landgate 2015)
- Water Register (DoW 2015b)
- Perth Groundwater Atlas (DoW 2015a)
- Weather and Climate Statistics Data (BoM 2015).

The City of Gosnells and City of Kalamunda have previously commissioned a range of studies and investigations across the MKSEA to understand the environmental attributes and values of the area and to demonstrate the feasibility of industrial development. The various reports associated with these investigations have been reviewed as part of the preparation of this document and include:

- MKSEA Environmental Review: Flora, Vegetation, Fauna and Wetlands (Cardno BSD 2005)
- MKSEA Engineering Feasibility Study (GHD 2005)
- MKSEA Preliminary Transport Study (Cardno BSD 2006)
- MKSEA Surface Water and Groundwater Investigation and Monitoring Program (Aquaterra 2008)
- Preliminary Investigation of Aboriginal Heritage – City of Gosnells MKSEA (ACHM 2009)
- The Flora, Vegetation and Wetlands of the MKSEA (Tauss and Weston 2010)
- MKSEA Surface Water and Groundwater Monitoring and Investigation Report (Endemic 2012)
- District Water Management Strategy MKSEA Precincts 2 and 3 (TME 2014).
- Urban Water Management Plan Precinct 1A (McDowall Affleck, 2017)
- Local Water Management Plan Precinct 3A (Emerge, 2017)

In addition to the above information, site-specific investigations have been conducted. These have aimed at providing more detail to the existing regional information. These site-specific investigations include:

- Wetland Buffer Assessment and Determination (360 Environmental)
- Spring Flora and Vegetation Survey and Assessment, Delineation and Classification (360 Environmental)

The above studies have been reviewed to determine any potential limitation of local surface water flow paths and existing surface and groundwater levels. This is important, as they can have implications for the stormwater management measures and the extent of earthworks that may be required to facilitate subdivision.

3.2 CLIMATE

The climate of the site (which applies to the wider Perth metropolitan region) is described as Mediterranean, with hot, dry summers and moderately wet, mild winters. The closest weather station to the site which records rainfall and temperature data is located approximately 3 km south of the site (Bureau of Meteorology (BoM) station number 9106). Based on weather data collected from 1961 to 2015, the area experiences an average of 825 mm of annual rainfall (Bureau of Meteorology 2015).

3.3 GEOTECHNICAL CONDITIONS

3.3.1 TOPOGRAPHY

The site is generally low-lying, with elevation ranging from approximately 20m Australian height datum (AHD) in the east to 17m AHD in the west (DoW 2008b).

Topographical contours are shown in **Figure 2**, indicating the elevation characteristics of the site.

3.3.2 SOILS AND GEOLOGY

The Geological Survey of Western Australia, as documented in Perth Metropolitan Region 1:50,000 Environmental Geology Series Armadale Part Sheets 2033 I & 2133 IV (Jordan 1986), indicates the site is comprised of:

- Clayey sand (Sc): silty in part, pale grey-brown, medium to coarse, poorly sorted, sub-angular to rounded, frequent heavy minerals, rare feldspar, of alluvial origin.
- Sand (S10): white to pale grey at surface, yellow at depth, fine to medium-grained, moderately well sorted, subangular to subrounded quartz, of eolian origin, over other units.

The mapped extent of the above soils units across the site is shown in **Figure 3**.

As the perched ground water table is close to the surface, the site will need to be filled for clearance to groundwater for drainage which will be completed in the Urban Water Management Plan during detailed design.

3.3.3 ACID SULFATE SOILS

Regional acid sulfate soils (ASS) risk mapping (DER 2006) indicates that the site is classified as having a moderate to low risk of ASS occurring within 3 m of the natural soil surface, as shown in **Figure 4**.

3.4 SURFACE WATER

3.4.1 WETLANDS

360 Environmental Pty Ltd (360 Environmental) was commissioned by Evangelous Litis Nominees Pty Ltd to undertake a spring flora and vegetation survey and wetland assessment, delineation and classification (the survey) of the site. The survey is required to assess the value and conservation significance of the remnant flora and vegetation present within the survey area. This information will then be used to assess potential options for future use. The following scope of work was undertaken within the survey area: A Level 2 Flora and Vegetation assessment in accordance with the Environmental Protection Authority's (2004) Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51. An assessment and description of the wetlands and wetland boundaries within the site based on A geomorphic approach to global classification for inland wetlands (Semeniuk and Semeniuk, 1995).

Soil sampling to map soil types. Soil type mapping was used to delineated and assist in mapping wetland boundaries and used to create the wetland buffer zone.

The development site is generally cleared with a few spares trees.

3.4.2 *EXISTING DRAINAGE NETWORK*

The site doesn't have any upstream catchments flowing through the site and therefore doesn't have any existing drainage through the site.

The site generally sheet flows towards the open swale along Brook Road.



Photo 1 General Site Photo



Photo 2 Brook Road verge swale

3.5 SURFACE WATER MONITORING

3.5.1 SURFACE WATER FLOW RATES

Surface water monitoring was carried out by Endemic between June 2009 and December 2010 across the greater MKSEA area which included (Endemic 2012):

- Surface water streamflow monitoring within the Yule Brook
- Surface water level monitoring within the Yule Brook and road verge drainage swales
- Surface water quality monitoring within the Yule Brook and road verge drainage swales
- Wetland water level monitoring.

There are no surface water monitoring locations within the site however the two locations within the Yule Brook are downstream of the site and associated drainage discharge points.

3.5.2 SURFACE WATER QUALITY RESULTS

Monitoring at M1 and M2 was undertaken on 14 occasions between June 2009 and October 2010. The results of the monitoring are provided in **Table 3**.

Table 3 Pre-development surface water quality results

Analyte	Units	NWQMS guideline trigger*	SCWQIP guideline trigger*	M1		M2	
				Average	St.dev	Average	St.dev
Temperature	ºC	-	-	14.39	2.28	14.75	2.48
pH		6.5-8.0	-	7.44	0.61	7.50	0.47
Electrical Conductivity (EC) **	mS/cm	0.12-0.30	-	0.81	1.55	1.12	2.19
Dissolved oxygen (DO)	mg/L	-	-	7.75	1.11	7.18	1.23
Redox	mV	-	-	3.52	50.01	-9.17	65.97
Total suspended solids (TSS)	mg/L	-	-	20.38	21.41	17.67	17.89
Total dissolved solids (TDS)	mg/L	-	-	343.69	610.25	247.38	162.40
Total nitrogen (TN)	mg/L	1.2	1 - 2	0.90	0.28	0.94	0.38
NOx-N	mg/L	0.15	-	0.35	0.21	0.44	0.34
NO2-N	mg/L	-	-	0.02	0.01	0.01	0.00
Nitrate-NO3	mg/L	-	-	0.36	0.22	0.41	0.31
Total kjehldahl nitrogen (TKN)	mg/L	-	-	0.55	0.32	0.54	0.26
Total phosphorous (TP)	mg/L	0.065	0.1 - 0.2	0.08	0.14	0.07	0.14
Filterable reactive phosphorous (FRP)	mg/L	0.04	-	0.01	n/a	0.01	n/a

*(ANZECC 2000); values taken from (Endemic 2012)

** measured EC concentrations detailed in the Endemic monitoring data provided in Appendix E appear to be incorrectly labelled as mS/cm and should be µS/cm, when taken in context with recorded TDS concentrations.

Surface water quality within Yule Brook is generally consistent upstream and downstream of the site discharge locations. Both TN and TP concentrations are within guideline trigger values provided in the SCWQIP (SRT 2009) and NWQMS (ANZECC 2000).

3.5.3 PRE-DEVELOPMENT SURFACE RUNOFF MODELLING

Pre-development modelling was carried out to support the DWMS (TME 2014).

McDowall Affleck has calculated the predevelopment and post development flows in accordance with Australian Rainfall and Runoff based on the proposed development plan completed by Meyer Shircore and Associates.

We have based the design flows based on the site having 10% of the site area set aside for landscaping.

Storage requirements based on predevelopment discharge from the site to Brook Road.

Final flow rates and storage requirements can be determined at the Urban Water Management Plan Stage.

Table 4 Pre-development peak inflows and outflows

Predevelopment		Postdevelopment	
10 yr Peak Flow (l/s)	100 Yr Peak Flow (l/s)	10 yr Peak Flow (l/s)	100 Yr Peak Flow (l/s)
242	563	782	1800

Table 5 Peak Storage Requirements for 10 yr ARI and 100 yr ARI storm events with Predevelopment Flows

10 Yr ARI Storage (m3)	100 Yr ARI Storage (m3)
306	563

3.6 GROUNDWATER

3.6.1 GROUNDWATER LEVELS

Information on groundwater from the DoW online *Water Register* (DoW 2015) indicates that groundwater beneath the site is a multi-layered system comprised of the following:

- Perth – Superficial Swan unconfined aquifer
- Perth – Leederville confined aquifer
- Perth – Yarragadee North confined aquifer.

Groundwater data from the *Perth Groundwater Atlas* show that maximum groundwater levels across the site range between 10m AHD and 11m AHD (DoW 2015b). The nearest DoW monitoring bore (WIN 4883) is located approximately 3 km to the north west of the site and a number of water bodies are located between

the site and this bore. It is therefore not considered that the DoW bore is appropriate to calibrate site specific maximum groundwater levels (MGL).

Groundwater monitoring was carried out by Endemic for 18 months commencing in July 2009 (Endemic 2012) with 11 monitoring bores installed across the broader DWMS area. Two of these were located close to the site. Data loggers were installed in each of the bores with manual measurements taken quarterly for calibration purposes.

MGL recorded range between approximately 18m AHD in the northwest and 19m AHD in the southeast of the site. The monitoring results showed that the site is subject to the seasonal perching of groundwater and is highly responsive to rainfall (Endemic 2012).

3.6.2 GROUNDWATER QUALITY

Water quality monitoring was carried out at two locations within the site on 9 occasions between September 2009 and December 2010. Monitoring included sampling of physio- chemical parameters in situ and laboratory analysis of nutrients, metals and other analytes (Endemic 2012). The measured groundwater quality is summarised in **Table 6** and details the parameters significant to, and managed within, this LWMS (i.e. physio-chemical parameters and nutrient concentrations).

Table 6 Groundwater quality

Analyte	Units	NWQMS guideline trigger*	SCWQIP guideline trigger*	GW01		GW11	
				Ave	St dev	Ave	St dev
Temp	ºC	-	-	21.81	13.94	16.63	7.78
pH		6.5-8.0	-	4.84	4.01	4.17	3.81
EC	mS/cm	0.12-0.30	-	8.28	14.40	2.22	4.13
DO	mg/L	-	-	1.04	1.84	2.41	3.05
Redox	mV	-	-	-18.60	26.39	-0.34	6.17
TSS	mg/L	-	-	542.29	1004.92	512.01	1111.62
TDS	mg/L	-	-	12.07	16.70	1.18	0.94
TN	mg/L	1.2	1 - 2	3.46	3.86	1.57	1.39
NO_x-N	mg/L	0.15	-	0.04	0.03	0.18	0.25
NO_2-N	mg/L	-	-	0.00	-	<0.1	-
Nitrate-NO_3	mg/L	-	-	0.17	0.19	0.26	0.24
TKN	mg/L		-	5.20	3.18	2.07	0.81
TP	mg/L	0.065	0.1 - 0.2	0.41	0.39	0.57	0.36
FRP	mg/L	0.04	-	0.02	-	0.08	0.03

*(ANZECC 2000); values taken from (Endemic 2012)

As shown in **Table 6**, groundwater beneath the site has a low pH and low salinity. TN and TP concentrations are considered 'Low' to 'Moderate' in relation to SCWQIP (SRT 2009) and NWQMS (ANZECC 2000) guidelines trigger values. These concentrations are representative of the historical land use of the site including small scale agriculture and farming (discussed in **Section 3.6**).

3.7 CURRENT AND HISTORICAL LAND USES

A review of historic aerial photography indicates that the site has been predominately used for rural lifestyle and small scale agricultural land uses. The majority of the site was cleared of remnant vegetation prior to support such land uses with isolated patches of remnant vegetation in degraded condition, subject to partial clearing and high levels of weed invasion.

A search of the Department of Environment Regulation's (DER) Contaminated Sites Database (DER 2015) found there to be no registered contaminated sites within or in proximity to the site.

3.8 SUMMARY OF EXISTING ENVIRONMENT

In summary, the environmental investigations conducted to date indicate that:

- The site receives 825 mm of average annual rainfall with the majority of rainfall received in June and July.
- Topography of the site ranges from 20 m Australian height datum (AHD) in the south east to 17 m AHD in the north west.
- The site consists of white to pale grey at at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin over sandy clay to clayey sand of the Guildford Formation according to the Geological Survey Maps of Perth.
- The whole site is mapped as having a moderate to low risk of encountering acid sulfate soils (ASS) within 3 m of the surface.
- The land to the south of the site is categorised as Conservation category wetland, with the rest of the site categorised as resource enhancement.
- 360 Environmental completed a Spring Flora and Vegetation Survey and Wetland Assessment, Delineation and Classification report and Wetland Buffer Assessment and Determination in July 2010 to better understand the developable potential of the site.
- The current development plans take into account the environmental advice provided by 360 Environmental to ensure protection of the wetlands.
- Hydrological modelling based on Australian Rainfall and Runoff (AR&R) and in further detail to the modelling of the greater MKSEA to the south of the site documented in the District Water Management Strategy (DWMS).
- Yule Brook is located approximately 100m North of the site.
- Emerge completed the LWMS for MKSEA 3A which located Surface water quality within Yule Brook in the locality of the site has low TN and TP concentrations upstream and downstream.
- Maximum groundwater levels (MGL) across the site range between 10 m AHD near the western boundary and 11 m AHD near Welshpool Road, and are either at the surface or very shallow beneath most of the site. Given the low permeability soils the MGL is more likely a reflection of seasonally perched groundwater rather than a permanent superficial aquifer.
- 360 Environmental noted a perch groundwater table during the winter months and moisture 150mm-280mm below the surface in the summer month of November
- The site has historically been used for rural lifestyle and small scale agricultural purposes.

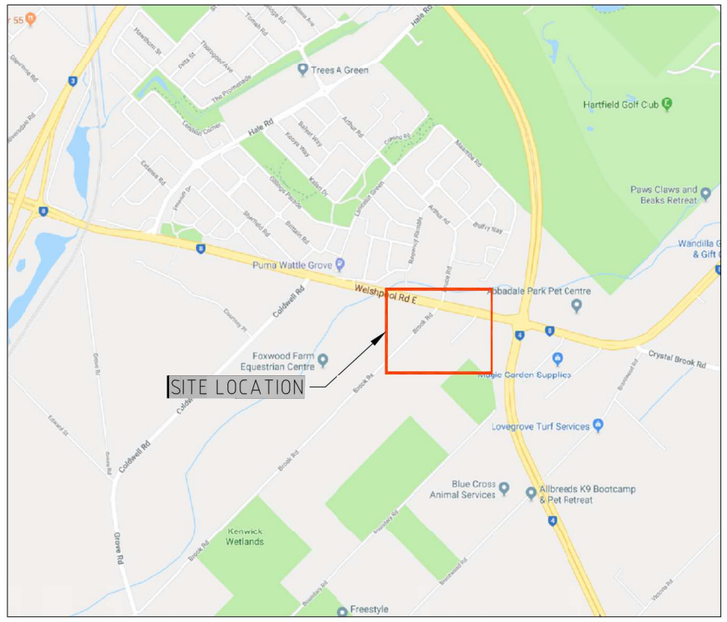


PLAN

SCALE 1:2500

LEGEND

SITE BOUNDARY



LOCALITY PLAN

N.T.S.

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PROJECT: LOT 36 WESHPOOL ROAD & LOT 810 BROOK ROAD WATTLE GROVE

TITLE: SITE LOCATION

ENGINEER SIGN:

DRAWING NUMBER: 15574 - FIG 1

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PLAN

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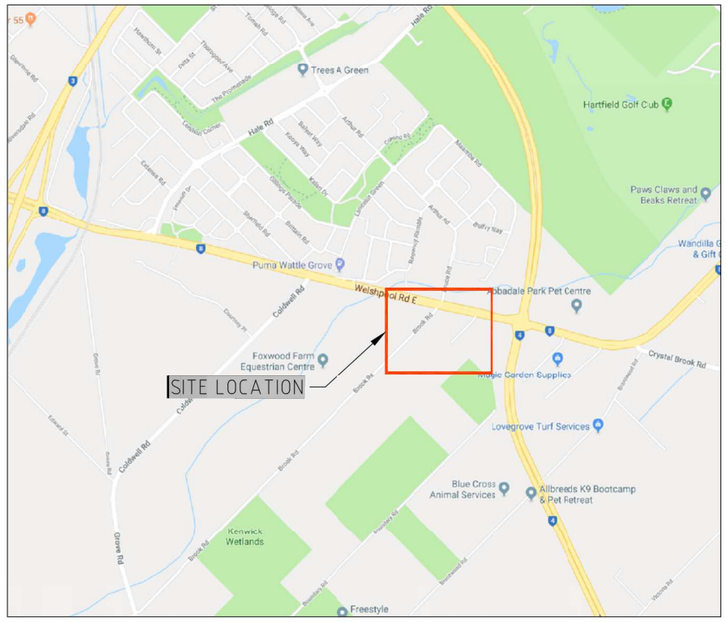
LEGEND

SITE BOUNDARY

EXISTING CONTOUR 19

AAMGL GROUNDWATER CONTOUR 13.0



LOCALITY PLAN

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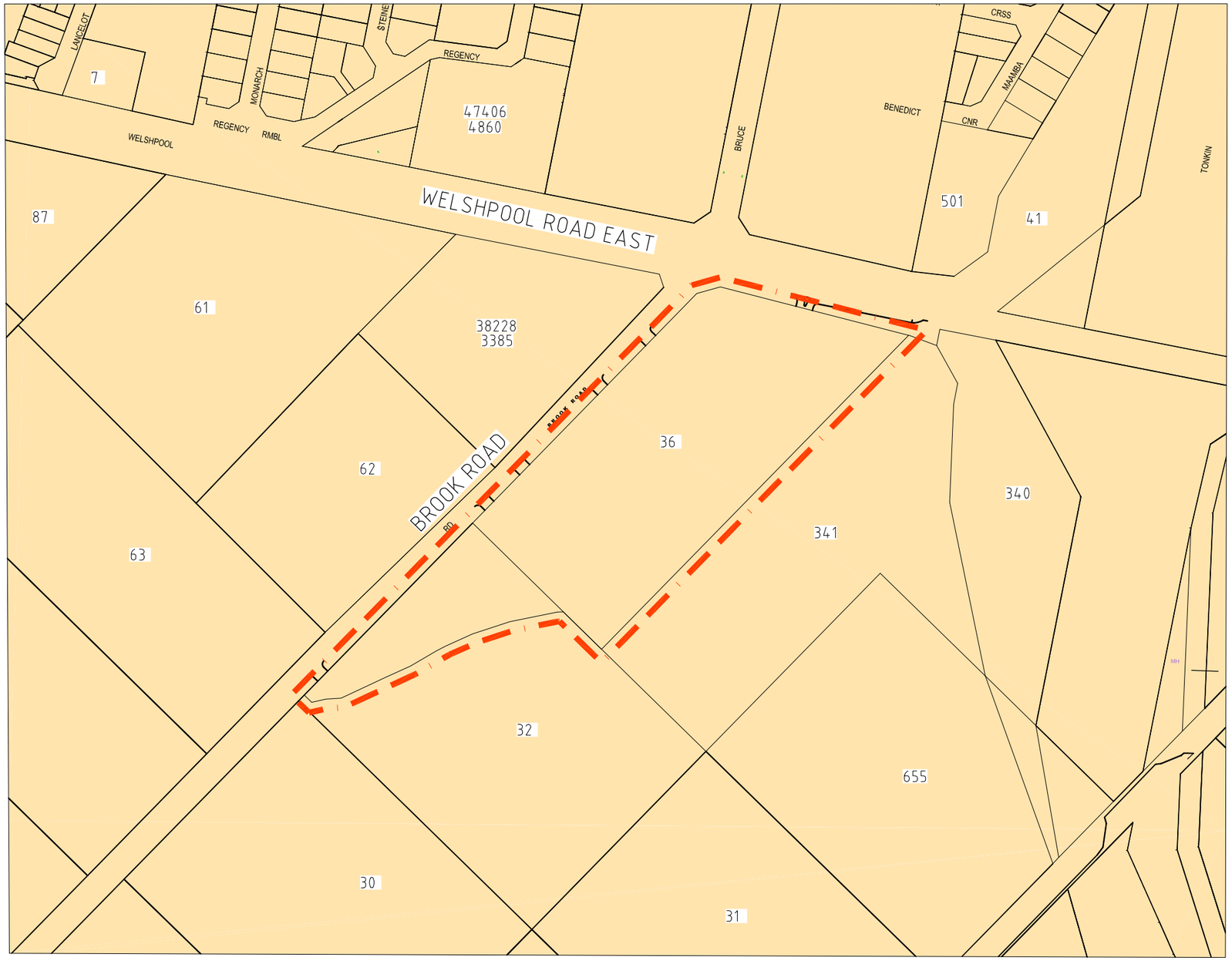
PROJECT: LOT 36 WESHPOOL ROAD & LOT 810 BROOK ROAD WATTLE GROVE

TITLE: SITE CONDITIONS

ENGINEER SIGN:

DRAWING NUMBER: 15574 - FIG 2

REVISION: A



LEGEND

SITE BOUNDARY

S10 SAND

PLAN

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CLIENT: EVANGELOS LITIS NOMINEES PTY LTD

PROJECT: LOT 36 WESHPOOL ROAD & LOT 810 BROOK ROAD WATTLE GROVE

TITLE: SITE GEOLOGY

ENGINEER SIGN:

DRAWING NUMBER: 15574 - FIG 3

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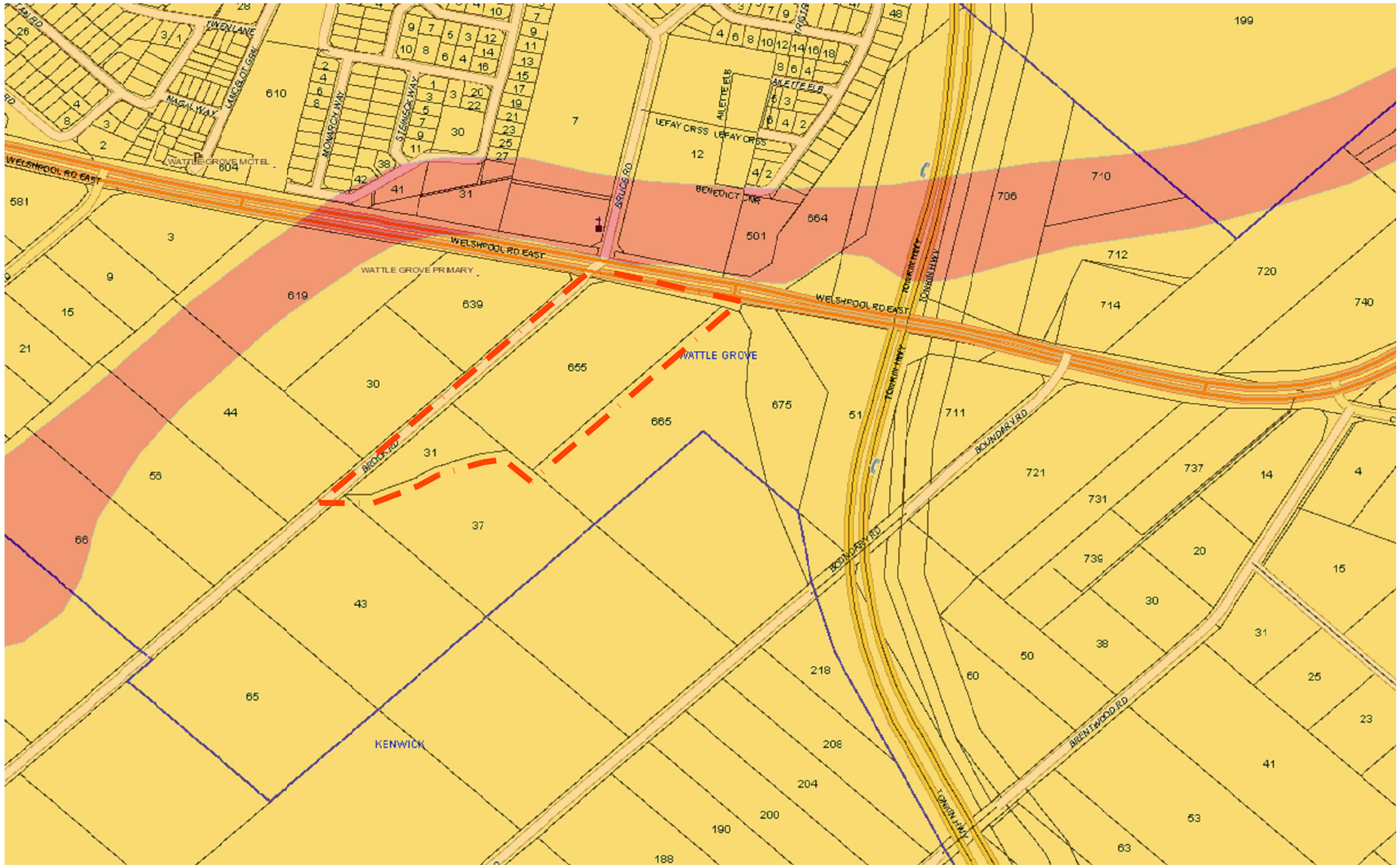

LEGEND

- SITE BOUNDARY
- MODERATE TO LOW ASS DISTURBANCE RISK (<3m FORM SURFACE)
- MODERATE TO HIGH ASS DISTURBANCE RISK (<3m FORM SURFACE)

PLAN

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PROJECT: LOT 36 WESHPOOL ROAD & LOT 810 BROOK ROAD WATTLE GROVE

TITLE: ACID SULFATE SOIL RISK MAPPING

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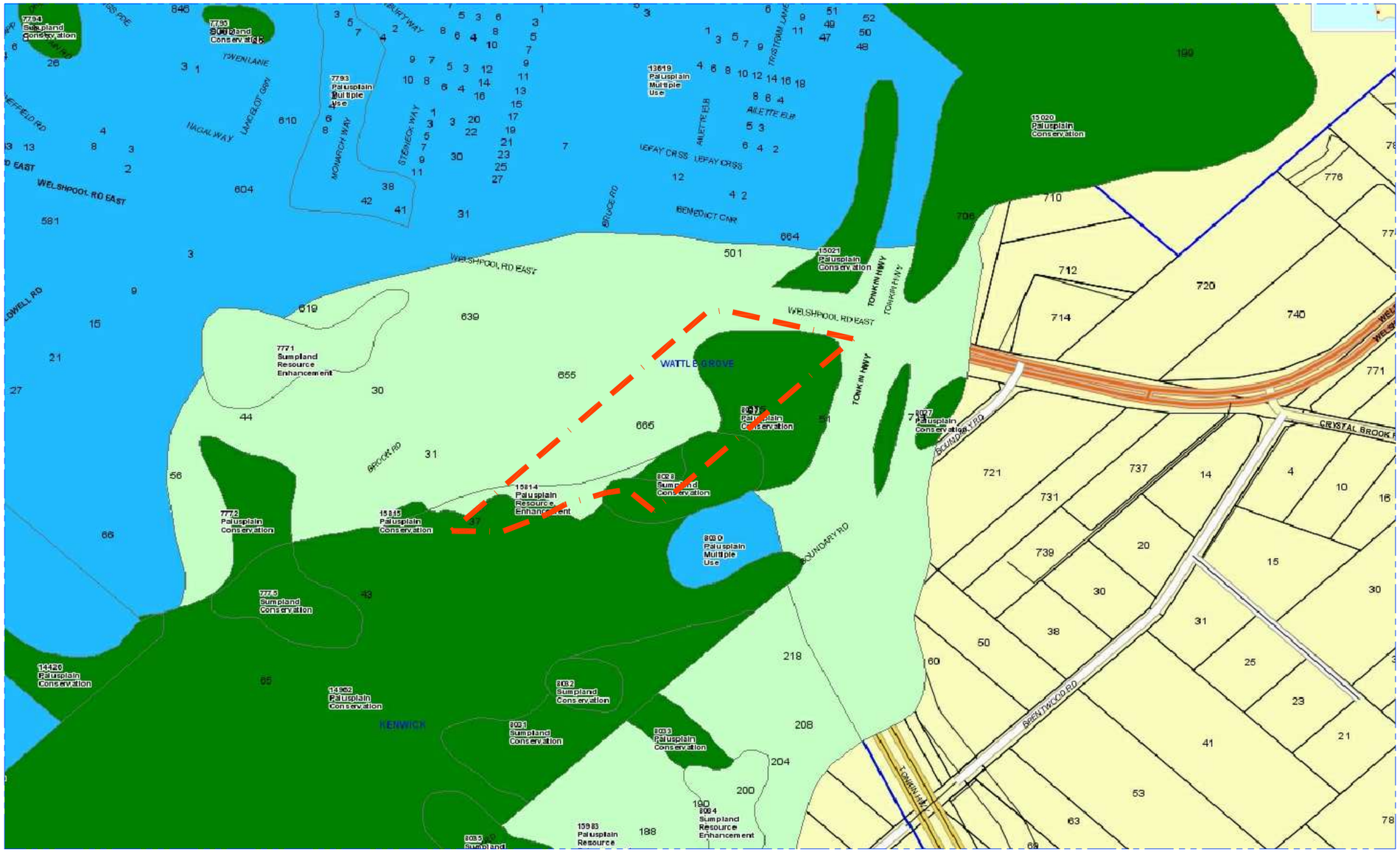

PLAN

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PROJECT: LOT 36 WESHPOOL ROAD & LOT 810 BROOK ROAD WATTLE GROVE

TITLE: GEOMORPHIC WETLANDS

ENGINEER SIGN:

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REVISION: A

4 DESIGN CRITERIA AND OBJECTIVES

This section outlines the objectives and design criteria that this LWMS and future Urban Water Management Plans (UWMP) must achieve. The water management strategy covers stormwater management, groundwater management and water consumption.

4.1 WATER CONSERVATION

Water conservation design criteria are proposed which are consistent with the guidelines presented in Better Urban Water Management (WAPC 2008) and in consideration of the criteria proposed in the DWMS (TME 2014). This LWMS proposes the following water conservation criteria:

1. Minimise water requirements for the establishment and maintenance of swales and other landscaped areas.
2. Minimise water use within lots.

The manner in which these objectives will be achieved is further detailed in **Section 5**.

4.2 GROUNDWATER MANAGEMENT

The principle behind the groundwater management strategy is to maintain the existing groundwater hydrology. This LWMS proposes the following groundwater management criteria:

1. Finished floor levels of buildings should have a minimum 500mm clearance from MGL.
2. Conveyance swales and subsoil drains will be set at pre-development MGL, the underlying clay layer or existing drain inverts.
3. Inverts of flood detention structures to be set at or above MGL, the underlying clay layer or existing drain inverts.
4. Maintain or improve groundwater quality leaving the site.
5. The manner in which these objectives will be achieved is further detailed in **Section 6**.

4.2.2 STORMWATER MANAGEMENT

The principle behind stormwater management at the site is to mimic the pre-development hydrological conditions, as described in **Section 3.4**. This principle and the guidance documents discussed in **Section 1.3** and **1.4** have guided the stormwater management criteria.

This LWMS proposes the following stormwater management design criteria:

1. Runoff from lots will be treated at source, within each lot.
2. Detain flows up to the 100 year ARI storm within our site with predevelopment flows.
3. Finished floor levels should have a 300 mm clearance from the 100 year ARI stormwater level within conveyance swales and the flood detention structure.
4. Apply appropriate non-structural measures to reduce pollutant loads.

5 WATER SOURCE ALLOCATION, INFRASTRUCTURE, FIT-FOR-PURPOSE AND WATER USE

5.1 FIT-FOR-PURPOSE WATER USE

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted. Fit-for-purpose principles have been utilised in the water conservation strategy for this development.

5.1.1 SCHEME WATER

The development operates within the Water Corporation Integrated Water Supply System (IWSS) and therefore will be supplied by scheme water for potable and non-potable uses.

5.1.2 GROUNDWATER

There is approximately 10% of drainage and landscaped areas proposed within the site. At an average irrigation rate of 6,750 kL/ha/yr, will be required 2872kL/yr based on a gross developable site area of 4.2Ha (0.42 Ha Landscaping).

5.2 WATER CONSERVATION MEASURES

5.2.1 ESTATE SCALE CONSERVATION MEASURES

Water use can be reduced on a development scale within drainage reserves, swales and landscaped areas by employing Water Wise Gardening (WWG) measures and minimising soft landscaping. The following water efficiency measures will be used within the development:

- Improve soil with conditioner certified to Australian Standard AS4454 to a minimum depth of 150mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
- Use ATU effluent for irrigation purposes.
- Control systems must be able to irrigate different zones with different irrigation rates.
- Emitters must disperse coarse droplets or be subterranean.
- Utilise subsoil irrigation where appropriate.
- Minimise the amount of turf areas.
- Where turf is used it should be drought tolerant.
- Mulch garden beds to 75 mm with a product certified to Australian Standard AS4454.
- Minimise use of fertilisers and utilise slow release fertilisers.

WWG principles will be adopted within drainage reserves and swales (where required) within the development. Irrigation of road verges will be the responsibility of the adjacent lot owner.

5.2.2 *WATER EFFICIENT FITTINGS*

The water conservation strategy for the development proposes that all buildings use WEFA where appropriate. Water efficient fittings and toilets can be mandated through the building licence process.

5.3 WASTEWATER MANAGEMENT

The Water Corporation has advised that the nearest connection point for the development is 2.5km to the west on the other side of Roe Highway. The development may be serviced using an Aerobic Treatment Unit (ATU).

6 GROUNDWATER MANAGEMENT STRATEGY

6.1 GROUNDWATER LEVEL MANAGEMENT

The primary objective for groundwater level management is to ensure that finished floor levels have appropriate clearance from groundwater.

6.1.2 GROUNDWATER LEVELS

As discussed in **Section 3.5.1**, maximum groundwater levels (MGL) across the site range between 10 m AHD near the western boundary and 11 m AHD near Welshpool Road, and a perched groundwater table is either at the surface or very shallow beneath most of the site.

Finished floor levels of buildings will be required to have a minimum clearance of 500 mm from MGL consistent with Local Government requirements. This will be achieved via imported fill where necessary.

Drainage storage will be provided along open swale landscaping along Brook Road to contain the 100 year ARI with predevelopment flows.

A subsoil drainage system may be designed to control the groundwater subject to achieving a free discharging outlet. This can be confirmed at detailed design.

6.2 GROUNDWATER QUALITY MANAGEMENT

The main objective for the management of groundwater quality is to maintain or improve the existing groundwater quality on site. This can be achieved by treating surface runoff prior to infiltration via application of appropriate WSUD measures, thereby reducing the total nutrient load into the groundwater that originates from the development.

The reduction of nutrient load to the groundwater will be achieved in the development by:

- Directing first flush stormwater to vegetated treatment areas (detailed further in Section 7.1.2.4).
- Drought tolerant turf species that require minimal water and nutrients will be used.
- Roll-on turf will be used within the drainage reserves and road verges, to prevent the high nutrient input requirement during establishment of the turf.

The above measures will improve the quality of the water prior to it infiltrating into the underlying groundwater.

7 STORMWATER MANAGEMENT STRATEGY

The principle behind the stormwater management strategy for the site is to maintain the existing hydrology by matching pre-development flow rates leaving the site and maintaining flow paths across the site for upstream (arterial) flows.

The Stormwater management strategy focusses of two key aspects:

1. Stormwater peak flow rates maintained at predevelopment levels
2. Stormwater runoff quality.

The post-development modelling is completed in accordance with Australian Rainfall and Runoff to ensure predevelopment flows are maintained.

7.1 WSUD STRATEGIES

Treatment of the first flush (15mm) via,

Surface-based WSUD measures that may be considered within lots could include:

- Bio-retention areas
- Rain gardens
- Vegetated swales/landscaping strips and infiltration areas.

7.1.2 GREASE AND SEDIMENT TRAPS

Certain land uses can produce sediments and hydrocarbons to a level that cannot be treated by GPTs. Grease and sediment traps can be used as a secondary level treatment system to remove these smaller particles. Grease and sediment traps must be regularly maintained to ensure the efficiency of the device.

Depending on the final nature of the development and specific land uses, these may be applicable to some lots within the site. These are more likely to be required where there is either a high vehicle/ traffic load, or where vehicle servicing/maintenance is to be carried out onsite.

7.1.3 OIL-WATER SEPARATORS

Oil-water separators can be used to provide water quality treatment at a lot scale, particularly for small industrial or commercial lots where larger BMPs are not feasible due to site constraints. There are a range of systems available which incorporate some combination of filtration media, hydrodynamic sediment removal, oil and grease removal, or screening to remove pollutants from stormwater.

Oil-water separators are best used in commercial, industrial and transportation type land uses i.e. areas that are expected to receive high sediment and hydrocarbon loadings, such as car parks and service stations. Depending on the final nature of the development and specific land uses, these may be applicable to some lots within the site.

7.1.4 TRASH RACKS

Trash racks are usually permanent structures which intercept trash and other debris to protect the environmental quality of water. Trash racks are to be constructed upstream of all permanent retention basins and will require

regular maintenance to remove debris and silt and ensure their ongoing efficiency. Trash racks may also be incorporated in the design of GPTs.

7.2 DRAINAGE DESIGN ASSESSMENT

7.2.1 LOT DRAINAGE

The development of the site will require it to be filled however the predevelopment flow path will be maintained along Brook Road. In order to maintain the pre-development hydrology, the flows along Brook Road runoff from major events (up to the 100 year ARI event) will be detained onsite via landscaped open swales prior to discharge from lot. A detention storage of 563m^3 is required within the site. This storage volume and peak flow rates have been calculated using Australian Rainfall and Runoff.

Predevelopment		Postdevelopment	
10 yr Peak Flow (l/s)	100 Yr Peak Flow (l/s)	10 yr Peak Flow (l/s)	100 Yr Peak Flow (l/s)
242	563	782	1800

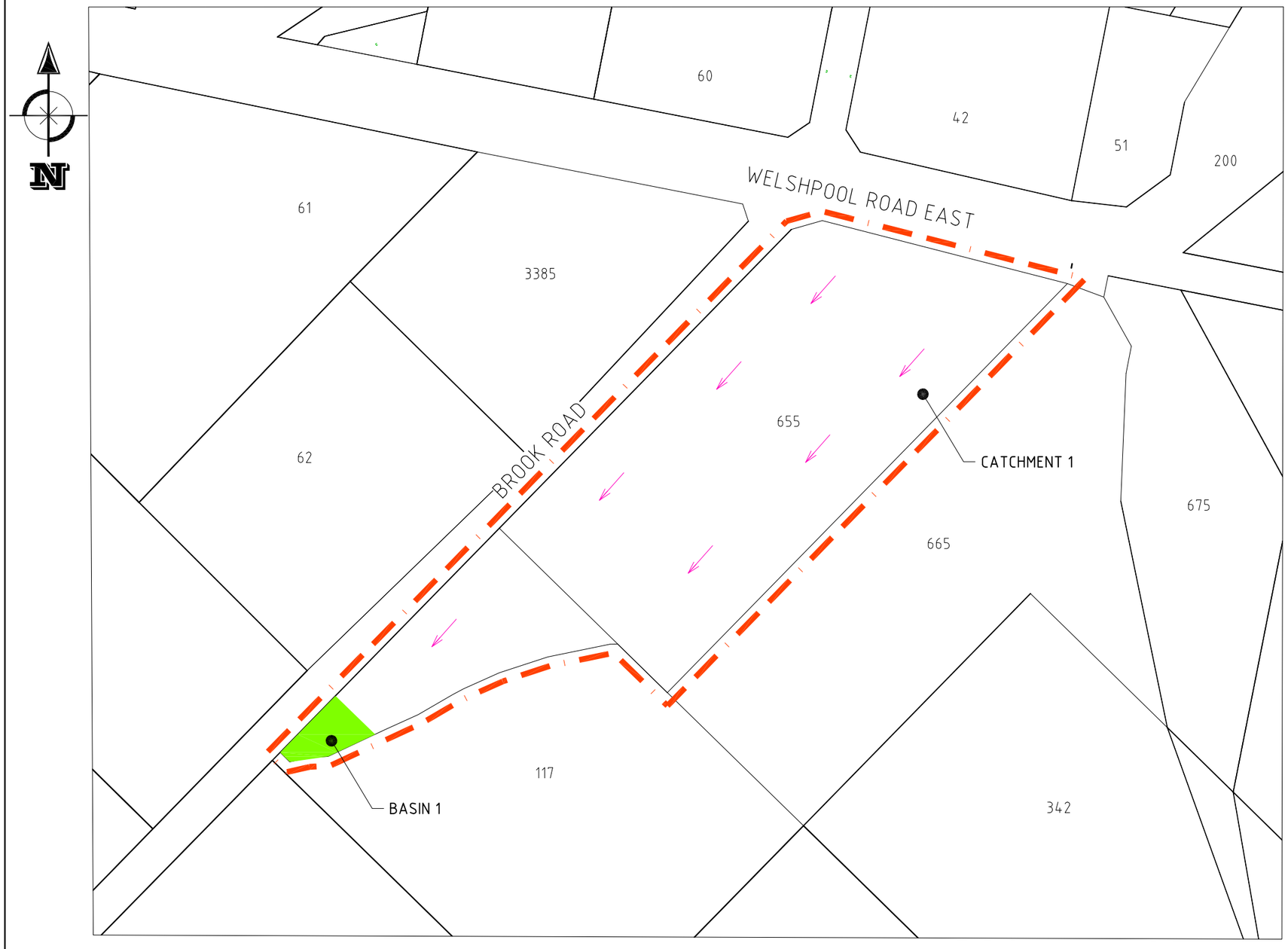
10 Yr ARI Storage (m^3)	100 Yr ARI Storage (m^3)
306.0	563.0

7.3 NON-STRUCTURAL WATER QUALITY MEASURES

The structural measures proposed within the site provide both a storage and treatment function to stormwater runoff, as detailed in **Section 7.1**. A number of non-structural measures will also be implemented to help reduce nutrient loads within stormwater runoff.

These measures include:

- Street sweeping on a regular basis.
- Minimising fertiliser use to establish and maintain vegetation within landscape open drains.
- Drought tolerant turf species that require minimal water and nutrients will be used.
- Nutrient absorbing vegetation within landscaped open swales



LEGEND

SITE BOUNDARY

DRAINAGE BASIN

PIPED FLOW PATHS
(1 YEAR ARI)

PRE-DEVELOPMENT		POST-DEVELOPMENT	
10YR PEAK FLOW (l/s)	100YR PEAK FLOW (l/s)	10YR PEAK FLOW (l/s)	100YR PEAK FLOW (l/s)
242	563	782	563

PRE-DEVELOPMENT	POST-DEVELOPMENT
10YR ARI STORAGE (l/s)	10YR ARI STORAGE (l/s)
306	563

PLAN

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PROJECT: LOT 36 WESHPOOL ROAD & LOT 810 BROOK ROAD WATTLE GROVE

TITLE: 1 YEAR ARI INUNDATION

ENGINEER SIGN:

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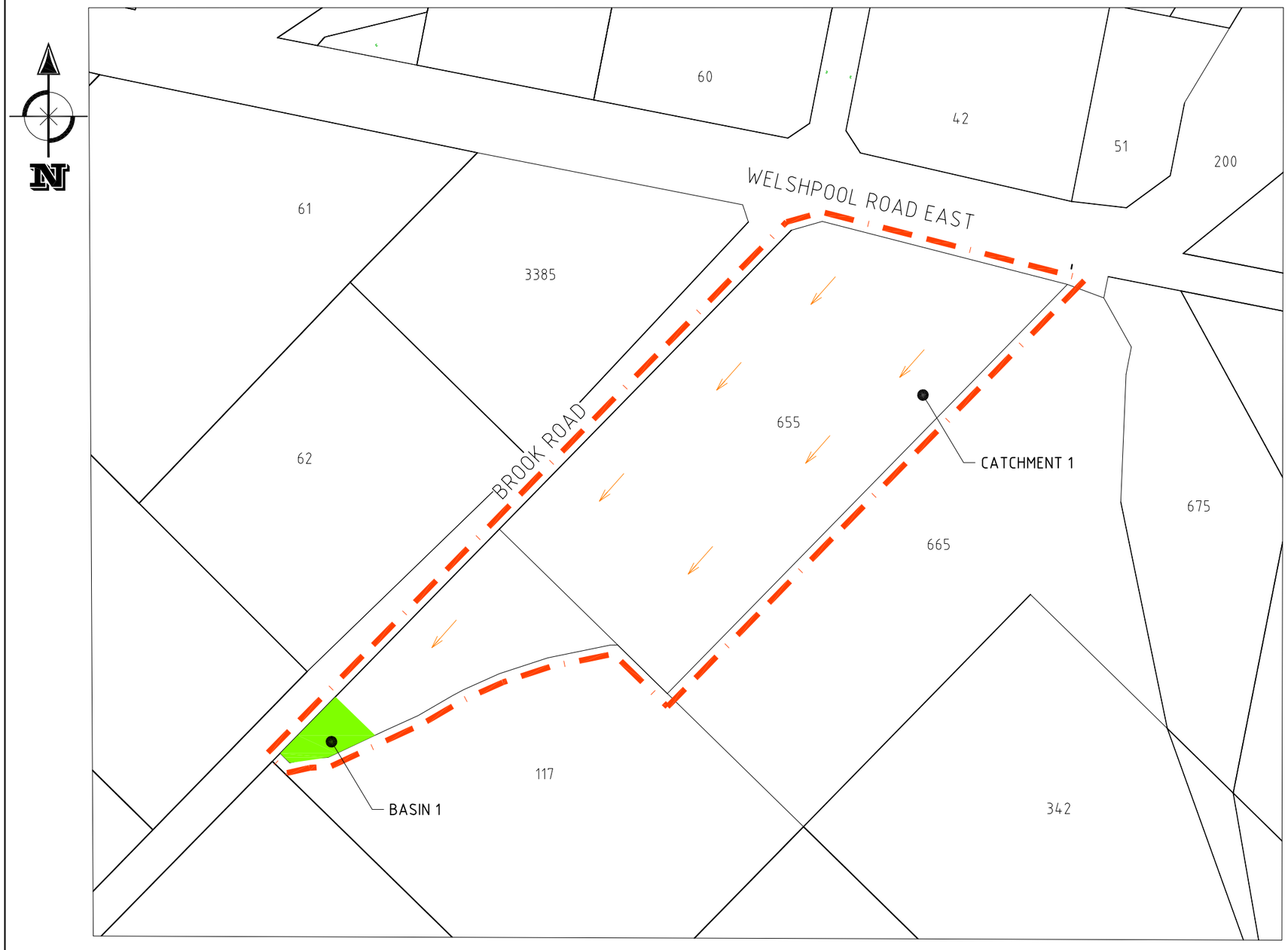

LEGEND

SITE BOUNDARY

DRAINAGE BASIN

PIPED FLOW PATHS
(10 YEARS ARI)

PRE-DEVELOPMENT		POST-DEVELOPMENT	
10YR PEAK FLOW (l/s)	100YR PEAK FLOW (l/s)	10YR PEAK FLOW (l/s)	100YR PEAK FLOW (l/s)
242	563	782	563

PRE-DEVELOPMENT	POST-DEVELOPMENT
10YR ARI STORAGE (l/s)	10YR ARI STORAGE (l/s)
306	563

PLAN

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TITLE: 10 YEAR ARI INUNDATION

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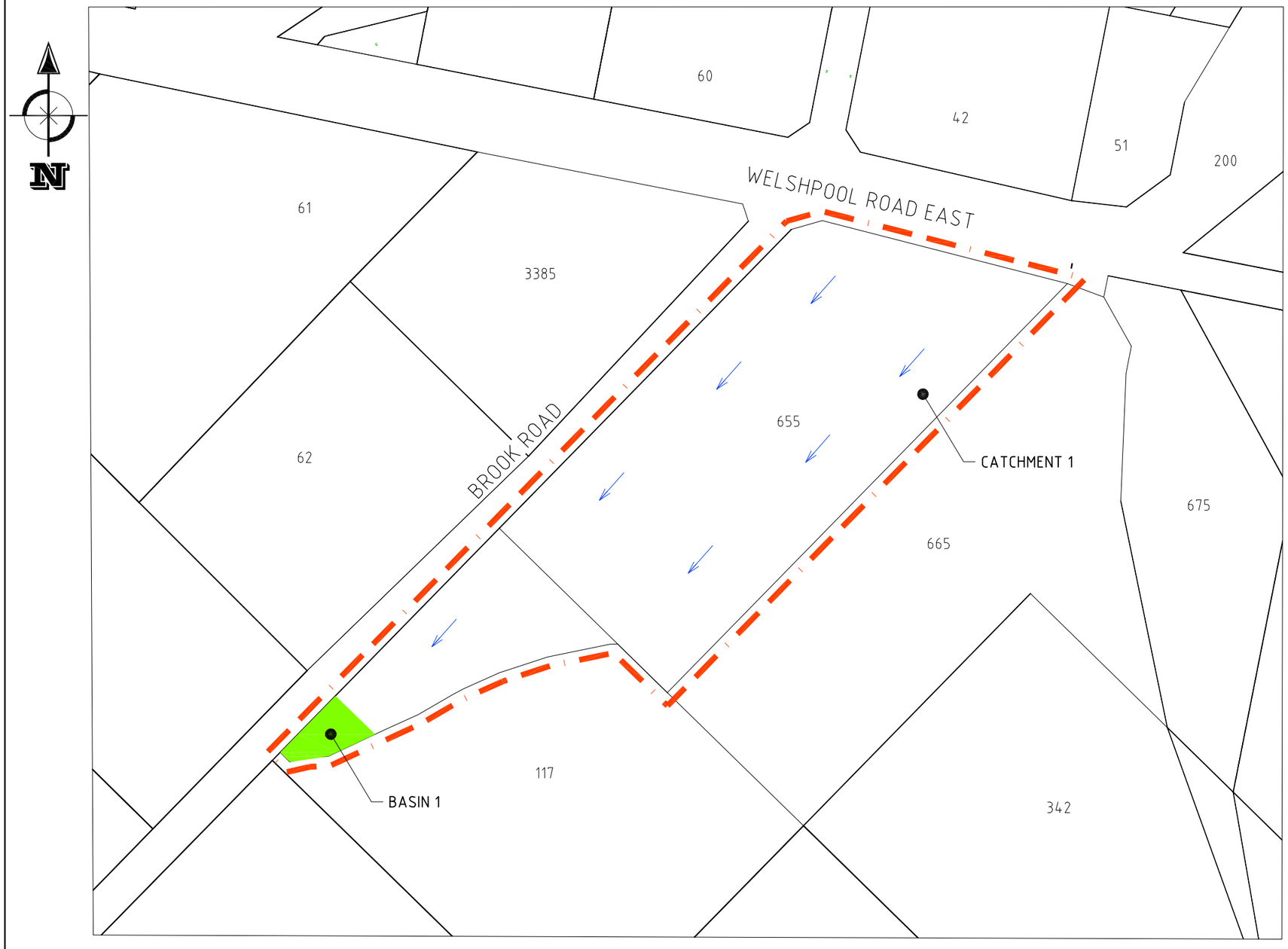

LEGEND

SITE BOUNDARY

BASIN AREA TO CONTAIN 1 IN 100 YR

SURFACE FLOW PATHS (100 YEARS ARI)

PRE-DEVELOPMENT		POST-DEVELOPMENT	
10YR PEAK FLOW (l/s)	100YR PEAK FLOW (l/s)	10YR PEAK FLOW (l/s)	100YR PEAK FLOW (l/s)
242	563	782	1800l/s

PRE-DEVELOPMENT	POST-DEVELOPMENT
10YR ARI STORAGE (l/s)	10YR ARI STORAGE (l/s)
306	563

PLAN

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TITLE: 100 YEAR ARI INUNDATION

ENGINEER SIGN:

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8 SUBDIVISION AND URBAN WATER MANAGEMENT PLANS

The requirement to undertake preparation of more detailed water management plans to support subdivision is generally imposed as a condition of development. The development of any future UWMP should follow the guidance provided in Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions (DoW 2008c).

While strategies have been provided within this LWMS that address planning for water management within the site, future subdivision designs and the supportive UWMP will clarify details not provided within the LWMS. The main areas that will require further clarification include:

- Stormwater storage within lots
- Imported fill specifications and requirements
- Implementation of water conservation strategies
- Subsoil drainage location and spacing
- Non-structural water quality improvement measures
- Nutrients and management and maintenance requirements
- Construction period management strategy
- Monitoring and evaluation program
- Status of groundwater abstraction license.

These are further detailed in the following sections. As stated above, ongoing monitoring of groundwater will be detailed in the UWMP, however in this LWMS is outlined broadly in **Section 9**.

8.1 STORMWATER STORAGE AND INFILTRATION WITHIN LOT

The development stormwater management strategy assumes that all lots will detain runoff from the 100 year ARI event to allow pre-development flow rates leaving the site to be maintained. It is developers responsibility to ensure that the appropriate storage is provided within site, consistent with the details provided in **Section 7.2.1**.

8.2 IMPORTED FILL SPECIFICATIONS

As discussed previously the use of clean fill may be required to ensure adequate clearance from the 100 year ARI flood levels and MGL is maintained. Soils beneath bio-retention areas would ideally have a high PRI to ensure at-source nutrient retention leading to the protection of the underlying aquifer. The in situ soils can potentially provide the necessary treatment should the PRI be sufficient.

8.3 IMPLEMENTATION OF WATER CONSERVATION STRATEGIES

A number of potential measures to conserve water have been presented within this LWMS. These water conservation strategies will be incorporated into the design and the ongoing maintenance of all landscaped areas. Landscape design measures that will be incorporated into the water conservation strategy will be further detailed within the future UWMPs produced for the development.

8.4 NON-STRUCTURAL WATER QUALITY IMPROVEMENT MEASURES

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the Stormwater Management Manual for Western Australia (DoW 2007).

Some measures will be more appropriately implemented at a local government level, such as street sweeping, however many can be implemented relatively easily within the design and maintenance of the development and landscaped open drains. It is expected that the future UWMPs will provide a schedule of management and maintenance actions including timing and responsible parties.

8.5 NUTRIENTS, MANAGEMENT AND MAINTENANCE REQUIREMENTS

The management measures to be implemented to address surface water quality, such as the use of vegetation within landscaped open swales will require ongoing maintenance.

Ongoing management and irrigation of landscaped areas will be the responsibility of the developer.

The design of the open swales will be developed to minimise the potential for nutrients to be mobilised quickly from site. This could be done by ensuring that the core of swales is vegetated with reeds and rushes and not with fertilised turf.

Ongoing nutrient inputs will need to be carefully managed to avoid mobilisation to downstream environments. This will include the use of low phosphorous and/or slow release fertlisers.

It is expected that the future UWMPs will set out the design (e.g. landscape surface treatments) maintenance actions (e.g. nutrient application), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions). Given that approval from the local government and DoW will be sought for the proposed measures, it is anticipated that consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

8.6 CONSTRUCTION PERIOD MANAGEMENT STRATEGY

It is anticipated that the construction stage will require some management of various aspects (e.g. dust, surface runoff, noise, traffic etc.). The management measures undertaken for construction management will be addressed either in the future UWMPs or a separate Construction Management Plan (CMP).

8.7 MONITORING AND EVALUATION PROGRAM

It will be necessary to confirm that the management measures that are implemented are able to fulfil their intended management purpose, and are in a satisfactory condition to ensure their function is not reduced. A post-development monitoring program will be developed to provide this confirmation, and it will include details of objectives of monitoring, relevant issues and information, proposed methodology, monitoring frequency and reporting obligations.

These monitoring programs are discussed in **Section 9** of this LWMS and will be further detailed at the UWMP stage.

9 MONITORING AND MAINTENANCE

9.1 MANAGEMENT AND MAINTENANCE

It is proposed that the overall condition of the development will be monitored on a bi-annual basis. This monitoring will be implemented after the completion of the civil and landscaping works and will continue for a period of two years.

A visual assessment will be undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities are achieving the overall management objectives for the development. The parameters that will be monitored include:

- Nutrients and water quality
- Gross pollutants
- Terrestrial weeds
- Irrigation
- Vegetation density

The management and maintenance objectives will be detailed within future UWMPs along with details of the corresponding monitoring program.

9.2 WATER QUALITY MONITORING

9.2.1 PRE-DEVELOPMENT MONITORING

In addition to the groundwater and surface water monitoring data presented in the DWMS, additional groundwater and surface water monitoring will be undertaken for the UWMP. Groundwater and surface water data will be presented in subsequent UWMPs and used to inform detailed design.

9.2.2 POST-DEVELOPMENT MONITORING

Post-development monitoring will be carried out to ensure that the proposed storage and treatment measures, detailed in **Section 7**, are working efficiently. Predevelopment nutrient levels comparison for both surface water and groundwater across the site is proposed to confirm that the water treatment infrastructure is performing as intended.

9.2.3 POST-DEVELOPMENT TRIGGER VALUES

Groundwater water quality targets have been derived from background levels measured during monitoring prior to development, provided in **Table 5**. Surface water quality targets have been identified in consideration of the water quality monitoring carried out within Yule Brook, provided in **Table 3**. Trigger values have also been established in consideration of the NWQMS (ANZECC 2000) and the SCWQIP (SRT 2009) guideline trigger values. The trigger criteria proposed are shown in **Table 12**.

Analyte	pH	EC (mS/cm)	TN (µg/L)	TP (µg/L)	FRP (µg/L)	NOx (mg/L)	TKN (µg/l)
Groundwater	6.5 - 8.0	4.5	2.1	0.4	0.04	0.15	3.10
Surface water	6.5 - 8.0	0.8	1.2	0.1	0.04	0.34	0.46

Table 12 Water quality trigger values

The change of landuse from small scale agriculture to commercial, and implementation of the proposed water management strategies (detailed in **Sections 6** and **7**) are expected to result in a reduction in groundwater nutrient concentrations across the site. It is therefore proposed that the post- development trigger values provided in **Table 12** are dynamic values, and should be assessed in the context of additional data gained from any continued monitoring. The trigger values proposed recognise the existing site conditions and change in landuse, and work toward achieving the target concentrations for the receiving Swan Canning river systems (SRT 2009) over time.

9.3 CONTINGENCY ACTION PLAN

A Contingency Action Plan (CAP) will be detailed and implemented as a part of each UWMP. The CAP is effectively a plan of steps that will be undertaken should certain water quality criteria be reached.

9.3.1 TRIGGER CRITERIA

As indicated, the trigger values proposed in **Section 9.2.4** have been derived from water quality levels measured during pre-development monitoring. These values should be reviewed for each UWMP to include additional data gained from any continued monitoring.

9.3.2 CONTINGENCY ACTIONS

If the results from the initial monitoring occasion indicate that nutrient concentrations exceed the nominated trigger values, a number of contingency measures may be employed.

The first action that should be undertaken if trigger criteria are exceeded is to repeat the monitoring to remove the potential for sampling error. If the repeat monitoring still shows results which breach the trigger value, the next action will be to compare groundwater monitoring results for the upstream (incoming) nutrient concentrations with the downstream (outgoing) nutrient concentrations.

If the downstream nutrient concentrations are >20% higher than the upstream nutrient concentrations, the following actions should be undertaken:

1. Review nutrient application practices to identify source if possible.
2. Conduct surveillance of the site to determine any other potential and obvious nutrient inputs, including within lot treatment structures.
3. Remove source if possible (e.g. fertiliser input, etc.).

If the downstream nutrient concentrations are found to be generally consistent with the upstream concentrations the next action will be to conduct a site-specific comparison of background data collected within the site prior to development. There is some amount of variability (both spatially and temporally) in nutrient concentrations experienced across the site and the trigger values may need to be modified following additional monitoring. This information should then be used as a management tool in consultation with local government to determine if the trigger values should be revised.

Following the implementation of the above contingency measures the water quality will be re-sampled. If the results of the analysis still show water quality characteristics which breach the trigger values an additional set of upstream/downstream monitoring bores should be installed at another key representative area, or samples taken from another surface water location. The additional bores/locations will be sampled as per the ongoing sampling regime already being undertaken. If the results from the second area demonstrate results consistent with the first area, DoW and local government will be informed of the results, and the proponent will work with DoW and local government to determine if the results are representative of a broader catchment management issue, and whether any additional contingency actions need to be implemented onsite.

9.4 REPORTING

A post-development monitoring report will be prepared on conclusion of the two year monitoring period, and will be provided to the local government and the DoW. Interim results (spreadsheet) can be provided to either local government or DoW on request during the monitoring program.

10 IMPLEMENTATION

The LWMS is a key supportive document for the development. The development of the LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the area and to guide the development of the future UWMPs.

10.1 ROLES AND RESPONSIBILITY

The LWMS provides a framework that the proponent can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations, are consistent with relevant State and Local Government policies and have been endorsed by the City of Kalamunda. The responsibility for working within the framework established within the LWMS rests with the developer of the land/land holders. It is anticipated that future UWMPs will be developed in consultation with the City of Kalamunda and DWER and in consideration of other relevant policies and documents.

The responsibility to implement and maintain within lot water quality treatment measures that are appropriate to the land use will be with the developer.

10.2 CONCLUSIONS AND RECOMMENDATIONS

The recommended approach to water management for this site includes:

- Lots detain runoff from up to the 100 year ARI and provide treatment specific to land use.
- Maintain predevelopments

This LWMS demonstrates that, by following the recommendations detailed above, the site is capable of being developed for the intended industrial use.

11 REFERENCES

11.1 GENERAL REFERENCES

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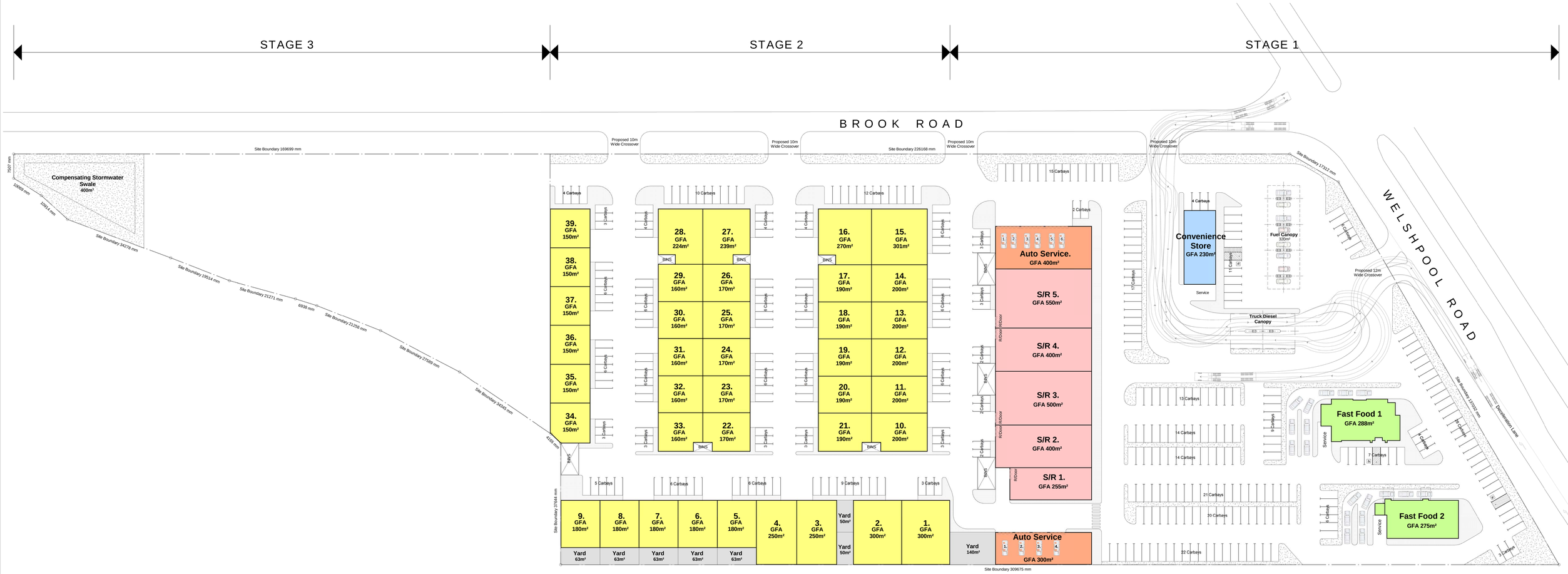
APPENDIX 1 – PROPOSED DEVELOPMENT PLAN



SITE PLAN

SCALE: 1 : 500

Landscaping
A. Hard Landscaping
Defined as paved walkways either open or covered.
B. Soft Landscaping
Defined as vegetative landscaping.

Gross Floor Area : GFA
A. All Floor Areas on this plan are shown as GROSS FLOOR AREA.
Unless otherwise noted as Nett Floor Area.
B. Definition of Gross Floor Area is defined as:
i/ GROSS FLOOR AREA OF TENANCY:
Gross Floor Area of an individual Tenancy is defined as the area contained between the centre line of common tenancy walls and the outside edge of external walls.
ii/ GROSS FLOOR AREA OF A BUILDING:
Gross Floor Area of a Building is defined as the total area contained between the outside edge of external walls

Nett Floor Area : NFA
A. Nett Floor Area of a Tenancy on this plan is defined as the area between external or tenancy dividing walls.
B. This area is inclusive of toilets if the toilets are exclusive to the Tenancy.

STAGE 1 - SITE CRITERIA

1. Overall Site Area		42,551.7m²
Stage 1		19,331.3m²
2. Floor Area		
a. Convenience Store		230m²
b. Fast Food		563m²
c. Showroom		2,105m²
d. Car Service		300m²
e. Auto Service		400m²
Total		**3,598m²**
3. Carparking		
i. Required		
a. Convenienve Store	230m² @ 6/100m²	13.8
	+ 1 per bowser	5.0
b. Fast Food	563m² @ 10/100m²	56.3
c. Showroom	2,105m² @ 4/100m²	84.2
d. Auto Service	@ 4 Bays to Working Bay	16.0
	+ 1 per employee	6.0
e. Auto Service	@ 4 Bays to Working Bay	24.0
	+ 1 per employee	8.0
Total		**213.3 Carbays**
ii. Provided		
a. On Site		228
b. Drive Thru		18
Total		**246 Carbays**

STAGE 2 - SITE CRITERIA

1. Overall Site Area		42,551.7m²
Stage 2		15,796.2m²
2. Floor Area		
a. Industrial		7,534m²
b. Yard		500m²
Total		**8,034m²**
3. Carparking		
i. Required		
a. Industrial	7,534m² @ 2/100m²	150.7
	500m² @ 2/100m²	10.0
Total		**160.7 Carbays**
ii. Provided		
a. On Site		151
Overall Site Carparking		
i. Required		
a. Stage 1		213.3
b. Stage 2		160.7
Total		**374 Carbays**
ii. Provided		
a. Stage 1		246
b. Stage 2		151
Total		**397 Carbays**

PROPOSED LIGHT INDUSTRIAL DEVELOPMENT
LOCATION:LOT 32 & 36, BROOK ROAD, WATTLE GROVE WA
FOR:Mr. J. LITIS

SK006
FEB 2018
1
As indicated @ B1

7795

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APPENDIX 2 – DRAINAGE CALCULATIONS

Modified Copas Equation		Job No.	15574
		Rev	0
Project	Brook Road LWMS	Date	8/02/2018
		Calcs By	VT

IFD Location 32.008S 115.993E

Catchment Area Proposed Light Industrial Development

The Kinematic Wave Equation has been used to calculate overland flow times (AR&R 1987 Volume 1)

PARAMETERS

Pre Development	
Total Area (m^2)	42,552
Coeff of Runoff C_{10}	0.2
Slope (m/m)	0.023
n*	0.01
Length (m)	410

Constant Inflow Rate (l/s) = 0

Duration (min) = 0

Post Development	
Total Area (m^2)	42,552
Area of Pervious (m)	4,255
Area of Impervious (m^2)	38,297
Slope (m/m)	0.010
n*	0.013
Length (m)	410
C_{10} of Road Reserve	0.90
C_{10} of Lots	0.2
Ave Coeff of Runoff C_{10}	0.83
Limit Post Development Outflow	Yes
Limit Post Development Outflow To 1 in X Storm	All
Pipe Outflow Rate (l/s)	
Infiltration Rate (m/d)	
Area of Infiltration (m^2)	
Infiltration Rate (l/s)	0.0
Total Outflow or Infiltration Rate (l/s)	0.0

RESULTS

Storm Event (Yr)	Pre Development		Post Development				
	T_c (min)	Predev Flow Rate (l/s)	T_s (min)	T_c (min)	PostDev flow Rate (l/s)	PostDev Outflow Rate (l/s)	Storage Required (m^3)
1	11.1	84	40	18.6	269	84	156.0
2	9.7	124	30	16.3	311	124	219.0
5	8.6	191	30	14.5	620	191	266.0
10	8.0	242	20	13.5	782	242	306.0
20	7.3	316	20	12.3	1017	316	370.0
50	6.6	449	20	11.0	1440	449	479.0
100	6.1	563	15	10.1	1800	563	563.0

APPENDIX 3 – GEOTECHNICAL REPORT

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Factual Report on Geotechnical Investigations

Proposed Industrial Subdivision Coldwell Road, Kenwick

Prepared for
Linc Property Pty Ltd

Project 88698.07
August 2016



Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	88698.07	Document No.	R.001.Rev1
Document title	Factual Report on Geotechnical Investigations Proposed Industrial Subdivision		
Site address	Coldwell Road, Kenwick		
Report prepared for	Linc Property Pty Ltd		
File name	88698.07.R.001.Rev1		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Sergio Neves	Dan Reaveley	28 July 2016
Revision 0	Sergio Neves	Dan Reaveley	9 August 2016

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	1	Linc Property Pty Ltd (Steve Robertson)
Revision 1	1		Linc Property Pty Ltd (Steve Robertson)

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		9/8/2016
Reviewer		9/8/2016

bsi. ISO 9001 Quality Management

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Geotechnics | Environment | Groundwater

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Appendix A: About This Report

Appendix B Drawing

Factual Report on Geotechnical Investigations
Proposed Industrial Subdivision
Coldwell Road, Kenwick

1. Introduction

This factual report presents the results of geotechnical investigations undertaken by Douglas Partners Pty Ltd for a proposed industrial subdivision within the proposed Maddington Kenwick Strategic Employment Area (MKSEA) in Kenwick, WA. The investigations were commissioned in several emails dated 5 January, 20 April and 5 July 2016 by Mr Ben Lisle and Mr Brett Chivers of Linc Property Pty Ltd, and was undertaken in accordance with Douglas Partners' proposals PER150614(Rev1) dated 18 December 2015 and PER160163 (Rev1) dated 20 April 2016.

The purpose of the investigations was to assess the subsurface conditions beneath the proposed development areas as described in Section 2, and thus provide factual information to Linc Property Pty Ltd in order to assist in the planning and the civil design of the proposed development.

The geotechnical investigations included the excavation of 127 test pits, seven in-situ permeability test and laboratory testing of selected samples.

2. Site Description

The proposed development area comprises 27 individual allotments with a combined area of approximately 50 ha (Refer to Drawing 1, Appendix B). It is bounded by Coldwell Road and Yule Brook to the southeast, Edward Street, rural properties and a proposed PTA Rail Infrastructure Facility area to the southwest and northwest, and rural properties and Welshpool Road East to the north and northwest.

At the time of the geotechnical investigations, the proposed development area comprised farmland and associated farm buildings, with Lot 501 (No.92) Grove Road being used as a turf farm. Grove Road crossed the site at its centre in a northwest-southeast direction. Vegetation generally consisted of short pasture grass, tall grass and reeds and lawn areas, with some bushes and trees up to approximately 15 m in height.

The ground surface level falls to approximately RL 10 m at the south western corner of the site, from a high point of approximately RL 15.0 m at the north eastern corner of the site.

The Armadale 1:50,000 Environmental Geology sheet indicates that shallow sub surface conditions beneath the site are likely to comprise the following units:

- A thin layer of Bassendean sand overlying clayey materials of the Guildford Formation, possibly at shallow depth;
- Clayey sand materials of the Guildford Formation; and

- Sandy silt alluvium associated with Yule Brook, which occurs on the eastern boundary of the site.

The Perth Groundwater Atlas (2004) indicates that in May 2003, the groundwater level was between RL 6 m along the south western site boundary and RL 9 m at the eastern corner of the site (i.e. between 3 m to 4 m below existing surface level). It is noted that given the likely presence of shallow clay and based upon our experience in the area, a perched groundwater table is possible at shallow depths.

Published acid sulphate soil risk mapping indicates that the site is mostly located within an area of "moderate to low risk of acid sulphate soils occurring within 3 m of natural soil surface". An area of "high to moderate risk" is shown immediately adjacent to the south eastern site boundary, associated with the sandy silt deposits in the vicinity of Yule Brook.

3. Field Work Methods

Field work was carried out between 14 December and 23 December 2015, 28 April and 4 May 2016 and on 8 July 2016 and comprised the excavation of 127 test pits, seven in-situ permeability tests and dynamic cone penetrometer (DCP) or Perth sand penetrometer (PSP) testing, depending on the encountered ground conditions, adjacent to each test pit.

The test pits (TP1 to TP9, TP14 to TP16, TP24 to TP39, TP41 to TP94, TP96 to TP112, TP01 to TP13 and TP201 to TP213) were excavated to a maximum depth of 3.0 m using a backhoe with a 600 mm toothed bucket. The test pits were logged in general accordance with AS1726-1993 by a suitably experienced geotechnical engineer from Douglas Partners. Soil samples were recovered from selected locations for subsequent laboratory testing.

The PSP and DCP tests were carried out adjacent to the test pits in accordance with AS 1289.6.3.3 and AS 1289.6.3.2, to assess the in situ density of the shallow soils.

Seven in-situ permeability tests (TP14, TP41, TP52, TP63, TP77, TP105 and TP110) were carried out using either the falling head method or the constant head method at depths of between 0.5 m and 0.7 m below existing ground levels. The location, depths of testing, and results are discussed in detail in Section 4.3.

Test locations were determined using GPS coordinates and site features, and are marked on Drawing 1 in Appendix B. Surface elevations at each test location were estimated from a survey plan provided by Linc Property Pty Ltd, Google Earth or the Perth Groundwater Atlas, and are quoted in m AHD.

4. Field Work Results

4.1 Ground Conditions

A summary of the ground conditions encountered at the test locations is given in the next page:

- **Topsoil** (Sand and Clayey Sand) – between 0.05 m and 0.4 m in thickness, comprising sand and clayey sand, with some silt, gravel and roots and a trace of cobbles.
- **Non-engineered Filling and Filling** (Sand, Sandy Gravel, Gravelly Sand, Clayey Sand and Sandy Clay) – apparently loosely to well compacted non-engineered granular filling with various amounts of deleterious materials, and apparently well compacted granular and cohesive filling. Weakly cemented sand filling was also recorded at particular test locations between 0.1 m and 0.8 m in thickness
- **Sandy and Gravelly Materials** (Sand, Slightly Silty Sand, Gravel, Gravelly Sand and Sandy Gravel) – generally medium dense to very dense, becoming loose at particular test locations, sandy and gravelly materials, with various quantities of clay and silt. Weakly cemented sand (coffee rock) was also encountered at particular test locations, approximately varying between 0.2 m and 0.35 m in thickness.
- **Clayey Sandy and Gravelly Materials** (Slightly Clayey to Clayey Sand, Sandy Clay, Gravelly Clayey Sand, Clayey Sandy Gravel and Sandy Silt) – generally firm to hard clayey sandy and gravelly materials, with pockets of ironstone. A soft sandy silt layer becoming stiff with depth was recorded at a test location undertaken adjacent to the Yule Brook.

A summary of the depths below existing surface level and relative level to the base of the non-engineered filling and filling, and sandy gravelly materials, is summarised in Table 1 below.

Table 1: Summary of Depth to the Base of Non-engineered Filling and Filling, Surface Sand, Sandy Silt, Gravel Gravelly Sand and Sandy Gravel zone and Approximate Relative Levels

Ground Investigation	Test Location	Surface Level (m AHD) [1]	Depth to Base of non-engineered Filling and Filling (m)	Level to Base of non-engineered Filling and Filling (m AHD)	Depth to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m)	Level to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m AHD)
January 2016	TP1	9.90	-	-	0.80	9.10
	TP2	10.10	-	-	0.90	9.20
	TP3	10.10	0.5[6]	9.60[6]	-	-
	TP4	9.80	-	-	0.50	9.30
	TP5	9.80	-	-	0.70	9.10
	TP6	10.20	0.60 or 1.10[6]	9.60 or 9.10[6]	1.70	8.50
	TP7	10.50	-	-	1.20	9.30
	TP8	10.00	-	-	0.30	9.70
	TP9	9.90	-	-	1.00	8.90
	TP14	10.20	-	-	-	-
	TP15	11.20	0.20	11.00	>1.80	<9.40
	TP16	10.80	1.00	9.80	1.60	9.20
	TP24	10.80	-	-	1.80	9.00

Table 1 (continued): Summary of Depth to the Base of Non-engineered Filling and Filling, Surface Sand, Sandy Silt, Gravel Gravelly Sand and Sandy Gravel zone and Approximate Relative Levels

Ground Investigation	Test Location	Surface Level (m AHD) [1]	Depth to Base of non-engineered Filling and Filling (m)	Level to Base of non-engineered Filling and Filling (m AHD)	Depth to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m)	Level to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m AHD)
January 2016	TP25	12.00	-	-	>2.50[5]	<9.50[5]
	TP26	11.30	-	-	>2.00	<9.30
	TP27	11.00	0.20[4]	10.8[4]	0.80	10.2
	TP28	10.60	-	-	0.30	10.30
	TP29	11.50	-	-	2.40	9.10
	TP30	11.30	0.50[4]	10.80[4]	1.10	10.20
	TP31	11.10	-	-	0.60	10.50
	TP32	11.10	0.80	10.30	1.20	9.90
	TP33	11.10	0.70	10.40	1.70	9.40
	TP34	11.00	-	-	1.50[5]	9.50[5]
	TP35	10.30	0.70 or 0.85[6]	9.60 or 9.45[6]	1.90[2]	8.40[2]
	TP36	10.80	0.80	10.00	1.40	9.40
	TP37	10.80	0.60[3]; [4]	10.20[3]; [4]	1.70	9.10
	TP38	11.00	0.60[3]	10.40[3]	1.00[2]	10.00[2]
	TP39	11.50	-	-	>2.30	<9.20
	TP41	11.30	-	-	2.20	9.10
	TP42	12.00	-	-	>2.00	<10.00
	TP43	12.40	-	-	>2.00	<10.40
	TP44	12.60	-	-	>2.50	<10.10
	TP45	12.00	-	-	>2.50	<9.50
	TP46	12.80	1.00	11.80	1.60	11.20
	TP47	12.20	1.30	10.90	1.60	10.60
	TP48	11.30	0.35	10.95	0.85	10.45
	TP49	9.70	2.20[3]	7.50[3]	-	-
	TP50	10.80	-	-	0.50	10.30
	TP51	11.20	-	-	0.60	10.60
	TP52	11.60	-	-	0.90	10.70
	TP53	11.60	-	-	1.10	10.50

Table 1 (continued): Summary of Depth to the Base of Non-engineered Filling and Filling, Surface Sand, Sandy Silt, Gravel Gravelly Sand and Sandy Gravel zone and Approximate Relative Levels

Ground Investigation	Test Location	Surface Level (m AHD) [1]	Depth to Base of non-engineered Filling and Filling (m)	Level to Base of non-engineered Filling and Filling (m AHD)	Depth to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m)	Level to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m AHD)
January 2016	TP54	11.90	-	-	1.10	10.80
	TP55	12.30	-	-	0.60	11.70
	TP56	12.40	-	-	0.45	11.95
	TP57	11.20	0.20	11.00	0.70	10.50
	TP58	11.50	-	-	0.60	10.90
	TP59	11.90	0.20	11.70	0.60	11.30
	TP60	12.40	-	-	0.60	11.80
	TP61	12.60	-	-	0.60	12.00
	TP62	12.40	-	-	1.30	11.10
	TP63	11.80	0.30	11.50	-	-
	TP64	11.60	-	-	0.80	10.80
	TP65	12.20	-	-	0.50	11.70
	TP66	12.60	-	-	0.40	12.20
	TP67	12.40	-	-	0.60	11.80
	TP68	12.00	-	-	0.50	11.50
	TP69	12.00	-	-	0.50	11.50
	TP70	11.80	-	-	0.65	11.15
	TP71	11.90	0.45	11.45	1.10	10.80
	TP72	12.00	-	-	1.20	10.80
	TP73	12.20	-	-	1.00	11.20
	TP74	12.00	-	-	0.40	11.60
	TP75	11.80	-	-	0.80	11.00
	TP76	11.60	-	-	0.80	10.80
	TP77	12.00	-	-	1.10	10.90

Table 1 (continued): Summary of Depth to the Base of Non-engineered Filling and Filling, Surface Sand, Sandy Silt, Gravel Gravelly Sand and Sandy Gravel zone and Approximate Relative Levels

Ground Investigation	Test Location	Surface Level (m AHD) [1]	Depth to Base of non-engineered Filling and Filling (m)	Level to Base of non-engineered Filling and Filling (m AHD)	Depth to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m)	Level to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m AHD)
January 2016	TP78	12.00	0.50	11.50	1.30	10.70
	TP79	11.50	-	-	0.50	11.00
	TP80	11.60	-	-	0.80	10.80
	TP81	11.30	-	-	0.80	10.50
	TP82	11.50	-	-	0.60	10.90
	TP83	11.20	0.60	10.60	0.90	10.30
	TP84	11.60	0.90	10.70	1.10	10.50
	TP85	11.10	-	-	0.80	10.30
	TP86	11.40	0.40	11.00	1.10	10.30
	TP87	11.90	0.40 or 1.0[6]	11.50 or 10.90[6]	1.40	10.50
	TP88	11.60	0.40[4]	11.20[4]	-	-
	TP89	11.80	0.75	11.05	1.50	10.30
	TP90	12.10	0.80	11.30	1.70	10.40
	TP91	12.10	0.80[4]	11.30[4]	1.10	11.00
	TP92	12.10	-	-	0.45	11.70
	TP93	12.00	0.70[4]	11.30[4]	1.40	10.60
	TP94	12.00	0.70	11.30	-	-
	TP96	12.20	1.20[7]	11.00[7]	1.50[5]	10.70[5]
	TP97	12.40	1.40	11.00	2.10	10.30
	TP98	12.40	1.30[7]	11.10[7]	2.20	10.20
	TP99	11.40	1.20[4]	10.20[4]	-	-
	TP100	12.40	1.10	11.30	1.80	10.60
	TP101	12.10	1.90	10.20	-	-
	TP102	12.60	1.30	11.30	2.00	10.60

Table 1 (continued): Summary of Depth to the Base of Non-engineered Filling and Filling, Surface Sand, Sandy Silt, Gravel Gravelly Sand and Sandy Gravel zone and Approximate Relative Levels

Ground Investigation	Test Location	Surface Level (m AHD) [1]	Depth to Base of non-engineered Filling and Filling (m)	Level to Base of non-engineered Filling and Filling (m AHD)	Depth to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m)	Level to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m AHD)
January 2016	TP103	12.80	1.20	11.60	-	-
	TP104	13.00	0.60	12.40	-	-
	TP105	13.20	0.30	12.90	0.80	12.40
	TP106	13.60	-	-	0.40	13.20
	TP107	13.90	-	-	0.30	13.60
	TP108	13.90	-	-	1.40	12.50
	TP109	9.60	1.00	8.60	1.30	8.30
	TP110	12.50	0.60	11.90	1.30	11.20
	TP111	12.60	0.40	12.20	1.10	11.50
	TP112	12.60	-	-	0.50[5]	12.10[5]
April-May 2016	TP201	13.00	0.40	12.60	-	-
	TP202	13.00	-	-	0.60	12.40
	TP203	13.50	-	-	0.70	12.80
	TP204	13.00	0.30	12.70	0.70	12.30
	TP205	13.00	-	-	0.90	12.10
	TP206	13.00	-	-	0.90	12.10
	TP207	15.00	0.90	14.10	1.60	13.40
	TP208	15.50	0.90	14.60	1.40	14.10
	TP209	15.00	0.30	14.70	1.90	13.10
	TP210	16.00	0.90	15.10	>1.0	<15.00
	TP211	16.00	0.60	15.40	>1.0	<15.00
	TP212	16.00	0.70	15.30	>1.0	<15.00
	TP213	16.00	>0.80	<15.20	-	-

Table 1 (continued): Summary of Depth to the Base of Non-engineered Filling and Filling, Surface Sand, Sandy Silt, Gravel Gravelly Sand and Sandy Gravel zone and Approximate Relative Levels

Ground Investigation	Test Location	Surface Level (m AHD) [1]	Depth to Base of Non-engineered Filling and Filling (m)	Level to Base of Non-engineered Filling and Filling (m AHD)	Depth to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m)	Level to Base of Sand, Sandy Silt, Gravel, Gravelly Sand and Sandy Gravel Zone (m AHD)
July 2016	TP01	14.00	1.80	12.20	-	-
	TP02	14.00	0.30	13.70	1.50	12.50
	TP03	15.00	0.30	14.70	0.60	14.40
	TP04	16.00	0.70	15.30	1.50	14.50
	TP05	12.00	0.80	11.20	-	-
	TP06	10.00	0.20	9.80	0.90	9.10
	TP07	10.00	-	-	0.70	9.30
	TP08	11.00	-	-	0.90	10.10
	TP09	11.00	-	-	0.50	10.50
	TP10	11.00	-	-	0.50	10.50
	TP11	12.00	-	-	0.70	11.30
	TP12	13.00	-	-	1.40	11.60
	TP13	13.00	0.25	12.75	0.50	12.50
	TP14	13.00	1.00	12.00	1.50	11.50

Notes: [1] Surface level from a survey plan provided by Linc Property Pty Ltd, Google Earth or the Perth Groundwater Atlas.
[2] Layers of organic sand were recorded between 0.4 m and 0.65 m in thickness.
[3] Layers of organic filling were recorded between 0.25 m and 0.70 m in thickness.
[4] Includes cemented filling.
[5] Cemented sand (Coffee Rock) approximately varying between 0.2 m and 0.35 m in thickness.
[6] Depth or level of possible filling.
[7] Recorded as filling (topsoil).

4.2 Groundwater

Groundwater was observed within four test pits excavated between 12 December and 24 December 2015, and within eight test pits excavated on 8 July 2016. It is expected that the groundwater within two of test pits, TP35 and TP106 is perched groundwater. The test pits were

immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels. No free groundwater was observed within any of the test pits excavated on 28 April 2016 and 4 May 2016. Groundwater levels are summarised in Table 2.

Table 2: Summary of Observed Groundwater Levels

Date	Test Location	Surface Level [1] (m AHD)	Groundwater Depth (m)	Groundwater Level [2] (RL m AHD)
18 December 2015	TP35	10.30	1.90[3]	8.40[3]
16 December 2015	TP67	12.40	2.40	10.00
17 December 2015	TP78	12.00	2.90	9.10
21 December 2015	TP106	13.60	1.70[3]	11.90[3]
8 July 2016	TP01	14.00	1.30[3]	12.70[3]
	TP02	14.00	1.20[3]	12.80[3]
	TP03	15.00	1.30[3]	13.70[3]
	TP04	16.00	1.70[3]	14.30[3]
	TP06	10.00	1.30[3]	8.70[3]
	TP07	10.00	0.70[3]	9.30[3]
	TP08	11.00	0.90[3]	10.10[3]
	TP11	12.00	1.90[3]	10.10[3]

Notes [1]: Surface level interpolated from a survey plan supplied by Linc Property Pty Ltd and Google Earth.
[2]: Groundwater Level = Interpolated Surface Level – Groundwater Depth.
[3]: Seepage

It should be noted that local groundwater levels can be affected from many sources including climatic conditions, bore water usage, surrounding development, drainage systems etc. and therefore will vary over time.

4.3 Permeability

Seven in-situ permeability tests using either the constant head method or the falling head method were undertaken within the site. The constant head tests were undertaken in accordance with AS 1547-2000 Appendix 4.1F, while the falling head test values were estimated using Hvorslev's method (1951). Permeability values were also derived using the laboratory results in Section 5 and Hazen's formula, which applies for sand in a loose state. Results of the permeability analysis are summarised in Table 3 (next page).

Table 3: Summary of Permeability Analysis

Test Location	Depth (m)	Measured Permeability[1]		Derived Permeability (m/s) [2]	In situ Conditions of Tested Material
		(m/s)	(m/day)		
TP14	0.50	1.9×10^{-5}	1.6	-	Stiff to Very Stiff Clayey Sand
TP41	0.70	1.3×10^{-4}	11.2	-	Medium Dense Sand, trace of silt
TP52	0.50	1.3×10^{-4}	11.2	1.0×10^{-4}	Medium Dense to Dense Sand, trace of silt
TP63	0.50	1.3×10^{-5}	1.1	-	Very Stiff to Hard Clayey Sand
TP77	0.50	1.4×10^{-4}	12.0	1.7×10^{-4}	Medium Dense Sand, trace of silt
TP105	0.50	1.9×10^{-5}	1.6	-	Interface of sand filling and sand, with some clay
TP110	0.70	1.8×10^{-5}	1.5	-	Interface of sand filling and sand, with some clay

Notes: [1]: In-situ assessment.
[2]: Hazen's formula. Method mostly applicable for sandy soils.

5. Geotechnical Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of:

- The particle size distributions of 14 samples;
- The Atterberg limits and linear shrinkage of 8 samples;
- The shrink/swell index of nine samples.
- The organic content on five samples; and
- The modified maximum dry density (MMDD), optimum moisture content (OMC) and the California bearing ratio (CBR) values of four samples

The laboratory test results are summarised in Table 4 to Table 6.

Table 4: Results of Soil Identification Laboratory Testing

Test Location	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	lss (%)	Material
TP2	1.1-1.3	-	-	-	-	-	-	-	3.2	Clayey Sand
TP14	0.3-0.5	52	<0.0135	0.16	72	19	53	13.5	-	Sandy Clay/Clayey Sand, with some gravel
TP31	0.6-0.8	-	-	-	-	-	-	-	2.6	Clayey Sand
TP37	0.2-0.3	44	<0.0135	0.21	34	16	18	8.0	-	Filling (Clayey Sand)
TP48	1.0-1.3	-	-	-	-	-	-	-	1.5	Clayey Sand
TP49	1.6-1.8	23	<0.0135	0.39	-	-	-	-	-	Filling (Clayey Sand)

Table 4 (continued): Results of Soil Identification Laboratory Testing

Test Location	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	Iss (%)	Material
TP51	1.1-1.4	19	<0.0135	0.60	29	20	9	5.5	0.1	Slightly Gravelly Slightly Clayey Sand
TP52	0.3-0.5	5	0.1	0.41	-	-	-	-	-	Sand, with some silt
TP54	2.3-2.4	31	<0.0135	0.48	65	18	47	15.0	-	Clayey Sand, with some gravel
TP63	0.3-0.5	19	<0.0135	0.45	32	14	18	5.5	-	Slightly Clayey Slightly Gravelly Sand
TP66	0.6-0.8	-	-	-	-	-	-	-	2.1	Clayey Sand
TP68	0.5-0.65	-	-	-	-	-	-	-	2.2	Clayey Sand
TP74	0.7-0.8	-	-	-	-	-	-	-	2.1	Clayey Sand
TP77	0.3-0.5	3	0.13	0.48	-	-	-	-	-	Sand, trace of silt
TP79	0.8-1.15	25	<0.0135	0.39	73	14	59	20.0	5.6	Slightly Gravelly Clayey Sand
TP87	0.5-0.6	20	<0.0135	0.30	-	-	-	-	-	Slightly Clayey Sand, trace of gravel
TP92	0.5-0.8	-	-	-	-	-	-	-	3.8	Clayey Sand
TP96	0.9-1.0	3	0.18	0.52	-	-	-	-	-	Filling (Sand with some gravel and a trace of clay)
TP103	0.6-0.7	5	0.16	0.51	-	-	-	-	-	Filling (Slightly Gravelly Sand, with some silt)
TP104	1.2-1.3	13	<0.0135	8.5	-	-	-	-	-	Slightly Clayey Sandy Gravel
TP106	0.5-0.6	61	<0.0135	0.07	-	-	-	-	-	Sandy Silt, with some gravel

Where:

- The % fines is the amount of particles smaller than 75 µm.
- A d_{10} of 0.17 mm means that 10% of the sample particles are finer than 0.17 mm.
- A d_{60} of 0.23 mm means that 60% of the sample particles are finer than 0.23 mm.
- I_{ss}: Shrink-Swell Index
- PL: plastic limit.
- LL: liquid limit.
- PI: plasticity Index.
- LS: linear shrinkage
- '-' means 'Not Tested'

Table 5: Results of Topsoil, Filling and Surface Sand Organic Content Laboratory Testing

Test Location	Depth (m)	Organic Content (%)	Material
TP37	0.2-0.3	4.9	Filling (Clayey Sand)
TP38	0.4-0.5	6.0	Filling (Clayey Sand)
TP49	1.6-1.8	19.3	Filling (Sand)
TP70	0-0.1	2.6	Topsoil
TP106	0.5-0.6	5.5	Sandy Silt, with some gravel

The CBR tests were undertaken at a target compaction level of 95% of modified maximum dry density. The samples were tested after soaking for four days with a confining surcharge of 4.5 kg, and the results are presented in Table 6 below.

Table 6: Results of Laboratory Testing for Pavement Design

Test Location	Depth (m)	MMDD (t/m^3)	CBR (%)	OMC (%)	Swell (%)	Material
TP14	0.3-0.5	1.816	1.5	15.2	5.0	Sandy Clay/Clayey Sand, with some gravel
TP63	0.3-0.5	2.070	4	9.1	4.5	Slightly Clayey Slightly Gravelly Sand
TP87	0.5-0.6	2.050	16	8.8	0	Slightly Clayey Sand, trace of gravel
TP106	0.5-0.6	1.786	13	18.2	0.5	Sandy Silt, with some gravel

Notes:
- MMDD: modified maximum dry density.
- CBR: California bearing ratio.
- OMC: optimum moisture content.

6. References

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.2-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Dynamic Cone Penetrometer Test.
3. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
4. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
5. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004.

7. Limitations

Douglas Partners has prepared this factual repor for this project at Coldwell Road, Kenwick in accordance with Douglas Partners proposals dated 18 December 2015 and 20 April 2016 and acceptance received from Mr Ben Lisle and Mr Brett Chivers of Linc Property Pty Ltd dated 1 December 2015, 20 April and 5 July 2016. The work was carried out under Douglas Partners Conditions of Engagement.

This factual report is provided for the exclusive use of Linc Property Pty Ltd for this project only and for the purposes as described in the factual report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this factual report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas Partners, does so entirely at its own risk and without recourse to Douglas Partners for any loss or damage. In preparing this factual report Douglas Partners has necessarily relied upon information provided by the client and/or their agents.

The results provided in the factual report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas Partners field testing has been completed.

This factual report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas Partners cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this factual report.

This factual report, or sections from this factual report, should not be used as part of a specification for a project, without review and agreement by Douglas Partners. This is because this factual report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

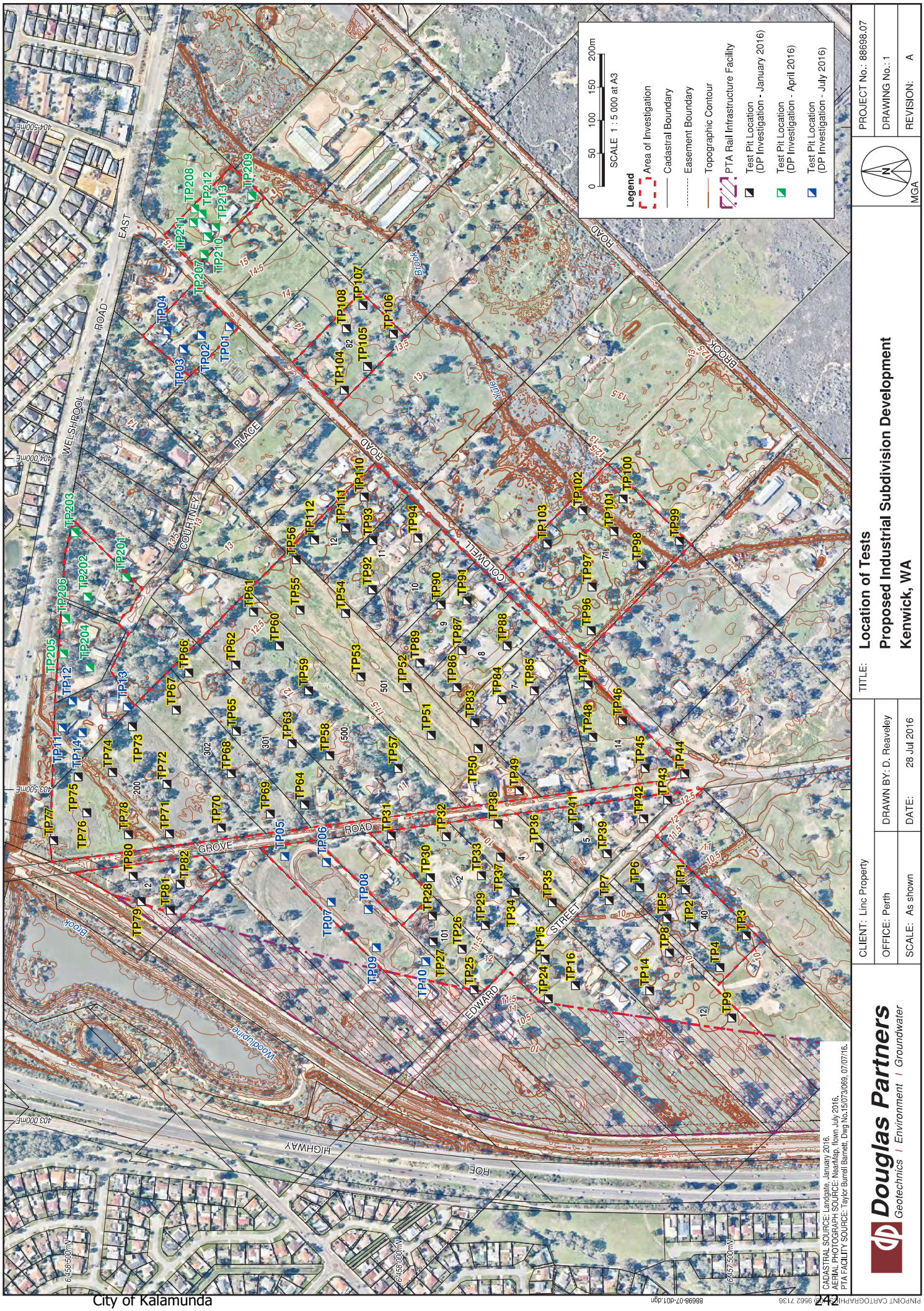
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawing


Legend
Area of Investigation
Cadastral Boundary
Easement Boundary
Topographic Contour
PTA Rail Infrastructure Facility
Test Pit Location (DP Investigation - January 2016)
Test Pit Location (DP Investigation - April 2016)
Test Pit Location (DP Investigation - July 2016)
0 50 100 150 200m
SCALE 1 : 5 000 at A3
PROJECT No.: 88698.07
DRAWING No.: 1
REVISION: A
MGA
TITLE: Location of Tests
Proposed Industrial Subdivision Development
Kenwick, WA
CLIENT: Linc Property
OFFICE: Perth
SCALE: As shown
DRAWN BY: D. Reaveley
DATE: 28 Jul 2016
Douglas Partners
Geotechnics / Environment / Groundwater
CADASTRAL SOURCE: Landgate, January 2016.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown July 2016.
PTA FACILITY SOURCE: Taylor Burrell Barnett, Dwg No.15/073/069, 07/07/16.
88698-07-001.dgn
PINPOINT CARTOGRAPHY (08) 9562 7136
WELSHPOOL ROAD EAST
COURTNEY PLACE
COLDWELL ROAD
BROOK ROAD
GROVE ROAD
EDWARD STREET
ROE HIGHWAY
Brook
Woodlupine
Yule
404 500mE
404 000mE
403 500mE
403 000mE
6 458 500mN
6 458 000mN
6 457 500mN

Lots 32 and 36 Brook Road, Wattle Grove

Wetland Buffer Assessment and Determination

July 2010

Prepared for: Evangelos Litis Nominees

Document Reference	Revision	Prepared by	Reviewed by	Submitted to Client	
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Executive Summary

Evangelos Litis Nominees is proposing to develop part of Lot 32 and Lot 36 Brook Road, Wattle Grove from a disused rural paddock to a light industrial complex. As part of Lot 32 contains a Conservation Category Wetland (CCW) the proposed development requires the assessment and implementation of an appropriate buffer distance between the proposed development and the CCW.

To determine what an appropriate buffer distance may be, the seven step process outlined by the Department for Planning and Infrastructure in the *Guide for the Determination of Wetland Buffer Requirements* has been followed. In their most basic form, buffers involve separating wetlands from adjacent landuses by fences or distance to preserve wetland (natural) attributes and functions.

The only relevant threatening processes that has the potential to impact upon the CCW for this site and the proposed use is diminished water quality due to incorrect drainage. Based on site information including drainage patterns and soils it appears there is very little, if any, drainage that currently flows into the CCW from the proposed development area. The proposed development will be designed to maintain predevelopment drainage patterns.

There is no published guidance regarding specific separation distances and as the threatening processes can be managed, the establishment of a large buffer is unwarranted. However, in recognising the significance of CCWs, the proponent proposes a 25 metre buffer. This buffer will provide protection of the CCW to meet the management objectives of preserving wetland (natural) attributes and functions.

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1 Introduction

Evangelos Litis Nominees (the proponent) is proposing to develop Lots 32 and 36 Brook Road, Wattle Grove (the site) (Figure 1) from a disused rural paddock to a showroom and storage facility complex. As part of Lot 32 contains a Conservation Category Wetland (CCW), the proposed change to a light industrial development requires the assessment of an appropriate buffer, or separation, distance between the proposed development and the CCW wetland.

In their most basic form, buffers involve separating wetlands from adjacent landuses by fences or distance. Neither are mutually exclusive, and in some cases, a combination can provide a solution. Additional features designed into the proposed development to protect the wetland from the threatening processes associated with the proposed development can also assist in providing a solution.

To determine what an appropriate buffer distance may be, the seven step process outlined in the *Guide for the Determination of Wetland Buffer Requirements* (Department for Planning and Infrastructure (DPI), 2005) has been followed. The seven steps outlined areas follows:

- Step 1: Acknowledge existence of wetland.
- Step 2: Identify Wetland Attributes, Wetland Management Category and Establish Management Objective.
- Step 3: Define Wetland Function Area.
- Step 4: Define Threatening Processes.
- Step 5: Identify Role of Separation.
- Step 6: Establish Separation Requirement.
- Step 7: Apply Separation Requirement to Proposal and Assess Ability of Separation to Achieve Management Objective.

These seven stages are structured in way that enables the establishment of an appropriate buffer between wetlands and existing or proposed developments. Developing an appropriate buffer provides an important tool in achieving and maintaining the desired processes, functions and attributes of wetlands. That is, the purpose of any buffer is to provide adequate protection to deal with all separation issues (e.g. habitat protection, fire management, water quality management).

The Environmental Protection Authority's (EPA) *Environmental Guidance for Planning and Development – Guidance Statement No. 33* (2008) was also used for guidance in assessing an appropriate separation distance. However, as EPA (2008) refers to, and is consistent with, the DPI (2005) document, the methodology outlined by the DPI has been chosen as the preferred methodology for this assessment. Discussions with other decision making authorities (e.g. Department of Environment and Conservation (DEC)) indicated the EPA (2008) document as well

as guidance listed on various government department websites should be considered when assessing wetland buffers. However, in reviewing these sources it was noted that they only provide generalised considerations and recommended separation distances. The DPI (2005) document is more comprehensive and provides a framework that allows for the inclusion of other information.

The following assessment, in accordance with the DPI's (2005) framework, provides justification for the proposed buffer between the CCW and the proposed development.

2 Site Description

2.1 Site Location and Features

The proposed development area includes Lot 36 and part of Lot 32 (Figure 2). Covering approximately 5.5 ha, the proposed development area is bound to the west by Brook Road, to the north by Welshpool Road East, other rural lots to the east and south and Soil Land, a commercial operation, to the east. The development site is predominately cleared and generally appears to drain towards Welshpool and Brook Roads.

2.2 Bush Forever

The proposed development area is located within Bush Forever Site (BFS) 387. BFS 387, known as Greater Brixton Street Wetlands, has landscape features including vegetated wetlands, Yule Brook and vegetated uplands (Government of Western Australia (WA), 2000). The greater Bush Forever site is known to contain Threatened Ecological Communities (TEC), Declared Rare Flora (DRF) and Priority flora (PF) (Government of WA, 2000). BFS 387 is considered one of the most floristically diverse areas of the Swan Coastal Plain (Government of WA, 2000).

2.3 Flora and Vegetation

2.3.1 Flora

360 Environmental (2010) undertook a flora, vegetation and wetland assessment that included the proposed development area in spring 2008 (Appendix A). The flora and vegetation component was undertaken to the standard of a Level 2 survey in accordance with the Environmental Protection Authority's (EPA) (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51*.

The field investigations, which included multiple sampling sites and reconnaissance transects across the site throughout Spring 2008 (Figure 3) observed no conservation significant flora within the proposed development area.

However, there were two conservation significant species found within the CCW on Lot 32 (Figure 3). These are as follows:

- *Baeckea* sp. Perth Region R.J. Cranfield 444 (Priority 3).
- *Grevillea thelemanniana* (Priority 4).

There were also 18 regionally significant flora species found within the CCW and Lot 32.

2.3.2 Vegetation Communities

The vegetation units within the site are part of the Guildford Vegetation complex. When analysed, the vegetation data collected during the spring 2008 survey (360 Environmental, 2010) indicated there are 4 vegetation types present on the proposed development area (Figure 4). These were described as:

- Vegetation Unit 1: Mid-dense to closed heath-scrub of *Actinostrobus pyramidalis-Banksia telmatiaea-Hypocalymma angustifolium-Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes and open native annual herbs.
- Vegetation Unit 2: Mid-dense to open heath of *Melaleuca viminea-Hypocalymma angustifolium- Acacia lasiocarpa* over mid-dense *Actinostrobus pyramidalis* seedlings, open naturalised alien grasses and open annual herbs.
- Vegetation Unit 3: Melaleuca rhaphiophylla low woodland over *Melaleuca viminea* low open shrubs, sparse sedges and naturalised alien grasses.
- Vegetation Unit 4: *Corymbia calophylla* low woodland over dense naturalised alien grasses.

The results of the data analysis indicated the vegetation communities present did not align with any threatened or priority ecological communities. The vegetation communities for the majority of the proposed development area is considered completely degraded.

2.3.3 Vegetation Condition

Using the vegetation condition assessment scale found in Bush Forever (WA Government, 2000) the condition of the vegetation across the site was assessed as part of 360 Environmental's (2010) flora, vegetation and wetland assessment. The results indicated the vegetation condition across the proposed development area was mostly considered "completely degraded", with some areas of "completely degraded to degraded" (360 Environmental, 2010) (Figure 5).

The area of remnant vegetation on Lot 32 was considered generally to be in degraded-good to good condition (Figure 5).

2.4 Wetlands

There are no Ramsar wetlands or Directory of Important Wetlands on the site (Department of Environment, Water, Heritage and the Arts (DEWHA), 2009).

Wetlands of the site have been described and mapped by Hill *et al*. (1996) and assigned a management category which reflects their condition and environmental values. There are three categories that wetlands are assigned, "Conservation Category" (CCW), "Resource Enhancement" (REW) and "Multiple Use" (MUW) depending on their condition and environmental values. "Conservation Category"

wetlands being those with the highest level of ecological attributes and functions, followed by "Resource Enhancement" then "Multiple Use".

The proposed development area is within a REW palusplain wetland (Hill et al, 1996) (Figure 6) which is part of the Greater Brixton Street wetlands. The DEC (2009) identifies this wetland with the Unique Feature Identifier number (UFI) 13367. A CCW also covers part of Lot 32 outside of the proposed development area (Figure 6).

The flora, vegetation and wetland assessment undertaken in spring 2008 evaluated both the REW and CCW wetland using the three methods that are recommended by the DEC (2007) to assess the accuracy of the current DEC mapping and evaluation categories (360 Environmental, 2010). These include:

- The questionnaire of the V and C Semeniuk Research Group (VCSRG) (1998) that was designed for the Western Australian Water and Rivers Commission.
- The questionnaire in EPA *Bulletin 686* (1993).
- Assessment of wetland vegetation condition based on the Bush Forever methodology (Government of WA, 2000).

The management category allocated to the area of palusplain UFI 13367 on the site by the VCSRG (1998) methodology was REW, though based on the Bulletin 686 (1993) and Bush Forever methodology (Government of WA, 2000) the management category allocated was MUW.

The flora, vegetation and wetland assessment (360 Environmental, 2010) also mapped minor differences against the Hill et al (1996) dataset such as an area mapped as "not wetland" in the eastern section of Lot 32 and two areas of dampland and an area of sumpland (Figure 7).

2.5 Soils and Groundwater

Site soils are comprised of very poorly drained, uniform, non-cracking clays (Department of Agriculture and Food, 2010) and depth to groundwater is approximately seven to eight metres below ground level flowing in a south westerly direction (Department of Water, 2010) (Appendix B).

2.6 Topography

Site elevations are between approximately 17 and 20 metres AHD, falling from the north-east of the site towards the south-west (Department of Water, 2010) (Appendix B). Surface contours generally follow the groundwater contours (Appendix B).

3 Development Description

The proposed development of showrooms and wharehouses is classified as light industrial under the Shire of Kalamunda's *Planning Scheme No. 3*. Under this scheme, the proposed uses have the following definitions.

- Showroom - premises used for displaying or offering goods for sale by wholesale or retail, automotive parts and accessories, camping equipment, electrical light fittings, equestrian supplies, floor coverings, furnishings, furniture, household appliances, party supplies, swimming pools or goods of a bulky nature.
- Warehouse - premises used to store or display goods and which may include sale by wholesale.

The first stage of the proposed development includes seven showrooms and a single warehouse building. The showrooms comprise of a total floor area of 3793 m^2 while the warehouse will be 1406 m^2. All buildings will be set back 23 metres from Welshpool and Brook Roads. This land will be used primarily for parking but will be landscaped to minimise the visual impact. A rate of one tree for every twelve parking bays will be observed. This strip will incorporate a three metre strip with a footpath.

The proposal also includes three new access points. One crossover on Welshpool Road, one on Brook Road and a direct crossover to provide access to the warehouse building. These access points will help distribute traffic throughout the site and facilitate access for traffic coming west from Welshpool Road.

Subsequent phases of development will also be focused around light industrial buildings (showrooms and warehouses).

4 Process for Determination of Wetland Buffer

4.1 Acknowledge Existence of Wetland

The wetland proposing to be buffered is a CCW mapped over the southern portion of Lot 32 (Figure 6). This is listed under DEC wetland management category as UFI 7773. It is classified as a palusplain wetland, which are typically extensive wetlands located on flat land that are seasonally waterlogged.

4.2 Identify Wetland Attributes, Wetland Management Category and Establish Management Objective

A Level 2 flora, vegetation and wetland assessment was undertaken in Spring 2008 on the CCW (360 Environmental, 2009). Although there is likely to be minor variations in the actual boundary of the CCW, the assessment confirmed the management category for the majority of the area to be classified as a CCW (Figure 7). The purpose of the CCW management category is to preserve wetland (natural) attributes and functions (Hill *et al*, 1996).

A review of the justification for the high management category identified over the CCW the following key values, functions and attributes of the wetland.

- Significant flora species present.
- Vegetation quality is quite high, in good condition and has low numbers of weed species.
- High species and habitat diversity.
- Natural water or drainage flows.
- Forms part of a regionally significant wetland system.
- Part of BFS 387.
- Potentially provide habitat for a range of fauna.
- Maintain processes essential to retaining wetland function area (WFA) condition.
- Contributes to the aesthetics in the region.

These are the key attributes critical to the determination of the extent of the boundary of the WFA and any appropriate separation or management requirement (Table 1).

4.3 Define Wetland Function Area

Where practicable, the WFA is the area required to support the attributes of the wetland (Table 1) and is the area which needs to be protected to ensure the important functions and values of the wetland can be maintained. It would normally include the wetland, the wetland vegetation and any directly associated dependent terrestrial habitat (DPI, 2005).

DPI (2005) indicates the WFA should ideally be comprised of the wetland itself, the wetland vegetation and any directly associated dependent terrestrial habitat. As this CCW is part of a larger palusplain wetland, for the purposes of this assessment, the WFA is the area mapped as CCW on the DEC's *Geomorphic Wetlands* database. This area comprises wetland vegetation with no directly associated dependent terrestrial habitat.

Historically, the adjacent vegetation is likely to have included wetland vegetation however this has been cleared and replaced by naturalised alien grasses. These do not need protection. While the proposed development area (and the buffer area) is within BFS 387, it has been degraded to such an extent that its viability as a conservation area has been lost. Therefore, this area has been excluded from the WFA.

Although there is likely to be connectivity in the groundwater system, the *Perth Groundwater Atlas* (Department of Water) indicates groundwater is likely to flow in a westerly to south-westerly direction.

4.4 Define Threatening Processes

Threatening processes are those that could potentially threaten the significant attributes of the wetland. These were identified based on consideration of the environmental risks of the surrounding area.

The threatening processes as demonstrated through Table 1 requiring separation and/or management for the site are habitat modification and diminished water quality.

Table 1. Requirements to Support Significant Attributes of the Site.

Significant Attribute	Requirement to support attribute, for the purpose of defining the WFA.	Definable boundary /extent	Key threatening processes	Role of separation
Significant flora species present.	Maintain all significant flora species.	WFA.	Habitat modification.	Protection from direct disturbance.
High vegetation quality.	Maintain all vegetation.	WFA.	Habitat modification.	Protection from direct disturbance.
High species and habitat diversity.	Maintain representation of all wetland communities.	WFA	Habitat modification	Protection from direct disturbance.
Natural water flows.	Maintain natural state of wetland.	WFA	Diminished water quality	Protection from direct disturbance. Protect from additional surface water drainage.
Forms part of a regionally significant wetland system.	Maintain natural state of wetland.	WFA	Diminished water quality	Can link adjacent wetland separation areas. Protection from direct disturbance.
Part of BFS 387.	Support attributes consistent with management objectives.	WFA	Habitat modification	Can link adjacent wetland separation areas. Protection from direct disturbance.
Potentially provide habitat for a range of fauna.	Maintain all areas on which associated fauna are dependent.	WF	Habitat modification	Protection from direct disturbance. Can provide indirect support for wetland function through hydrological and terrestrial processes.

Significant Attribute	Requirement to support attribute, for the purpose of defining the WFA.	Definable boundary /extent	Key threatening processes	Role of separation
Maintain processes essential to retaining WFA condition.	Maintain natural state of wetland.	WFA	Habitat modification. Diminished water quality	Protection from direct disturbance. Can provide indirect support for wetland function through hydrological and terrestrial processes.
Aesthetics.	Maintain wetland area.	WFA	Habitat modification	Protection from direct disturbance.

Although habitat modification is listed as a key threatening process in the above table the proposed development does not propose the removal of any vegetation of significance within or adjacent to the WFA. The vegetation condition between the proposed development and the CCW is considered completely degraded (Figure 5).

Therefore, the only relevant key threatening process applicable for this proposal is diminished water quality. This has also been noted as the key issue to be managed through discussions with the DEC (pers. com, 29/06/2010; 1/07/2010). Any potential threat to habitat modification can be addressed through management of this issue.

4.5 Identify Role of Separation

The role of separation (ie distance and management) for each attribute was identified based on consideration of Table 1 and Table 2. Table 2 outlines the DPI's (2005) recommended separation and management requirements for CCWs. As diminished water quality is the only significant threatening process identified, only these recommended separation requirements are considered relevant.

Table 2. CCW – Separation and Management Measures

Key Threatening Process	Recommended Separation and/or Management	Separation Area Management
Alteration to the water regime	• Regulation of groundwater abstraction as catchment management measure	• Area to be vegetated with deep-rooted perennial vegetation

KEY THREATENING PROCESS	RECOMMENDED SEPARATION AND/OR MANAGEMENT	SEPARATION AREA MANAGEMENT
Habitat modification	● 100 m weed infestation ● Up to 100 m for bird habitat depended on extend of use ● 6-50 m firebreak ● Fence for controlling exotic fauna access. ● ≥100 m to minimise edge effects	● Preferable native plant communities ● 6 m firebreak minimum, inside of fence. ● Fence to limit vehicle, stock and exotic fauna access. ● Clear perimeter outside of fence, path, firebreak road). ● Fire control to maintain habitat and species diversity ● Minimise track access/clearing maximise native vegetation ● Management for water quality outcomes as required.
Inappropriate recreational use	● ≥50 m to improve aesthetics ● ≥50 m for barrier ● Fence, paths for controlling access	
Diminished water quality	● Drainage inflows eliminated or managed. ● Where a proposal may affect wetland water quality particularly through un-channelised flow, detailed site specific work should be undertaken to determine the specific separation measures required, including management measures.	

(Source: DPI, 2005)

4.6 Establish Separation Requirement

There is no specific separation distance to manage diminished water quality. However it is recommended that:

- Drainage inflows be eliminated or managed.
- Where a proposal may affect wetland water quality particularly through un-channelised flow, detailed site specific work should be undertaken to determine the specific separation measures required, including management measures.

Two key features associated with the site when considering the separation requirements are the proposed land use and the natural site drainage. The proposed land use is not considered a potentially contaminating activity and due the generally sealed nature of the site, there will be no significant use of fertilisers, pesticides or

non-native plant species that may otherwise be common place in other land uses such as residential or agricultural.

The drainage across the site currently runs in a south-westerly direction and not directly into the CCW (Figure 8) (Appendix B). It also appears a significant amount of the site drains towards Welshpool and Brook roads. The development will be designed to maintain the current drainage patterns to ensure there is no increase in water drainage into the CCW. Site drainage will also be designed to capture and treat all water on-site to the Department of Water's required standards. This includes the capture and retention on site of 99% of all rain events. However, due to the site soils, described by the Department of Agriculture (2010) as being very poorly draining, uniform, non-cracking clays, there is a natural, pre-development runoff from the site that is higher than typically associated with the Swan Coastal Plain.

It is not expected there will be significant potential impacts associated with drainage as it will be treated on site and the natural drainage direction is proposed to be retained.

4.7 Apply Separation Requirement to Proposal and Assess Ability of Separation to Achieve Management Objective

The result of following this process has indicated the proposed development does not pose a significant risk to the adjacent CCW. The recommendation suggests a very small buffer, if any, is required. However, recognising the importance of the wetland system the adjacent CCW is part of, a fenced, 25 metre buffer is proposed as an appropriate separation distance.

This is considered preferable to no buffer as although it is unlikely there will be any significant impacts associated with the proposed development as a result of direct impacts, it provides separation for any fauna that may utilise the CCW as habitat. Once construction of the proposed development is complete, activities on the site will be relatively quiet and there will be no general public access into the buffer area. Therefore, although separation distances for fauna are often larger than 25 metres, the nature of the proposed development warrants a small buffer consistent with surrounding industries and activities.

5 Conclusion

The proponent is proposing to develop Lot 36 and part of Lot 32 Brook Road, Wattle Grove from a disused rural paddock to a light industrial site. Due to the existence of a CCW over part of Lot 32 an appropriate buffer distance between this and the proposed development is required.

The process outlined by the DPI in the *Guide for the Determination of Wetland Buffer Requirements* has been followed. The only potential threatening process identified on the CCW associated with the proposed development is considered to be the potential for diminished water quality due to a change in drainage patterns. There is no specific buffer distance recommended for this threatening process and a site specific investigation is suggested. Based on site information including drainage patterns and soils it appears there is very little, if any, drainage that currently flows into the CCW from the proposed development area. The proposed development will be designed to maintain the same drainage flows as predevelopment.

There is no published guidance regarding specific separation distances and as the threatening processes can be managed, the establishment of a large buffer is unwarranted. However, in reciognising the significance of CCWs, the proponent proposes a 25 metre buffer. This buffer will provide protection of the CCW to meet the management objectives of preserving wetland (natural) attributes and functions.

6 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

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It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

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- 360 Environmental. 2010. *Spring 2008 Flora and Vegetation Survey and Wetland Assessment, Delineation and Classification* (Unpublished Report). Perth, WA.
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FIGURES



Legend

- Site Boundary
- Cadastral Boundary

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- CADASTRES SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2007

SCALE

0 10 20 40 60 80 100

Metres

1:2,000 @ A3

LOCALITY MAP



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Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Site Location
Figure 1

404600 404800 405000

6458200 6458000 6457800

Welshpool Road

Brook Road

Lot 36

Lot 32

N

Legend

- Site Boundary
- Proposed Development Area

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
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14.07.10	1	LD002.AB.02

Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Proposed Development Area
Figure 2

404600 404800 405000

6458200 6458000 6457800

Walshpool Road

Brook Road

Lot 36

Lot 32

H13 H14 H15 H16 H17 H18 Q14/H10 Q9/H9 Q7/H7 Q8/H8 Q11

N

Legend

- Site Boundary
- Quadrat and Auger Location
- Proposed Development Area

Priority and DRF Location

- *Baeckea* sp. Perth Region (R.J. Cranfield 444)
- *Grevillea thelemanniana*

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2007

SCALE

0 10 20 40 60 80 100

Metres

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LOCALITY MAP



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HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

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Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Conservation Significant Flora Mapped During Spring 2008 (360 Environmetal, 2009)
Figure 3

404600 404800 405000

6458200 6458000 6457800

Lot 36

Lot 32

3 3 3 4 2 2 2 3 2 1

N

Legend

- Site Boundary
- Proposed Development Area

Vegetation Communities

- 1
- 2
- 3
- 4

Vegetation Description

1. Mid-dense to closed heath-scrub of *Actinostrobus pyramidalis-Banksia telmatiaea-Hypocalymma angustifolium-Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes and open native annual herbs; and

2. Mid-dense to open heath of *Melaleuca viminea- Hypocalymma angustifolium- Acacia lasiocarpa* over mid-dense *Actinostrobus pyramidalis* seedlings, open naturalized alien grasses and open annual herbs.

3. *Melaleuca rhaphiophylla* low woodland over *Melaleuca viminea* low open shrubs, sparse sedges and naturalized alien grasses.

4. *Corymbia calophylla* low woodland over dense naturalized alien grasses.

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2009
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 12.5 25 50 75

Metres

1:2,000 @ A3

LOCALITY MAP



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Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Vegetation Communities Mapped During Spring 2008 (360 Environmental, 2009)
Figure 4

404600 404800 405000

6458200 6458000 6457800

Lot 36

Lot 341

Lot 32

Lot 342

Lot 31

N

City of Kalamunda

404600 404800 405000

Legend

- Site Boundary
- Proposed Development Area

Vegetation Condition

- Good - Very Good
- Good
- Degraded - Good
- Degraded
- Completely Degraded - Degraded
- Completely Degraded

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
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SCALE

0 10 20 40 60 80 100

Metres

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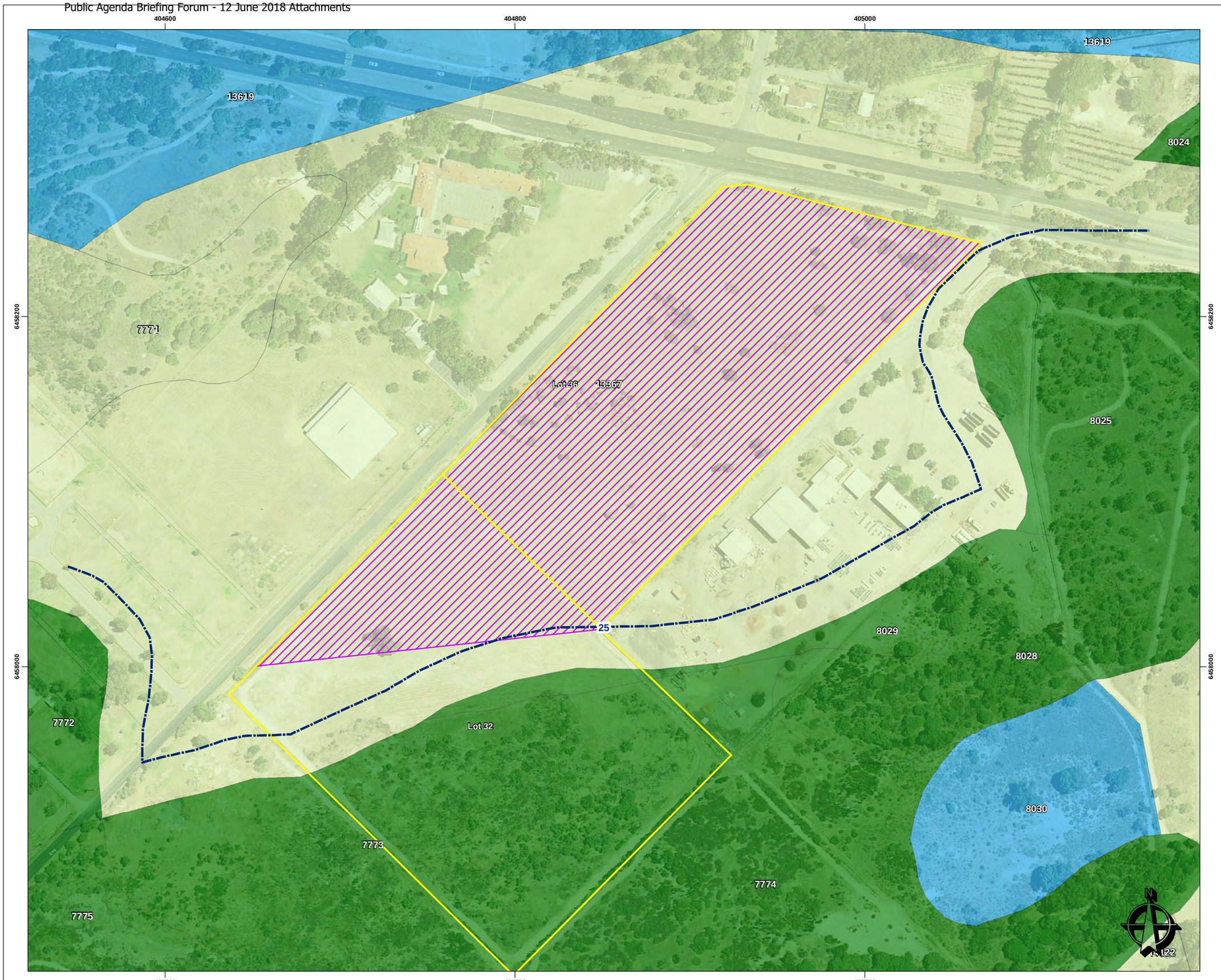
Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Vegetation Condition Mapped During Spring 2008 (360 Environmental, 2009)
Figure 5



City of Kalamunda

Legend

- Site Boundary
- Proposed Development Area

Geomorphic Wetlands, Swan Coastal Plain

- Conservation
- Resource Enhancement
- Multiple Use
- 25m Buffer

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- GEOMORPHIC WETLANDS SOURCED FROM DEC 2008
- LOCALITY MAP SOURCED FROM LANDGATE 2007

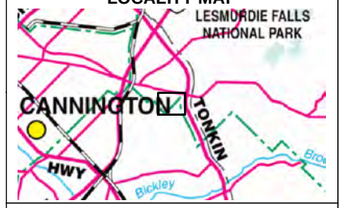
SCALE

0 10 20 40 60 80 100

Metres

1:2,000 @ A3

LOCALITY MAP



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Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Geomorphic Wetlands and DEC Wetland Management Categories
Figure 6

404600 404800 405000

6458200 6458000 6457800

Welshpool Road

Brook Road

Dampland REW

Lot 36

Paluspalain 13367 REW

Dampland REW

Not Wetland

25

Paluspalain 13367 REW

Lot 32

Paluspalain 7773 CCW

Sumpland/Dampland (likely to be part of 8028)

N

Legend

- Site Boundary
- Proposed Development Area

Geomorphic Wetlands

- Dampland
- Palusplain
- Sumpland
- 25m Buffer

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2007

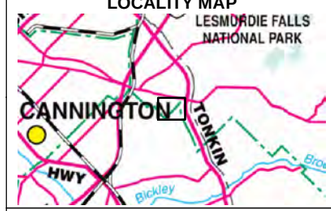
SCALE

0 10 20 40 60 80 100

Metres

1:2,000 @ A3

LOCALITY MAP



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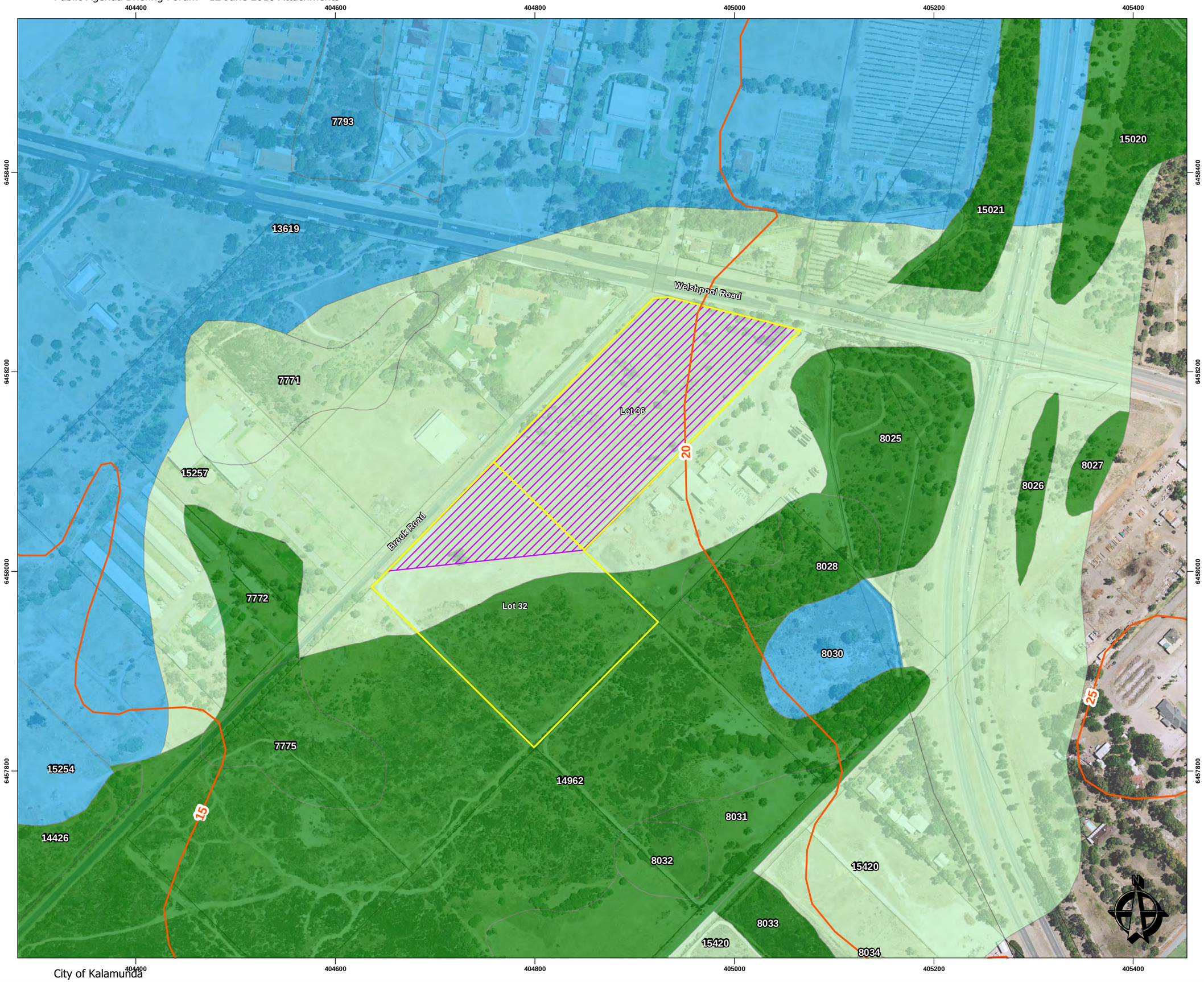
Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Wetland Mapping From Spring 2008 (360 Environmental, 2009)
Figure 7

Attachment 10.1.4.1



Legend

- Contours (elevation - mAHD)
- Site Boundary
- Proposed Development Area
- Cadastral Boundary

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Not Applicable

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- CADASTRES SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2007

SCALE

0 12.5 25 50 75 100 125

Metres

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LOCALITY MAP



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Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Wetland Buffer Assessment
Topography
Figure 8

APPENDIX

APPENDIX A

Spring 2008 Flora and Vegetation Survey and Wetland Assessment, Delineation and Classification

Lots 32 and 36 Brook Road, Wattle Grove

Spring 2008 Flora and Vegetation Survey and Wetland Assessment, Delineation and Classification

Prepared for: Evangelos Litis Nominees

Document Control Report Reference	Revision	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
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EXECUTIVE SUMMARY

360 Environmental Pty Ltd (360 Environmental) was commissioned by Evangelous Litis Nominees Pty Ltd (the client) to undertake a spring flora and vegetation survey and wetland assessment, delineation and classification (the investigation) of Lots 32 and 36 Brook Road, Wattle Grove (the survey area) (Figure 1). The survey is required by the client to determine potential constraints of the site associated with the presence of significant flora (including Declared Rare Flora (DRF)), Priority Flora and rare vegetation types (including Threatened Ecological Communities (TECs)).

The following scope of work was undertaken within the survey area:

- A Level 2 Flora and Vegetation assessment in accordance with the Environmental Protection Authority's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51.*
- An assessment and description of the wetlands and wetland boundaries within the site based on *A geomorphic approach to global classification for inland wetlands* (Semeniuk and Semeniuk, 1995).
- Soil sampling to map soil types. Soil type mapping was used to delineated and assist in mapping wetland boundaries.

All of the remnant native vegetation of Lot 32 was vegetation of the Guildford Vegetation Complex. Most of this vegetation was in degraded to good condition and showed similarities to a recognized TEC or vegetation that has not previously been well documented on the SCP and is likely to be of high conservation significance. Most of the native flora taxa recorded in the current survey was highly dependent on surface waters and/or groundwater. The entire survey area was confirmed as being either CCWs or REWs.

From the stratigraphical sampling that was conducted on site, it was evident that the natural distribution of sediments (both laterally and vertically) over the survey area is complex. Potential evidence of the EPBC-listed Muchea Limestone TEC was observed and this is not currently known to be represented elsewhere in the Greater Brixton Street Wetlands.

Although this survey found that some small changes to the DEC (2008) Swan Coastal Plain Wetlands Dataset may be undertaken with regard to the classification and mapping of wetlands at a fine scale, no further work should be required.

The patterns of regional groundwater flow, sub-surface and surface flow (in both natural drainage and constructed drains) are known to link the survey area with other areas of highly water-dependent biota in the Greater Brixton Street Wetlands (Perth

Groundwater Atlas, 2008; VCSRG, 2001) and will need to be considered during design stages prior to any application submission.

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1. Introduction

1.1. Background and Aims

360 Environmental Pty Ltd (360 Environmental) was commissioned by Evangelous Litis Nominees Pty Ltd (the client) to undertake a spring flora and vegetation survey and wetland assessment, delineation and classification (the investigation) of Lots 32 and 36 Brook Road, Wattle Grove (the survey area) (Figure 1). The survey is required by the client to determine potential constraints of the site associated with the presence of significant flora (including Declared Rare Flora (DRF)), Priority Flora and rare vegetation types (including Threatened Ecological Communities (TECs)).

1.2. Scope of Work

1.2.1. Spring Flora and Vegetation Survey

The following scope of work was undertaken within the survey area:

- A Level 2 Flora and Vegetation assessment in accordance with the Environmental Protection Authority's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. *No. 51.*

This included:

- Quadrat-based floristic description of the vegetation types within the project area.
- Mapping of the vegetation types and extent of any significant vegetation and flora with GPS. Photographs of each vegetation type and any other significant features.
- Complete flora inventory (including weeds) of the site.
- An assessment of vegetation condition on site and mapping.

1.2.2. Wetland Assessment, Delineation and Classification

The following scope of work was undertaken for the wetland assessment, delineation and classification:

- An assessment and description of the wetlands and wetland boundaries within the site based on *A geomorphic approach to global classification for inland wetlands* (Semeniuk and Semeniuk, 1995).
- Soil sampling to map soil types. Soil type mapping was used to delineated and assist in mapping wetland boundaries.

1.3. Objectives

This investigation was undertaken in accordance with 360 Environmental's proposal 454 AB (dated 18 February 2008). This study aimed to:

- Survey and map the vegetation communities.
- Compile a comprehensive species list.
- Identify any flora and vegetation issues that may need to be addressed in any subsequent environmental approvals.
- Map sub-surface soil profiles across the site.
- Compare the results of the flora, vegetation and sub-surface soil profiles to delineate and classify wetlands present on site.

1.4. Aims

In recognition if the potential environmental values of the surevy area based on discussion outlined in the EPA's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. *No. 51* thesurvey aimed to provide:

- A desktop review of the documented high conservation status flora and TECs in the vicinity of the project area.
- An inventory of the vascular flora observed during the field investigation of the survey area, including flora of conservation significance and naturalized alien taxa.
- A description and mapping of the small-scale vegetation units and vegetation condition in the survey area.
- Mapping of the boundaries of wetlands as determined by vegetation assemblages, shallow stratigraphy and watertable levels determined during transects through the survey area.
- An assessment of the conservation significance of the flora, vegetation units and wetlands of the areas considered above.
- Provision of recommendations based on the findings for potential options to progression of site development.

1.5. Report Format

The remainder of this report comprises the following components:

- Section 2 – Site Description
- Section 3 – Regional Setting
- Section 4 – Methodology

- Section 5 – Desktop Survey of Flora and Vegetation of Conservation Significance
- Section 6 – Field Flora Survey
- Section 7 – Field Vegetation Survey
- Section 8 – Field Wetland Survey
- Section 9 – Discussion and Conclusion
- Section 10 – Limitations
- Section 11 – References

2. Site Description

2.1. Site Location and Features

The survey area consists of Lots 32 and 36 Brook Road Wattle Grove (Figure 1). The site is bound to the west by Brook Road, to the north by Welshpool Road East and other rural lots to the east and south and totals approximately 5.5 hectares.

The entire site is within Bush Forever Site 387 (Figure 2) and also contains conservation significant wetlands. Approximately half of the site is currently categorised as Conservation Category Wetland (CCW) and the other half is categorised as Resource Enhancement Wetland (REW) (Figure 3).

2.2. The Geomorphology and Geology of the Survey Area

The Swan coastal Plain (SCP) consists of a series of geomorphological elements which are sub-parallel to the present coastline (McArthur and Bettenay, 1960). Each of these geomorphic elements has distinctive geology, vegetation, topography and soils.

Wattle Grove is located on the Pinjarra Plain on the eastern side of the SCP where the soils are predominantly alluvium of the Guildford Formation overlaid in places by aeolian sands of the Bassendean Dunes (Gozzard, 1983).

3. Regional Setting

3.1. Climate

Weather records for the Gosnells City weather station for the past 17 years can be used to gain an understanding of the climate in the vicinity of the survey area (Table 1, adapted from Bureau of Meteorology, 2008). The climate in the area can be described as warm, sub-humid and Mediterranean with a pronounced annual drought for 4-5 months each year and cool, wet winters (Gentilli, 1971).

3.2. Landforms and Superficial Sediments (soils)

The survey area is located about 2 km west of the scarp of the Darling Plateau. The eastern side of the SCP in the vicinity of the survey area comprises two landform units of regional scale (the Ridge Hill Shelf and the Pinjarra Plain) that are orientated more or less parallel to the coast, east of the Bassendean Dunes (McArthur and Bettenay, 1960).

The survey area is located within the Pinjarra Plain, in the south-west corner of Wattle Grove near a convergence of the Pinjarra Plain, the Ridge Hill Shelf and the Bassendean Dunes. The north-west boundary of Lots 32 and 36 is located where Bassendean Sands very shallowly overlie the Pinjarra Plain. The current survey area is part of a low relief wetland landscape dissected by Yule Brook; an alluvial fan complex (that includes considerable fine-scale heterogeneity of landforms and sediments) that slopes gently to the south west towards the Canning River.

The Ridge Hill Shelf geomorphic unit (also known as the Foothills unit of Churchward and McArthur, 1980), a more or less continuous platform, of about 1-3 km in width, located immediately to the west of the scarp of the Darling Range. It comprises Quaternary-aged sand, clay, conglomerate and laterite of various units including the Yoganup and Forrestfield Formations (Churchward and McArthur, 1980). The Ridge Hill Shelf is dissected by many channel wetlands (e.g. Yule Brook and Bickley Brook) that have their headwaters on the Darling Plateau and flow west onto the SCP or terminate within the foothills (Perth Groundwater Atlas, 2004).

The Pinjarra Plain comprises mainly Quaternary-age fluvial sediments of the Guildford Formation that originated on the Darling Plateau and Scarp and were deposited on to the SCP as alluvial fans of gravel, sand, loam and clay (Churchward and Mc Arthur, 1980). The sediments of the Pinjarra Plain were also subsequently re-worked in some places by channel migration and localised aeolian processes. Other materials such as Muchea Limestone and ferricrete were formed in situ on the Pinjarra Plain. There is a fine-scale hydrogeological complexity in the alluvial fan formations of the Guildford Formation that is unparalleled elsewhere on the SCP (VCSRG, 2001). The Greater

Brixton Street Wetlands are part such an alluvial fan complex that is associated with Yule Brook. The varied array of stratigraphic sequences and hydrological patterns recorded by VCSRG (2001) in the Greater Brixton Street Wetlands correlates with the rich mosaic of fine-scale vegetation assemblages in the area. The high habitat heterogeneity is undoubtedly a major factor underpinning the high biodiversity of the region.

The Bassendean Dunes geomorphic unit is an undulating plain of low-relief dunes generally composed of well-drained, deep, quartz sands (Bassendean Sands). Wetlands in the Bassendean Dunes are usually basins and there are few drainage channels in this area.

The superficial sediments (soils) of the Wattle Grove – Kenwick areas in the vicinity of Bush Forever Site (BFS) 387 have been mapped at a scale of 1:50,000 by Jordan (1986). This mapping illustrates, in general terms, a sequence of habitats that grade into each other down the gentle slope of the alluvial fan complex within BFS 387. This soil sequence in BFS 387 ranges from Lot 36 (at the upper extreme of the landscape) down to the Brixton St Reserve in Alton St, Kenwick (at the lower extreme of the landscape) (Table 2). In this sequence, Lots 32 and 36 (between about 14-20 m Australian Height Datum (AHD)) were mapped as shallow Bassendean Sands over sandy clay of the Guildford Formation (S10). The area of BFS 387 that is located between Bickley Rd and Brixton St (below about 8m AHD in the alluvial fan complex) was mapped as clayey-sand soils of the Guildford Formation (Sc). The BFS 387 lands that lie in the lower part of the alluvial fan complex (south west of Brixton St and below about 6m AHD) were mapped as Guildford Formation sandy clay (Cs). The University of WA Allison Baird Reserve, mid way down the slope, can be seen to include the greatest diversity of soils (S10, Sc and S8) at this scale.

Thus the lands included in BFS 387 and adjacent lands that are part of the same alluvial fan, although they comprise a continuum of soil types, can be divided into several main zones with regard to soil type and these zones can be correlated with topography (the latter expressed as metres AHD and mapped in the Perth Groundwater Atlas, 2004). Although there are many other factors including stratigraphic sequence, depth to water table and hydroperiod that also determine plant habitats in the area, the soil zones (as above) can be seen to be correlated with vegetation assemblages and the preferred habitat of individual plant species (Goble-Garrat, 1991; Keighery, 2000; VCSRG, 2000).

3.3. Wetlands and Hydrology

The wetlands of Wattle Grove and Kenwick are part of the Keysbrook (P1) and the Mungala (B/P2) Consanguineous Wetland Suites (VCSRG, 1991; Hill et al., 1996). The Keysbrook Wetland Suite comprises palusplains (seasonally waterlogged flats), creeks (seasonally inundated channels) and floodplains (seasonally inundated flats)

within the gently sloping setting of the alluvial fan formations of the Pinjarra Plain. The Mungala Wetland Suite is set in the transitional zone where the Bassendean Dunes shallowly overlie the Pinjarra Plain and form where the alluvial fan distributaries of creeks terminate in the Bassendean sandplain. The Mungala Wetland Suite comprises lakes (permanently inundated basins), sumplands (seasonally inundated basins), floodplains and creeks. The Keysbrook Wetland Suite occurs most commonly south of Gosnells; the occurrence of wetlands of this suite in Kenwick/Wattle Grove is a northern outlier of this suite.

Palusplains comprise the largest area of wetlands on the SCP; about 66% of the wetland area between Wedge Island and Dunsborough is palusplain (Hill et al., 1996). However less than 6 % of palusplains within the eastern SCP between Gingin and Mandurah retain native vegetation (Hill et al., 1996). Thus wetlands of the Keysbrook and Mungala suites, that have been evaluated as CCW or REW in the *Geomorphic Wetlands Swan Coastal Plain Dataset* of the Department of Environment and Conservation (DEC, 2008) are subject to a high level of protection under policies of the Western Australian Environment Protection Authority.

All wetlands of the Keysbrook and Mungala Consanguineous Wetland Suites that have retained their geomorphic integrity (i.e. those wetlands that have not been infilled, excavated, mined or have not had structures built on them) particularly those with vegetation and other attributes in good condition, are of high conservation significance (Hill et al., 1996).

The hydrology of the Greater Brixton Street Wetlands is known from several main sources that are listed below.

- The geomorphic classification and mapping of geomorphic wetlands and assessment of wetland management categories for the wetlands of the area at a scale of 1:25,000 by Hill et al. (1996). These maps form the basis of the Wetland Database of the DEC (2008a).
- A fine scale stratigraphic and hydrological study of the area by the Vic and Christine Semeniuk Research Group (VCSRG) (2001). This study established an extensive monitoring system throughout the Greater Brixton Street Wetlands that has been used to track the ground and surface water levels of the area from 1999 to the present. This study forms a baseline database of the hydrology of the area at a scale that is appropriate to understanding the water requirements of the biota.
- The groundwater maps of the Perth Groundwater Atlas (2004) at a scale of 1:20,000.
- The Swan River Trust/Swan Catchment Centre (2007) monitoring of flow rates and nutrient levels in Yule Brook.

The Greater Brixton Street Wetlands (BFS 387) are located adjacent to Yule Brook, a short distance upstream from where it drains into the Canning River. The major hydrological recharge mechanisms in the Yule Brook catchment are direct precipitation, groundwater recharge via seepage from the Darling Range foothills, flow from the base of the Darling Plateau and channelled surface runoff (VCSRG, 2001). The groundwater contour lines in the Yule Brook and Bickley Brook catchment (that includes the survey area and the other wetlands of the Greater Brixton Street Wetlands) are orientated parallel to the surface topography contour lines (Perth Groundwater Atlas, 2004). The coincidence of the topographic gradient with the direction of the groundwater flow and the location of Lot 36 at the high end of the slope, above the other Greater Brixton Street Wetlands, means that the ground and surface waters at Lots 36 and 32 (respectively) discharge downslope through the Greater Brixton Street Wetlands on their way towards the Canning River.

Small ridges and mounds of Bassendean Sands in the Greater Brixton Street Wetlands (the most pronounced of these being located in the UWA Allison Baird Reserve) also form small-scale localised perched water mounds that slowly discharge water laterally onto the adjacent palusplains. VCSRG (2001) described the hydrology of the small-scale seasonally waterlogged slopes (paluslopes) that are maintained by such seepages from low ridges in the Greater Brixton Street Wetlands and found artesian pressure heads in some aquifers in these settings. Paluslopes are a very uncommon on the SCP and are poorly documented in this region. Paluslopes are more prevalent in the high rainfall zone near the south coast of Western Australia in the Warren Biogeographical Region.

The sumplands within the survey area (Figure 4) are generally small basins that are of a round to elliptical shape; these are commonly referred to as claypans (Marshall, 2000) and are usually inhabited by characteristic assemblages including shrubs such as *Melaleuca lateritia* and *Melaleuca rhaphiophylla*, the grass *Amphibromus nervosus* and very species-rich assemblages of annual herbs and geophytes. There are also a number of seasonally-inundated small channels in BFS 387 (VCSRG, 2001) that drain towards Yule Brook. The natural vegetation remnants in the latter are dominated by low *Melaleuca* spp. trees and tall shrubs that can form a closed canopy over a sparse understorey of sedges. None of these channels in BFS 387 now appear to retain natural vegetation along their entire course from the foothills of the Darling Range down to the Yule Brook. Most of these channels have been excavated and/or diverted to facilitate the surface and sub-surface drainage of roads and residential areas. There are discontinuities along the course of some of these channels (such as low dunes) that appear to naturally partition these channels into a linear series of narrow elongated sumplands. There are also man-made discontinuities along the course of many of these channels, such as roads, buildings or dumped landfill, which disrupt their geomorphic integrity. However, some these channels retain both native

vegetation and natural channel geometry in a relatively undisturbed condition along short lengths of their course in BFS387 between Brook Rd and Boundary Rd (VCSRG, 2001).

In the Greater Brixton Street Wetlands, the complex natural hydrogeology is over-printed by a grid of excavated drainage channels that influence hydrological variables such as soil moisture and the depth to groundwater, and vegetation.

4. Methodology

4.1. Guiding Principles

The survey and analysis methods adopted in the flora and vegetation survey were conducted in reference to:

- The EPA's position paper with regard to terrestrial biological surveys as an element of biodiversity protection (EPA, 2002).
- The EPA's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. *No. 51*.
- The EPA's (2006) Guidance Statement No. *10 Level of Assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 Region* (EPA, 2006).
- The EPA's (2008) *Environmental Guidance for Planning and Development*.

The survey area is located on the eastern SCP, in the *Swan Coastal Plain Biogeographical Region* (IBRA, 2000) of the South West Botanical Province of Western Australia. The current survey was conducted at Level 2 and included background research (a desktop study), a reconnaissance field survey and a comprehensive field survey (EPA, 2004b). With regard to the current regional survey project, the three components of the Level 2 search were fulfilled as below.

- Background Research. A literature review and a search of the rare flora, TECs and wetland values were carried out including searches of the relevant Federal and Western Australian Government databases. Advice and information was also sought from a number of relevant experts and stakeholders in government, scientific institutions and the community regarding the known conservation values and other environmental issues applicable to the target area.
- Reconnaissance Survey. A reconnaissance field survey was carried out in September 2008 to verify the accuracy of the background information and to obtain an overview of the range of flora, vegetation and wetland values in the area. Transects were walked through the areas that were identified from aerial photographs as retaining natural vegetation. This allowed opportunistic sampling and recording of the flora and vegetation in the more degraded areas, targeted searches of habitat that could potentially harbour rare flora and the selection of suitable sites to install quadrats for detailed sampling.
- Comprehensive Field Survey. The level of knowledge of the flora and vegetation of the target area was enhanced by a detailed, quadrat-based flora and vegetation field survey. To investigate the conservation value of the

vegetation in the current survey area a multivariate analysis of the floristic data obtained in the current survey was carried out against a baseline SCP floristic dataset of Gibson et al. (1994). This provided an indication of the similarity of the vegetation types within the survey area with previously defined Floristic Community Types (FCTs) in the context of the *Swan Coastal Plain Biogeographical Region*. The classification assisted in the objective evaluation of the conservation significance of the vegetation assemblages found in the survey area.

The three wetlands within the survey area that are mapped in the *Swan Coastal Plain Wetlands Dataset* (DEC, 2008a) were also ground truthed and re-evaluated with regard to mapping, geomorphic classification and management category during the reconnaissance and detailed survey above and subsequently (using the additional fine-scale data obtained during the flora and vegetation field survey).

4.2. Flora Sampling, Vegetation Description and Classification

The flora, vegetation and wetlands field survey was carried out from September to December 2008. Colour aerial photographs were used to interpret the vegetation patterns of the survey area prior to the reconnaissance survey. These interpretations were then verified using ground traverses to record dominant species and vegetation structure and to search for flora of conservation significance. Quadrat sites were selected to be representative of the vegetation types as interpreted above. One or more quadrats or releves were surveyed, where possible, in each vegetation type encountered in the project footprint.

A total of 4 sampling quadrats (each of area 100m^2) were established in species-rich native vegetation that was in good condition (Figure 5). The quadrat size in this survey was determined by that used in the previous surveys that contributed to the SCP dataset of Gibson et al. (1994). All of the vascular plant taxa in these quadrats were recorded. Voucher specimens were collected, where necessary, and identified with reference to the WA Herbarium collections. At each quadrat, a number of data were also recorded as outlined below:

- Location statement (including GPS coordinates); landform description; vegetation structure using height and foliage projective cover (in cover classes i.e. 2-10%, 30-70%, 70-100%) for dominant vascular flora taxa within the site (Table 3); presence and cover class of all vascular flora taxa in the quadrat (including naturalised alien taxa); vegetation condition (Table 4) using a scale modified from that of Keighery (1994) as in Bush Forever study (Govt of WA, 2000a); surface sediments; natural litter; and estimated time since last fire. Overstorey abundance was estimated over a larger area (approximately 400m2) encompassing the marked quadrat in each case. The shallow

stratigraphy and depth to groundwater at the time of survey were also investigated (by manual augering) in many of the quadrats above (and at a number of other sites where the vegetation did not warrant detailed study).

The nomenclature and classification of all flora taxa in the current survey were aligned with that currently used in FloraBase, the public interface of the WA Herbarium (2008). However an important feature of the current survey area was that a number of flora taxa recorded were morphological variants that are the subjects of taxonomic research. Therefore a number of synonyms and informal names allied to voucher specimens were also quoted, where necessary, to support any taxonomic concepts that required further explanation.

A multivariate analysis of the site vs. species (presence/absence only) matrix derived in the current survey of was carried out by E. A. Griffin in combination with the SCP dataset of Gibson et al., (1994) using PATN® software (Appendix A), in order to determine the FCTs of the survey area vegetation in the context of Gibson et al. (1994). The determination of FCTs in this manner was useful as part of the assessment of the conservation significance of vegetation on the SCP, as it provided a measure of objective comparison of the floristics of the vegetation of the areas with listed TECs. The classification of vegetation in this method was also useful in verifying the patterns derived intuitively in the field in this complex and species-rich vegetation. This process required that, prior to analysis, the nomenclature of the flora taxa recorded in the current survey was aligned with that used in Gibson et al. (1994). A number of taxa recorded in the survey were not recorded by Gibson et al. (1994) and the analysis method required these to be deleted from the analysis. The boundaries of the major vegetation units derived from the field observations and the detailed site data analysis were mapped onto colour aerial photography of the area at a scale of 1:2,000 (Figure 6a).

4.3. Wetland Assessment

4.3.1. Wetland identification and delineation

Identification and delineation of a wetland relies on evidence from three disciplines: hydrology, stratigraphy and vegetation (Hill et al., 1996). An introductory guide to some basic requirements in the identification and delineation of wetlands is provided in DEC (2007). The hydrology, stratigraphy and vegetation of the survey area was investigated in the identification and delineation of the wetlands in the current survey.

A limited field survey of the hydrology and shallow stratigraphy of the wetlands in the survey area was undertaken that included the manual augering of sampling sites in October to December 2008. This work was necessary in the process of identifying wetlands (i.e. distinguishing between putative wetland and upland zones) and in delineating (i.e. mapping) wetlands in the study area, in accordance with the

guidelines of DEC (2007). The detailed flora and vegetation study in the current survey also contributed to the wetlands study. A total 10 study sites were selected to sample the vegetation, hydrology and stratigraphy of the survey area (Figure 5). Surface sediments and the presence of waterlogging or inundation of surface sediments were also recorded opportunistically elsewhere throughout the survey area from August to December. Four of the hydrology/stratigraphy study sites (H7-H9 and H10) were located in good condition vegetation and coincided with flora study quadrats (Q7-Q9 and Q14) respectively in Lot 32. An additional six hydrology/stratigraphy study sites (H13-H18) were located in areas of more degraded vegetation in the survey area. The flora species present in an area of approximately 200m^2 around each of these additional augering sites were also recorded as releves, that is, without the marking out of formal flora sampling quadrats.

To determine the depth to the watertable and the stratigraphic sequence at each of the 10 study sites, holes were augered manually down to the water table (where possible). The autumn and early winter rainfall at Gosnells, the nearest weather station to Wattle Grove, was close to the long-term mean for these seasons.

The sediments from the auger holes were sampled at 10cm intervals, labelled and then examined via a low power stereoscopic microscope to assess grain size and sediment fabric. The presence of calcareous materials in the samples was determined after application of several drops of 10% hydrochloric acid to each sample. The sediments were classified and described using terms consistent with Semeniuk and Semeniuk (2004) (Tables 5 and 6).

The habitat preferences of each of the native flora species recorded at each of the hydrology/stratigraphy study sites and at each flora quadrat in the survey area were investigated by checking the habitat notes of all occurrences of these species (across the known geographical range for each of these species) as recorded on herbarium voucher labels in FloraBase (WA Herbarium, 2008), in Paczkowska and Chapman (2000), in Keighery and Keighery (2000), in Bush Forever (Government of Western Australia, 2000) and in Marchant et al. (1987) as required.

Lists of the obligate wetland flora species (those plants generally restricted to wetland habitats), the facultative wetland flora species (those plants that can occur in either wetland or upland habitats) and calcicole species (those plants that generally inhabit calcium carbonate rich habitats) that were present within the survey area were then assembled on the basis of these desk-top investigations. This list was then critically examined in the context of field data collected by the botanist in wetland flora surveys to derive a final list of wetland taxa within the survey area.

4.3.2. Geomorphic classification of wetlands

The geomorphic classification of wetlands in the survey area was conducted by examining the data from the hydrology, stratigraphy and vegetation field study and by brief observations of the topography in the field and in topographic maps (Perth Groundwater Atlas, 2004). The wetlands were then classified by the system of Semeniuk and Semeniuk (1995), (Table 7).

4.3.3. Evaluation of wetland management category

To provide guidance on the level of protection and the management objectives that are appropriate to each wetland, wetlands on the SCP have been evaluated following Hill et al. (1996) and assigned to one of three management categories (CCW, REW, or Multiple Use Wetland (MUW)) in the *Geomorphic Wetlands Swan Coastal Plain Dataset* (DEC, 2008a).

The methods for evaluating wetlands on the SCP are currently under revision (DEC, 2007). In the interim, three methods are recommended by DEC (2007) to evaluate the management category of wetlands.

The first of the methods recommended to evaluate the management category of wetlands is a questionnaire, commonly referred to as *Bulletin 686* (EPA, 1993) that was designed before the SCP wetlands were comprehensively mapped by Hill et al. (1996). The acknowledged drawback of this questionnaire is that it tends to allot the highest scores to wetlands with standing water (such as lakes and sumplands) and those wetlands that include optimum waterbird habitats (such as open water, dense vegetation, roosting trees and mud flats adjacent to open water). *Bulletin 686* does not adequately score wetland condition, floristic complexity, the presence of habitat of less conspicuous fauna and the functions and values of wetlands such as damplands and palusplains (DEC, 2007). The exceptional biodiversity, scarcity and conservation values of some of the latter wetland types on the SCP have only recently became apparent through initiatives such Hill et al.(1996) and Bush Forever (Govt of WA,2000). Methods of wetland evaluation other than, or supplementary to, EPA (1993) are required to assist in the adequate evaluation of all types of wetlands on the SCP.

The second method for wetland management category evaluation that is currently recognized by DEC (2007) is a questionnaire that was designed for the Western Australian Water and Rivers Commission by VCSRG (1998). The latter enables wetland attributes to be assessed from first principles, irrespective of wetland type.

The third method for wetland management category evaluation involves wetland vegetation condition. The vegetation condition scale of Govt of WA (2000) and guidelines regarding wetland vegetation in Hill et al. (1996) are recommended for use in this evaluation (DEC, 2007).

All of the methods above were used to evaluate the management categories of the wetlands in the current survey. The features of each of these methods are summarized below.

4.3.3.1. *Bulletin 686* (EPA, 1993) method of wetland evaluation

Bulletin 686 was designed to allocate wetlands to five categories: High Conservation, Conservation, Conservation and Recreation, Resource Enhancement, and Multiple Use, according to the graphs in EPA (1993). These management categories were updated in Hill et al. (1996) (Table 8) to the system now recognized on the SCP (DEC, 2007). *Bulletin 686* consists of a questionnaire that includes several parts, as outlined in Table 9.

In EPA *Bulletin 686*, wetland basins are evaluated as isolated units (with either sharp boundaries, or with diffuse boundaries). It is acknowledged that palusplains and damplands are not adequately evaluated by the use of *Bulletin 686* (DEC, 2007).

4.3.3.2. VCSRG (1998) method of wetland evaluation

The Water and Rivers Commission instrument designed by the VCSRG (1998), supplements Hill et al. (1997) and takes into account all of the types of wetlands (including palusplains) that have been mapped within the southern SCP. This system recognizes that evaluation demands an approach to capture the recognised natural values of all wetland types.

In this evaluation system, six classes of wetland values (wetland type, wetland processes, wetland habitats, wetland functions, biodiversity and scientific value as in Table 10) are examined and scored for the wetland in question. Essentially, each of these values is graded as high, moderate, or low for the wetland being evaluated and this is translated to the management categories of CCW, REW, or MUW, respectively. The six wetland values are first checked against the criteria that are appropriate at the level of CCW (Table 11). If the wetland does not meet the CCW criteria for at least one question in each of the six values, the wetland is then checked for these values again at the level of REW (Table 12). Then, if necessary, any values that do not meet the criteria in the latter are checked against the criteria at the level of MUW (Table 13). The wetland is then allocated to the management category (CCW, REW or REW) that achieved the best score in the questionnaire (Table 10).

4.3.3.3. Vegetation condition in the evaluation of wetland management category

The percentage of natural vegetation remaining in a wetland is another measure recommended (Hill et al., 1996; DEC, 2007) to rapidly assess the “naturalness’ of a wetland and thus provides a second tier assessment method of determining the preliminary management category for a wetland (Table 14). This method was applied

to the wetland evaluations in the current survey area in addition to the methods of VCSRG (1998) and EPA (1993), using vegetation condition as assessed in the current survey. In this survey, the vegetation condition evaluation is of particular importance because of the very high conservation significance of any remnant vegetation of the Guildford Vegetation Complex that is in good condition.

The detailed data (including photographs, flora lists and vegetation descriptions) that was used in the survey to support the vegetation condition assessment of the wetlands under evaluation is presented in the Appendices B and C. The definition of undisturbed vegetation used in the evaluation of wetland management category conformed with the categories from “pristine” to “good” in the vegetation condition scale used in Govt of WA (2000) (Table 4).

Under the vegetation condition evaluation method (Table 14) wetlands retaining at least 50% native vegetation cover were evaluated as CCW, those retaining 10-50% native vegetation cover were evaluated as REW and those retaining less than 10% native vegetation cover were evaluated as MUW.

The pattern of vegetation distribution that is present in many palusplains on the SCP presents some specific difficulties in wetland management category evaluation and in wetland management. These palusplains are usually laterally extensive and their original native vegetation has often been cleared except for small patchy remnants that are dispersed amongst larger expanses of paddocks (that may still retain other wetland values), highly modified wetlands such as drains, roads and other built structures. If such palusplains are evaluated over their entire area, the vegetation condition is, effectively, averaged out over the whole palusplain. The latter would mean that most palusplains on the SCP would not achieve the score of CCW, regardless of the high conservation significance remnants of vegetation in excellent condition that they may encompass. The alternative method of evaluation, which is more commonly used, is to evaluate parts of an extensive palusplain as several, separate entities (after defining the boundaries that are to be used in the assessment).

5. Desktop Assessment of Flora and Vegetation

5.1. Flora Desktop Study

A comprehensive search of the flora taxa of conservation significance (at the national, state and regional levels) that are known to have distributions that may include the survey area (or habitats similar to those found in these areas) was conducted in the literature and the databases of rare flora maintained by relevant agencies. The main aim of this search was to predict the occurrence of the taxa of conservation significance most likely to occur within the study area and so assist the targeted search and recognition of these taxa in the field survey. Apart from the names of these taxa and their listed conservation significance codes, other relevant information (where available) such as geographic distribution, locality records, growth form, habitat and flowering time was also included in the list compiled (Appendix B: Table A.1). The sources of these data are listed below.

- The list of Flora of National Conservation Significance was compiled from the *Threatened Flora Database* of the DEHWA (2008a).
- The list of Flora of State Significance (the taxa listed as DRF and Priority Flora in Western Australia) was compiled from searches of three WA DEC Threatened Flora Databases. The parameters for each search are shown below.

  a. The Threatened (Declared Rare) Flora Database, for records in the rectangle defined by the coordinates 320 00' 00" - 320 02'20" S and 1150 58' 00" - 1160 00' 10" E.

  b. The Western Australian Herbarium Specimen Database (WAHERB) for records in the rectangle defined by the coordinates above; and

  c. The *Declared Rare and Priority Flora List Database* for the locations Beckenham, Brixton, Cannington, Forrestfield, Gosnells, High Wycombe, Kenwick, Kewdale, Maddington, Maida Vale, Orange Grove, Perth Airport, Wattle Grove and Welshpool.
- The list of Flora of Regional Significance was compiled from the records of other field surveys conducted in the vicinity of the survey area (including Keighery and Keighery,2000; Govt of WA, 2000; Cardno BSD, 2005; Tauss, 2007; Keighery and Tauss, 2008; and Tauss and Weston, 2009). All geographical distributions were checked on FloraBase (WA Herbarium, 2008).
- Much of the data about localities, distributions and flowering times of many of these taxa were provided by the DEC database search output. Other data of form, features and habitats were added from Paczkowska and Chapman

(2000) and WA Herbarium (2008). Additional data was compiled from examination of herbarium specimens and their labels in the Western Australian Herbarium, consultations with other botanists, Marchant et al. (1987), Hoffman and Brown (1998) and relevant parts of the Flora of Australia series.

5.1.1. Flora of national conservation significance

Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Flora taxa (species, subspecies or varieties) that are listed as being of National Conservation Significance under the *EPBC Act 1999* are designated in one of the six categories (Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, Extinct in the Wild) as defined by DEWHA (2008a).

A search of DEWHA's *Threatened Species Database* (2008a) for the local government areas of Gosnells, Kalamunda and Canning showed that 14 Flora Taxa of National Conservation Significance listed under the *EPBC Act 1999* have been recorded in these areas. These taxa were *Acacia anomala* (Vulnerable), *Acacia aphylla* (Endangered), *Andersonia gracilis* (Endangered), *Anthocercis gracilis* (Endangered), *Caladenia huegelii* (Endangered), *Conospermum undulatum* (Vulnerable), *Darwinia apiculata* (Endangered), *Diuris drummondii* (Vulnerable), *Drakaea elastica* (Endangered), *Dryandra mimica* (Endangered), *Lasiopetalum pterocarpum* (syn. *Lasiopetalum* sp. Serpentine. S. Paust 1103A), *Lepidosperma rostratum* (Endangered), *Macarthuria keigheryi* (Endangered) and *Thelymitra stellata* (Endangered). Several of these taxa (*Acacia anomala,* Acacia aphylla, *Anthocercis gracilis*, *Darwinia apiculata*, *Lasiopetalum pterocarpum* and *Thelymitra stellata*) are typically restricted to rocky habitats of the Darling Plateau, thus they are unlikely to occur within the predominantly wetland settings of the current survey area.

Further searches of the literature and the databases of the DEC showed that six nationally significant flora species viz. *Andersonia gracilis* (Endangered), *Calytrix breviseta* subsp. *breviseta* (Endangered), *Diuris purdiei* (Endangered), *Eleocharis keigheryi* (Vulnerable), *Hydatella dioica* (Endangered) and *Lepidosperma rostratum* (Endangered) have been recorded in Bush Forever Site 387 (Govt. of WA). Additionally, there are also records of *Macarthuria keigheryi* (Endangered), *Tetraria australis* (Vulnerable) and *Caladenia huegelii* (Endangered) from Kenwick or nearby (WA Herbarium, 2008).

Two of the nationally significant flora taxa above (*Calytrix breviseta* subsp. *breviseta* and *Conospermum undulatum*) were recorded in Boundary Rd, Kenwick and Victoria Road, Maddington respectively by Cardno BSD (2005). *Conospermum undulatum* is also known to occur in the Clifford Road Bushland in Maddington (Bush Forever Site

53) (Bush Forever, 2000b). *Calytrix breviseta* var. *breviseta* has also been recorded from Boundary Rd in other field searches (WA Herbarium, 2008; Tauss and Weston, 2009). *Lepidosperma rostratum* and *Eleocharis keigheryi* have also been recorded by Koch (1994) in another Bush Forever Site in Kenwick, by Keighery and Tauss (2009) in BFS 387. Tauss and Weston (2009) also recorded *Lepidosperma rostratum* in Kenwick, outside of the Bush Forever site.

The flora taxa of national conservation significance that are most likely to occur in the vicinity of the survey area can thus be reduced to twelve taxa (Appendix B, Table A1). These are: *Andersonia gracilis*, *Caladenia huegelii*, *Calytrix breviseta* subsp. *breviseta*, *Conospermum undulatum*, *Diuris purdiei*, *Drakaea elastica*, *Dryandra mimica*, *Eleocharis keigheryi*, *Hydatella dioica*, *Lepidosperma rostratum*, *Macarthuria keigheryi* and *Tetraria australis*. Of these taxa, many are shrubs (*Andersonia gracilis*, *Calytrix breviseta* subsp. *breviseta*, *Conospermum undulatum*, *Banksia mimica* and *Macarthuria keigheryi*) that are either very conspicuous in flower during spring or are clearly distinguishable from other species in a vegetative state. The four EPBC listed sedge or sedge-like taxa in this list (*Eleocharis keigheryi*, *Hydatella dioica*, *Lepidosperma rostratum* and *Tetraria australis*) all occur in claypans, are difficult to distinguish in the field and are generally located only during intensive quadrat-based survey by experienced botanists. Two of the orchids are either conspicuous during their annual flowering (*Caladenia huegelii*) or have distinctive vegetative features (*Drakaea elastica*). The donkey orchid *Diuris purdiei* and the sedge *Tetraria australis* (both of which only flower after fire and otherwise have inconspicuous vegetative features) are probably the most cryptic of the rare species that could be present in the survey area.

5.1.2. Flora of state conservation significance

Wildlife Conservation Act 1950* and *Department of Environment and Conservation Priority Flora Taxa.

DRF taxa are protected under the *Wildlife Conservation Act 1950*. The list of taxa currently protected under this Act is gazetted in the *Wildlife Conservation (Rare Flora) Notice* (2007). Most DRF taxa, except recently-listed taxa, are usually also listed as Flora National Significance under the *EPBC Act 1999*. The DEC has also defined four classes of Priority Flora Taxa that are considered to be of conservation significance.

These taxa are grouped into four categories (Priority One, Priority Two, Priority Three, and Priority Four) depending on the perceived urgency of determining their formal conservation status as indicated by the degree of threat to these taxa.

10 DRF species are known from the vicinity of the current survey area (Appendix B, Table A1). These species are the same as the EPBC listed species for this area

except for *Eremophila glabra* subsp. *chlorella* that has not yet been listed at the Federal level but is expected to be listed in the near future after it undergoes the necessary assessment. In addition to the above, there are 44 Priority Species known from the area. Of these, 23 Priority Species have been recorded from Bush Forever Site 387.

5.1.3. Flora of regional conservation significance

Guidance Statement 51 (EPA, 2004b) and Bush Forever (WAPC, 2000) define several other criteria under which flora taxa or populations of these taxa may have conservation significance. In the current survey, such taxa are termed as being "regionally significant" when they occur on the eastern side of the SCP. The criteria for significance for these taxa (EPA, 2004b; WAPC, 2000) are:

- Populations that are at the limit of their known geographic range.
- Populations that are disjunct from their known geographic range.
- Taxa that are endemic to the eastern SCP.
- Taxa that are endemic to the SCP in the Perth Metropolitan Region.
- Taxa that are considered to be poorly reserved (applies to all DRF and Priority taxa).
- Populations that are significant in maintaining the regional presence of a flora taxon due to their location, population size, diversity of ages and/or health (applies to all DRF and Priority taxa).
- Taxa that are morphological variants or are otherwise significant taxonomically.
- Taxa that are uncommon in the area (generally applies to disjunct populations).
- Taxa that are significant due to their occurrence in restricted habitats of the eastern SCP.

In the current desktop survey, taxa considered regionally significant in a number of studies of the eastern SCP (including Keighery and Trudgen, 1992; Gibson et al., 1994; Keighery and Keighery, 2000; Govt of WA, 2000; Tauss, 2007; Keighery and Tauss, 2008, and Tauss and Weston, 2009) were reviewed against current known distributions on FloraBase (WA Herbarium, 2008). It was concluded that, currently, at least 80 regionally significant taxa are known from the vicinity of the survey area (Appendix B).

Most of these regionally significant taxa are confined to wetlands underlain by the Guildford Formation on the Pinjarra Plain and to the foothills of the Darling Range (on the eastern side of the SCP).

5.2. Vegetation Desktop Study

The eastern SCP is defined as the land encompassed by the McArthur and Bettenay (1960), Foothills and Pinjarra Plain geomorphic units (Govt of WA, 2000a and b). Less than 10% of the original extent of the vegetation of the eastern SCP now remains after the intensive agricultural use of the area and developments such as housing, industry and transport infrastructure (Bush Forever, 2000a and b). Therefore the native vegetation that remains on the eastern SCP is, considered to be of very high conservation significance.

Bush Forever Site 387 (The Greater Brixton St Wetlands) is the most species-rich area of all the Bush Forever Sites described in Bush Forever (WAPC, 2000) and as such is considered one of the most important conservation reserves in the *Swan Coastal Plain Biogeographical Region of Western Australia*. Currently more than 555 native plant taxa are known from the 127 ha of the Greater Brixton Street Wetlands (Keighery and Keighery, 2000).

5.2.1. Regional scale vegetation units of the Eastern Swan Coastal Plain

There have been numerous studies that have aimed to characterize, classify and/or map the vegetation types that are present within the *Swan Coastal Plain Biogeographical Region* to investigate the land-use capability of land that was covered with the native vegetation and to assess the conservation significance and reservation status of this vegetation. The terms Vegetation Systems, Vegetation Complexes and Vegetation Associations have been used to designate vegetation units mapped at various scales. All of these units are regional scale, high order units.

A. Vegetation Systems (Beard, 1979a)

Beard (1979a, 1979b, 1981) mapped the vegetation of the SCP as broad scale Vegetation Systems based on the structure of the dominant species of the canopy layer. In this mapping, the vegetation of most of the surevy area and the neighbouring area is indicated as Marri Woodland (e3Mi), of the Pinjarra Plain Vegetation System. In Beard's mapping the Pinjarra Plain extended from about Gingin to Dunsborough and was located between the Bassendean Vegetation System to the west and the Ridge Hill Shelf Vegetation System to the east. The Pinjarra Plain Vegetation System extended over soils that were optimum for pasture development and irrigation. Beard (1979a) considered that very little (if any) of this vegetation system was still extant and that any remnants were either relic trees over pasture grasses; a shrub layer with ground cover that was completely replaced by pasture plants; or ungrazed road verges that were only an indication of the nature of the original vegetation.

B. Vegetation Complexes (Heddle et al., 1980)

Heddle et al. (1980) characterized a number of vegetation units that were termed Vegetation Complexes of the Perth Region. The Vegetation Complexes were mapped on the assumption that the distribution of distinctive vegetation complexes (each complex comprising a number of plant communities aggregated in proportions characteristic of that complex) was correlated with the major geomorphic systems and soil units of the region (McArthur and Bettenay, 1960 and Churchward and McArthur, 1980, respectively).

In the vicinity of the surevy area (where the Ridge Hill Shelf, Pinjarra Plain and the Bassendean Dunes geomorphic systems are present) there were six Vegetation Complexes mapped by Heddle et al. (1980) viz. Forrestfield, Guildford, Swan, Cannington, Southern River and Bassendean Central and South. The relevant geomorphic units, the vegetation complexes associated with these geomorphic units and the percentage of native vegetation remaining within each vegetation complex in the Perth Metropolitan Area, as determined in Bush Forever (WAPC, 2000) are listed below (Table 15).

C. Vegetation Associations (Keighery and Trudgen, 1992)

In a study of the vegetation of the eastern SCP, Keighery and Trudgen (1992) identified several main Vegetation Associations within the Pinjarra Plain landform. These are listed below.

- *Corymbia calophylla* Woodland to Open Forest.
- *Casuarina obesa* Woodland to Open Forest.
- *Corymbia calophylla* and *Eucalyptus wandoo* Woodland to Open Forest.
- *Eucalyptus wandoo* Woodland to Open Forest.
- *Eucalyptus rudis* Woodland to Open Forest.
- Ephemeral Wetlands, a complex mosaic of shrublands, heaths, sedgelands and herblands.

The *Corymbia calophylla* and the *Casuarina obesa* woodlands and open forests and the wetland vegetation mosaic were considered to be the most common units prior to the large-scale clearing of the Pinjarra Plain.

5.2.2. Sub-regional scale vegetation units of the Eastern Swan Coastal Plain: Floristic Community Types

Early work to classify the vegetation of the SCP using numerical classification of floristic data was carried out by Havel (1968). Subsequent to the determination and mapping of the Vegetation Complexes of the SCP by Heddle et al. (1980), more comprehensive survey and analysis of the vegetation of the SCP was carried out by Gibson et al. (1994) to define finer-scale vegetation units than those of the regional-

scale Vegetation Systems of Beard (1979a) and the Vegetation Complexes of Heddle et al. (1980). The vegetation units derived by Gibson et al. (1994) and in subsequent updates referred to in Bush Forever (WAPC, 2000a) are known as the FCTs the SCP by Gibson et al. 1994 (SWA FCTs).

At least 15 FCTs has been identified in the City of Gosnells by Trudgen and Keighery (1995) and in the Bush Forever Sites of Cannington, Forrestfield, Kenwick, Maddington, Orange Grove, Queens Park, Southern River, Welshpool and Wattle Grove by various workers (Bush Forever, 2000b). (Some of the FCTs above were identified by inference rather than by multivariate analysis). The FCTs that have been listed in the vicinity of the survey area have been listed in Table 16.

5.2.3. Vegetation of conservation significance

Some of the native vegetation types in Western Australia that have been recognized as rare and/or threatened are listed as TECs under the *EPBC Act 1999*. Such vegetation is of National Conservation Significance under the *EPBC Act 1999* and is designated as one of six categories (Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, Extinct in the Wild) as defined by the Department of Environment, Water, Heritage and the Arts (DEWHA, 2008b). See Appendix B for definitions of the *EPBC Act 1999* categories.

The DEC also maintains a list of TECs that have been endorsed by the Western Australian Threatened Species and Communities Scientific Committee and the Environment Minister of Western Australia, but some of these are, as yet, not endorsed at the Federal level. These TECs are designated categories that are defined under the same criteria and are equivalent to the categories of TECs under the *EPBC Act 1999*. The DEC also maintains a list of TECs that have been endorsed by the Western Australian Threatened Species and Communities Scientific Committee but are yet to be endorsed by the Environment Minister of Western Australia. The latter TECs are designated as Priority Threatened Ecological Communities (PTECs).

A. Vegetation of National Significance

A search of the DEWHA's *Threatened Ecological Community Database* (2008b) for the local government areas of Gosnells, Kalamunda and Canning and further searches (including Trudgen and Keighery, 1995; Bush Forever, 2000; and the DEC *Threatened Ecological Community Database* for Cannington, Forrestfield, Kenwick, Maddington, Orange Grove, Queens Park, Southern River, Welshpool and Wattle Grove) showed that three TECs, listed under the *EPBC Act 1999* occur in this area (Table 17). These TECs were:

- SCP FCT 3a: *Eucalyptus calophylla –Kingia australis* woodlands on heavy soils (Endangered);

- SCP FCT 3b: *Corymbia calophylla Eucalyptus marginata* woodlands on sandy clay soils (Endangered); and
- Shrublands and woodlands on Muchea Limestone (Keighery and Keighery, 1995) (Endangered).

B. Vegetation of State Conservation Significance

A search of the *Threatened Ecological Communities Database* of DEC (2008b) and searches of the literature (including Trudgen and Keighery, 1995; WAPC, 2000) for Cannington, Forrestfield, Kenwick, Maddington, Orange Grove, Queens Park, Southern River, Welshpool and Wattle Grove showed that occurrences of nine TECs have been recorded in and are listed by the DEC (Table 17). These nine TECs have all been assessed under the same criteria as are used to determine TECs under the *EPBC Act 1999* and thus they are, in the scientific sense, all of national conservation significance. There were no PTECs listed by DEC (2008b) for this area.

6. Flora Field Survey

The native flora of the remnant vegetation of the survey area was found to be moderately species-rich, rich in rare flora and very rich in species of regional conservation significance. In Lot 36, the native flora has been replaced by a species-poor, naturalized alien assemblage of pasture grasses and herbs. A total of 90 taxa (39 taxa of native vascular flora and 51 taxa of naturalised alien flora) (Appendix C) were recorded in 4 sampling sites (quadrats) (Appendix D) and in reconnaissance transects through the survey area (Figure 5). In Lot 32, there was a range of 13 to 61 taxa recorded per 10m x 10m quadrat. The heath that inhabited the palusplain in the south of Lot 32 was the most species-rich vegetation type. The *Melaleuca rhaphiophylla* low open forest that inhabited the sumplands/damplands of the survey area was the least species-rich vegetation type.

From the current survey it was clear that Lot 32 was not as species- rich as some of the other blocks in BFS 387 (for example the UWA Allison Baird Flora Reserve in Brook Rd and Lot 106 Wanaping Rd). This relative paucity of native species in the current survey area was probably related to the relatively heterogeneous landscape rather than any degradation in Lot 32 in comparison to the very rich assemblage of soils and landforms in the UWA Reserve and Lot 106 Wanaping Rd.

6.1. Flora of National Conservation Significance

There were no flora species of national conservation significance found within the site.

6.2. Flora of State Conservation Significance

There were no DRF species, listed under the *Wildlife Conservation Act 1950*, found on the site. There were two species listed as Priority Flora by the DEC (Atkins, 2008) found in the current field survey wtihin Lot 32. These Priority Taxa are described below.

Baeckea sp. Perth Region R.J. Cranfield 444 (Myrtaceae) (Priority 3) is a sparse shrub less than about 1m in height that carries small pink and white flowers in summer. It occurs in wetlands in two very disjunct areas; Badgingarra and Kenwick-Oakford, and is often associated with *Banksia telmatiaea*. This taxon was found in Lot 32 in dense heath.

Grevillea thelemanniana (Proteaceae) (Priority 4) is an attractive low or prostrate shrub with dark red flowers and leaves divided into small flat leaflets. This attractive shrub was recorded on Lot 32. There has been some confusion in the past about the taxonomy of this plant. It was previously recognised as a subspecies within the *Grevillea thelemanniana* complex but was raised to specific status in 1995 by Olde and Marriot. Further work on the *Grevillea thelemanniana* complex is continuing to

recognize additional of taxa within this complex. The form of *Grevillea thelemanniana* from the Greater Brixton Street Wetlands is now considered to be confined to the Kenwick-Cannington area. A closely related taxon grows on the wetlands in the Cooljarloo area. A further taxon in the group is confined to a creekline in the Gillingarra area on the Dandaragan Plateau.

6.3. Flora of Regional Conservation Significance

Apart from EPBC-listed, DRF and Priority Species, the EPA (2004b) and WAPC (2000b) define a third set of criteria under which flora taxa (i.e. species, sub-species or varieties) may have conservation significance. This set of criteria is referred to in this report as 'regional conservation significance'.

The survey area was found to include at least 18 flora taxa that can be considered as regionally significant under these criteria (Table 20). A description of some of the more significant of these taxa is provided in Appendix B. For further taxonomic notes, particularly for the taxa names below that have not been aligned with the current nomenclature of WA Herbarium (2008) see Appendix C.

7. Vegetation Field Survey

7.1. Vegetation Units

The vegetation data collected in the quadrats of the survey area were tabulated and then the sites were grouped into five main vegetation units that were derived very simply from the variation between quadrats with regard to dominant structural and floristic characteristics (Table 21). This provided a description of the main fine-scale vegetation units present within the survey area and facilitated the mapping of the vegetation types and the condition of each vegetation type within the survey area (Figures 6a and 7).

7.1.1. Vegetation Unit 1

Vegetation Unit 1 was the most species-rich vegetation within the survey area. It was confined to the south of Lot 32 and was identified to be in good condition.

The weed cover was very low in this vegetation and there were no highly invasive weeds except for one or two plants of **Asparagus asparagoides*, **Echium plantagineum* and **Sparaxis bulbifera*. Most of the tracks throughout this unit were regenerating very well and showed abundant recruitment of native shrubs, annuals and geophytes, and few weeds.

Vegetation Unit 1 is described as mid-dense to closed heath-scrub dominated by *Actinostrobus pyra*midalis, *Banksia telmatiaea*, *Hypocalymma angustifolium* Mud Habitats Variant (C.Tauss 1850) and *Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes, *Schoenus subfascicularis* sedges and open native annual and perennial herbs including *Brachyscome pusilla*, *Centrolepis aristata*, and *Thysanotus manglesianus*.

The *Actinostrobus pyramidalis* was up to about 4m in height in some places, and in these areas, the understorey was dominated by an atypically tall formation of dense *Hypocalymma angustifolium* Mud Habitats Variant (C.Tauss 1850) (up to about 2.3m in height). More commonly however, this vegetation was a dense heath less than 2m in height with a number of co-dominant shrub species.

Associates of this vegetation included *Acacia lasiocarpa* var. l*asiocarpa* sens strict., *Acacia stenoptera*, *Angianthus preissianus*, *Aphelia cyperoides*, *Baeckea* sp. Perth Region (R.J. Cranfield 444), *Hakea varia*, *Melaleuca brevifolia*, *Caladenia paludosa*, *Calandrinia granulifera*, *Calothamnus hirsutus*, *Cassytha glabellla*, **Cicendia filifolia*, *Crassula colorata* var. *acuminata*, **Disa bracteata*, Drosera glanduligera, *Drosera heterophylla*, *Drosera macrantha* subsp. *macrantha*, *Drosera menziesii* subsp. *menziesii*, *Gahnia trifida*, *Goodenia micrantha*, *Grevillea thelemanniana*, *Haemodorum laxum*, **Heliophila pusilla*, *Hydrocotyle alata*, **Hypochaeris glabra*,

Isolepis stellata, **Juncus capitatus*, *Juncus pauciflorus*, *Lepidosperma* sp. Kenwick C.Tauss 2598, *Leucopogon polymorphus*, **Lotus subbiflorus*,**Monopsis debilis*, **Parentucellia latifolia*, **Parentucellia viscosa*, *Phyllangium paradoxum*, *Pogonolepis strictus*, *Quinetia urvillei*,**Sparaxis bulbifera*, *Stylidium calcaratum*, *Thelymitra antennifera*, *Thelymitra crinita*, *Thelymitra* sp., Tribonanthes australis, *Triglochin muelleri*, *Trithuria bibracteata*, *Utricularia multifida*, *Verticordia densiflora* subsp. *densiflora*, *Verticordia plumosa* var. *brachyphylla*, and *Verticordia lindleyi* subsp. *lindleyi*.

7.1.2. Vegetation Unit 2

Vegetation Unit 2 was the relatively species-poor and was confined to the edges of *Melaleuca rhaphiophylla* inhabited swales and basins in Lot 32.

There were few signs of disturbance in this vegetation apart from a recent fire in some areas; some small and localized soil disturbances and a number of old dumped vehicles. The weed cover was generally very low in this vegetation (except for some patches of the grass **Cynodon dactylon* near Brook Rd in areas of soil disturbance). There were no other highly invasive weeds except for one or two plants of **Asparagus asparagoides* and **Sparaxis bulbifera* confined to small areas. Most of the tracks throughout this unit were regenerating very well and showed abundant recruitment of native shrubs, annuals and geophytes, and few weeds.

Vegetation Unit 2 is described as mid-dense to open heath *of Melaleuca viminea-Hypocalymma angustifolium- Acacia lasiocarpa* over mid-dense *Actinostrobus pyramidalis* seedlings, open naturalized alien grasses and open annual herbs dominated by *Centrolepis aristata* and *Pogonolepis strictus*.

Associates of this vegetation included *Acacia saligna* var. *saligna, *Anagallis arvensis* var. *arvensis, Baumea juncea*,**Briza maxima*, *Cassytha glabellla*, *Cassytha racemosa*, **Cicendia filifolia*, *Comesperma* aff. *polygaloides* (C. Tauss 2541),**Dittrichia graveolens*,**Ehrharta calycina*, *Goodenia micrantha*, *Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn , *Grevillea thelemanniana*, **Heliophila pusilla*, **Hordeum geniculatum*, *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850), **Juncus capitatus*, *Juncus pauciflorus, Lawrencia squamata*,**Lolium multiflorum*, **Lotus subbiflorus*, **Lythrum hyssopifolium* , *Melaleuca brevifolia*, *Melaleuca lateriflora* subsp. *acutifolia*, *Melaleuca rhaphiophylla*,**Monopsis debilis*, **Parentucellia viscosa*, **Plantago coronopus*, *Podolepis gracilis* Swamp Form (GJ Keighery 12803), *Samolus junceus*, *Schoenus subfascicularis *Sparaxis bulbifera*, *Tecticornia lepidosperma*, *Thysanotus manglesianus*, *Tribonanthes australis*, *Viminaria juncea*,**Vulpia bromioides* and *Wilsonia backhousei*.

7.1.3. Vegetation Unit 3

Vegetation Unit 3 was *Melaleuca rhahiophylla* low open forest to woodland over *Melaleuca viminea* low open shrubs, sparse sedges and open grasses.

This vegetation was relatively species-poor and was confined to shallow swales and basins in the surevy area. There were some moderate signs of disturbance in much of this vegetation with localized soil disturbances; a number of old dumped vehicles and weed invasion of the understorey. The weed cover was generally sparse to moderate (except on Lot 36 where the native understorey was dominated by pasture herbs, grasses and other weeds).and comprised naturalized alien grasses including **Cynodon dactylon*, **Ehrharta calycina*,**Ehrharta longiflora* and **Pennisetum clandestinum*.

Associates of this vegetation included *Acacia saligna* var. *saligna*, **Asparagus asparagoides*, *Astartea affinis*, *Banksia littoralis*, *Baumea juncea*,**Bromus diandrus*, **Briza maxima*, *Cassytha racemosa*, *Centrolepis aristatus*, *Eucalyptus rudis* subsp. *rudis*, **Euphorbia terracina*, *Ficinia nodosa*, *Gahnia trifida, *Gladiolus undulatus*, *Hypocalymma angustifolium* Mud Habitat Variant (C.Tauss 1850), *Jacksonia sternbergiana*, *Lepidosperma longitudinale*, **Lolium multiflorum*, *Lobelia anceps*,**Lotus subbiflorus*, **Lythrum hyssopifolium*, *Melaleuca brevifolia*, **Phytolacca octandra*,**Rumex crispus*, *Schoenus subfascicularis* **Sparaxis bulbifera*, *Viminaria juncea* and **Vulpia bromioides*.

7.1.4. Vegetation Unit 4

Vegetation Unit 4 was *Corymbia calophylla* (Marri) low woodland over pasture grasses and herbs. There were only two small areas of this vegetation (in Lots 32 and 36) and both had a degraded understorey dominated by pasture grasses and herbs. Associates of this unit included *Acacia pulchella* var. glaberrima, *Schoenus subfascicularis* and Xanthorrhoea brunonis.

7.2. Conservation Significance of the Vegetation

All of the remnant native vegetation that was recorded within the survey area is part of the Guildford Vegetation Complex. This was clear from several lines of evidence. Firstly, the stratigraphy and hydrology of all of the study sites in the survey area (except potentially H16 and H18) was characteristic of the alluvial fan deposits of the Pinjarra Plain. Secondly the floristic composition of the vegetation (that comprised assemblages with overwhelming numbers of taxa that are either confined to the eastern SCP or are regionally significant on the eastern SCP) was characteristic of the Guildford Vegetation Complex. Thirdly, when the floristic data matrix collected in the current survey (Appendix D) was analysed via cluster analysis by Griffin and Associates (Appendix A), the sites of the current survey clustered with other sites

recorded from the Guildford Vegetation Complex in the study of Gibson et al. (1994). As most of the original vegetation of the Guildford Vegetation Complex has been cleared, with only 6% or less of the former area of this vegetation now remaining uncleared (WAPC, 2000), all of the native vegetation remaining in Lot and 32 is considered to be of, at least, regional conservation significance.

The range of fine-scale vegetation units that were determined within the survey area was compared (Tables 22, 23 and 24) to units that have been mapped previously (at a similar scale) within the Greater Brixton Street Wetlands (in Mattiske and Associates, 1992; the various studies collated by Marshall, 2000; and the study of VCSRG, 2001; respectively). This comparison was carried out to gain a general appreciation of the similarities and differences between the vegetation of the survey area and other areas of the City of Gosnells and the Greater Brixton Street Wetlands. The latter was important as a 'first pass' check to determine if there were any vegetation types that are present in the survey area that may not be represented locally within the conservation estate of Bush Forever.

The comparison of the vegetation units recorded in the current survey with those mapped in the survey area Brook Rd by Mattiske and Associates (1992) (Table 22), showed little similarity. As the latter survey was conducted at essentially a reconnaissance level and the field work was done in early summer (when many wetland taxa of BFS 387 are largely inconspicuous).

The comparison of the vegetation units recorded in the current survey with those collated from all previous surveys of BFS 387 by Marshall (2000) (Table 23) showed that three of the main vegetation units recorded in the current survey (Units 1, 4 and 5) had some affinity with the vegetation units recorded by other in BFS 387 in the habitats of water-filled depressions and seasonally waterlogged or inundated flats. The Marri unit of the current survey was a degraded and very small remnant and therefore not of conservation significance. There was insufficient floristic or habitat information in Marshall (2000) to assess the extent to which the other three vegetation units were represented elsewhere in BFS 387. On the very limited data provided in Marshall (2000) it appeared that Vegetation Unit 3 that was recorded in the survey (*Melaleuca viminea/Actinostrobus pyramidalis* heath and scrub) has not been previously recorded or mapped in BFS 387.

The comparison of the vegetation units recorded in the survey with those recorded in VCSRG (2001) was a little less difficult than the preceding comparisons as the survey used the same terminology for recording landforms and habitats as VCSRG (2001). From this, it could be seen that three of the main vegetation units recorded in the survey (Units 1, 4 and 5) had close affinity with the vegetation units and habitat units as recorded by VCSRG (2001). As before, Vegetation Unit 5, the Marri unit could be discounted as it was degraded and very small remnant and therefore not of conservation significance.

There was also significant similarity between Vegetation Unit 3 in the survey and the *Melaleuca uncinata* inhabited dampland channels recorded by VCSRG (2001) in the area between Brook and Boundary Rd in the east of BFS 387. This *Melaleuca* vegetation unit was not recorded previously in BFS 387. As the taxonomy of *Melaleuca uncinata* in the Perth Region has been unclear for many years and has only recently become resolved, it is possible that *Melaleuca viminea* may have been misidentified as *Melaleuca uncinata* in VCSRG (2001). The taxon that was formerly known as *Melaleuca uncinata* in the Perth Region has now been determined as *Melaleuca osullivanii* (WA Herbarium, 2008).

The multivariate analysis conducted of the floristic data matrix collected in the current survey (Appendix E) in combination with the SCP dataset of Gibson et al. (1994) (to determine the similarity between the survey sites and the FCTs of the latter), produced a number of insights into the conservation values of vegetation in the survey area (Appendix A). However this analysis encountered a number of common methodological problems. The sites of the current survey did not fit the FCTs of the SCP very well and two possible reasons for this were proposed by Griffin (Appendix A). The first reason was that the survey area may have been subject to disturbance (such as loss of native species and/or the addition of weed species to quadrat data) and this disturbance may have altered the floristic composition of the survey sites significantly in comparison to the sites that Gibson et al. (1994) may have sampled in closely related vegetation. The second possible reason was that the survey area included vegetation that was poorly sampled (or not sampled at all) in Gibson et al. (1994) and thus there was little or no basis for true comparison of the two datasets.

The results of the analysis with regard to the individual sites in the current survey are briefly discussed below to explain the conclusions arrived at with regard to the affinities of the vegetation in the current survey and the FCTs and TECs known from the vicinity of the survey area (Tables 25 and 26; Figure 6b).

7.2.1. Site Q7

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to cool-01 (FCT 17), Paga-5 (FCT 17), Ellis-1 (FCT 17), Q9 in the current survey, Possum-2 (FCT 16), MTB-5 (FCT 17), cool-11 (FCT 17), Ellis-1 (FCT 18), FL-10 (FCT 12), Water- 2 (FCT 13), Twin- 4 (FCT 6), low 10b (FCT 11). This site was in good to degraded condition and therefore it is likely that some of the differences between this site and the most similar sites in Gibson et al. (1994) were due to degradation. However it could also be representative of vegetation that was not well sampled in Gibson et al., (1994). The vegetation is similar to the *Melaleuca rhaphiophylla- Gahnia trifida* seasonal wetlands FCT 17 (as suggested by the multivariate analysis) but as the latter is confined to coastal calcareous settings, Q7

is more likely to be representative of a vegetation type not sampled in Gibson et al. (1994).

7.2.2. Site Q8

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q14 in the current study, Yule-4 (FCT 10a), Q9, Bull -8 (FCT7), Bull -7 (FCT5), Bull -6 (FCT7). This site was in good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q8 in the Kenwick – Wattle Grove area. This site is thus considered to have affinity to SCP FCT 10a: Shrublands on Dry Clay Flats which is listed as an Endangered TEC by the DEC.

7.2.3. Site Q9

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q14, Q7 in the current study, Twin-4 (FCT 6). This site was in degraded condition and therefore it seems likely that the differences between this site and the most similar sites in Gibson et al. (1994) may have been due to degradation. However it could also be a degraded example of a FCT not sampled in Gibson et al. (1994).

7.2.4. Site Q14

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q8, Q9 in the current study, FL-7 (FCT 8), Pearce -1 (FCT 6), Bull-8 (FCT 7).

This site was in degraded condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to this degradation or due to the fact that the latter study did not sample vegetation closely comparable to Q14 in the Kenwick – Wattle Grove area. The vegetation was similar to the TEC: Herb-rich Shrublands in Clay Pans (Vulnerable)/ Weed dominated wetlands on heavy soil/ Herb-rich Saline Shrublands in Clay Pans (Vulnerable). It is a *Melaleuca viminea* dominated FCT and thus not sampled in Gibson et al. (1994) and from data available of BFS 387, probably an uncommon vegetation assemblage of BFS 387 and equivalent in conservation value to other TECs of the SCP. It is possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.

8. Wetlands Field Survey

There are currently three palusplain wetland areas within the survey area that have been identified and mapped under numbers known as Unique Function Identifiers (UFIs) in the *Geomorphic Wetlands Swan Coastal Plain Dataset* of the DEC (2008a) (Table 27; Figures 3 and 4).

The boundaries of wetlands in DEC (2008a) are not constrained within cadastral boundaries. In some cases however, where a wetland is very extensive (> 70 ha) and it is not classified as a lake or a sumpland) and parts of it have been disturbed, separate management categories and UFIs have been assigned to parts of the wetland as appropriate to the varying remnant values of each part. Although the wetlands of the survey area and the Greater Brixton Street Wetlands are mapped in the *Geomorphic Wetlands Swan Coastal Plain Dataset* as discrete areas, it is important to understand that the alluvial fan complex that includes all of the land between Roe Highway and Tonkin Highway in Kenwick and Wattle Grove (including the Greater Brixton Street Wetlands) effectively forms one extensive, wetland ecosystem. In this ecosystem the individual wetland areas mapped under separate UFI are interconnected by such factors as groundwater flow, subsurface water flows along impermeable layers and channelled surface water flows (Perth Groundwater Atlas, 2004; VCSRG, 2001). In general, the only parts of Kenwick and Wattle Grove that are not wetlands are relatively small dunes where deeper Bassendean Sands overlie the muddy sediments of the Guildford Formation, or where fill has been imported to construct roads, houses or other structures in the wetlands.

8.1. Identification and Delineation of Wetlands

The identification and delineation of a wetland is reliant upon characteristics of hydrology, hydric soils and wetland vegetation (Hill et al., 1996). A general guide for the identification and delineation of wetlands is provided in DEC (2007). In accordance with the requirements of DEC (2007) the wetland status was investigated in detail at each study site and also more generally at other points of the current survey area, to distinguish between putative wetland and upland zones.

A limited field survey of the hydrology and shallow stratigraphy of wetlands 7773, 8029 and 13367, that are mapped in DEC (2008a) and occur in the survey area, was undertaken in addition to the detailed flora and vegetation study. Obligate and facultative wetland flora species at each study site in the survey area and elsewhere were noted during the flora and vegetation survey (Appendix F) and the preferred habitat of these was investigated by checking the habitat notes of all occurrences of these species as recorded on herbarium voucher labels in FloraBase (WA Herbarium,

2008), and in Keighery and Keighery (2000), Paczkowska and Chapman (2000) and Marchant et al. (1987), as required.

Despite the late winter drought during 2008 there was ample evidence of hydric soils and high water tables indicative of wetland conditions in most of the sample sites chosen within the site to be representative of the survey area (Table 28). The native vegetation of the Lot 32 and 36 was comprised of predominantly obligate wetland species. The vegetated areas of Lot 32 were all clearly wetlands under all of three criteria (hydrology, hydric soils and wetland vegetation). Similarly, the cleared area of Lot 32 was mostly wetland (on the criteria of hydric soils and hydrology) except for some drifts of deeper Bassendean Sands near Brook Rd. Lot 36 was largely cleared of native vegetation, however there were several remnant mature obligate wetland species (*Melaleuca rhaphiophylla* and *Eucalyptus rudis*) present. There were only two sites (in Lot 32 at H16 and in Lot 36 at H18) that did not include unequivocal evidence of wetland conditions. At the latter, there were no hydric soils encountered during augering, the water table was very low and the sites were cleared of native vegetation except a few Marri trees. In the centre of Lot 36, there was also an area where a small amount of brick rubble was encountered in the superficial sediments when augering was attempted. The latter was probably either imported fill or the remains of a demolished building. It was not possible to determine the watertable depth, the depth of the imported material or the superficial sedimentary sequence in the latter area by manual augering.

The wetlands determined by the process above were thus demonstrated to encompass the entire survey area (except for small areas on Lot 32 and Lot 36 near Brook Rd and along the eastern border of Lot 36 where deep Bassendean Sands were found to overlie the Guildford Formation Sediments (Figure 8).

The identification of wetlands of the Endangered EPBC –listed TEC: Shrublands and woodlands on Muchea Limestone (Keighery and Keighery, 1995) also rely on stratigraphic, hydrological and vegetation evidence. This TEC occurs on a geological unit known as Muchea Limestone or Plain Limestone in the Urban Geology Map Series (Gozzard 1982). This unit occurs as low emergent mounds or subaerial lenses of limestone, in a discontinuous distribution from Muchea to Benger along the eastern side of the SCP. These mounds are Pleistocene in age and are thought to have formed from the precipitation of carbonates from artesian waters. The Muchea Limestone TEC includes a range of landforms (such as well-drained, low limestone ridges, damplands and sumplands) that provide a variety of plant habitats. The vegetation assemblages that have been found in this TEC are quite varied and include calcicole plants such as *Melaleuca huegelii*, *Eucalyptus decipiens* and *Casuarina obesa* (Keighery and Keighery 1995). There were a number of flora species recorded in the survey area that are generally considered to be calcicole species. Such species are common in near-coastal areas of the SCP in calcareous sands of the Quindalup

and Spearwood Dunes. However on the Pinjarra Plain, they are usually only found in wetlands underlain by Muchea Limestone. There was one site in the current survey where traces of calcareous materials were encountered in the stratigraphic profile. This site was H17 in Lot 32.

8.2. Geomorphic Classification of Wetlands

The wetlands within the survey area were classified according to the geomorphic system of Semeniuk (1987) in which the hydroperiod and geomorphic features of wetlands were the sole determinants of wetland class (regardless of wetland biota or the factors that maintain wetland conditions). Most of the existing classifications and mapping of the wetlands of the surevy area in DEC (2008a) were confirmed in the current field survey, except for several small possible modifications (Table 29; Figure 8).

Most of the study sites surveyed in the survey area were located in an undulating plain that was underlain by shallow aquitards and were waterlogged in the late winter and early spring of 2008 (Table 29). These areas were all mapped as palusplains UFIs 7773, 8029 and 13367 in the DEC SCP Wetlands Dataset (2008a) and were confirmed as palusplains in the current field survey. However within palusplain UFI 7773 there was a small basin/swale (at Q7 in Lot 32) that may need to be reclassified and remapped. Similarly within Lot 36 there were two small basins/swales at H13 and H14 that may need to mapped as damplands or sumplands within the existing palusplain UFI 13367.

8.2.1. Palusplains 7773, 8029 and 13367 on Lot 32: mostly no changes to DEC (2008) noted in current survey.

Most of the study sites surveyed in the surevy area (Q8, Q9, Q14, H15, and H17) were located in an undulating plain and were waterlogged in the late winter and early spring of 2008 with rainwater perched by the superficial sediments (Table 28). These areas are mapped as palusplains UFIs 7773, 8029 and 13367 in the DEC SCP Wetlands Dataset (2008a) and were clearly confirmed as palusplains in the current field survey (Table 29; Figure 8).

8.2.2. Palusplain 7773 in the vicinity of Q7-H7 in Lot 32: dampland noted in current survey.

In DEC (2008a) the area of Q7 was mapped as part of palusplain 7773. The investigations in Q7-H7 in the current survey showed that this area is probably a dampland (seasonally waterlogged basin). The surface sediments at Q7 were peaty sand and the ground surface was waterlogged in early spring. On October 18, 2008 when the site was augered the sediments were moist down to water table at 230cm below the ground surface. In years of average or above winter rainfall, it is considered

that the muddy layers from about 60 cm below the ground surface would perch rainwater for an extended period in winter and spring. There was obligate wetland vegetation (*Melaleuca rhaphiophylla* low forest) at the site; however this was somewhat at odds with the relatively low water table currently present at this site.

In this survey it is considered that the wetland at Q7 was actually a part of the channel (swale) that is mapped as sumpland UFI 8028 in DEC (2008a) on the adjacent block on Boundary Rd (Figure 8). It is probable that there has been some disruption of the hydrology of this system of wetland channels.

8.2.3. Palusplain 13367 in the vicinity of H13 and H14 on Lot 36: damplands noted in current survey.

In DEC (2008a) the area encompassing H13 and H14 was mapped as part of palusplain 13367. In the finer scale investigation in the current survey, both of these areas were found to be seasonally waterlogged shallow swales and thus the classification of dampland would probably be more appropriate for these areas.

At H13, the surface was waterlogged in winter but on November 30, 2008 when the site was augered the sediments were moist down to water table at 280cm below the surface. The peaty layer found at the ground surface, the rusty mottles of the sediments at about 70cm below the ground surface and the obligate wetland vegetation present on the site were all indications that a much higher water table (causing inundation of the soil surface at times) was present seasonally at this site in the past. In years of average or above winter rainfall the muddy sediments from 80cm below the ground surface may perch rainwater. There may also have been other factors that maintained a high water table in this location in the past (such as surface or sub-surface run off) that may now be disrupted.

At H14 the surface was also waterlogged in winter but when augered the sediments were moist down to the water table at 150cm below the ground surface. In years of average or above winter rainfall, it is considered that the watertable would be considerably above the level recorded in this survey. The surface soils would be waterlogged or inundated in such circumstances and this would enable the development of the obligate wetland vegetation that is currently present at the site.

8.3. Evaluation of Wetland Management Categories

The three wetland areas (UFIs 7773, 8029 and 13367) that are mapped in the DEC's *Swan Coastal Plain Wetlands Dataset* (2008a) were evaluated in the current survey using the three methods that are recommended by DEC (2007) for this purpose (Appendix G). The values of each wetland that contributed to these evaluations are summarised below.

8.3.1. Palusplain UFIs 7773/ 8029: CCW

The topography and hydrology of this wetland is largely unaltered by human activities. It is a palusplain located on the Pinjarra Plain and thus a scarce wetland type. This palusplain is part of a unique larger area that is representative of the wetlands of the Keysbrook Consanguineous Suite in the Kenwick –Wattle Grove area at a specific elevation along the topographical gradient of the alluvial system associated with Yule Brook between the Darling Range and the Canning River. In the current survey, it was confirmed that this palusplain extends over approximately half of the area of Lot 32.

The palusplain is partly altered with regard to wetland processes such as recharge and discharge mechanisms and sedimentary processes due to the clearing of the catchment area, roads and other hard surfaces and the dredging and diversion of Yule Brook and other surface drainage in the area. However much of this modification can be remediated by the re-vegetation of the catchment area, remediation of surface drainage and the restoration of Yule Brook as a living stream.

Palusplain 7773/8029 is a naturally vegetated area that is located high in the groundwater catchment area compared to the rest of the BFS 387 wetlands. It thus performs another important wetland function in maintaining the hydrological regime (in terms of quality and quantity of groundwater) in the other wetlands in BFS 387 that are located downslope.

This palusplain is underlain by wetland sediments of a Pinjarra Plain alluvial fan that are unusual on the SCP. There are indications in this wetland that it is underlain by Muchea Limestone, a rare formation on the SCP. It is part of a largely-undisturbed gradient of soil and sediment types from the Darling Range Foothills to the Canning River.

In the evaluation of this wetland by the method of VCSRG (1998), this wetland satisfied the criteria for CCW for wetland type, wetland habitats, wetland functions, biodiversity and scientific value. For wetland processes, it satisfied the criteria for REW. Therefore, overall, under this method palusplain 7773/8029 was evaluated as a CCW.

In the evaluation of this wetland by the method of Bulletin 686 (EPA, 1993) palusplain 7773/8029 scored 17 points for Natural Attributes (using Part IIB of the questionnaire appropriate for seasonal wetlands with poorly defined boundaries). It also scored 15 points in Part III for Human Use Attributes. These scores meant that the wetland satisfied the criteria for REW. However this wetland included gazetted rare flora and this value takes precedence over all other wetland attributes in EPA (1993). Therefore palusplain 7773 was evaluated as a CCW.

Palusplain 7773/8029 included vegetation in good to very good condition and native vegetation covered almost all of the area of these wetlands. This also supported the allocation of the management category of CCW to this area.

8.3.2. Palusplain UFI 13376: REW

Although the vegetation of the part of wetland 13367 that occurs in Lots 32 and 36 was degraded to completely degraded, this wetland was allocated the management category of REW. This decision was made in the current survey because this wetland is a scarce wetland type (a palusplain on the Pinjarra Plain that is part of the Keysbrook Consanguineous Wetland Suite) and it retains some of the wetland processes and functions that are important to areas of very high conservation significance in BFS 387 down slope from it.

The area of Lots 32 and 36 is part of a regionally important hydrological/ecological link (part of Greenways 98, 102, 106; WAPC 2000a, Map 7) that supports a nationally significant system of wetlands (Alan Tingay and Associates, 1998).

The management category allocated to the part of palusplain 13367 that occurs on Lots 32 and 36 by the method of VCSRG (1998) was REW. The management category allocated to the wetland by the method of EPA Bulletin 686 (1994) was Multiple Use Wetland (MUW).

The vegetation of the wetland was degraded to completely degraded and thus the management category allocated to this wetland on the basis of vegetation condition was also MUW.

The clearing of the catchment area, the building of roads and other hard surfaces around this palusplain, the dredging and diversion of Yule Brook and the excavation of artificial drains along roads may be affecting the recharge and discharge of palusplain 13367. The natural pattern of sediment deposition on this wetland from the regular flooding of Yule Brook and the spread of floodwaters over the alluvial plain (that includes Lots 32 and 36) has been altered by development. The wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes).

9. Discussion and Conclusions

All of the remnant native vegetation of Lot 32 was vegetation of the Guildford Vegetation Complex. Most of this vegetation was in degraded to good condition and showed similarities to a recognized TEC or vegetation that has not previously been well documented on the SCP and is likely to be of high conservation significance. Most of the native flora taxa recorded in the current survey was highly dependent on surface waters and/or groundwater. The entire survey area was confirmed as being either CCWs or REWs.

From the stratigraphical sampling that was conducted on site, it was evident that the natural distribution of sediments (both laterally and vertically) over the survey area is complex. Potential evidence of the EPBC-listed Muchea Limestone TEC was observed and this is not currently known to be represented elsewhere in the Greater Brixton Street Wetlands.

Although this survey found that some small changes to the DEC (2008) *Swan Coastal Plain Wetlands Dataset* may be undertaken with regard to the classification and mapping of wetlands at a fine scale, no further work should be required.

The patterns of regional groundwater flow, sub-surface and surface flow (in both natural drainage and constructed drains) are known to link the survey area with other areas of highly water-dependent biota in the Greater Brixton Street Wetlands (Perth Groundwater Atlas, 2008; VCSRG, 2001) and will need to be considered during design stages prior to any application submission.

10. Survey Limitations

The EPA's (2004) *Guidance for the Assessment of Environmental Factors - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51* identified the main factors that can limit and constrain such surveys. The current project was evaluated against these factors and several significant constraints and limitations were found to be present. The constraints and limitations identified by this process are discussed below.

Scope, intensity, competency and experience of personnel, and availability of resources in the survey

No limitations were present with regard to the flora and vegetation survey.

The scope of the survey was very wide as flora, vegetation and wetlands were to be investigated at a detailed level. A high intensity and level of survey (Level 2) was used for the current flora and vegetation survey as was appropriate to the high conservation value of the flora, vegetation and wetlands of the area and in accordance with EPA recommendations. This survey added considerably to what was previously known about the area. For example, two species of rare and threatened flora and four Priority Flora taxa were recorded in the current survey that were not known previously from this part of BFS387. One of these flora species, *Austrostipa juncifolia* subsp. Southern River (P1) was not known previously from BFS 387. The vegetation was mapped in detail after quadrat-based survey at a high level of taxonomic accuracy and TEC occurrences were identified within the site. All of the latter data were previously not available for this area.

The botanist who carried out the survey was a qualified botanist, specializing in the taxonomy of wetland and monocot taxa, with postgraduate research training in wetland ecology, over 16 years experience in WA, recent experience in five other surveys in BFS387 and/or the adjacent vegetation, and the evaluation of over 70 wetlands in the area. The technical assistants both had prior experience in wetland and flora surveys.

Disturbances that affected the results of the survey

Significant limitations were encountered due to anthropogenic disturbance of the survey area and also due to the erratic climate patterns experienced in 2008.

Most of the survey area had been burnt recently but it was regenerating well. The pattern of this fire was not consistent with wildfire. The floristic composition of the sites where there had been recent fire was dominated by species that re-seed profusely after fire such as *Actinostrobus pyramidalis*. Many of these species do not persist in the vegetation when it has not been burnt for many years and this may have

confounded the multivariate analysis of the data, to some extent, and made it difficult to allot survey sites to FCTs of Gibson et al. (1994), as the reference sites in the latter may have been sampled in vegetation with a different fire history.

The lack of late winter and spring rain in 2008 did not allow the ground and surface water levels to rise to the levels expected in the Perth Region during the time planned for the survey between about August and November. Although almost the entire survey area was waterlogged and some areas were shallowly inundated when the survey reconnaissance was started in August, the wetlands dried out rapidly. By early October, when the wetlands are usually experiencing peak water levels and the shallow auguring was conducted (as planned) there was no standing water in the sumplands. It was also not possible to auger down to the groundwater table at some sites as the sediments were relatively dry by this stage. This weather pattern exacerbated the difficulty involved in attempting to classify wetlands within the short period allocated to this task. However the floristic indicators of long term wetland conditions were intact over most of the area (except Lot 36) and this enabled a reliable, comprehensive, wetland delineation, assessment of wetland type and wetland management category to be made in most cases.

Availability of contextual information for the survey data

Although no limitations were encountered in the flora and vegetation survey, a minor limitation was encountered in the vegetation analysis due to the lack of contextual data about fine scale vegetation patterns on the SCP. There were abundant data of collections of individual taxa in the literature and in FloraBase (WA Herbarium, 2008) that assisted greatly in the interpretation of the flora survey. However the interpretation of vegetation significance was constrained by the insufficient data available to conclusively define the conservation significance of some types of vegetation on the SCP.

The process described by Bush Forever (WAPC, 2000) to determine the conservation values of remnant vegetation on the SCP in areas such as the current survey area, involves the comparison of floristic data from a survey area (the survey dataset) with data from Gibson et al. (1994) (the SCP dataset). The use of appropriate software to define clusters of sites using indices of similarity in floristic composition can be part of this process. These clusters of sites are called FCTs. Some of the FCTs determined in Gibson et al. (1994) have been listed as TECs of the SCP, after assessment (according to the Federal and international criteria) by the Threatened Species and Communities Scientific Committees at the Federal and/or WA State level. TECs have conservation status at both State and Federal level that provides additional legal protection over that already afforded under the *Environmental Protection Act 1986* and its associated clearing regulations. The limitation inherent in this process is that, although Gibson et al. (1994) was a very large regional scale survey, it fell short of being a truly representative sample of the vegetation types of the very diverse

vegetation of the SCP. Thus subsequent survey data of rare vegetation types, that were not included in Gibson et al. (1994), when compared statistically with the SCP dataset, often show low levels of similarity with all of the sites in the SCP dataset. In many cases, where the survey dataset has not shown close similarity with any TECs defined by Gibson et al. (1994), many botanists have concluded that no vegetation of conservation significance was present in their survey.

Completeness

Minor limitations/constraints were experienced in the current flora and vegetation survey. The flora and vegetation survey collected significant field data, analysed to the extent possible given the available contextual data and presented all of the above in this report. The only aspects that constrained the flora and vegetation survey were fire history and climatic conditions. These constraints may have affected the completeness of the flora inventory as some annual flora species may have been present within the survey area but may not have been evident at the time of the survey. However the percentage of the total flora in the current survey that was comprised of annuals was not greatly below that recorded over many years of intensive flora recording and collecting in BFS 387. The latter is an indication that the annual flora of the survey area was considerably developed in the current survey area in spring 2008, despite the late winter-early spring drought of that year. The flora inventory of this survey area presented in Appendix C is likely to be reasonably complete.

11. Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

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It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

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Figures

404600 404800 405000

6458200

6458000

WELSHPOOL RD

BROOK RD

Brook Road

Lot 36

Lot 32

N

Legend

- Site Boundary
- Cadastral Boundary

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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- CADASTRES SOURCED FROM LANDGATE 2007
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SCALE

0 10 20 40 60 80

Metres

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LOCALITY MAP



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Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Site Location
Figure 1

404600 404800 405000

6458200

6458000

Brook Road

Lot 36

Lot 32

Bush Forever Site 387

N

404600 404800 405000

City of Kalamunda

Legend

- Site Boundary
- Bush Forever Site

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Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Bush Forever
Figure 2



Legend

- Site Boundary
- Conservation
- Resource Enhancement
- Multiple Use

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- GEOMORPHIC WETLANDS SOURCED FROM DEC 2008
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SCALE

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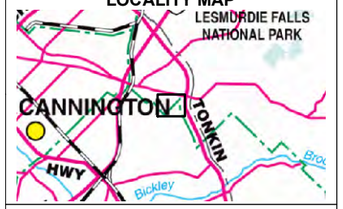
LOCALITY MAP



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Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
DEC Wetland Management Categories
Figure 3

337



Legend

- Site Boundary

Geomorphic Wetlands

- Palusplain
- Sumpland

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SCALE

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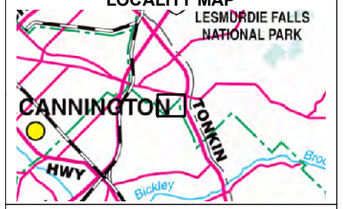
LOCALITY MAP



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Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
DEC Geomorphic Wetland Classifications
Figure 4

404600 404800 405000

6458200 6458000

Welshpool Road

Brook Road

Lot 36

Lot 32

Lot 28

H13 H14 H15 H16 H17 H18

Q14/H10 Q9/H9 Q7/H7 Q8/H8

N

Legend

- Site Boundary
- Quadrat and Auger Location

Priority and DRF Locations

- *Baeckea* sp. Perth Region (R.J. Cranfield 444)
- *Grevillea thelemanniana*

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Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Locations of Sampling and Flora of Conservation Significance
Figure 5

Attachment 10.1.4.1



Legend

Site Boundary

Vegetation Communities

1
2
3
4

Vegetation Description

1. Mid-dense to closed heath-scrub of *Actinostrobus pyramidalis-Banksia telmatiaea-Hypocalymma angustifolium- Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes and open native annual herbs; and

2. Mid-dense to open heath of *Melaleuca viminea-Hypocalymma angustifolium- Acacia lasiocarpa* over mid-dense *Actinostrobus pyramidalis* seedlings, open naturalized alien grasses and open annual herbs.

3. *Melaleuca rhaphiophylla* low woodland over *Melaleuca viminea* low open shrubs, sparse sedges and naturalized alien grasses.

4. *Corymbia calophylla* low woodland over dense naturalized alien grasses.

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SCALE

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Metres

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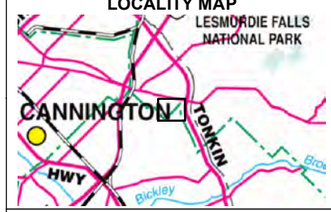
LOCALITY MAP



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Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Vegetation Communities
Figure 6a

404600 404800 405000

6458200

6458000

Lot 26

Lot 341

Lot 32

Lot 4

3

2

1

4

FCT8/7 - TEC

ML - EPBC

Q14

Q9

Q7

Q8

N

404600 404800 405000

City of Kalamunda

Legend

Quadrat Location

Site Boundary

Vegetation Units (as per Figure 3)

1

2

3

4

KEY

Vegetation also referable to DEC -Listed SWA TECs (Gibson *et al.* 1994; DEC 2008):

FCT7-TEC: Herb-rich Saline Shrublands in Clay Pans (Vulnerable)

FCT8-TEC: Herb-rich Shrublands in Clay Pans (Vulnerable)

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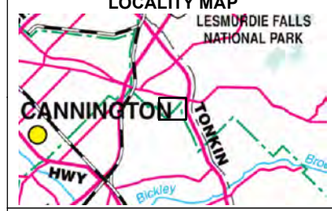
SCALE

0 10 20 40 60 80

Metres

1:1,700 @ A3

LOCALITY MAP



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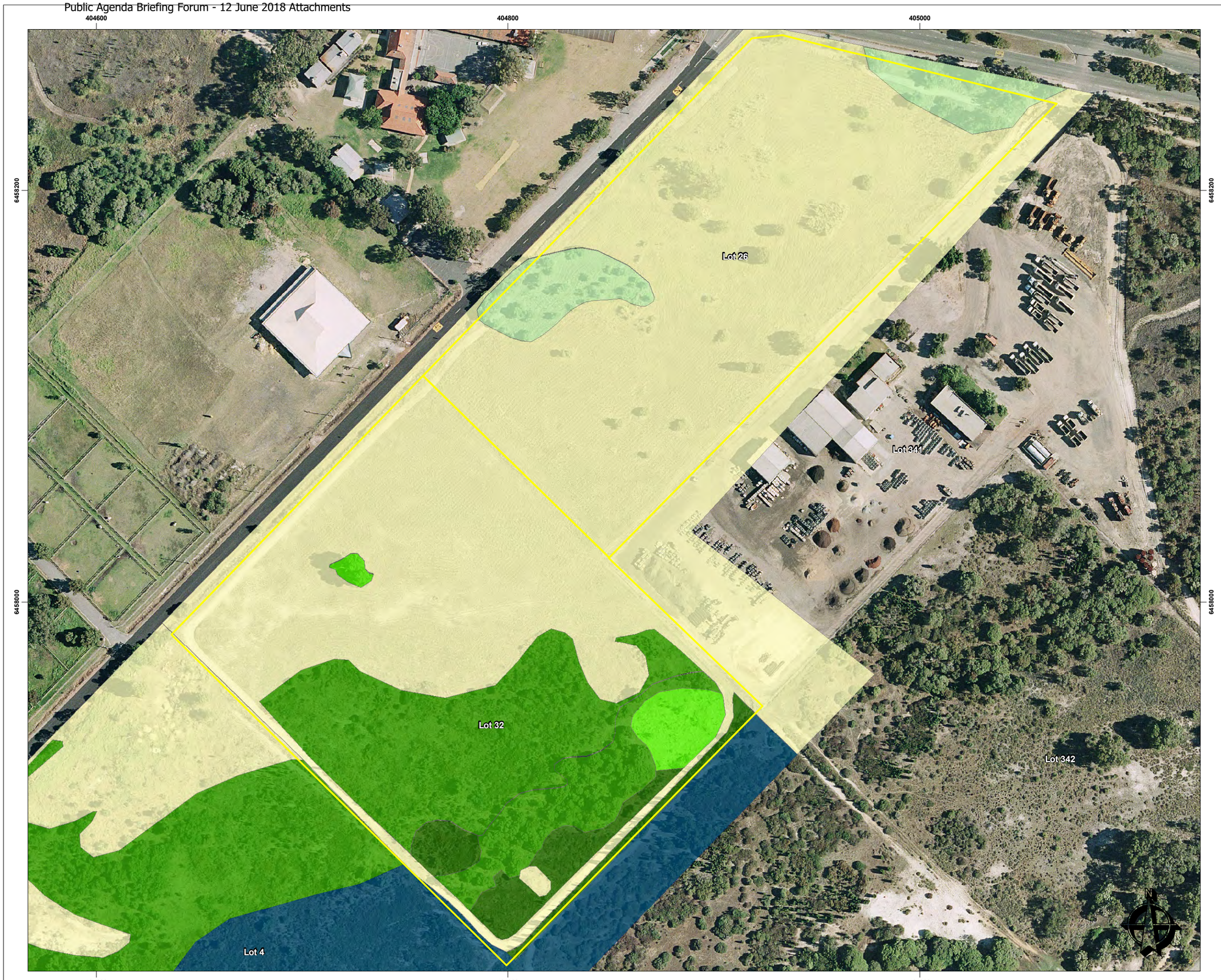
Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Vegetation Communities
Figure 6b



Legend

- Site Boundary

Vegetation Condition

- Good - Very Good
- Good
- Degraded - Good
- Degraded
- Completely Degraded - Degraded
- Completely Degraded

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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SCALE

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Metres

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LOCALITY MAP



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Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Vegetation Condition
Figure 7

404600 404800 405000

6458200

6458000

Walshpool Road

Dampland REW

Lot 36

Dampland REW

Palusplain 13367 REW

Brook Road

Not Wetland

Lot 32

Palusplain 13367 REW

Palusplain 7773 CCW

Sumpland/Dampland (likely to be part of 8028)

Palusplain 7773 CCW

Sumpland 7775 CCW

N

City of Kalamunda

Legend

- Site Boundary

Geomorphic Wetlands

- Dampland
- Palusplain
- Sumpland

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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SCALE

0 10 20 40 60 80

Metres

1:1,700 @ A3

LOCALITY MAP



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Evangelos Litis Nominees Pty Ltd
Lots 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Wetland Mapping From Spring 2008
Figure 8

Tables

TABLE 1: Climatic Data from Gosnells City Weather Station (1991-2008).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE (1991-2008)												
Mean daily max (°C)	32.7	32.7	30.3	26.2	22.6	19.5	18.7	19.1	20.6	23.5	27.4	30.1
Mean daily min (°C)	18.1	18.5	17.1	14.6	12.1	9.8	9.0	8.8	10.0	11.3	14.4	16.0
RAINFALL (1961-2008). Mean annual rainfall: **835.4 mm** Total rainfall in 2008, up to and including 15.12.08: **883.8 mm**												
Mean monthly rainfall (mm)	11.9	16.2	15.4	45.4	107.0	178.7	164.6	129.2	80.8	48.2	27.8	10.7
Monthly rainfall 2008 (mm)	0	31.6	12.9	170.8	103.9	142.5	195	21.5	85.2	47.8	59.0	13.6

TABLE 2: Soils of the slope down the alluvial fan complex of BFS 387 (adapted from Jordan, 1986).

Soil Unit	Descriptors Applicable to Soil Unit	Landform
Sand over sandy clay (Qpb/ Qpa: S10)	Shallow (Pleistocene) Bassendean Sands over Pleistocene alluvium of the Guildford Formation	Palusplains of Pinjarra Plain at approx. 20-10m AHD (Lots 32 and 36 and most of the lands from Welshpool Rd to Bickley Rd inc. parts of the UWA Allison Baird Reserve)
Clayey sand (Qpa: Sc)	Pleistocene alluvium of the Guildford Formation	Palusplain- floodplains of Pinjarra Plain at approx. 7-10m AHD in the Allison Baird Reserve and Lots 48 and Pt 35 Brixton St, Kenwick (between Brixton St and Bickley Rd)
Sandy clay (Qpa: Cs)	Pleistocene alluvium of the Guildford Formation	Palusplains- floodplain of Pinjarra Plain at < 7m AHD approx. (Brixton St Reserve)
Deep Bassendean Sands (Qpb: S8)	Deep (Pleistocene) aeolian sands: Bassendean Sands	Dunes at 12-14m AHD approx. in UWA Allison Baird Reserve

TABLE 3: Vegetation Structure Classification (adapted from Bush Forever, Govt of WA 2000).

LIFE FORM and HEIGHT	CANOPY COVER			
	Dense 70% - 100%	Mid Dense 30% - 70%	Open 10% - 30%	Sparse 2% - 10%
Trees 10-30m Trees < 10m	Closed forest Low closed forest	Open forest Low open forest	Woodland Low woodland	Open woodland Low open woodland
Shrubs > 2m Shrubs < 2m	Closed scrub Closed heath	Scrub Heath	Open scrub Open heath	Tall open shrubs Low open shrubs
Grasses, Herbs Rushes or Sedges	Closed grasses, herbs, rushes or sedges	Grasses, herbs, rushes or sedges	Open grasses, herbs, rushes or sedges	Sparse grasses, herbs, rushes or sedges

TABLE 4: Bushland Vegetation Condition (adapted from Bush Forever, Govt of WA 2000).

Code	Condition	Description of Vegetation
P	Pristine	No obvious signs of disturbance.
E	Excellent	Vegetation structure characteristic of the vegetation type remains intact, disturbance affects individual species only, and weeds are non-aggressive species.
VG	Very Good	Vegetation structure altered somewhat; obvious signs of disturbance, but recovering. Some highly invasive weeds may be present at low abundance.
G	Good	Vegetation structure modified significantly by very obvious multiple disturbances but ability to regenerate is retained (by e.g. recruitment of native species from abundant soil seed bank).
D	Degraded	Vegetation structure severely impacted by disturbance; scope for regeneration but not to a state approaching good (sic) condition without intensive management
CD	Completely Degraded	Vegetation structure no longer intact; the area almost completely without native species e.g. isolated native trees or shrubs over pasture ('parkland cleared').
TC	Totally Cleared	No native vegetation remaining on site.

TABLE 5: Wetland Sediment Classification (adapted from Semeniuk and Semeniuk, 2004).

Descriptor	Diameter of Grains
gravel	>2mm
coarse to very coarse sand	0.5-2mm
fine to medium sand	0.125-0.5mm
very fine sand	0.063-0.125mm
mud or peat	<0.063mm

TABLE 6: Wetland Sediment Definitions (adapted from Semeniuk and Semeniuk, 2004).

Sediment	Definition
sand	Sand grain supported sediment with minor or no interstitial mud
humic sand	Sand grains coated with a thin layer of fine organic particles
muddy sand or peaty sand	Sand grain supported sediment with interstitial mud, or peat
sandy mud or sandy peat	Mud (or peat) supported sediment with floating sand grains
mud (or peat)	Mud (or peat) dominant (i.e. <10% sand)

TABLE 7: Geomorphic Classification of Wetlands (adapted from Semeniuk and Semeniuk, 1995).

	Channel	Basin	Slope	Flat	Hill
Permanent inundation	river	lake	-	-	-
Seasonal inundation	creek	sumpland	floodplain	-	-
Seasonal waterlogging	trough	dampland	palusplain	paluslope	palusmont
Intermittent inundation	wadi	playa	balkarra	-	-

Table 8: Management categories of wetlands from EPA Bulletin 686 as updated in Hill et al., (1996).

Management Category	General Description	Management Objective
H – High Conservation (incorporates EPA Bulletin 686 categories H and C)	Wetlands which support a high level of attributes and functions.	To preserve wetland attributes and functions through reservation in national parks, crown reserves and state owned land and protection under Environmental Protection Policies.
R - Resource Enhancement (incorporates EPA Bulletin 686 categories O and R)	Wetlands which may have been partly modified but still support substantial attributes and functions.	To restore wetlands through maintenance and enhancement of wetland attributes and functions by protection in crown reserves and state or local government owned land and by Environmental Protection Policies or in private property by sustainable management.
M - Multiple Use (aligned with EPA Bulletin 686 category M)	Wetlands with few attributes which still provide important wetland functions.	Use, development and management should be considered in the context of water, town (land use) and environmental planning through land care.

Table 9: EPA Bulletin 686 questionnaire (EPA, 1993).

Part I: Presence of Rare Species If the wetland includes gazetted rare flora or fauna species then the wetland is automatically allocated to CCW. If this is the case, it is recommended that the questions in Part I and Part II of the questionnaire should still be answered to provide additional management information. However the scores arrived at in Part II and Part III for a wetland that includes rare species will not alter the allocation of the H category to this wetland.
Part II: Natural Attributes Part IIA: For permanent and seasonal wetlands with well defined boundaries i. Environmental geology classification: wetlands in the QuindalupDunes or in river/estuary floodplain receive the highest score. ii. Adjacent wetlands. Wetlands that have no other wetlands within a 2km radius of them receive the highest score. iii. Habitat diversity. If the composition and structure of the vegetation of the wetland under evaluation is significantly different to that found at other nearby wetlands, the wetland receives the highest score. iv. Drought refuge. Wetlands that are major drought refuges for birds receive the highest score. v. Area of wetland. Wetlands greater the 100ha in area receive the highest score. vi. Habitat type. Vegetation and landforms typical of lakes and sumplands are scored (fringing rushes and sedges, extensive in lake beds of rushes and sedges, large paperbark trees, islands, flooded grassland, permanent or seasonal open water, low thickets and samphires). vii. Emergent vegetation. Wetlands with a moderate cover (40-60%) of emergent vegetation receive the highest score as both open water and vegetation are as wetlands with both are considered best waterbirds habitat. viii. Adverse water quality. Oil slicks, algal blooms or botulism that have been observed or reported from the wetland in the last two years lower the score received by the wetland. ix. Drainage. This deal with drains into and/or out of the wetland that can alter water levels or water quality. Wetlands with few drains entering the wetland receive the highest score. Wetlands with outlet drains constructed to maintain water levels receive the highest score, whilst outlet drains constructed to dry out the wetland receive the lowest score. x. Adjacent nutrient scores. Wetlands with more than one nutrient source lower the score received by the wetland. xi. Area of wetland modified. Wetlands with 0-10 % of area modified receive the highest score. xii. Reserve Area. The ratio of the area of wetland to the area of reserve around the wetland is considered in this question. The lowest wetland to reserve ratio (< 0.1) receives the highest score. iii. Native vegetation buffer. Wetlands with 90-100% of the wetland perimeter of at least 50m of buffer vegetation receive the highest score. Part IIB: For seasonal and episodic wetlands with poorly defined boundaries (each zone of the wetland is usually scored as a separate assessment) The questions above for environmental geology classification, adjacent wetlands, habitat diversity, habitat type, drainage, area of wetland modified are scored as above. Wetland size is also considered, and wetlands >100ha in area receive the highest score in the latter question.
Part III: Human Use Questionnaire Wetlands that have attributes such as aesthetic values, historical and archaeological features, reserve status, community group involvement, passive and active recreation usage, and other uses such as agriculture, mining or water supply receive the highest scores.

Table 9: EPA Bulletin 686 questionnaire (EPA, 1993) (continued).

Part IV: Supplementary Questions

These questions concern the occurrence of rare, but ungazetted, flora andfaunaspecies, the effect of wetlands on nearby land values, the frequency of human use of wetlands and the importance othe wetland to the owner. This section is usually only evaluated if the management category obtained by the uses ofParts I, II and III above produces falls in one of the transitional zones between categories on the EPA (1994) graph.

If the wetland undergoing the evaluation does not include gazetted rare species, two graphs are provided at the end the Bulletin 686 questionnaire to determine management category. These graphs display the total Part II scores received by the wetlands that were evaluated in the process of designing this evaluation instrument versus their total Part III scores. The first graph applies to "permanent and seasonal wetlands with well defined boundaries". The second graph applies to "seasonal and episodic wetlands with poorly defined boundaries". The graphs are both divided up into five areas. Each of these areas delineates one of the five wetland management categories (H, C, O, Rand M) as defined by the EPA (1993). The appropriate graph from Bulletin 686 is used to plot Part I scores vs. Part II scores for each wetland under evaluation to determine its management category.

TABLE 10: A score sheet for wetland evaluation (adapted from VCSRG, 1998).

Six classes of wetland values	Criteria met at the level of CCW	Criteria met at the level of REW	Criteria met at the level of MUW
1.Wetland type	Yes /No	Yes /No	Yes /No
2.Wetland processes	Yes /No	Yes /No	Yes /No
3.Wetland habitats	Yes /No	Yes /No	Yes /No
4.Wetland functions	Yes /No	Yes /No	Yes /No
5.Biodiversity of wetland	Yes /No	Yes /No	Yes /No
6.Scientific value of wetland	Yes /No	n/a	n/a
Total Score	Best score = 6	Best score = 5	Best score = 5

TABLE 11: Conservation Category Wetlands criteria checklist for wetland evaluation (VCSRG, 1998).

Wetland type: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. it is an anthropogenically unaltered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland) 2. it is a scarce wetland type 3. it is a representative wetland type (i.e., representative of its consanguineous suite)
Wetland processes: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland is subject to anthropogenically unaltered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes,) 2. the wetland exhibits unusual wetland processes 3. the wetland exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting)
Wetland habitats: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland is a habitat for rare and endangered fauna 2. the wetland is a habitat for rare and endangered flora 3. the wetland exhibits a high diversity of habitats
Wetland functions: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland is necessary for maintenance of large faunal populations 2. the wetland is a refuge for resident fauna 3. the wetland is an important breeding, feeding or watering site for migratory populations (local and international) 4. the wetland is a significant regional component of the hydrological cycle (has an important hydrological storage, recharge or discharge function; or an hydrochemical function)
Wetland Biodiversity: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland exhibits unaltered wetland vegetation and fauna 2. the wetland has a scarce vegetation association or faunal association 3. the wetland has a highly diverse wetland flora or fauna
Wetland Scientific value: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland contains scientifically significant pollen records 2. the wetland is underlain by unusual wetland sediments (indicators of wetland history) 3. the wetland has unusual geomorphology (i.e., it is situated in an unusual geomorphic setting or contains unusual geomorphic features within it)

TABLE 12: Resource Enhancement Category Wetlands criteria checklist for wetland evaluation (VCSRG, 1998).

Wetland type: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. it is an anthropogenically altered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland) but retains its natural geomorphology and natural, if modified, hydrological mechanisms.
Wetland processes: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. the wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) but not to the degree that habitats cannot still be identified and rehabilitated
Wetland habitats: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. the wetland habitats are disturbed but the wetland is a habitat for rare and endangered fauna or flora, or the wetland exhibits a high diversity of habitats and for these reasons should be re-habilitated (i.e., water quality addressed, water levels naturalised, re-vegetation of communities undertaken, and re-establishment of ecological links with surrounding areas via corridors and/or buffer zones)
Wetland functions: A wetland may be classed as Resource Enhancement if it satisfies one or more of the following criteria 1. the wetland is necessary for maintenance of specific faunal populations 2. the wetland is a breeding, feeding or watering site for migratory faunal populations (local) 3. the wetland is a fauna refuge but is degraded and requires re-vegetation or improvement of water quality 4. the wetland is a significant local component of the hydrological cycle (has an hydrological storage, recharge or discharge function; or an hydrochemical function) 5. the wetland is a regionally important hydrological or ecological link in a system 6. portion of extended wetlands is vegetated and therefore functions as an ecological corridor
Wetland Biodiversity: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. the wetland exhibits some unaltered wetland vegetation and fauna which may be extended through re-vegetation programmes

TABLE 13: Multiple Use Category Wetlands criteria checklist for wetland evaluation (VCSRG, 1998).

Wetland type: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. it is an anthropogenically altered wetland type and retains its natural geomorphology but has highly modified, hydrological mechanisms.
Wetland processes: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. the wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) to the degree that habitats can no longer be identified and rehabilitated
Wetland habitats: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. the wetland habitats are disturbed such that re-vegetation is possible but not rehabilitation (i.e., sediments, water quality and water levels, are altered so that re-establishment of original flora and fauna communities is not possible)
Wetland functions: A wetland may be classed as Multiple Use if it satisfies one or more of the following criteria 1. the wetland is necessary for maintenance of low numbers of faunal populations 2. the wetland is a feeding or watering site for local migratory faunal populations (usually in association with a number of other wetlands as no single wetland is sufficient to maintain species) 3. the wetland is a component of the hydrological cycle and therefore to catchment management (has an hydrological storage, recharge or discharge function; or an hydrochemical function, albeit a minor function)
Biodiversity: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. the wetland has minor biodiversity, but does have ecosystem diversity and landscape diversity

Table 14: Vegetation status assessment in the evaluation of the management category of wetlands (adapted from Hill *et al.*, 1996, Table 3).

Category	General Description	Vegetation status assessment
C–Conservation	Wetlands which support a high level of attributes and functions.	>50% vegetation undisturbed
R - Resource Enhancement	Wetlands which may have been partly modified but still support substantial attributes and functions.	10-50% vegetation undisturbed
M - Multiple Use	Wetlands with few attributes which still provide important wetland functions.	<10% vegetation undisturbed

Table 15: Vegetation Complexes (Heddle et al., 1980) in the vicinity of the survey area.

Foothills (Ridge Hill Shelf) Vegetation Complexes 1. Forrestfield Vegetation Complex (9% remaining) Open forest of *Corymbia calophylla– Eucalyptus wandoo- E. marginata* to open forest of *E. marginata- Corymbia calophylla – Allocasuarina fraseriana- Banksia* spp. Fringing *Eucalyptus rudis* low forest in the gullies that dissect this landform.
Pinjarra Plain Vegetation Complexes 1. Guildford Vegetation Complex (6% remaining) A mosaic of open forest to tall open forest of *Corymbia calophylla- Eucalyptus wandoo- E. marginata and woodland of E. wandoo* (with rare occurrences of *E. lane-poolei*). Minor components include *E. rudis- Melaleuca rhaphiophylla.* 2. Swan Vegetation Complex (11% remaining) Fringing woodland of *Eucalyptus rudis- Melaleuca rhaphiophylla* with localised occurrences of low open forest of *Casuarina obesa* and *Melaleuca cuticularis.* 3. Cannington Vegetation Complex (1% remaining) A mosaic of the vegetation of the Bassendean, Karrakatta, Southern River and Vasse vegetation complexes.
Bassendean Dunes Vegetation Complexes 1. Southern River Vegetation Complex (17% remaining) Open woodland of *Corymbia calophylla-Eucalyptus marginata- Banksia* spp. with fringing woodlands of *E. rudis- Melaleuca rhaphiophylla* along creek banks. 2. Bassendean Central and South Vegetation Complex (24% remaining) Woodland of *Eucalyptus marginata- Allocasuarina fraseriana- Banksia spp* to low woodland of *Melaleuca* spp. and sedgelands on the moister sites.

Table 16: The Floristic Community Types of the Swan Coastal Plain that have been listed in Bush Forever Sites in the vicinity of the current survey area.

Supergroup 1: Foothills and Pinjarra Plain FCTs FCT 2: Southern wet shrublands (Dundas Road, Forrestfield). FCT 3a: Eucalyptus calophylla –Kingia australis woodlands on heavy soils (Dundas Rd,Forrestfield; Brixton Street Wetlands, Kenwick). FCT 3b: Corymbia calophylla – Eucalyptus marginata woodlands on sandy clay soils (Clifford Road, Maddington).
Supergroup 2: Seasonal Wetland FCTs FCT 4: Melaleuca preissiana damplands (Queens Park Bushland). FCT 7: Herb rich saline shrublands in claypans (Greater Brixton Street Wetlands;Kenwick Road, Kenwick). FCT 8: Herb rich shrublands in claypans (Greater Brixton Street Wetlands and Kenwick Road, Kenwick). FCT 10a: Shrublands on dry clay flats (Greater Brixton Street Wetlands, in Yule Brook Reserve). FCT 12: Melaleuca teretifolia/Astartea shrublands. FCT 13: Deeper wetlands on heavy soils. S2: Northern *Pericalymma ellipticum* dense low shrublands (Hartfield Park, Forrestfield).
Supergroup 3: Uplands centred on Bassendean Dunes (or Dandaragan Plateau) FCTs FCT 20a: Banksia attenuata woodlands over species-rich dense shrublands (Dundas Road, Forrestfield; Pioneer Park, Forrestfield; Queens Park Bushland; Bougainvillea Avenue, Forrestfield; Hartfield Park, Forrestfield; Welshpool Road, Wattle Grove; and White Road, Orange Grove). FCT 20b: Eastern Banksia attenuata and/or Eucalyptus marginata woodlands (Clifford Road, Maddington) FCT 21c: Low lying Banksia woodlands or shrublands (Greater Brixton Street Wetlands in Yule Brook Reserve). FCT 23a: Central Banksia attenuata –B. menziesii woodlands (Greater Brixton Street Wetlands in Yule Brook Reserve; Queens Park Bushland and Hartfield Park, Forrestfield).
Restricted Floristic Community Type Mosaic Shrublands and woodlands on Muchea Limestone (Passmore Street, Southern River; Carousel Wetlands).

TABLE 17: Vegetation of Conservation Significance known from the vicinity of the survey area.

SCP FCT	Name of TEC	Occurrences in vicinity of current survey area	Conservation Status (WA) DEC, 2008	Conservation Status (Federal) EPBC Act
2	Southern wet shrublands	Dundas Road, Forrestfield	Endangered EN B) ii)	
3a	*Eucalyptus calophylla –Kingia australis* woodlands on heavy soils	Dundas Road, Forrestfield and Greater Brixton Street Wetlands	Critically Endangered CR B) ii)	Endangered
3b	*Corymbia calophylla Eucalyptus marginata* woodlands on sandy clay soils	Clifford Road, Maddington	Vulnerable VU B)	Endangered
7	Herb rich saline shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)	
8	Herb rich shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)	
10a	Shrublands on dry clay flats (Greater Brixton Street Wetlands, in Yule Brook Reserve)	Greater Brixton Street Wetlands, in Yule Brook Reserve	Endangered EN B) ii)	
20a	*Banksia attenuata* woodlands over species-rich dense shrublands	Hartfield Park, Dundas Road, Pioneer Park, Bougainvillea Avenue, Forrestfield; Queens Park Bushland; Welshpool Road, Wattle Grove and White Road, Orange Grove	Endangered EN B) ii)	
20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands	Clifford Road, Maddington	Endangered EN B) i) EN B) ii)	
n/a	Shrublands and woodlands on Muchea Limestone (Keighery and Keighery,1995)	Passmore Street, Southern River Carousel Wetland, Cannington	Endangered EN B) ii)	Endangered

TABLE 18: Species-richness and native annual species-richness of Lot 32 Brook Rd compared with other areas of high conservation significance flora nearby.

Survey Area (area does not include completely degraded lands)	Total native taxa	Total native annual taxa (% of total native taxa)	Total current EPBC/DRF Taxa	Total current Priority Taxa
Greater Brixton Street Wetlands (BFS387) (<126.7 ha). Keighery and Keighery (2000)	555+	140 (25.2%)	7	26
Lot 106 Wanaping Rd, Kenwick (BFS387) (8ha). Keighery and Tauss (2008)	220	44 (19.9%)	2	6
Lots 17-33, 36,340 and 341 Brook Rd – Boundary Rd. (BFS387) (>40ha of bushland) Mattiske and Assoc. (1992)	97	11 (11.3%)	1 (0 in Lots 32 and 36)	1 (1 in Lots 32 and 36)
Lots 105A Brixton St and 107 Kenwick Rd (4ha). Koch (2003).	67	8 (11.9%)	1	2
Lot 32 Brook Rd (BFS387) (1.5ha of bushland). This survey.	44	4 (9.1%)	0	2

TABLE 19: Summary of the Flora of National and State Significance recorded in the survey area.

Species	Status	Notes	Location
Baeckea sp. Perth Region (R.J. Cranfield 444)	P3		Lot 32
Grevillea thelemanniana	P4	Fits criteria for future DRF and EPBC listing as Threatened Flora	Lot 32

TABLE 20: Other Flora of Conservation Significance (Flora of Regional Significance) recorded in the survey area.

KEY	1.Taxa that are significant on SCP due to geographical location		
Code	Description		
r	Populations at the northern (N) or southern (S) limit of their known geographic range, limit indicated as follows. Example: r (N or S, Locality, Region).		
d	Populations disjunct from their known geographic range		
p	Poorly reserved *i.e.* known from only a few populations in reserves (applies to all Declared Rare Flora and Priority Taxa)		
s	Significant populations in reference to location, population size, diversity of ages and/or health (applies to all Declared Rare Flora and Priority taxa)		
u	Uncommon in the area (generally applies to disjunct populations)		
	2. Taxa that are significant on SCP due to regional endemicity and occurrence in restricted habitats		
eSWA	Taxa endemic to the Swan Coastal Plain		
eSWA(P)	Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region		
h	Habitat Example: h (wetlands)		
	3. Taxa that are significant for taxonomic reasons		
t	Morphological variant, significant taxonomically		
	4. Codes to major landform units of Swan Coastal Plain and nearby		
QD	Quindalup Dunes	F	Foothills
SP	Spearwood Dunes	R	Riverine
BD	Bassendean Dunes	Es	Estuarine
PP	Pinjarra Plain	DR	Darling Range

Taxon	Conservation Significance Code
Acacia lasiocarpa var. lasiocarpa sens. strict.	*s, u, h (wetland PP) t*
Actinostrobus pyramidalis	s, h (wetlands PP)
Anigozanthos viridis subsp. *viridis*	s, u, h (palusplains PP)
Banksia telmatiaea	r (S,?Serpentine, SWA), p, s, u, h (wetlands PP)
Chaetanthus aristatus	s, h (wetlands PP)
Comesperma aff. *polygaloides* (C. Tauss. 2541)	s, u, h (palusplains PP) t
Gahnia trifida	h (saline/ calcareous palusplains)
Goodenia pulchella subsp. Coastal Plain B (M. Hislop 634) pn	h(wetland PP) t
*Hypocalymma angustifolium (*Mud Habitat Variant. C.Tauss 1850)	s, h (palusplains, PP), t
Lepidosperma sp. Kenwick. C.Tauss 2598	h (?palusplains, PP) t
Melaleuca brevifolia	p, s, u, h (wetlands, PP)
Podolepis capillaris	d, s, u, h (palusplains PP) ?t
Pogonolepis stricta	h (mud sumplands and palusplains PP)
Samolus junceus	s, u, h(wetlands calcareous, saline, SD/PP/Est /R)
Scaevola lanceolata	h (palusplains, PP)
Schoenus rigens	p, s, u, eSWA, h (mud and peaty wetlands PP/BD)
Tecticornia lepidosperma	s, u, h(palusplain/floodplain PP/R)
Verticordia plumosa var. *brachyphylla*	h (palusplains, PP/F)

TABLE 21: Classification (by structure and dominant species) of vegetation recorded in the field survey.

MAP UNIT No.	VEGETATION SUMMARY	LOTS	STUDY SITES	VEGETATION CONDITION
	Mid dense to dense heaths and scrubs			
1	*Actinostrobus pyramidalis-Banksia telmatiaea-Hypocalymma angustifolium- Melaleuca seriata* dense over *Chaetanthus aristatus* –Schoenus fascicularis rushes, sedges and native annual herbs	Lot 32	Q8	Good to Very Good
3	*Melaleuca viminea- Hypocalymma angustifolium- Acacia lasiocarpa* mid-dense heath over *Actinostrobus pyramidalis* seedlings, grasses and annual herbs.	Lot 32	Q9, Q14	Good to Degraded
	Low Forest and Woodland			
4	*Melaleuca rhaphiophylla* low forest over *Melaleuca viminea* over sedges and open grasses.	Lots 32 and 36	Q7, H13,H14	Good to degraded
5	*Corymbia calophylla* (Marri) low open woodland over pasture grasses and herbs.	Lots 32 and 36	H18	Degraded, isolated trees only.

TABLE 22: Vegetation units found in the current survey area in the context of units mapped in Mattiske and Associates (1992).

Mapped area	Mattiske and Associates (1992) vegetation units	Current Survey
Lot 32	Low open woodland of *M. rhaphiophylla-M. preissiana* with occasional *B. littoralis* over tall mixed Myrtaceae-Proteaceae spp.-*A. pyramidalis* over sedges.	No *M. preissiana* present- this is probably taxonomic error in Mattiske and Assoc (1992). Otherwise similar to Unit 4 in current survey
Lot 32	Halophytic complex of *Sarcocornia quinqueflora* and sedges	There was no S. *quinqueflora* present in entire survey area- this is probably taxonomic error in Mattiske and Assoc (1992). No units equivalent to that of Mattiske and Assoc (1992) in current study. The area mapped in Mattiske and Assoc (1992) is now a dense heath dominated by *Hypocalymma, Acacia lasiocarpa, Melaleuca lateriflora* and *M. brevifolia*.
Lots 32 and 36	Disturbed areas dominated by weeds and grasses with occasional sedges, *Hypocalymma* and *Eucalyptus* spp.	Equivalent to the completely degraded areas of Lots 32 and 36 in current study.

TABLE 23: Vegetation units found in the current survey area in the context of assemblages and habitat attributes of the Greater Brixton St Wetlands (Marshall, 2000).

Habitat (Marshall, 2000).	Local Scale Vegetation Units (Marshall, 2000).	Occurrence in current survey area
Water-filled depressions	1. *Melaleuca rhaphiophylla* low woodland	**Yes= Unit 4**
	2. *Eucalyptus rudis- M. rhaphiophylla* open woodland to low open woodland	**Yes=Unit 4**
	3. *Melaleuca rhaphiophylla- M. preissiana-Banksia littoralis* low woodland	No
	4. *Melaleuca lateritia* shrubland-*Amphibromus nervosus* grassland	No
	5. *Pericalymma* open heath	No
	6. Halophytic complex	No.
	7. *Chaetanthus* flats	No
	8. Sedgelands	No
Seasonally waterlogged or inundated flats	1. *Viminaria juncea* tall shrubland	No
	2. *Actinostrobus* scrub	**Yes = Unit 1**
	3. *Pericalymma- Tremulina* scrub	No
	4. *Hypocalymma angustifolium* – Myrtaceae spp. open heath	**Yes= Units 1**
	5. Myrtaceae spp. – Proteaceae spp.-*Actinostrobus pyramidalis* closed heath	**Yes = Units 1**
	6. *Verticordia plumosa – Hypocalymma angustifolium* closed heath	**Yes= Unit 1 in area adjoining Q8**
	7. Myrtaceae species mixed open heath	?
	8. *Acacia saligna* tall shrubland	No
	9. *Verticordia plumosa-V. densiflora- V. acerosa* low closed heath	No
Dry or occasionally waterlogged flats	1. Mixed low shrubland 2. *Pericalymma* shrubland 3. Mixed scrub 4. Tall scrub 5. Eremaea scrub 6. Closed heath of Myrtaceae-Proteaceae ssp.	No dry flats in winter in Lots 32 and 36 except Marri areas as below.
Uplands	1. *Corymbia calophylla* woodlands	**Yes= degraded unit 5**
	2. *Banksia* woodland or low open woodland	No
	3. *Eremaea* low shrubland	No

TABLE 24: Vegetation units found in the current survey area in the context of assemblages and habitat attributes of the Greater Brixton St Wetlands (after VCSRG, 2001).

Habitat in VCSRG (2000). (and same nomenclature used in current survey)	Vegetation units in BFS387 in VCSRG (2001).	Vegetation units in current survey.
High sand ridges	*Banksia menziesii*	No
Low sand ridges	*Eremaea pauciflora*	No
Dry sand mounds	*Corymbia calophylla*	Yes= Unit 5
Wet mounds	*Viminaria juncea*	No
Sandy paluslopes	*Pericalymma ellipticum, Tremulina tremula;* or *Viminaria juncea*	No
Sand flats	*Acacia lasiocarpa, Calytrix breviseta*	No
Sandy palusplains	*Pericalymma ellipticum* (in gradation between basin and paluslope); or *Viminaria juncea*	No
Mud flats	*Banksia telmatiaea, Actinostrobus pyramidalis*	Yes=Unit 1
Muddy palusplains	*Meeboldina cana* (transitional area between two veg. units)	No
Muddy floodplains	*Halosarcia* (= ?*Tecticornia lepidosperma*) (transitional area between two veg. units)	No
Channels	*Melaleuca uncinata*	This unit in VCSRG (2001) may be equivalent to Unit 3 in the current study as the landform and location of the VCSRG unit is comparable to that in current study mapped as *Melaleuca viminea.*
Sumplands	*Melaleuca lateritia/Meeboldina cana*	No
Damplands	*Melaleuca rhaphiophylla, Melaleuca viminea*	Yes = Unit 4

TABLE 25: Floristic Community Types of the SCP determined in the current survey area.

Survey Site Number	FCT suggested by multivariate analysis of floristic data only	Affinity of survey site to FCTs and TECs of the Swan Coastal Plain as evidenced by the habitat, floristic and structural data recorded in the current survey (Figure 6b).
Q7	?17	Vegetation similar to the *Melaleuca rhaphiophylla- Gahnia trifida* seasonal wetlands FCT 17 but more probably a vegetation type not sampled in Gibson et al. (1994) and likely to be, at least, equivalent in conservation value to the TECs of the SCP.
Q8	?10a	Vegetation similar to the TEC: Shrublands on Dry Clay Flats (Endangered)
Q9	?6	A degraded example of a *Melaleuca viminea* dominated FCT not sampled in Gibson et al. (1994) and from data available of BFS387, probably an uncommon vegetation assemblage of BFS387 (see discussion with regard to Table 27 above)
Q14	8/?6/7	Vegetation similar to the TEC: Herb-rich Shrublands in Clay Pans (Vulnerable)/ ?Weed dominated wetlands on heavy soil/ Herb-rich Saline Shrublands in Clay Pans (Vulnerable). A *Melaleuca viminea* dominated FCT not sampled in Gibson et al. (1994) and from data available of BFS387, probably an uncommon vegetation assemblage of BFS387 (see discussion with regard to Table 27 above) and equivalent in conservation value to other TECs of the SCP. Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.

TABLE 26: Vegetation of conservation significance (TECs) found in the current survey compared to the regional distribution of TECs.

SCP FCT	Name of TEC	Occurrences in vicinity of current survey area	Conservation Status (WA) DEC, 2008	Conservation Status (Federal) EPBC Act	Occurrence of TECs in current survey area
2	Southern wet shrublands	Dundas Road, Forrestfield	Endangered EN B) ii)		No
3a	*Eucalyptus calophylla –Kingia australis* woodlands on heavy soils	Dundas Road, Forrestfield and Greater Brixton Street Wetlands	Critically Endangered CR B) ii)	Endangered	No
3b	*Corymbia calophylla Eucalyptus marginata* woodlands on sandy clay soils	Clifford Road, Maddington	Vulnerable VU B)	Endangered	No
7	Herb rich saline shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)		Yes at Q14
8	Herb rich shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)		Yes at Q14
10a	Shrublands on dry clay flats	Greater Brixton Street Wetlands, in Yule Brook Reserve	Endangered EN B) ii)		Yes at Q8
20a	*Banksia attenuata* woodlands over species-rich dense shrublands	Hartfield Park, Dundas Road, Pioneer Park, Bougainvillea Avenue, Forrestfield; Queens Park Bushland; Welshpool Road, Wattle Grove and White Road, Orange Grove	Endangered EN B) ii)		No
20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands	Clifford Road, Maddington	Endangered EN B) i) EN B) ii)		No
n/a	Shrublands and woodlands on Muchea Limestone (Keighery and Keighery,1995)	Passmore Street, Southern River Carousel Wetland, Cannington	Endangered EN B) ii)	Endangered	No

Table 27: Wetlands mapped in *Geomorphic Wetlands Swan Coastal Plain Dataset* in the current survey area.

Lot Number	Wetland UFI	Geomorphic Classification in DEC (2008)	Management Category in DEC (2008)
32	7773	palusplain	CCW
32	8029	palusplain	CCW
32	13367	palusplain	REW
36	13367	palusplain	REW

Table 28: Study sites and wetland identification within the survey area.

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
Q7-H7 Lot 32	Surface waterlogging in winter.	Peaty sand at surface over muddy sand from –60cm, mud from–140cm.	5 taxa inc. *Mel rha ,Gah tri, Mel bre, Lep lon*	2 taxa *Aca sal* var. *sal, Mel vim* subsp. *vim*	1. Hydric soils: peaty sand, shallow aquitard. 2. Hydrology: waterlogged in winter. 3. Vegetation dominated by wetland taxa (50% of taxa O or F)	Currently palusplain 7773, may prove to be dampland/ sumpland with further study.
Q8-H8 Lot 32	Surface waterlogging in winter.	Shallow muddy sands perch rainwater	20 taxa inc. UU*Aca las* var. *las, Act pyr, Ani vir* subsp. *vir, Cha ari, Gah tri, Gre the, Hyp ang*.	5 taxa inc. *Bau jun, Sam jun, Sch sub, Ver den* subsp. *den*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (78% of taxa O or F)	Palusplain 7773
Q9-H9 Lot 32	Surface waterlogging in winter.		6 taxa inc. UUUU*Aca las* var. *las, Cha ari, Gah tri, Mel lat* subsp. *acu, Mel rha*.	2 taxa M*el vim* subsp. *vim, Sch sub.*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (50% of taxa O or F)	Palusplain 7773
Q14-H10 Lot 32	Surface waterlogging in winter.	Shallow mud at -25cm perches rainwater	8 taxa inc. *Aca las* var. *las.*, Act *pyr, Cha ari, Gah tri, Hyp ang*.	3 taxa inc. *Aca sal* var. *sal*, *Mel vim* subsp. *vim, Tec lep*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (58% of taxa O or F)	Palusplain 7773
H13 Lot 36	Surface waterlogged in winter. WT in late spring at -280cm.	Peaty sand at surface over mottled sand at -70cm , muddy sand	*Mel rha*		1. Hydric soils: peat and mottled sand. 2. Hydrology: waterlogging in winter. 3. Vegetation dominated by obligate wetland species.	Palusplain 1337 but may prove to be a

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
		and deep sand				dampland on further study.
H14 Lot 36	Surface waterlogged in winter. WT in late spring at -150 cm.	Sandy peat over sand	*Mel rha, Gah tri.*	*Mel vim* subsp. *vim.*	1. Hydric soils: peat. 2. Hydrology: waterlogging in winter. 3. Vegetation dominated by obligate wetland species.	Currently palusplain 13367 but may prove to be a sumpland on further study.
H15 Lot 36	Surface waterlogged in winter. WT in late spring at -160 cm.	Peaty sand over muddy sand over muddy sand with quartz gravel.	No native vegetation remains	none	1. Hydric soils: peaty sand and shallow aquitard. 2. Hydrology: waterlogging in winter. .	Palusplain 13367
H16 Lot 32	WT in late spring at -210 cm.	Deeper Bassendean Sand overlies the Guildford Formation here than is present over most of Lot 36.	No native vegetation remains except a few *Cor cal*	none	Hydric soils at -160cm indicated by mottling and deeper aquitard present. No evidence surface waterlogging or inundation. Vegetation mostly cleared so insufficient data.	Currently palusplain 13367, but this small, localized area of deeper sand within palusplain is not wetland
H17 Lot 32	Surface waterlogging in winter.	Shallow sandy mud perches rainwater	No native vegetation remains	none	1. Hydric soils: shallow aquitard andcalcareous nodules. 2. Hydrology: waterlogging in winter. 3. Vegetation cleared so insufficient data.	Palusplain 13367

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
H18 Lot 36	WT in late spring at -240 cm.	Deeper Bassendean Sand overlies the Guildford Formation here than is present over most of Lot 36.	No native vegetation remains except a few *Cor cal*	none	No evidence of hydric soils, surface waterlogging or inundation, vegetation cleared so insufficient data.	Currently palusplain 13367, but this small, localized area of deeper sand within palusplain is not wetland

Table 29: Wetland classifications within the survey area.

Area	Current Classification	Hydroperiod	Landform	Proposed change
Lot 32	Palusplain 7773	Surface waterlogging observed in winter at Q8,Q9 and Q14	Plain	No change
Lot 32	Palusplain 7773	Q7: Surface waterlogging observed in winter. Vegetation indicating inundation. Probably part of sumpland 8029 and possibly also linked hydrologically to sumpland 7775.	Shallow basin/swale	Sumpland/ dampland, requires further study.
Lot 32	Palusplain 8029	Surface waterlogging observed in winter	Plain	No change
Lot 32	Palusplain 13367	Surface waterlogging observed in winter H17	Plain	No change.
Lot 32	Palusplain 13367	Small areas of deeper sand drifts in some places that probably remain dry except in wetter than average winter at H16.	Plain	Not wetland
Lot 36	Palusplain 13367	Surface waterlogging observed in winter. H13 and H14	Shallow basin/swale	Change to dampland.
Lot 36	Palusplain 13367	Surface waterlogging observed in winter. H15	Plain	No change.
Lot 36	Palusplain 13367	H18. Small areas of deeper sand drifts in some places that probably remain dry except in wetter than average winter.	Plain	Not wetland

Appendices

Appendix A

Floristic Community Type – PATN Statistical Analysis

1.0 INTRODUCTION

1.1 Purpose of this report

The current report is intended to help clarify the assignment of Floristic Community type (FCT) designation to vegetation community (site) data. FCTs were defined by Gibson et al (1994) based on site data collected from vegetation on the Swan Coastal Plain. In particular, the potential that a Threatened Ecological Community (English and Blyth 1997) is represented by the data collected needs to be clarified.

1.2 Location of Brook Road Wattle Grove Sites

The sites were from Lots 28 and 32 Brook Rd Wattle Grove that were surveyed in Tauss (2008).

1.3 Brief background to floristic analysis of vegetation on the Swan Coastal Plain

Floristic analysis (ie., analysis of variation in vegetation based on the species present, rather than description of structural variation and dominance) as a significant component of the understanding of the variation present in the native vegetation of the Swan Coastal Plain dates to Gibson *et al* (1994 – all references to the SCP survey in the current report refer to this publication), the first publication to document the floristics of the vegetation of a large part of the Swan Coastal Plain. While the SCP survey is based on a very significant amount of work, it must be viewed as a "first pass" survey, limited, in the context of the great variety of vegetation present in the very large area surveyed, by the relatively limited number (509) of sites (quadrats) it is based on. To a limited degree, this limitation has subsequently been addressed in an "update" to the work of the SCP survey (which describes additional units). However, there is no detailed publication of the results of this update available and the additional data used are not readily available in an appropriate form (ie., one that would enable ready comparison of new data to the overall data set).

The units described by the SCP survey are a series of "floristic community types", a "unit" whose rank is defined by the use within a study. The SCP survey surveyed a very large survey area and defined a relatively small number of floristic community types. Consequently, the floristic community types they have described are of a very high order (see Trudgen 1999, volume 1, for further discussion of this point). This is an extremely important point to fully grasp in interpreting the analysis presented by the SCP survey and in understanding the meaning of analysis of other data sets when they are compared to the floristic community types of the SCP survey.

The important effects of the limited size data set used by the SCP survey and of the relatively small number of floristic community types defined by them, can be summarised by the following points:

1. the definition of all but two of the Threatened Ecological Communities for vegetation on the Swan Coastal Plain (English and Blyth 1997) has been based on the floristic community types of the SCP survey. It therefore follows, that with two exceptions, only vegetation units from one study that are different at a very high order of floristics are treated as rare by Government. No account is taken of other important differences, such as differences in structure and dominance;

2. for the definition of floristic community types to be robust, a sufficient sized database is needed to give adequate precision in their definition. About half of the floristics community types (or sub types) of the SCP survey are based on less than 10 sites. It is likely that with a larger data set there would be significant alteration in the classification of those floristic community types from the SCP survey based on small numbers of sites.

3. as noted above, many (if not most) of the floristic community types defined by the SCP survey are very broad. They contain very significant variation in floristics, structure and dominance. Some (or in more highly cleared parts of the Swan Coastal Plain much) of this variation may be rare by any reasonable definition, but it is currently "buried" within larger groups;
4. there is likely to be significant variation not sampled by the SCP survey. This includes some variation at a high level of floristic difference (see Trudgen 1999, volume 1, for an example of this) and undoubtedly quite significant (large!) amounts of variation at "medium" and "low" levels.

5. the document, and its use by Government, has focussed attention in the environmental impact assessment process on the high level of units described, deflecting attention from the layers of variation beneath these units that also have significant conservation value.

From these points it is obvious that there is a need for a major "upgrade" to the floristic analysis of the vegetation of the Swan Coastal Plain to provide a more detailed floristic classification that considers not only more of the variation present, but explicitly recognises more of the variation present in formally described units.

Obviously, such a reworking would have some effect on what vegetation is considered rare on the Swan Coastal Plain. It needs to be stressed that it would be very unlikely to find that any of the vegetation currently considered to be rare on the basis of the SCP survey*'s* classification was not rare. On the other hand, it is likely that such a review would very probably consider to be rare some vegetation which is not currently considered rare.

1.4 Data provided

It is very important in comparing different sets of floristic data that they are comparable in the application of names, in the intensity of the survey (ie., the effort of searching resulting in similar proportion of the flora at sites being recorded) and in the size of the site recorded. If the data from different data sets is not comparable in these ways, it reduces the clarity of the results of the analyses carried out. If the discrepancy in the comparability of the data sets is large, the results may become meaningless.

A brief observation of the from Brook Road Wattle Grove, compared to other datasets of the flora of the SCP indicates that the Brook Road Wattle Grove sites above may be low in the numbers of geophytes (eg orchid) and annual species recorded.

2.0 METHODS

2.1 Data Preparation

The data from the Brook Road Wattle Grove sites were provided into a standard MS Access based database designed for this type of data. One virtue of the database is that the species recorded at each site are stored against standard codes (numbers, those used by the Western Australian Herbarium) for each species. This facilitates ready comparison of data from different surveys stored in the same system.

After the data were incorporated into the database (containing the data from other projects), a process of reconciliation of flora species names with those used in the SCP survey was undertaken. This step was necessary at least because of changes in nomenclature over the last ten years and the potential of survey specific variations in the application of names. The reconciliation involved:

- reducing some infra-specific names to the relevant species name,
- combining some taxa where confusion is known to have occurred in field observations and identifications, and
- omitting some names (mostly, where a species had only been identified to genus).

The reconciliation process was relatively straight forward as most of the names had already been standardised. Most reconciliation was to conform with the methods that the SCP survey used to manage confusing taxa plus some nomenclatural changes (see Appendix).

2.2 Comparability of datasets

It was concluded that the some of the sites in the dataset were probably only modestly compatible to obtain reliable determinations.

2.3 Comparisons made

Two sets of data were evaluated. The data from the 14 sites plus the 509 sites from the SCP survey of the southern part of the Swan Coastal Plain (south of Gingin) were combined.

The main purpose was intended to assign the individual sites to the Floristic Community Types (FCTs) defined in the SCP survey.

These data are provided in CT_Brook Road Wattle Grove.mdb.)

2.4 Analyses carried out

The approach was the use of numerical classification techniques (PATN) based on the similarity of the floristic composition of the Brook Road Wattle Grove sites to sites in the SCP survey data set.

2.4.1 PATN

Several modules of the numerical classification package PATN (Belbin 1987) were used for the analyses. The parameter values were the same as used by the SCP survey used to ensure consistency of analysis with that study.

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification based on the results of ASO), DEND (representation of classification) and NNB (determination of sites most similar to each site – nearest neighbours). The results of the analyses were imported into a database (BM_TimsThicket.mdb) so that site characteristics and previous classifications (eg., Floristic Community Types derived in earlier classifications) could be associated and various analyses based on these data could be performed.

The assignment of floristic community types to the Brook Road Wattle Grove sites was made by summarising the results of two different methods:

- the classification, and
- the twenty nearest neighbours.

Experience demonstrates that the results of these are likely to vary, but that from nearest neighbours is likely to make more sense.

To the classification dendrogram of the combined dataset the FCT assigned by the SCP survey was associated with the SCP survey sites. The apparent FCTs were assigned to the Brook Road Wattle Grove sites by interpreting the position of these sites in the dendrogram (particularly by the way they joined to the SCP sites.

The 20 sites in the combined data set that were most similar to each of the Brook Road Wattle Grove sites were obtained from the nearest neighbour method (NNB). By associating those nearest neighbours from the SCP survey, the most likely FCTs for each of the Brook Road Wattle Grove sites were determined.

An attempt was then made to reconcile these different assignments of a Floristic Community Type.

3.0 LIMITATIONS

It has been found in earlier projects that the addition of new sites to the SCP survey data set to produce a combined classification disrupts the original classification. The more data added, the higher the level of the disruption. This problem can make it difficult to assign Floristic Community Types to new sites using this method.

Secondly, it is common for new data to group to their cohorts. In some cases this has proven to result from common deficiencies in the data, ie. whole groups of species missing. This absence tends to draw them together. The more sites in the added batch, the tighter they draw together.

The analyses are conducted without personal knowledge of the sites and no photographs were provided. It was noted that some sites had been disturbed.

4.0 RESULTS

4.1 Determination of floristic community type by classification

The classifications was unable to suggest any relationships as all the new sites grouped together at the end of the dendrogram. This suggested that the sites are significantly difference from the SCP quadrats. The likely reason for this is the degree of disturbance with most new sites having shared 'absences'. One site (Q1) was relatively rich but its geographic proximity may have contributed to it being grouped with its cohorts.

Figure 1. Relevant portions of Dendrogram all Quads and Releves

site	FCT from NNB	sp	dendrogram
Q01	8	63	
Q03	8	33	
Q04	7/8	37	
Q05	7	20	
Q11	?17/7	21	
Q13	7	33	
Q08	?10a	28	
Q14	8/?6/7	16	
Q10	?6	24	
Q12	7	23	
Q02	?6	16	
Q07	?17	11	
Q06	?6	13	
Q09	?6	14	

(Brook Road Wattle Grove sites Q*)

4.2 Determination of floristic community type using Nearest Neighbour method

The nearest neighbour analysis also suggests that the sites do not fit the FCTs well. This is a relatively common phenomenon when adding largely dampland sites to the SCP dataset. This is for two reasons; these sites can be very different and the SCP dataset has a low number of wetland types and those defined as FCTs are relatively generalised. A common occurrence is that new dampland sites tend to disrupt the SCP FCT classification.

Table 1. Results of Nearest Neighbour analysis

s	s1	fct1	v1	s2	fct2	v2	s3	fct3	v3	s4	fct4	v4	s5	fct5	v5
Q01	Q04		0.35	Q03		0.49	Q08		0.55	ELLEN-1	8	0.57	Q11		0.61
Q02	Q05		0.54	Q04		0.64	Q11		0.66	Q14		0.67	Q03		0.68
Q03	Q04		0.34	Q13		0.48	Q01		0.49	Q05		0.5	Q10		0.50
Q04	Q03		0.34	Q01		0.35	Q05		0.51	Q11		0.52	Q13		0.56
Q05	Q11		0.33	Q13		0.45	Q14		0.47	Q03		0.5	Q04		0.51
Q06	Q09		0.66	Q02		0.70	Q10		0.71	Q07		0.71	Q12		0.75
Q07	Q10		0.64	cool 01	17	0.65	Q02		0.69	Q06		0.71	PAGA-5	17	0.72
Q08	Q14		0.42	Q11		0.44	Q13		0.53	Q03		0.53	Q12		0.54
Q09	Q13		0.52	Q14		0.57	Q03		0.61	Q05		0.62	Q06		0.66
Q10	Q11		0.45	Q12		0.46	Q13		0.47	Q03		0.50	Q14		0.53
Q11	Q05		0.33	Q13		0.38	Q08		0.44	Q10		0.45	Q14		0.48
Q12	Q14		0.44	Q10		0.46	Q13		0.52	Q03		0.52	Q08		0.54
Q13	Q11		0.38	Q14		0.45	Q05		0.45	Q10		0.47	Q03		0.48
Q14	Q08		0.42	Q12		0.44	Q13		0.45	Q05		0.47	Q11		0.48

s	s6	fct6	v6	s7	fct7	v7	s8	fct8	v8	s9	fct9	v9	s10	fct1	v10
Q01	Q05		0.63	ELLEN-2	8	0.64	Q12		0.64	ELLEN-5	8	0.65	Q13		0.65
Q02	Q07		0.69	Q10		0.7	Q01		0.70	Q06		0.70	Q08		0.72
Q03	Q11		0.51	Q12		0.52	Q08		0.53	Q14		0.54	Q09		0.61
Q04	Q12		0.57	Q08		0.58	Q10		0.59	BULL-6	7	0.61	Q02		0.64
Q05	Q02		0.54	Q12		0.55	Q08		0.56	Q10		0.58	Q09		0.62
Q06	TWIN-4	6	0.76	Q14		0.76	WATER-2	13	0.78	Q05		0.8	Q13		0.8
Q07	ELLIS-1	17	0.72	Q09		0.73	Possum2	16	0.75	MTB-5	17	0.76	cool 11	17	0.76
Q08	Q01		0.55	Q05		0.56	Q04		0.58	Q10		0.60	YULE-4	10a	0.66

s	s6	fct6	v6	s7	fct7	v7	s8	fct8	v8	s9	fct9	v9	s10	fct1	v10
Q09	Q11		0.69	Q08		0.7	Q07		0.73	Q12		0.76	Q10		0.78
Q10	Q05		0.58	Q04		0.59	Q08		0.60	Q07		0.64	Q01		0.65
Q11	Q03		0.51	Q04		0.52	Q12		0.56	Q01		0.61	Q02		0.66
Q12	Q05		0.55	Q11		0.56	Q04		0.57	Q01		0.64	BULL-8	7	0.71
Q13	Q12		0.52	Q09		0.52	Q08		0.53	Q04		0.56	Q01		0.65
Q14	Q10		0.53	Q03		0.54	Q09		0.57	Q01		0.67	Q02		0.67

s	s11	fct1	v11	s12	fct1	v12	s13	fct1	v13	s14	fct1	v14	s15	fct1	v15
Q01	Q10		0.65	ELLEN-3	8	0.66	AUSTB-2	7	0.66	BULL-6	7	0.66	Q14		0.67
Q02	TWIN-2	6	0.72	TWIN-4	6	0.74	Q13		0.77	ELLEN-7	6	0.79	TWIN-3	6	0.79
Q03	FL-3	8	0.67	ELLEN-5	8	0.67	FL-7	8	0.68	Q02		0.68	BULL-8	7	0.69
Q04	ELLEN-1	8	0.65	KOOLJ-6	10a	0.66	FL-3	8	0.67	GINGIN-2	7	0.67	Q14		0.68
Q05	Q01		0.63	BULL-8	7	0.70	BULL-6	7	0.78	YULE-4	10a	0.78	Q06		0.8
Q06	TWIN-10	15	0.80	Possum2	16	0.81	ELLEN-7	6	0.82	PAGA-5	17	0.82	PAGA-2	13	0.83
Q07	ELLIS-3	18	0.77	FL-10	12	0.77	WATER-2	13	0.77	TWIN-4	6	0.81	low10b	11	0.82
Q08	Q09		0.7	Q02		0.72	BULL-8	7	0.73	BULL-7	5	0.75	BULL-6	7	0.75
Q09	Q01		0.83	Q04		0.83	TWIN-4	6	0.83	ELLEN-7	6	0.83	PEARCE-1	6	0.83
Q10	Q02		0.7	Q06		0.71	TWIN-4	6	0.74	ELLEN-7	6	0.74	BULL-8	7	0.75
Q11	Q09		0.69	ELLIS-1	17	0.75	BULL-6	7	0.75	BULL-8	7	0.77	MTB-5	17	0.77
Q12	BULL-6	7	0.72	Q06		0.75	MUD-3	8	0.75	FL-7	8	0.75	Q09		0.76
Q13	BULL-6	7	0.73	BULL-8	7	0.74	Q02		0.77	GINGIN-3	7	0.78	TWIN-2	6	0.78
Q14	Q04		0.68	FL-7	8	0.72	PEARCE-1	6	0.73	BULL-8	7	0.75	Q06		0.76

s	s16	fct1	v16	s17	fct1	v17	s18	fct1	v18	s19	fct1	v19	s20	fct2	v20
Q01	AUSTB-7	7	0.67	low09a	5	0.67	KOOLJ-6	10a	0.68	MUD-6	8	0.68	AUSTB-8	7	0.69
Q02	BAMBUN-	7	0.82	CARAB-3	11	0.82	BULL-8	7	0.82	AUSTB-6	5	0.83	ELLEN-5	8	0.83
Q03	MUD-2	8	0.69	BULL-6	7	0.70	ELLEN-1	8	0.70	MUD-6	8	0.72	MUD-3	8	0.72
Q04	MUD-2	8	0.68	ELLEN-5	8	0.7	BULL-7	5	0.70	ELLEN-3	8	0.71	BULL-8	7	0.71
Q05	YULE-5	7	0.80	KOOLJ-7	10a	0.81	WONN-3	9	0.82	TWIN-2	6	0.82	C58-4	10a	0.83
Q06	PB-3	29b	0.83	Q08		0.84	TWIN-2	6	0.84	CARAB-1	15	0.84	Q03		0.85
Q07	PAGA-2	13	0.82	WOODP-1	30a	0.82	McLART-1	13	0.82	CAPEL-9	12	0.83	Q14		0.84
Q08	BRIX-1	8	0.76	ELLEN-7	6	0.76	BRIX-3	8	0.77	MUD-3	8	0.77	TWIN-2	6	0.77
Q09	Q02		0.86	FL-10	12	0.86	WATER-3	3c	0.88	NAVB-4	24	0.88	Possum2	16	0.88
Q10	CARAB-2	7	0.77	BULL-6	7	0.77	ELLIS-1	17	0.77	PAGA-5	17	0.77	ELLEN-3	8	0.77
Q11	BULL-7	5	0.78	C58-4	10a	0.78	YULE-4	10a	0.79	hymus01	11	0.80	BAMBUN-1	7	0.80
Q12	ELLEN-7	6	0.77	YULE-5	7	0.77	ELLEN-2	8	0.78	ELLEN-3	8	0.79	FL-3	8	0.80
Q13	FL-7	8	0.78	Q06		0.8	AUSTB-8	7	0.8	YULE-5	7	0.80	TWIN-3	6	0.80
Q14	ELLEN-7	6	0.78	ELLEN-4	8	0.79	TWIN-2	6	0.80	BULL-6	7	0.81	FL-10	12	0.81

s – the site being compared
s1 to s20 – the 1st to 20th most similar sites
f1 to f20 – the FCT of the similar sites (only for SCP sites)
v1 to v20 – the dissimilarity value between the site and the similar sites (values above 0.6 tend to indicate low similarity)

4.3 Combining the results

The interpretation for the nearest neighbour analysis is presented in Figure 1. This allows a degree of comparison between the two methods which are modestly consistent.

Much of the uncertainty suggested in these analyses is likely to be a product of the sites being wetland related communities. The intrinsic diversity of these communities coupled to the relatively small number of communities in the SCP data lead commonly to high uncertainty with this style of analysis.

Table 2 is a summary of the richness of the new sites in relation to the putative FCTs. In general terms, most sites appear to be low total richness and low in plant families commonly overlooked in cursory examination or more vulnerable to loss in disturbed areas.

Table 2 Richness of sites and FCTs

			selected plant families																		
					x	x	x	x	x	x	x	x		x				x	x	x	
site	fct	#spp	031	032	054B	054C	054D	054E	054F	054J	054L	066	090	143	163	165	273	281	341	343	345
	10a	51	2.5	5.9		0.3	0.1		1.4	0.5	0.4	2.8	2.9	2.6	0.8	1.9	4.6	1.4	1.4	3.0	2.9
	17	14	0.9	2.9		0.1			0.1			0.1			0.3	0.6	1.9	0.8			1.3
	6	26	3.4	1.8		0.6	0.2	0.2	0.8	0.3		1.2	0.9	2.0	0.6	0.8	3.1	0.2	0.1	0.4	2.7
	7	46	3.9	4.6		0.2		0.1	1.2	0.7	0.1	1.3	0.1	2.2	0.2	1.1	2.9	2.1	0.8	1.8	6.9
	8	52	5.4	6.0	0.0	0.3	0.3		2.0	0.8	0.6	1.3	0.9	2.0	0.7	1.9	3.5	1.0	1.3	2.1	4.1
Q01	8	63	4	3					1			5	3	4	2	2	5	1	1	1	6
Q02	?6	33	1		1				1				2		1		5				1
Q03	8	37	3	1					1				1		1	2	3		1		3
Q04	7/8	20	4	1					1			2	1	2	1		4	1			5
Q05	7	21		2					1				2		1		6			1	2
Q06	?6	33	3	1	1										2		3				
Q07	?17	28	2	2	1												2				
Q08	?10a	16	2	4									1	1	2	1	6				1
Q09	?6	24	4	2											1	1	3				
Q10	?6	23	4	2									1		1	1	3		1		1
Q11	?17/7	16	2	2									2		1	1	5		1		1
Q12	7	11	3	3											1	1	2		1		3
Q13	7	13	6	3									1		1	1	4		2		3
Q14	8/?6/7	14	1	1											2	1	3				2

These sites are difficult to assign to any FCTs, probably due to disturbance but possibly they represent communities not in the FCT data. Site condition assessment may be used to distinguish between these possibilities.

4.0 REFERENCES

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5.0 APPENDIX

Appendix 1 Species combinations made to assist in reconciling taxonomic changes and identification difficulties between this survey and SCP data.

FCODE	name	lookup
031	Austrostipa juncifolia	omitted
031	Avena barbata	Avena barbata/fatua
031	Hordeum geniculatum	Hordeum leporinum
031	Pennisetum clandestinum	omitted
031	Pentaschistis aeroides	Pentaschistis airoides/pallida
031	Tribolium uniolae	omitted
032	Isolepis nodosa	omitted
039	Leptocarpus aristatus	Chaetanthus aristatus
039	Leptocarpus canus	omitted
039	Leptocarpus roycei	Meeboldina roycei
039	Lyginia imberbis	Lyginia barbata
054B	Myrsiphyllum asparagoides	Asparagus asparagoides
054F	Thysanotus manglesianus	Thysanotus patersonii/manglesianus
060	Gladiolus undulatus	omitted
060	Romulea rosea var. australis	Romulea rosea
066	Monadenia bracteata	Disa bracteata
066	Thelymitra sp.	omitted
090	Grevillea thelemanniana	Grevillea thelemanniana subsp. obtusifolia
090	Grevillea thelemanniana subsp. preissii	omitted
090	Petrophile media var. juncifolius Ms	omitted
103	Rumex acetosella	omitted
103	Rumex crispus	omitted
109	Phytolacca octandra	omitted
111	Calandrinia sp. Wattle Grove (G.J. Keighery 10905)	Calandrinia granulifera
143	Drosera macrantha subsp. macrantha	Drosera macrantha (Swan coastal plain form BJK & NG 228)
149	Crassula colorata var. acuminata	Crassula colorata
163	Acacia lasiocarpa var. lasiocarpa	Acacia lasiocarpa
163	Acacia saligna var. saligna	Acacia saligna
165	Lotus subbiflorus	Lotus suaveolens
165	Nemcia capitata	omitted
175	Boronia crenulata subsp. viminea	Boronia crenulata
183	Comesperma aff. polygaloides	omitted
221	Lawrencia squamata	omitted
273	Astartea affinis	Astartea aff. fascicularis
273	Eucalyptus calophylla	omitted
273	Melaleuca brevifolia	Melaleuca bracteosa
273	Melaleuca viminea subsp. viminea	Melaleuca viminea
273	Verticordia plumosa var. brachyphylla	Verticordia plumosa
288	Leucopogon sp.	omitted
293	Anagallis arvensis var. caerulea	Anagallis arvensis
310	Echium plantagineum	omitted
316	Bellardia trixago	omitted
326	Eremophila glabra subsp. chlorella	Eremophila glabra
329	Plantago coronopus	Plantago major
341	Goodenia pulchella subsp. Coastal Plain B (L.W. Sage 2336)	Goodenia pulchella
345	Angianthus pygmaeus	Angianthus preissianus
345	Brachyscome pusilla	Brachyscome bellidioides
345	Lagenifera huegelii	omitted
345	Podolepis capillaris	omitted

Appendix B

Results of the desktop flora search for species of conservation significance

APPENDIX B

Desktop Study: Flora of Conservation Significance. Lots 32 and 36 Brook Rd Wattle Grove

Note: The names of taxa in Tables A1 and A2 below are those current on Florabase at WA Herbarium (2008). Where there is variation within a currently published taxon as listed on Florabase, the abbreviations *sens lat.* (in the broad sense) or *sens. strict.* (in the strict sense) are added after the current Florabase name. Voucher specimen details for morphological variants that are significant in the vicinity of the current survey area are also provided, where necessary. (See also the taxonomic notes and synonyms in Appendix B).

DEFINITIONS OF CONSERVATION SIGNIFICANCE

1. Flora of National Significance (Federal EPBC Act, 1999) (TABLE A1 below)

Critically Endangered

Taxa that have been thoroughly surveyed and found to have been subject to a major contraction in area or which were originally of limited distribution and are now facing severe modification or destruction throughout their range in the immediate future.

Endangered

Taxa that have been adequately surveyed and found to have been subject to a major contraction in area or which were originally of limited distribution and are now in danger of significant modification throughout their range in the near future.

Vulnerable

Taxa that have been adequately surveyed and found to be declining and/or have declined in distribution and/or condition and whose ultimate security has not been assured or taxa that are still widespread but are believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

2. Flora of State Significance: Declared Rare Flora (WA Wildlife Conservation Act) (TABLE A1 below)

DRF: Declared Rare Flora – Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

3. Flora of State Significance: Priority Flora Taxa (WA Department of Environment & Conservation) (Atkins, 2008) (TABLE A1 below)

P1: Priority One – Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

P2: Priority Two – Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

P3: Priority Three – Poorly Known Taxa

Taxa which are known from several populations and the taxa are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.

P4: Priority Four – Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa are considered to require monitoring every 5-10 years.

4. Flora of Regional Significance (EPA, 2004) (TABLE A2 below)

Apart from EPBC-listed, DRF and Priority Species, Guidance Statement 51 (EPA, 2004B) and Bush Forever (Government of Western Australia, 2000) define other criteria under which flora taxa (i.e. species, sub-species or varieties) or populations of these taxa may have conservation significance. In the current survey of Lots 32 and 36 Brook Rd, Wattle Grove, such taxa and populations are termed "regionally significant". The criteria for significance of these elements of the flora are discussed in Section 4.1.3 in the main body of the report.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

KEY

Nationally Significant Flora (DEWHA, 2008)
CE Critically Endangered
EN Endangered
VU Vulnerable

State Significant Flora (Atkins, 2008)
DRF Declared Rare Flora – Extant Taxa
P1 Priority One – Poorly Known Taxa
P2 Priority Two – Poorly Known Taxa
P3 Priority Three – Poorly Known Taxa
P4 Priority Four – Rare Taxa

d Populations disjunct from their known geographic range
eSCP Taxa endemic to the eastern Swan Coastal Plain
eSCP(P) Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region
p Taxa considered to be poorly reserved (applies to all DRF and Priority taxa)
r Populations at or near limit of their known geographic range
s Significant populations in maintaining regional presence of a flora taxon
t Significant taxonomically, morphological variant
u Uncommon in area (generally applies to disjunct populations)

(Note: MKSEA is Maddington-Kenwick Strategic Employment Area as in Tauss & Weston ,2008)

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Acacia oncinophylla subsp. *patulifolia*	P2	Darling Scarp Forrestfield- Gosnells	Sep-Oct		Tall shrub- low tree with yellow flowers on laterite, granite.
Andersonia gracilis	DRF EN p, s, d	Kenwick, Cannington, Badgingarra, Nambung, Cataby, Swan View	(Sep-) Oct-Nov	*	Slender erect or open straggly shrub, 0.1–0.5 (–1) m tall; flowers white, pink, purple. White/grey sand, sandy clay, gravelly loam; winter-wet areas.
Anthotium junciforme	P4 p, s	Kenwick, Albany Upper Swan, Serpentine, Busselton, Scott River Plain,	Dec-Mar	*	Grass-like tufted herb <40 cm tall; fls purple to pale blue (rarely white or pink), terminal on stalks > than lves. Low in landscape in eucalypt woodlands or winter-wet flats.
Aponogeton hexatepalus	P4	Kenwick, Pinjarra, Capel, Bunbury, Boyanup, Nannup	Aug-Sep	*	Rooted aquatic herb, leaves straplike, floating part of leaf broader than the submerged part. Shallow winter pools on clay soils, rivers.
Asteridea gracilis	P3	Darling Range, Gordon River, Gosnells (DR), Bindoon	Sep-Oct		White flowering annual daisy – clay and clay over granite.
Baeckea sp. Perth Region (R.J. Cranfield 444) (syn. *B. tenuifolia)*	P3 p, s, d	Kenwick, Moora, Cannington, Lancelin, Mogumber, MKSEA	Jan-Mar	*	Erect open shrub 40-70cm tall; flowers white, pink. Sand and clayey soils; winter-wet depressions.
Banksia mimica	DRF VU	Wattle Grove, Kalamunda, Whicher Range, Gingin	Dec-Jan		Low, semi-prostrate shrub; flowers yellow. White or grey sand over laterite, sandy loam.
Byblis gigantea (syn. B. lindleyi)	P2 p, d, r, eSCP(P)	Kenwick, Cannington, Jandakot, Brookton Highway	Sep-Jan	*	Perennial herb to 60cm tall; leaves terete, long, with glandular hairs, insectivorous; flowers blue/pink/purple. Seasonally wet soils, sandy clay, swampy areas.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Calytrix breviseta subsp. *breviseta*	DRF EN p, s , eSCP(P)	Kenwick (Gosnells, Bellevue), MKSEA	Sep-Oct	*	Shrub 0.4–1m tall; flowers purple, blue. Sandy clay, swampy flats.
Caladenia huegelii	DRF EN p, s , eSCP	Capel, Banjup, Canning Vale, Melville, Yallingup, Queens Park, Malaga	Sep-Oct		Geophytic orchid to about 0.4m in height. Large red and white flowers with very long fringe on labellum. Banksia woodland on dunes and around wetlands.
Calothamnus rupestris	P4	Ellis Bk, Boyagin Rk, Gosnells, Darling Range, Southern R, MKSEA	Sep-Oct		Large shrub with pink-red flowers. Darling Range and scarp, watercourses. Granite and clay.
Centrolepis caespitosa	P4 p, s	Kenwick (Yule Brook), South Stirling, Pearce, Meckering, (Byford)	Nov (Oct-Dec)	*	Tufted annual, herb (forming a rounded cushion up to 25mm across). White sand, clay; salt flats, wet areas.
Chamaescilla gibsonii (syn. *Chamaescilla* sp. Ellen Brook (GJK 12501)	P3 s , eSCP	Kenwick, Mogumber, Capel, Muchea,	Sep	*	Tuberous herb; flowers blue. Clay -sandy clay; winter-wet flats, claypans.
Comesperma rhadinocarpum	P2 p, s ,d	Kenwick, Mullewa, Cataby, (Greenough R, Irwin R)	Oct-Nov	*	Herb; flowers blue. Sandy soils.
Conospermum undulatum	DRF VU p, s , eSCP(P)	Kenwick, Forrestfield, Orange Grove, Newburn, Lesmurdie, MKSEA	Aug-Nov	*	Erect, narrow shrub to 2m tall; leaves broad with undulate margins. Grey or yellow-orange clayey sand.
Cyathochaeta teretifolia	P3 p, s, u	Bullsbrook, MKSEA, Pinjar, Blackwood,			Tall sedge, on SCP usually associated with artesian springs or seepage from dune aquifers. Significant number of recorded locations on SCP no longer extant although more common in Jarrah Forest & Warren regions.
Diuris drummondii	DRF EN	Albany, Lake Muir, Bunbury, Mandurah, Gingin	Nov-Jan		Tall donkey orchid with pale yellow flowers, amongst sedges under Paperbarks in peaty damplands and on margins of sumplands.
Diuris purdiei	DRF VU p, s, eSCP	Perth - Waroona, Busselton	Sep-Oct		Slender donkey orchid with 5-10 narrow, spirally twisted leaves. Seasonally wet, recently burnt shrublands, usually *Regelia* and/or *Pericalymma*. On sand over clay.
Drosera occidentalis subsp. *occidentalis*	P4 p, s	Kenwick, Gingin-Pinjarra, Palgarup, Darling Range, Wattle Grove,	Nov-Dec	*	Pygmy sundew with sparse, open rosette of red leaves and white to very pale pink flowers. In white peaty sand of margins of winter wet swamps
Drakaea elastica	DRF EN	Capel to Cataby	Sep-Nov		Small hammer orchid with small, glossy, pale green leaf being the most conspicuous and distinctive feature for most of the growing season. In humic sands on margins of peaty wetlands.

Tauss, C. (2008). Lots 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Eleocharis keigheryi	DRF VU	Kenwick, Lesueur, Ellenbrook, Boyanup	Aug-Nov	*	Rhizomatous, clumped perennial grass-like sedge to 40cm tall; flowers green. Clay, sandy loam; emergent in freshwater: creeks, claypans.
Eremophila glabra subsp. *chlorella* ms	DRF p, s, u	Kenwick-Cannington, Moora, Cataby, Mogumber, MKSEA	Jul-Aug	*	Shrub to 1m tall; flowers green, yellow. Sandy clay, sumplands.
Eryngium pinnatifidum subsp. *palustre* ms	P3 p, s	Kenwick, Forrestdale, Gingin, Capel, Arrowsmith	Sep-Nov	*	Herb to 50cm tall; flowers white, pale blue. *Melaleuca* shrublands and low open vegetation on winter-wet sandy-clay flats.
Eryngium subdecumbens ms	P3 p, s	Kenwick, Ruabon, Busselton, Kooljerrenup	Oct-Nov	*	Prostrate perennial, herb, to 15cm high; stems tubular; flowers white, green. Clay, grey sand; seasonally wet flats, claypans, swamps.
Grevillea thelemanniana	P4 p, s, eSCP(P)	Kenwick, MKSEA	Jun-Sep	*	Dense spreading shrub <1m; branchlet indumentum appressed, sparse or absent; leaves glabrous above, not pitted; flower pink-red, limb cream. Winter-wet heathland on grey sand.
Haemodorum loratum	P3 p, s, d	Wattle Grove, Cockleshell Gully, Mogumber, Eneabba, Bullsbrook, Boonanaring	Sep-Nov		Grey or yellow sand, gravel.
Halgania corymbosa	P3	Darling scarp and plateau. Gosnells, Susannah Brook, Red Hill	Oct		Small shrub with bright blue flowers. Sandy clay over granite near watercourses.
Haloragis aculeolata	P2 p, s, d	Gingin, N Bannister, Yalgorup, Albany	Nov-Dec		Decumbent herb of seasonal wetlands. Sand or clay over limestone. Flowers yellow-brown.
Haloragis tenuifolia	P3 p, s	Ruabon, Collie, Gingin, Maddington, Wooroolloo, Harvey	Sep-Nov		Decumbent herb of clay seasonal wetlands. Flowers brown-red.
Hydrocotyle lemnoides	P4 p, s	Kenwick, Perth-Bolgart, Lane Poole, Eneabba	Aug-Oct	*	Aquatic annual herb; flowers purple. Seasonal swamps.
Hydatella dioica	DRF EN	Kenwick, Upper Swan, (Midland)	Sep-Nov	*	Dioecious, tufted subaquatic herb 5cm tall; flowers red. Muddy clay, seasonal swamps.
Isopogon drummondii	P3 p, s, d	Forrestfield, Wattle Grove, Orange Grove, Moora, Midland, Mt Lesueur	Feb-Jun	*	Erect, lignotuberous shrub, 0.4–1m tall; flowers yellow, cream. White, grey or yellow sand, often over laterite.
Lepidosperma rostratum	DRF EN p, s, eSCP(P)	Kenwick, Forrestdale Lake NR, MKSEA	Jun-Aug	*	Erect tufts to 0.5m tall; base fibrous, dull pale brown; inflorescence erect, spicate. Palusplain grey clay to sandy clay, peaty sand.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Macarthuria keigheryi	DRF EN p, s, d	Perth airport, Forrestfield, Queens Park, Kenwick, Cooljarloo, Moora	Sep-Mar		Low soft shrub with hairy branches, small cream flowers. In sand, or sand over clay in Banksia woodland or sometimes on fringes of Marri-Kingia.
Meeboldina decipiens subsp. *decipiens* B.G. Briggs ms	P3 r ,u, eSCP	Capel, Waroona, Cannington		?	Tall dioecious rush, of muddy palusplains. Poorly known. CA Gardner record from 'Cannington' probably from UWA Allison Baird Reserve on Brook Rd.
Olax scalariformis	P3 p, s, d	Eneabba-Esperance	Oct-Dec		Shrub 30-80 cm tall; flowers cream, white. Sand, sandy loam.
Pimelea imbricata var. major	eSCP, s	Moore River – Yalgorup, Kenwick, MKSEA	Oct-Feb	*	Erect shrub (0.1–) 0.2–0.8(–1) m tall; flowers white. Sand or sandy clay; seasonally waterlogged depressions, watercourses.
Ptilotus sericostachyus subsp. *roseus*	P1	Cannington, Armadale, Pinjarra, Kelmscott	?		Poorly known. May now be extinct in the Cannington area.
Rhodanthe pyrethrum	P3 d	Kenwick, Forrestdale, Bullsbrook-Boyanup-Denmark, Capel	Sep-Oct (-Dec)	*	Erect, slender, succulent-stemmed herb to 20cm tall; flowers white, yellow. Clay, sandy-clay, winter wet depressions, clay pans, swamps.
Schoenus benthamii	P3 p, s	Kenwick, Mogumber, Busselton, Manypeaks, Cape Arid	Oct-Nov	*	Tufted perennial sedge 15-45cm tall; flowers brown. White, grey sand, sandy clay, winter wet flats, swamps.
Schoenus capillifolius	P2 p, s	Kenwick, Carousel, Waroona, Pearce, Waterloo, Beaufort River, Beverley.	Sep-Nov	*	Semi-aquatic, tufted annual sedge 5cm tall; flowers green. Brown mud, claypans.
Schoenus natans	P4	Pinjarra, Cannington, Gingin, Lake Muir, Busselton, Beaufort R, W. Dale	Aug-Nov		Aquatic annual grass-like sedge 30cm high; flowers brown. Winter-wet depressions.
Schoenus pennisetis	P1 p, s	Kenwick, MKSEA, Forrestdale, Pinjarra, Busselton, Byford, Wongan Hills	Aug-Dec	*	Annual sedge to 15cm tall; flowers dark purple, black. Grey or peaty sand, sandy clay, winter wet depressions.
Schoenus sp. Waroona (GJ Keighery 12235)	P3, p, s, eSCP	Kenwick, Harvey, Waroona	Oct	*	Small tufted annual. Clay or sandy clay, winter-wet flats.
Stachystemon axillaris	P4, r	Kalbarri, Eneabba to Forrestfield	Jul-Oct		Sparse shrub< 1.2m tall, flowers greenish. Banksia woodland, sand.
Stylidium longitubum	P3 p, s	Pinjarra, Pinjar, Ellenbrook, Kenwick, Yoongarillup	Oct-Feb		Slender annual herb, flowers white-pink. Clay wetlands.
Tetraria australiensis	DRF VU p, s, eSCP	Ambergate, Mundijong, Ruabon, Yarloop ,Cardup, ?Cannington	Nov-Dec?		Tufted perennial sedge, occasionally to 1.2 x 0.5m. Leaves hairy at base. Bases of culms not bulbous. Flowers after fire.
Tetratheca sp. Granite (S Patrick 1224)	P3	Kalamunda to Wungong	Sep-Oct		Small shrub with pink flowers. Quartz sand over granite.

Tauss, C. (2008). Lots 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Thelymitra magnifica	P3	Norwood Reserve, Maida Vale, Crystal Brook	Oct		Orchid with brown-yellow flowers. Clay and clay over granite. Foothills, scarp and plateau of Darling Range.
Triglochin stowardii	P3	Moora, Highbury, Meckering	Sep-Oct		Tufted annual, herb, to 10cm tall. Clay, sand; swamps, salt lakes.
Trichocline sp. Treeton (B.J. Keighery & N. Gibson 564)	P2 s, p	Beaufort R, Augusta-Perth, Kenwick, MKSEA	Oct-Nov	*	Tuberous, perennial, herb. Sand clay over ironstone; seasonally wet flats.
Tripterococcus paniculatus sp. W. R. Barker ms	P1 p, s	Pinjar, Ruabon, Canning Vale, Badjingarra, Busselton	Nov-Feb		Tuberous herb to about 1m or more in height. Flowers greenish-yellow. Margins of seasonal wetlands.
Verticordia lindleyi subsp. *lindleyi*	P4 p, s	Murray R - Moore R, Forrestdale, Kenwick, Cannington, Muchea, Gingin MKSEA	May, Nov-Jan	*	Erect, more or less open shrub to 75cm tall; flowers pink, purple. Sand, sandy clay, winter wet depressions.
Villarsia submersa	P4	Kenwick, Forrestdale, Boyanup-Denmark, Frankland R, Lane Poole	Sep-Oct	*	Floating elliptic leaves and white fringed flowers. Shallow seasonal pools on clay depressions.

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove.

KEY

Locations

QD Quindalup Dunes
SD Spearwood Dunes
BD Bassendean Dunes
PP Pinjarra Plain
F Foothills
R Riverine
Es Estuarine
DR Darling Range

Criteria for regional conservation significance of taxa occurring on the Eastern Swan Coastal Plain.

d SCP populations that are disjunct from their main geographic range in other regions
eSCP Taxa endemic to the Swan Coastal Plain
eSCP(P) Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region
p Taxa considered to be poorly reserved on the SCP (applies to all DRF and Priority taxa)
r Taxa in the survey area at limit or close to limit of their known geographic range on the SCP [*e.g.* r (S, Kenwick SWA)means that the southern end of the taxon's range is at Kenwick in the IBRA(2000) Swan Coastal Plain Bioregion]
s Significant populations (due to size, genetic factors or other) for maintenance of taxa on the SCP
t Significant taxonomically; morphological or genetic variants that require further study
u Uncommon on the SCP (generally applies to disjunct populations but could also be due to rare habitat, lack of collections etc.)
h Confined to specific and restricted habitats *e.g.* h (claypans PP) = confined to claypans of the Pinjarra Plain

(Note: MKSEA is Maddington-Kenwick Strategic Employment Area as in Tauss & Weston,2008)

SPECIES/TAXON	CONSERVATION SIGNIFICANCE CODE	Previously recorded in BFS 387	NOTES
Acacia lasiocarpa var. *lasiocarpa sens. strict.*	s, u, h (wetland PP) t	*	Previously (in error) called *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (GJ Keighery 5026) in Marshall (2000). Known from Kenwick and? Midland. Geographical range requires further study.
Acanthocarpus canaliculatus	s, u, h (wetlands PP)	*	Low shrub-like monocot with small white flowers.
Actinostrobus pyramidalis	s, h (wetlands PP)	*	Columnar conifer with dark foliage to about 10m in height killed by fire and slows to regrow from seed.
Amphibromus nervosus	s, h (mud sumplands PP)	*	Tall grass of claypans, flowers in early spring when inundated
Anarthria laevis	s, u, r(N, Wattle Grove, SWA) h (palusplians, PP)	*	Tufted, dioecious rush. On SCP only known from Allison Baird Reserve Kenwick-Wattle Grove, MKSEA and Ruabon. More common in WAR and ESP Bioregions.
Anigozanthos bicolor subsp. *bicolor*	u, s, r (S, Kenwick) h(palusplains PP)	*	Pearce Airport, Talbot Rd, Brixton St are only locations on SCP. More common in Jarrah Forest
Anigozanthos viridis subsp. *viridis*	s, u, h (palusplains PP)	*	Green-flowered Kangaroo Paw. Yoongarillup to Gingin
Angianthus preissianus	u, h(wetlands, QD/PP)	*	Tiny annual daisy of saline coastal wetlands (Rottnest, Creery Is.) and muddy clay palusplains (Gingin to Mandurah)
Austrostipa mollis	h (PP/F)	*	Tall grass with long dense hairy inflorescence
Banksia telmatiaea	r (S,?Serpentine, SWA), p, s, u, h (wetlands PP)	*	Shrub to about 2m in height with brown flowers –forms dense stands. Most southern population may be no longer extant so Kenwick may bevery close to southern range end. Subject to threats and poorly conserved.
Boronia crenulata subsp. *viminea*	r (N, Kenwick SWA) s, u, d, h (wetlands PP/BD)	*	Small fragrant-leaved shrub with deep pink flowers

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONSERVATION SIGNIFICANCE CODE	Previously recorded in BFS 387	NOTES
Borya scirpoidea	s, u, h (wetlands PP/F)	*	Low grass-like monocot to about 10cm tall with white flowers, uncommon on SCP
Borya sphaerocephala	s, u, h (wetlands PP/F)	*	Low grass-like monocot to about 10cm tall with white flowers, uncommon on SCP
Brachyscome pusilla	s, u, h (muddy wetlands PP/SD/Es)	*	Conspicuous annual daisy with white ray florets. Uncommon from Lancelin to Yalgorup in muddy wetlands inc. estuarine setting at Alfred Cove and palusplains at Kenwick, Guildford and Caversham.
Burchardia bairdiae	r (S, Serpentine River SWA), s, u, h (peat/mud wetlands PP/R/BD) eSCP	*	Robust geophytic herb with white flowers. Peaty or muddy damplands, palusplains, paluslopes. Regan's Ford to Serpentine R.
Burchardia multiflora	u, s, h (mud wetlands PP/F)	*	Geophytic herb with pink markings on flowers. More common in WAR and JF Bioregions
Calandrinia sp. Kenwick (G.J. Keighery 10905) [syn. C. aff. *composita*]	h(wetlands PP), t	*	Tiny prostrate succulent annual herb; flowers pink. Eneabba-Esperance
Calectasia grandiflora subsp. *grandiflora* RL Barrett ms	u, s, h(mud palusplains PP)	*	Large-flowered Tinsel Lily. Restricted to a few location son eastern SCP at Mundijong, Serpentine and Brixton St Wetlands.
Calothamnus hirsutus	s, h(palusplains, PP)	*	Cooljarloo to Byford on PP. Also in Geraldton Sandplains Region
Caesia micrantha sens. lat. (Large Swamp Form B.J. Keighery & N. Gibson 122)	eSCP ?, t, h (wetlands PP)	*	Tuberous herb with pale blue flowers, may be confined to eastern SCP, requires more study
Centrolepis mutica	h (wetlands PP)	*	Minute sedge-like clumps
Chaetanthus aristatus	s, h (wetlands PP)	*	Dioecious, perennial rush with rusty brown inflorescences. Usually forms large dense populations
Chorizandra enodis	s, h (mud wetlands PP)	*	Perennial sedge with glaucous terete culms, globular inflorescences and a prominent involucral bract
Comesperma aff. *polygaloides* (C. Tauss. 2541)	s, u, h (palusplains PP) t		Sub-shrub to about 30cm with suckering habit and mauve-pink flowers in early to mid summer. First recorded in MKSEA (Tauss and Weston, 2008).
Conospermum huegelii	p, s, u, h (wetlands PP/F)	*	Low smoke bush with globular, white and blue inflorescences
Conostylis festucacea subsp. *festucacea*	s, u, h (palusplains PP)	*	Perennial stilted herb with woolly yellow flowers- usually forms dense clumps
Cyathochaeta equitans	s, u, d, h (sand dunes PP/F/S/BD)		Robust perennial sedge with inflorescence to about 1.5m or more in height. Eneabba to Esperance. Uncommon on SCP; records inc. Ambergate, Pinjarra, BFS 53, Hawkevale, Koondoola, MKSEA (Tauss & Weston,2008)
Cytogonidium leptocarpoides	r (N, Gingin SWA), s, u, h (wetlands, PP)	*	Small tufted dioecious rush, uncommon on SCP.
Darwinia citriodora	d, u, s, h(creek banks PP/F)		Recorded at Yule Brook near Welshpool Rd (Tauss & Weston, 2008; Tauss, 2007). Most of the (few) records on SCP are old and from areas where it is probably no longer extant e.g. Guildford. Abundant in DR and scarp.

Tauss, C. (2008). Lots 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS 387	NOTES
Dasypogon obliquifolius	s, d, u, h(sand dunes PP/F)		Robust perennial rhizomatous herb. Glaucous leaves, globular inflorescences on scapes to 1m in length. In BFS 53 Clifford Rd, Maddington Disjunct distribution: Jurien-Badgingarra-Lancelin & Maida Vale-Wattle Grove, MKSEA (Tauss & Weston,2008)
Dichopogon preissii	h (palusplains, PP)	*	Dainty lily with pink-mauve, pendulous flowers in spring
Dielsia stenostachya	d, u, eSCP(P) h(peaty damplands - floodplains BD/PP)		Intricate rush with hairy rhizomes. Peaty sand damplands usually in Bassendean Dunes. Recorded in MKSEA (Tauss & Weston, 2008) in a wetland maintained by an active Muchea Limestone spring.
Dodonaea ceratocarpa	d, u, s h(palusplains PP), ?t	*	Dioecious, 4-merous, hopbush with horned wings on fruit and narrow simple leaves. May be morphological variant.
Drosera macrantha sens. lat.(Swan Coastal Plain form BJK & NG 228)	? eSCP, h (wetland, PP), ?t	*	Tall, many-flowered climber. Clay wetlands. Requires taxonomic study.
Drosera bulbosa subsp. *bulbosa*	u, s, h(wetlands PP/F)	*	Sundew with large flat rosette and white flowers. Probably poorly collected.
Drosera heterophylla	r (S, Mundijong, SWA) u, s, h (palusplains PP)	*	Small erect/climbing sundew with crescent-shaped leaves, early spring flowering, white flowers.
Drosera menziesii subsp. *menziesii*	u, s, h (palusplains PP)	*	Small erect/climbing sundew with round red leaves and red stems, large bright pink flowers
Drosera neesii subsp. *neesii*	u, s, h (wetlands PP/BD)	*	Medium climbing sundew Cooljarloo, Muchea, Kenwick, Serpentine to Ambergate Reserve.
Drosera rosulata	h (wetlands PP)	*	Flat rosette sundew. Midland to Busselton.
Drosera tubaestylis	u, h(wetland PP)	*	Sundew with flat leaf rosette and white flowers in autumn
Eucalyptus decipiens subsp. *decipiens*	d, s, u (ML wetland PP)		Mallee usually confined to coastal Tamala Limestone but found in association with Muchea Limestone outcrops in the MKSEA (Tauss & Weston, 2008;) and at Southern River (Trudgen & Keighery 1994)
Gahnia trifida	h (saline/ calcareous palusplains)	*	Robust clumping sedge to over 1m in height with sharp edged leaves and dark brown, dense inflorescences, usually coastal.
Goodenia pulchella subsp. Coastal Plain B (M. Hislop 634)pn	h(wetland PP) t	*	Dainty perennial herb with yellow flowers. Generally limited to clay wetlands on eastern side of SCP.
Hakea ceratophylla	r (N, Kewdale SWA) u, s, h (palusplains PP)	*	Shrub to about 1.2m with brown flowers, uncommon on SCP and associated with TEC 3a. Widespread and common in Warren Region.
Hakea sulcata	h (palusplains,PP)	*	Sparse shrub to about 1.2 m in height with terete leaves and small, short- beaked woody fruits
Haemodorum simplex	h (palusplains,PP)	*	Geophytic herb with black inflorescence
Hydrocotyle alata	h (palusplians, PP)	*	Small herb, Bullsbrook to Ruabon. Also in Tuart Forest.

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS 387	NOTES
Hypocalymma angustifolium sens. lat. (Mud Habitat Variant. C.Tauss 1850)	s, h (palusplains, PP),t	*	Shrub to 2m when unburnt, white flowers. Common dominant species of heaths in Kenwick inc. MKSEA (Tauss & Weston, 2008). Part of the *H. angustifolium* complex. Taller and with flatter leaves than the more common (peaty sand habitat) *H. angustifolium* that is prevalent on SCP. Requires taxonomic and biogeographical study
Isotoma pusilla	s, h (muddy sumplands, PP)	*	Tiny, purple flowering herb that forms large populations in muddy sumplands and flowers as they dry out.
Isotoma scapigera	d, u, h (mud sumplands &palusplains ,PP)	*	Small purple flowered herb not often recorded from SCP.
Jacksonia alata	d, s, u (PP/F)		Small shrub less than about 40cm in height. Yellow pea flowers. Widespread in SW WA but very uncommon on SCP.
Kunzea micrantha subsp. *micrantha*	s, h (wetlands PP/F)	*	Shrub to about 1m in height with small pink globular inflorescences. Caversham to Dunsborough .Only 1-2 records off the ESCP (in Warren -Jarrah Forest)
Lambertia multiflora var. *darlingensis*	p, s, h (colluvium)		Shrub to 2m, flowers yellow. Deep sands or loamy, clayey or gravelly soils, laterite, granite; base of scarp, rocky hills, plateaus. Maddington (Clifford St BFS 53), lower Darling Scarp, Whicher Range
Lawrencia squamata	d, s, u r (S, Kenwick SWA), h (saline/calcareous wetlands/PP)	*	Occurs in only 2 disjunct areas on SCP: Bullsbrook and Cannington-Kenwick. Otherwise widespread in semi arid and arid regions.
Lepidosperma scabrum sens. lat. (Eastern Terete Form. BJ Keighery &N Gibson 232)	t, s, h (palusplains, PP)	*	Requires more study to determine distribution, taxonomy and conservation status
Lepidosperma sp. Kenwick. C.Tauss 2598	h(?palusplains, PP) t		An undescribed sedge taxon of taxonomic significance. More study required to determine distribution but may be confined to palusplains on eastern SCP. Recorded from MKSEA (Tauss and Weston,2008)
Leucopogon strictus	s, d, h (palusplains PP)		Generally prevalent in Daring Range, uncommon on SCP. Recorded in MKSEA (Tauss & Weston,2008)
Melaleuca brevifolia	p, s, u, h (wetlands)	*	Erect shrub or tree (rarely), 0.5–4m tall; flowers white, cream. White or grey sand, sandy loam, clay; swampy areas, drainage lines, salt lakes. Eneabba-Esperance, MKSEA
Melaleuca lateriflora subsp. *acutifolia*	h (wetland, PP)	*	Shrub to about 3m
Melaleuca osullivanii (syn. *M. uncinata)*	h (palusplains-floodplains PP/R)	*	Shrub to about 2m. Recorded on banks of Yule Brook in MKSEA (Tauss & Weston, 2008)
Mesomelaena tetragona	u, s, h(palusplains PP/F)	*	Robust semaphore sedge with prominent dark leaf bases. Uncommon on SCP.
Myriocephalus occidentalis	h (muddy sumplands PP)	*	Annual herb, flowers as wetlands dry in late spring
Neurachne alopecuroidea	h (PP/F)	*	Perennial grass with short, grey dense inflorescences
Patersonia juncea	s, u, r(N, ?Norwood Reserve SWA) h (wetlands PP/F)	*	Small perennial herb with purple Iris-like flowers. Old record from Midland probably no longer extant, therefore Norwood Reserve northern range limit.

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TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS 387	NOTES
Petrophile juncifolia (syn. Petrophile media var. *juncifolia*	u, s, h(palusplains PP)	*	Low shrub with long narrow +/- terete leaves
Petrophile seminuda	d, s, u, h (palusplains PP)	*	Shrub to about 1.2m with short cylindrical yellow inflorescences
Philydrella drummondii	h (palusplains PP)	*	Small herb with yellow flowers
Philydrella pygmaea subsp. *pygmaea*	h (palusplains PP)	*	Small herb with yellow flowers
Pimelea imbricata var. major	p, s, u, eSWA, h (mud palusplains and sumplands PP)	*	Erect shrub (0.1–) 0.2–0.8(–1) m tall; flowers white. Sand or sandy clay; seasonally waterlogged depressions, watercourses. Moore River – Yalgorup, Kenwick, MKSEA
Podolepis capillaris	d, s, u, h (palusplains PP) ?t	*	Annual daisy with wiry stems, small flowers (yellow ray florets). Very uncommon on SCP (only records from BFS387) but widespread in the drier inland areas of SW WA. ESCP form may be wetland variant.
Podolepis gracilis sens. lat. (Swamp form GJ Keighery 13 255)	s, u, h (mud sumplands & palusplains PP) t	*	Large white-pink flowering annual daisy.
Pogonolepis stricta	h (mud sumplands & palusplains PP)	*	Tiny, white flowering annual daisy – often a dominant species of the ground layer at mid –dense cover.
Prasophyllum drummondii	s, u, r(N, ?Kenwick SWA) h (wetlands PP/BD)	*	Medium height leek orchid with brownish-green flowers in spring in the absence of previous fire. Known range Muchea-Bullsbrook to Pinjarra but northern records are very old so it may no longer be extant north of Kenwick
Samolus junceus	s, u, h(wetlands calcareous, saline, SD/PP/Est /R)	*	Perennial herb with leafless stems and white-pink flowers. Tamala Limestone atYalgorup, Ludlow, Dunsborough & ML at Bootine, Gingin. Also widespread in other regions.
Scaevola lanceolata	h (palusplains, PP)	*	Low to prostrate perennial herb with long spikes of white flowers
Schoenolaena juncea	u, s, h(sumplands/palusplains PP/BD)	*	Pinjar to Ludlow mainly on ESCP. Tall perennial, geophytic herb with white flowers in summer.
Schoenus andrewsii	d, s, h (palusplains PP)	*	Tufted perennial sedge usually about 20cm in height with viscid culms. Occurs in wetlands in Geraldton Sandplains Region. On SCP only in BFS 387 (except old Maylands collection- but probably not extant there now)
Schoenus asperocarpus	h (palusplains PP)	*	Low annual tufted sedge
Schoenus bifidus	h (palusplains PP)	*	Small perennial sedge with small dark terminal inflorescence
Schoenus elegans	u, s, r (N, Kenwick, SWA) h (muddy wetlands/PP)	*	Only seven locations known on Florabase (Kenwick, Tuart Forest near Busselton, Helena River, Calingiri, Scott River Plain, Warren and an old Bayswater record that is probably no longer extant). Further study and upgrade to Priority Flora required.
Schoenus odontocarpus		*	

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TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS	NOTES
Schoenus plumosus	h (palusplains and clay sumplands PP)	*	Inconspicuous small annual sedge with woolly perianth segments
Schoenus rigens	p, s, u, eSWA, h (mud and peaty wetlands PP/BD)	*	Perennial sedge endemic to the eastern SCP.
Schoenus subflavus subsp. *subflavus*	u, s, r (N, Kenwick, SWA) h (muddy wetlands/PP)		Perennial sedge. On SCP only recorded from Kenwick (MKSEA) and Ruabon.
Schoenus unispiculatus	u, s, h (muddy palusplains and colluvium PP/F)	*	On the SCP known form only a handful of sites Pinjarra, Mundijong, Capel, Waroona, Talbot Rd, Kenwick and Carbarup. More occurrences on Darling Range and scarp
Schoenus variicellae	h (palusplains/sumplands PP)	*	Tiny annual sedge
Stylidium ecorne	h (palusplains/sump- lands PP)	*	Small annual trigger plant about 10cm in height
Stylidium petiolare	h(wetlands PP)	*	Small annual trigger plant about 10cm in height with white flowers
Stylidium roseo-alatum	p, s h(wetlands PP)	*	Slender annual (ephemeral) herb 3-7cm tall; flowers pink, red. Loam, clay loam, peaty sand; winter-wet depressions, swamps, creek beds. Kenwick, Toodyay, Bolgart, Armadale
Stylidium utricularioides	s, h(wetlands PP)	*	Slender annual herb to 15cm; flowers pink-white. Clay wetlands, granite. Kenwick, Helena Valley, Forrestdale, Capel, Byford, Ellenbrook, Bullsbrook
Synaphea acutiloba	s, u, h (palusplains PP/F)	*	Kenwick, Talbot Rd Bush, Darling Ranges, Walyunga NP, Byford
Tecticornia lepidosperma	s, u, h(palusplain/floodplain PP/R)	*	On SCP only known from Pinjarra, Bennett Brook, Kenwick and Burswood Island .Widespread in other regions.
Thelymitra antennifera	s, h (palusplains PP)	*	Small yellow flowering orchid (geophyte).
Thomasia macrocarpa	d, u, s, h(creek banks PP/F)		Shrub approx 1m in height with large pink flowers. Recorded on banks of Yule Brook near Welshpool Rd (Tauss, 2007a). Uncommon on SCP, abundant on Darling Scarp/Plateau
Thysanotus dichotomous	d, s, h(creek banks PP)		Intricate robust perennial herb to over 1m in height, almost leafless, with large mauve flowers. Seasonally waterlogged clay or granite. Widespread in SW but few records on SCP inc. Yule Brook (Tauss, 2007a), Byford (Tauss, 2007b).
Thysanotus rectantherus	u, s r(S, Wungong, SWA) h(palusplains PP/F)	*	Widespread in Jarrah Forest and semi-arid WA north-east Perth. Only SCP only known at Kenwick and Wungong.
Tremulina tremula	d, p, s, u, h (sumplands/ palusplains PP)	*	Robust dioecious rush with flat culms and small dark dense spikelets. Male spikelets pendulous.
Tribonanthes brachypetala	h (palusplains PP/F)	*	Tuberous perennial herb with yellow, reflexed perianth. Flowers in Aug-early Sept. Hybridizes with other *Tribonanthes.*

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS	NOTES
Tribonanthes uniflora (currently included in *T. longipetala sens. lat.*)	h (mud sumplands PP)	*	Geophytic herb with large white flowers with inflorescence usually a single flower
Tribonanthes violacea	h (wetland PP/R)	*	Small pale mauve early flowering tuberous herb.
Tricoryne humilis		*	Yellow flowering perennial herb
Tricoryne aff. *elatior* (C.Tauss 1905)	u, h (wetland PP),t		Robust herb with very scabrous stems and yellow flowers recorded from MKSEA (Tauss & Weston, 2008)
Triglochin muelleri	p, s, u, eSWA, h (clay sumplands PP)	*	Small annual herb in species-rich wetlands. Often grows with several other *Triglochin* species. Patchy records from Cooljarloo to Fish Rd Reserve near Busselton
Trymalium odoratissimum subsp. *odoratissimum* (*syn. T. floribundum* subsp. *floribundum)*	d, u, s, h(creek banks PP/F)		Shrub to about 2m in height. Abundant white flowers in spring. Yule Brook near Welshpool Rd (Tauss, 2007) and MKSEA (Tauss & Weston, 2008). Uncommon on SCP, abundant on Darling Scarp/Plateau
Trithuria bibracteata	s, h (palusplains/mud sumplands PP)	*	Minute tufted sedge-like plant, leaves in a rosette
Utricularia inaequalis	u, s h(wetlands PP)	*	Bladderwort with large lavender flowers. On SCP only recorded at Ellenbrook /Bullsbrook, Ruabon, Kenwick, Waroona ,Midland
Utricularia multifida	u, s h(wetlands PP/F/R)	*	Small bladderwort pink flowers. Bullsbrook to Ruabon, Alfred Cove on SCP. Widespread in other regions.
Utricularia violacea	u, s h(wetlands PP/F/R)	*	Tiny bladderwort purple flowers. Bullsbrook to Yoongarillup on SCP. More common in Warren –Jarrah Forest
Velleia trinervis sens. lat. (G.J. Keighery 10429)	r (N, Cooljarloo SWA), s, u, h (muddy sumplands PP) t	*	Pale yellow flowering perennial herb. Flowers in Aug-early Sept. Plentiful at Kenwick but uncommon elsewhere. One of a number of taxa thought to be included currently in the *V .trinervis* complex.
Villarsia capitata	s, h(muddy sumplands PP)	*	Small perennial herb with yellow flowers that forms large populations in shallow muddy pools.
Verticordia acerosa var. *preissii*	s, h (wetland, PP/F)	*	Small shrub with dainty, spidery perianth. Cream flowers aging to pink.
Verticordia huegelii var. *huegelii*	h (wetland, PP/F)	*	Small shrub with attractive bright yellow flowers.
Verticordia plumosa var. *brachyphylla*	h (palusplains, PP/F)	*	Small shrub with attractive pink-purple flowers. Very similar to *Verticordia plumosa.*
Wilsonia backhousei	d, s, u, h(saltmarsh, calcareous, palusplain PP/Est/R)	*	Small succulent mat plant. Kenwick is only location on SCP not on the coast. Widespread in other regions in calcareous, saltmarsh, estuarine settings.
Wurmbea dioica subsp. aff. *alba* = *Wurmbea dioica* subsp. Brixton (GJ Keighery 12803) =	r (N, Cervantes, SWA), s, u, h (mud sumplands PP)	*	Monoecious, geophytic herb to about 30-40 cm in height with large white flowers and sometimes pink-purple nectaries. Confined to mud sumplands where it flowers in early spring whilst plants are partially inundated. The informal name used for it creates confusion. Requires further taxonomic study.
Wurmbea dioica subsp. *alba*	h (palusplains PP)		Dioecious, geophytic herb to about 10 cm in height with small white flowers. Does not grow in sumplands.

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Appendix C

Vascular flora recorded in the spring 2008 field survey

APPENDIX C
Vascular flora recorded in the field survey of Lot 32 and 36 Brook Rd, Wattle Grove.

KEY TO TABLE B

Column 1: Taxon Name.
A list of families, genera, species, subspecies and varieties of vascular plants recorded in the current field survey, in alphabetical order by family. The nomenclature used conforms to current usage in FloraBase (WA Herbarium, 2009) except for a small number of taxa listed under informal names including the abbreviations as below and/or C.Tauss collection numbers. Voucher specimens of the taxa that are listed under informal names will be lodged in the WA Herbarium and will thus be available for further inspection.
Abbreviations:

- ***** preceding a name indicates a naturalized alien taxon (weed).
- 'aff.' (*affinis*): akin to, having an affinity (with) but not identical (to) (Lincoln *et. al.* 1982
- 'cf.' (*confer)*: compare (with) (Lincoln *et. al.* 1982)
- *'sens. lat.'* (*sensu lato):* in the broad sense (Lincoln et. al. 1982). Refers to specimens of taxa that are known to be broadly circumscribed and may be subdivided on further study.
- *'sens. strict.'* (*sensu strictus*)*:* in the narrow sense (Lincoln et. al. 1982). Refers to specimens that conform closely to the published type concept

Columns 2, 3: Location.
Taxa recorded from the three areas of the current field survey (Lot 32 and Lot 36) are listed separately in these columns.

Column 4: Taxa not previously recorded in BFS 387.
Taxa found in the current field survey but NOT listed in Mattiske and Associates (1992) for Brook Rd; or for Bush Forever Site 387 by Keighery and Keighery (2000); or do not appear in searches of FloraBase (WA Herbarium, 2009) using the search terms "Cannington", "Canning", "Kenwick", "Wattle Grove" and "Brixton" are also listed below.

Column 5: Notes/Other Names.
Synonyms and other issues regarding the names of taxa in the list are noted in this column.

Columns 6, 7, 8: Conservation Significance Codes at National, State and Regional Levels.
Column 6: Taxa currently gazetted under the Federal EPBC Act have **National Conservation Significance** in the categories of Critically Endangered (**CE**), Endangered (**EN**) and Vulnerable (**VU**). (See Appendix A for definitions of these categories).

Column 7: Taxa currently gazetted under the WA Wildlife Act, and listed in the DEC Priority Lists (Atkins, 2008) have **State Conservation Significance** in the categories **DRF**, and **P1**, **P2**, **P3**, **P4** respectively. (See Appendix A for definitions of these categories).

Column 8: Other taxa that have Regional Conservation Significance are defined by EPA (2004); many of the latter categories that are relevant to the Eastern Swan Coastal Plain are listed in Bush Forever (2000b). See also Appendix A for a comprehensive current list of these taxa known from the literature in the vicinity. These taxa are listed below with the codes **d, p, r, s**, **u**, **and t.** These codes and the categories they refer to are defined below. (These codes are also added to the taxa marked in Column 7 and 8 as they provide additional information about these taxa relevant to their occurrence at Brook Rd in the ESCP).

Column 9 (cont.);

Codes and criteria for regional conservation significance of taxa occurring on the Eastern Swan Coastal Plain

d SCP populations that are disjunct from their known geographic range.

eSCP Taxa endemic to the Swan Coastal Plain.

eSCP(P) Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region.

p Taxa considered to be poorly reserved on the SCP (applies to all DRF and Priority taxa).

r Taxa in the survey area at limit or close to limit of their known geographic range on the SCP (e.g. **r (S, Kenwick SWA)** indicates that the southern end of the taxon's range is at Kenwick in the IBRA (2000) Swan Coastal Plain Bioregion).

Locations
D Quindalup Dunes
SD Spearwood Dunes
BD Bassendean Dunes
PP Pinjarra Plain
F Foothills
R Riparian
Es Estuarine
DR Darling Range

s Significant populations (due to size or other factors) for maintenance of taxa on the SCP.

t Significant taxonomically; morphological or genetic variants that require further study.

u Uncommon on the SCP (generally applies to disjunct populations but could also be due to rare habitat, lack of collections etc.).

h Confined to specific and restricted habitats. [For example: h (claypans PP) = confined to claypans of the Pinjarra Plain.]

TABLE B: Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Anacardiaceae							
**Schinus terebinthifolius*		X	X	Brazilian Pepper Tree			
Apiaceae							
**Foeniculum vulgare*		X		Fennel			
Asclepidaceae							
**Gomphocarpus fruticosus*		X		Swan Plant			
Asparagaceae				Bridal Creeper			
**Asparagus asparagoides*	X	X					
Asteraceae							
**Arctotheca calendula*	X	X		Cape Weed			
**Conyza sumatriensis*	X	X		Fleabane			
**Dittrichia graveolens*	X	X		Stinkwort			
**Hypochaeris glabra*	X	X		Flatweed			
Podolepis capillaris	X						d, s, u, h (palusplains PP) ?t

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Asteraceae cont.							
Pogonolepis stricta	X						h (mud sumplands & palusplains PP)
**Sonchus oleraceus*	X	X		Milk Thistle			
**Ursinia anthemoides*	X	X					
Boraginaceae							
**Echium plantagineum*	X			Paterson's Curse			
Brassicaceae							
**Raphanus raphanistrum*	X	X		Wild Turnip			
Centrolepidaceae							
Centrolepis aristata	X						
Chenopodiaceae							
Tecticornia lepidosperma	X			syn. *Halosarcia lepidosperma*			s, u, h(palusplain/floodplain PP/R)

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Crassulaceae							
Crassula colorata var. *acuminata*	X						
Cupressaceae							
Actinostrobus pyramidalis	X			Swamp Cypress			s, h (wetlands, PP)
Cyperaceae							
Baumea juncea	X						
Gahnia trifida	X	X					h (saline/calcareous wetlands, PP)
**Isolepis marginata*	X						
Lepidosperma longitudinale	X						
Lepidosperma sp. Kenwick C.Tauss 2598	X		X	Undescribed taxon (pers. comm. R.L Barrett)			s, u, ?eSWA(P), h(palusplains, PP) t
Schoenus rigens	X						p, s, eSCP, h (wetland PP/BD)
Schoenus subfascicularis	X						

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Euphorbiaceae							
**Euphorbia terracina*		X	X				
**Ricinus communis*		X					
Gentianaceae							
**Centaurium erythraeum*	X						
Goodeniaceae							
Goodenia pulchella subsp. Coastal Plain (M. Hislop 634) pn	X			= *Goodenia pulchella* subsp. Coastal Plain (L.W Sage 2336) pn			s, h (wetlands, PP) t
Scaevola lanceolata	X						s, h (wetlands, PP)
Haemodoraceae							
Anigozanthos viridis subsp. *viridis*	X			Green Kangaroo Paw			s, u, h (palusplains PP)
Tribonanthes australis	X			Flannel Flower			h (palusplains PP/F)

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Iridaceae							
**Moraea flaccida*	X	X		Cape tulip			
**Romulea rosea* var. *australis*	X			Guildford Grass			
**Romulea rosea* var. *communis*	X			Guildford Grass			
**Sparaxis bulbifera*	X						
Juncaceae							
Juncus pallidus	X						
Lauraceae							
Cassytha glabella	X			Dodder			
Cassytha racemosa	X			Dodder			
Lobeliaceae							
**Monopsis debilis*	X						

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Lythraceae							
**Lythrum hyssopifolia*	X						
Mimosaceae							
Acacia lasiocarpa var. *lasiocarpa sens strict.*	X			The form of *Acacia lasiocarpa* var. *lasiocarpa* recorded in this survey (and other specimens from BFS387 in WA Herbarium,2008) closely match the type concept of *A. lasiocarpa* var. *lasiocarpa* and, in the strict sense, this taxon appears to be restricted to the eastern SCP (Tauss & Weston 2008, after B. Maslin pers. comm.). At BFS387, this taxon has been called previously (in error) *Acacia lasiocarpa* var. *bracteolata* Long Peduncle Variant (GJ Keighery 5026), (B. Maslin pers. comm.). *A. l.* var. *bracteolata* is not known to occur in BFS387 or Kenwick –Wattle Grove (WA Herbarium, 2008).			s,h (wetlands PP) ?t
Acacia pulchella var. glaberrima	X			Prickly Moses			
Acacia saligna subsp. *saligna* ms	X			Orange Wattle			
Acacia stenoptera	X						
Myrtaceae							
Baeckea sp. Perth Region (R.J. Cranfield 444)	X		X	=*Baeckea tenuifolia*		**P3**	s, p, d, r (S, Kenwick SWA)
Corymbia calophylla	X	X		=*Eucalyptus calophylla*, Marri			
Eucalyptus rudis subsp. *rudis*	X	X		Flooded Gum			

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Myrtaceae cont.							
Hypocalymma angustifolium Mud Habitat Variant (C.Tauss 1850)	x		x	Part of *Hypocalymma angustifolium* complex but varies from the more common form of *H. angustifolium* that is prevalent on margins of peaty- sand wetlands throughout the Bassendean Dunes and other areas of SCP.			s, h (palusplains, PP),t
Melaleuca brevifolia	x						p, s, u, h (wetland PP)
Melaleuca rhaphiophylla	x	x		Freshwater Paperbark			
Melaleuca seriata sens. lat.	x						
Melaleuca viminea subsp. *viminea*	x	x					
Verticordia densiflora var. *densiflora*	x						
Verticordia plumosa var. *brachyphylla*	x						h (palusplains, PP/F)
Onagraceae							
**Oenothera stricta subsp. stricta*	x			Evening Primrose			
Orobanchaceae							
**Orobanche minor*	x						
Papilionaceae							
Jacksonia sternbergiana		x		Stinkbush			
**Lotus subbiflorus*	x	x		=L. *suaveolens*.			

x

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Papilionaceae cont.							
**Lupinus cosentinii*	x	X		Blue Lupin			
**Lupinus luteus*	x			Yellow Lupin			
**Trifolium angustifolium*	x						
**Vicia sativa*	x	X		Vetch			
Phytolaccaceae							
**Phytolacca octandra*		X		Red Ink Plant			
Poaceae							
**Arundo donax*		X		Bamboo			
**Avena barbata*	x	X		Wild Oats			
**Briza maxima*	x	X		Blowfly Grass			
**Briza minor*	x						
**Bromus diandrus*	x	X					
**Cortaderia selloana*		X		Pampus Grass			
**Cynodon dactylon*	x	X		Couchgrass			
**Ehrharta calycina*	x	X		Perennial Veldt Grass			
**Ehrharta longiflora*	x	X		Annual Veldt Grass			
**Eragrostis curvula*	x	X		Love Grass			
**Hordeum leporinum*	x						
**Hyparrhena hirta*	x	X		Tambookie Grass			
**Lolium multiflorum*	x	X		Rye Grass			
**Pennisetum clandestinum*		X		Kikuyu			
**Polypogon monspeliensis*	x						

TABLE B (cont.): Inventory of Flora recorded in the Lots 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Poaceae cont.							
**Tribolium uniolae*	X	X					
**Vulpia bromoides*	X	X	X	Squirrel Tail			
Polygalaceae							
Comesperma aff. *polygaloides* (C. Tauss. 2541)	X		X	Sub-shrub, clonal growth, mauve flowers in mid summer. First recorded in Tauss & Weston (2008) in Kenwick.			s, u, h (palusplains PP) t
Polygonaceae							
**Rumex crispus*	X	X		Dock			
Primulaceae							
**Anagallis arvensis* var. *caerulea*	X			Blue Pimpernel			
**Anagallis arvensis* var. *arvensis*	X			Scarlet Pimpernel			
Samolus junceus	X						s, u, h (wetlands, calcareous, saline, SD/PP/ Es /R)
Proteaceae							
Banksia telmatiaea	X						r (S, ?Serpentine,SWA), p, s, u, h (wetlands PP)
Grevillea thelemanniana	X					**P4**	p, s, eSCP(P) h (palusplains PP)
Restionaceae							
Chaetanthus aristatus	X						s, h (wetlands PP)
Lyginia imberbis	X						
Scrophulariaceae							
**Parentucellia viscosa*	X						

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PLANNING SOLUTIONS
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Proposed Amendment to Local Planning Scheme No. 3

Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road Wattle Grove, Western Australia



PART B

Prepared for
Evangelos Litis Nominees Pty Ltd

March 2018

Appendix D

Flora, vegetation and wetlands site data (Spring 2008) (Tauss, 2008)

Site Q7-H7

Vegetation description: *Melaleuca rhaphiophylla* low closed forest over *Melaleuca viminea* low open shrubs, sparse sedges and naturalized alien grasses (Table C13). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Table C13: Vegetation in Quadrat 7 (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Trees <4.5m	>70%	*Melaleuca rhaphiophylla.*
Shrubs 1-2m	2-10%	*Acacia saligna* var. *saligna* (<2%), *Cassytha racemosa* (<2%), *Melaleuca viminea* subsp. *viminea* (<2%), *Melaleuca brevifolia* (<2%),**Phytolacca octandra* (<2%).
Perennial rushes and sedges	2-10%	*Gahnia trifida* (<2%), *Juncus pauciflorus* (<2%), *Lepidosperma longitudinale* (<2%)
Perennial herbs and geophytes	<2%	**Asparagus asparagoides* (<1%), **Rumex crispus* (<2%)
Grasses	10-30%	**Ehrharta calycina* (10-30%), **Ehrharta longiflora* (10-30%)



Plate 12: Vegetation adjacent to Q7-H7.
(Q7 is in the low forest of Freshwater Paperbark in the background of this photo).

SCP Floristic Community Type: The multivariate analysis (see Appendix E) of this vegetation was not conclusive. Q7 is most likely to be an eastern SCP floristic type that was not well sampled in Gibson *et al.,* (1994). As Q7 occurs on the eastern side of the SCP and is underlain by wetland sediments characteristic of the Pinjarra Plain (a habitat that is now mostly developed) it is probably an uncommon, poorly-reserved vegetation type.

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01095315390; 115.99228015400
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Vegetation condition: Good (13 taxa in 100m^2). Canopy structure intact, deep natural litter layer and low species richness of annuals and geophytes typical of this type of vegetation. Vegetation structure is regenerating well. Excellent native fauna habitat.
Naturalized alien taxa: The understorey includes an open cover of perennial alien grasses are limited by shade and deep litter layer.

Landforms/Sediments/Hydrology: Dampland/sumpland (seasonally waterlogged and intermittently inundated basin). This dampland has a narrow, elongated shape and appears to be part of a discontinuous channel that is comprised of several wetlands similar to this one (in the area between Boundary Rd and Yule Brook) that are orientated parallel to the direction of groundwater discharge from the Darling Range to the Canning River.
Surface sediments: peaty sand. Water Table: waterlogged at surface on 09.09.08. On 19.10.08, when the hole at H7 was augered (after a winter with a well below average rainfall) the sediments were moist down to water table at -230 cm. In wetter years this basin is probably inundated for short periods.

Table C14: Shallow Stratigraphy in H7

Depth from ground level (cm)	Sediments
0-50	Grey, medium, peaty, quartz sand
50-60	Pale brown, medium, quartz sand
60-90	Pale brown, medium, slightly muddy quartz sand
90-120	Pale yellow-brown muddy quartz sand
120-140	Pale grey muddy sand
140-180	Grey sandy mud
180-190	Grey mud
190-200	Grey –cream sandy mud
200-230	Grey muddy sand

Site Q8-H8

Vegetation description: Mid dense, patchy heath of *Actinostrobus pyramidalis-Verticordia densiflora* subsp. *densiflora-Baeckea* sp. Perth Region (R.J. Cranfield 444) over sparse *Chaetanthus aristatus* rushes and annual and perennial herbs (Table C15). Part of vegetation mapped as Vegetation Unit 1a (Figure 3).

Table C15: Vegetation in Quadrat 8: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 1-2 m	<2%	*Actinostrobus pyramidalis*
Shrubs <0.5m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (2-10%), *Acacia stenoptera* (<1%), *Actinostrobus pyramidalis* (10-30%), *Baeckea* sp. Perth Region (R.J. Cranfield 444) (2-10%), *Calothamnus hirsutus* (<1%), *Cassytha glabellla* (<1%), *Grevillea thelemanniana (*2-10%), *Hypocalymma angustifolium* Mud Habitats Variant (C. Tauss 1850) (2-10%), *Verticordia densiflora* subsp. *densiflora* (10-30%).
Perennial rushes and sedges	2-10%	*Baumea juncea* (<2%), *Chaetanthus aristatus* (2-10 %), *Gahnia trifida* (<2%), *Lepidosperma* sp. Kenwick C.Tauss 2598 (<2%), *Lyginia imberbis* (<1%), *Schoenus subfascicularis* (2-10%).
Perennial herbs and geophytes	2-10%	*Anigozanthos viridis* subsp. *viridis* (2-10%), *Drosera menziesii* subsp. *menziesii* (<1%), *Samolus junceus* (<2%), *Tribonanthes australis* (2-10%).
Grasses	2-10%	**Briza maxima* (<2%), **Ehrharta calycina* (2-10%)
Annual herbs	2-10%	*Centrolepis aristata* (2-10%), **Lotus subbiflorus* (<2%), **Juncus capitatus* (<1%), **Parentucellia viscosa* (<1%)

SCP Floristic Community Type: FCT 10a: Shrublands on Dry Clay Flats. WA DEC-listed TEC (Endangered).

Vegetation condition: Good. Vegetation structure is regenerating well after recent fire, retains rare floristic elements of high conservation significance. The area is adjacent to a large species-rich expanse of wetlands in very good condition, has a low total cover of weeds and the soil has not been disturbed, except for small localized areas. It is therefore likely to be colonized by a suite of native annuals over time. Good native fauna habitat.

Naturalized alien taxa: A small mid-dense area of **Ehrharta calycina* forms less than 10% total cover of this vegetation.



Plate 13: Vegetation at Q8-H8

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01085749460; 115.99203748000
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat).
Slope: Negligible. Surface sediments: Muddy quartz sand over shallow hardpan.
Water Table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H8 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer at about -50cm that prevented augering to the watertable.

Table C16: Shallow Stratigraphy in H8

Depth below ground level (cm)	Sediments
0-20	Pale brown-cream, slightly muddy medium quartz sand
20-50	Brown-cream muddy quartz sand

Site Q9-H9

Vegetation description: Mid dense heath of *Melaleuca viminea* subsp. *viminea – Melaleuca lateriflora* subsp. *acutifolia* over mid dense naturalized alien grasses and sparse *Schoenus subfascicularis – Gahnia trifida* sedges (Table C17). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Table C17: Vegetation in Quadrat 9: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 2-3m	2-10%	*Melaleuca lateriflora* subsp. *acutifolia* (2-10%), *Melaleuca rhaphiophylla* (2%)
Shrubs <2m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (<2%), *Cassytha glabella* (<2%), *Melaleuca brevifolia* (<2%), *Melaleuca viminea* subsp. *viminea* (30-70%), *Melaleuca lateriflora* subsp. *acutifolia* (<2%)
Perennial rushes and sedges	2-10%	*Chaetanthus aristatus* (<2%), *Gahnia trifida* (<2-10%), *Schoenus subfascicularis* (2-10%).
Perennial herbs and geophytes	<2%	* *Moraea flaccida* (<2%),**Sparaxis bulbifera* (<1%)
Grasses	30-70%	**Avena barbata* (10-30%), * *Ehrharta calycina* (10-30%), **Lolium multiflorum* (10-30%), **Tribolium uniolae* (<2%)



Plate 14. Vegetation at Q9-H9

SCP Floristic Community Type: The multivariate analysis of this vegetation was not conclusive. Q9 is likely to be an eastern SCP floristic type that was not adequately sampled and therefore not identified by Gibson *et al.,* (1994). As this site is located on the eastern SCP it is also likely be poorly reserved and of high conservation value.

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01141623200; 115.99208614100

Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Vegetation condition: Degraded to good. Understorey includes mid dense naturalized alien grasses except for small patches where low native shrubs and sedges remain abundant. Relatively species-poor (15 taxa in 100m^2) over much of this vegetation unit. This area has experienced a number of controlled fires that have been contained within the cadastral boundary of the block. The vegetation is however still capable of regenerating naturally. It is adjacent to a large, species-rich expanse of wetlands in very good condition and the soil has not been disturbed. It is therefore likely to be colonized by a suite of native annuals over time.

Naturalized alien taxa: Mid-dense naturalized alien grasses including some invasive species such as **Ehrharta calycina.*

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: Negligible.

Surface sediments: Shallow quartz sand over muddy sand over dark grey clay.
Water Table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H9 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer of clay at about -100cm that prevented augering to the watertable.

Table C18: Shallow Stratigraphy in H9

Depth from ground level (cm)	Sediments
0-30	Grey medium quartz sand
30-40	Dark grey muddy sand
40-50	Dark grey clay
50-100	Dark grey muddy sand

Site Q14-H10

Vegetation description: *Melaleuca viminea* subsp. *viminea* mid dense heath over open *Chaetanthus aristatus – Gahnia trifida* rushes and annual and *Centrolepis aristatus –Pogonolepis strictus* sparse perennial herbs (Table C23, Plate 19). Part of the vegetation mapped as Vegetation Unit 3b (Figure 3).

Table C23: Vegetation in Quadrat14: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 1-2 m	10-30%	*Acacia saligna* var. *saligna* (<2%), *Melaleuca brevifolia* (<2%), *Melaleuca viminea* subsp. *viminea* (10-30%)
Shrubs <1m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (2-10%), *Actinostrobus pyramidalis* (10-30%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (10-30%), *Cassytha glabellla* (2-10%), *Tecticornia lepidosperma* (<2%).
Perennial rushes and sedges	2-10%	*Chaetanthus aristatus* (<2%), **Ehrharta calycina* (<2%), *Gahnia trifida* (2-10%
Grasses	2-10%	**Briza maxima* (<1%), **Vulpia bromioides* (2-10%).
Annual herbs	2-10%	*Centrolepis aristata* (2-10%), **Dittrichia graveolens (<2%), Juncus capitatus* (<1%), **Lotus subbiflorus* (<2%), **Parentucellia viscosa* (<1%), *Pogonolepis strictus* (2-10%).

SCP Floristic Community Type: Allied to FCT 7: Herb-rich Saline Shrublands in Claypans. DEC-listed TEC (Vulnerable).

Vegetation condition: Good to degraded but much of it retains the potential to naturally regenerate to good condition bushland. **Naturalised alien taxa:** **Ehrharta calycina,* an aggressively- invasive naturalized alien grass occurs in this vegetation in patchy stands up 30% cover in some areas. The areas in better condition include annual grass weeds but also retain a native herbs and an open cover of *Actinostrobus pyramidalis* seedlings that will, as they mature and create shade, reduce the abundance of weeds.

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01056779680; 115.99152813600

Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 30.11.08

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments: Shallow quartz sand over cream sandy mud.
Watertable: Surface waterlogged on 9.09.08. On 30.11.08 when the hole at H10 was augered (after a winter with a well below average rainfall) the sediments were dry down to a hardpan at -25cm and a water table was not reached.

Table C24: Shallow Stratigraphy in H10

Depth from ground level (cm)	Sediments
0-20	Pale yellow-brown muddy quartz sand
20-25	Cream sandy mud



Plate 19. Vegetation Q14-H10

Vegetation description: *Melaleuca rhaphiophylla* low closed forest over naturalized alien grasses**.**
Associates included *Jacksonia sternbergiana, *Ehrharta calycina, *Euphorbia terracina* (Plate 22).
Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Location: Lot 36 Brook Rd, Wattle Grove adjacent to Welshpool Rd.
GPS lat/long: -32.00785911160; 115.99437998600
Vegetation condition: Degraded to completely degraded.

SCP Floristic Community Type: Due to vegetation condition it was not appropriate to do a detailed floristic analysis of this wetland. The remnant vegetation indicates that the original vegetation of this wetland was similar to that remaining at Site Q6 in Lot 28.

Landforms/Sediments/Hydrology: Sumpland (seasonally inundated basin). Landform: Shallow swale.
Surface sediments: peaty sand over muddy sand over deep sand.
Water table(s): Surface waterlogged on 22.09.08. On 30.11.08, when the hole at H13 was augered (after a winter with a well below average rainfall) the sediments were moist down to the water table at -280cm (Table C27).

Table C27: Shallow Stratigraphy in H13

Depth below ground level (cm)	Sediments
0-10	Black peaty sand
10-30	Pale brown, humic, medium, quartz sand
30-60	Pale yellow-brown medium, quartz sand
60-80	Pale yellow-brown medium, quartz sand with rusty mottles
80-100	Pale grey muddy quartz sand
100-120	Pale grey slightly muddy quartz sand
120-280	Pale grey quartz sand



Plate 22. Landscape at H13

Vegetation description: *Melaleuca rhaphiophylla* low open woodland over *Melaleuca viminea* subsp. *viminea* sparse low shrubs, *Gahnia trifida* sparse sedges and closed naturalized alien grasses (Plate 23). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Location: Lot 36 Brook Rd, Wattle Grove.
GPS lat/long: -32.00875000000; 115.99226670000

Vegetation condition: Degraded.

SCP Floristic Community Type: Due to vegetation condition it was not appropriate to do a detailed floristic analysis of this wetland. The remnant vegetation indicates that the original vegetation of this wetland was similar to that remaining at Site Q6 in Lot 28.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments: Sandy peat over quartz sand. (Table C28).
Water table: Surface waterlogged on 09.09.08. On 19.10.08, when the hole at H14 was augered (after a winter with a well below average rainfall) the water table was at -150cm

Table C28: Shallow Stratigraphy in Hole 14

Depth below ground level (cm)	Sediments
0-10	Dark brown sandy peat
10-20	Peaty medium quartz sand
20-40	Humic quartz sand
40-80	Medium grey quartz sand
80-90	Grey slightly muddy quartz sand
90-150	Medium grey quartz sand



Plate 23. Landscape at H14

Vegetation description: Naturalized alien pasture grasses and herbs. (Plate 24).

Location: Lot 36 Brook Rd, Wattle Grove.

GPS lat/long: -32.00923333000; 115.99223330000

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this wetland.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments: Peaty quartz sand over muddy sand over muddy sand with quartz gravel. (Table C29).
Water table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H15 was augered (after a winter with a well below average rainfall) the sediments were moist down to a watertable at -160cm.

Table C29: Shallow Stratigraphy in H15

Depth below ground level (cm)	Sediments
0-20	peaty, medium grey quartz sand
20-40	Cream slightly muddy quartz sand
40-60	Cream-grey muddy sand with rusty mottles
60-90	Pale yellow –grey muddy quartz sand
90-110	Grey muddy medium quartz sand
110-160	Grey, muddy medium quartz sand with quartz gravel



Plate 24. Landscape H15

Vegetation description: naturalized alien pasture grasses and herbs. (Plate 25).

Location: Lot 32 Brook Rd, Wattle Grove.
GPS lat/long: -32.01009189030; 115.99137827300

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this area. This area was probably Marri woodland originally (judging by the adjacent remnant vegetation).

Landforms/Sediments/Hydrology: Low sand dune adjacent to palusplain. Slope: negligible.
Water table: mottles at -160cm indicate maximum water table. On 30.11.08 water table at -210 cm.

Surface sediments: Deep quartz sand over muddy sand (Table C30).
Water table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H16 was augered (after a winter with a well below average rainfall) the sediments were moist down to the watertable at about -210 cm

Table C30: Shallow Stratigraphy in H16

Depth below ground level (cm)	Sediments
0-30	Grey quartz sand
30-40	Yellow medium quartz sand
40-160	Pale grey quartz sand
160-200	Pale grey quartz sand with rusty mottles
200-210	Muddy pale grey quartz sand



Plate 25. Landscape at H16

Vegetation description: naturalized alien pasture grasses and herbs. (Plate 26).

Location: Lot 36 Brook Rd, Wattle Grove.
GPS lat/long: -32.00980802500; 115.99214910200

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this wetland.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments and water table(s): Humic sand quartz sand over shallow sandy mud. Surface waterlogged on 9.09.08. On 30.11.08 when the hole at H17 was augered it not possible to auger past dry mud layer at – 70cm (Table C31).

Table C31: Shallow Stratigraphy in H17

Depth below ground level (cm)	Sediments
0-10	Grey-brown medium humic sand
20-30	Pale yellow medium quartz sand
30-40	Cream-grey sandy mud
40-50	Cream-grey sandy mud with white calcareous nodules
50-70	Pale grey sandy mud



Plate 26. Landscape at H17

Vegetation description: Scattered low *Corymbia calophylla* trees over naturalized alien pasture grasses and herbs (Plate 27).

Location: Lot 36 Brook Rd, Wattle Grove.
GPS lat/long: -32.00898182860; 115.99339376500

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this area. This area was probably Marri woodland originally (judging by the adjacent remnant vegetation).

Landforms/Sediments/Hydrology: Low sand dune adjacent to palusplain. Slope: negligible.
Surface sediments and water table(s): Humic sand quartz sand over deep sand. Surface dry on 9. 09 .08. On 30.11.08 when the hole at H18 was augered the water table was at –240cm.

Table C32: Shallow Stratigraphy in Hole 18

Depth from ground level (cm)	Sediments
0-10	Grey humic quartz sand
10-240	Pale grey quartz sand



Plate 27. Landscape H18

Appendix E
Multivariate Analysis
Species vs sites matrix

APPENDIX E

Taxa vs Study Sites Matrix Lot 32 &36 Brook Rd Wattle Grove (as used in Floristic Community Type analysis)

For explanations of names of taxa see Appendix B

Q1 = Quadrat 1, etc.; * before a name indicates a naturalised alien taxon

Taxa NOT found in quadrats of Gibson et.al (1994) (**indicated in bold type)** or not fully determined in current survey were not able to be included in the FCT analysis.

Taxon Name	Q7	Q8	Q9	Q14
Acacia lasiocarpa var. lasiocarpa *sens. strict* .		*	*	*
Acacia saligna var. *saligna*	*			*
Acacia stenoptera		*		
Actinostrobus pyramidalis		*		*
Anigozanthus viridis subsp. *viridis*		*		
**Asparagus asparagoides*	*			
**Avena barbata*			*	
Baeckea sp. Perth Region (R.J. Cranfield 444)		*		
Baumea juncea		*		
**Briza maxima*		*		*
Cassytha glabella		*	*	*
Cassytha racemosa	*			
Centrolepis aristata		*		*
Chaetanthus aristatus		*		
Dittrichia graveolens		*		*
Drosera menziesii subsp. menziesii		*		
**Ehrharta calycina*	*		*	*
**Ehrharta longiflora*	*			
**Eragrostis curvula*		*		
Gahnia trifida	*	*	*	*
Grevillea thelemanniana		*		
Hypocalymma angustifolium Mud Habitat Variant (C.Tauss 1850)		*		*
**Juncus capitatus*		*		*
Juncus pauciflorus	*			
Lepidosperma longitudinale	*			
Lepidosperma sp. Kenwick. (C.Tauss 2598)		*		
**Lolium multiflorum*			*	
**Lotus subbiflorus*		*	*	*
Lyginia imberbis		*		
Melaleuca brevifolia		*	*	*
Melaleuca lateriflora subsp. *acutifolia*			*	
Melaleuca rhaphiophylla	*			
Melaleuca seriata		*		
Melaleuca viminea subsp. *viminea*	*		*	*
**Moraea flaccida*			*	
**Parentucellia viscosa*		*		*
**Phytolacca octandra*	*			
Rumex crispus	*			
Samolus junceus		*		
Schoenus rigens		*		
Schoenus subfascicularis		*	*	
**Sparaxis bulbifera*			*	
Tecticornia lepidosperma				*
Tribolium uniolae			*	
Tribonanthes australis		*		
Verticordia densiflora var. *densiflora*		*		
Verticordia plumosa var. brachyphylla		*		

Appendix F

Wetland flora taxa recrded during the spring 2008 survey

APPENDIX F

Obligate and Facultative Wetland Taxa in Lot 32 and 36 Brook Rd Quadrats

For explanations of names of taxa see Appendix B

Q1 = Quadrat 1, etc.; * before a name indicates a naturalised alien taxon

For other taxa that occur in the survey area, there is either insufficient habitat data to decide wetland status, or there are no records of wetland habitat for them in sources used.

Taxon Name	Q7	Q8	Q9	Q14	Obligate Wetland Taxon (O)	Facultative Wetland Taxon (F)
Acacia lasiocarpa var. lasiocarpa *sens. strict* .		*	*	*	O	
Acacia saligna var. *saligna*	*			*		F
Acacia stenoptera		*				F
Actinostrobus pyramidalis		*		*	O	
Anigozanthus viridis subsp. *viridis*		*			O	
Baeckea sp. Perth Region (RJ Cranfield 444)		*				F
Baumea juncea		*			O	
Centrolepis aristata		*		*		F
Chaetanthus aristatus		*			O	
Drosera menziesii subsp. menziesii		*			O	
**Eragrostis curvula*		*				F
Gahnia trifida	*	*	*	*	O	
Grevillea thelemanniana		*			O	
Hypocalymma angustifolium Mud Habitat Variant (C.Tauss 1850)		*		*	O	
**Juncus capitatus*		*		*		F
Juncus pauciflorus	*				O	
Lepidosperma longitudinale	*				O	
Lepidosperma sp. Kenwick. (C.Tauss 2598)		*			O	
**Lolium multiflorum*			*			
**Lotus subbiflorus*		*	*	*	O	
Lyginia imberbis		*				F
Melaleuca brevifolia		*	*	*	O	
Melaleuca lateriflora subsp. *acutifolia*			*		O	
Melaleuca rhaphiophylla	*				O	
Melaleuca seriata		*				F
Melaleuca viminea subsp. *viminea*	*		*	*	O	
Samolus junceus		*				F
Schoenus rigens		*			O	
Schoenus subfascicularis		*	*		O	
Tecticornia lepidosperma				*		F
Tribonanthes australis		*				F
Verticordia densiflora var. *densiflora*		*				F
Verticordia plumosa var. brachyphylla		*			O	

Appendix G

Evaluation of wetland management categories

Appendix G
Evaluation of Wetland Management Categories for Lots 32 and 36 Brook Rd, Wattle Grove

To provide guidance on the level of protection and the management objectives that are appropriate to each wetland, wetlands on the Swan Coastal Plain have been evaluated and assigned to one of three management categories (Conservation, Resource Enhancement, or Multiple Use) in the Geomorphic Wetlands Swan Coastal Plain Dataset (DEC, 2008).

Conservation Category Wetlands (CCW) are intended to be managed for conservation to protect their very high value attributes and functions. Alteration to wetlands in this category is strongly discouraged by State and Federal environmental regulatory agencies. These wetlands are usually recommended for reservation into various classes of conservation reserve to protect them from any man-induced deterioration.

Resource Enhancement Category Wetlands (REW) have a priority management objective to maintain the wetland natural attributes and functions, and wherever possible to enhance the ecological status of the wetland by such activities as improving water quality or re-vegetating cleared areas with endemic, site-appropriate species.

Multiple Use Category Wetlands (REW) have a priority management objective to maintain multiple uses of the wetland, including ecological functions. This necessitates *maintaining the geomorphic integrity of the wetland.* It excludes destruction of the wetland through processes such as infilling, excavation, mining, or emplacing urban structures such as roads or buildings.

Three wetlands are currently mapped in the Swan Coastal Plain Wetlands Dataset (DEC, 2008) in Lots 32 and 36 Brook Rd, Wattle Grove as the following UFIs (and wetland classifications, and management categories):
7773 (palusplain, CCW) of which approximately 2.5ha is within the current survey area;
8029 (palusplain, CCW) of which less than 0.1 ha is within the current survey area; and
13367(palusplain, REW) of which approximately 5.5 ha is within the current survey area.

These three wetland areas are evaluated below using three methods:
1. The questionnaire of V & C Semeniuk Research Group (1998) that was designed for the Western Australian Water and Rivers Commission;
2. The questionnaire in Bulletin 686 of the Western Australian Environmental Protection of Authority (EPA, 1994); and
3. Assessment of wetland vegetation condition (see Section 4 of the report above and Appendix C).

The methods above are currently recommended by DEC (2007) for the evaluation of wetlands. The EPA Bulletin 686 questionnaire tends to result in high scores for lakes and sumplands that include habitats suitable for waterbirds and low scores for palusplains, damplands and other types of wetlands. EPA (1994) was, effectively, a preliminary attempt to evaluate the important wetlands of the region; it was designed before the wetlands of the region were comprehensively surveyed and mapped in Hill *et al.*, (1996). The questionnaire of the V & C Semeniuk Research Group was based on the large body of data collected in Hill *et al.*, (1996) and was specifically designed to capture the recognised natural wetland values of all types of wetlands that are present in the region. When used in combination, the three methods above provide a way to evaluate wetlands that represents the best consensus available between the scientific literature, the current policies of government agencies and the general attitudes of the Western Australian community.

In the evaluations below, each wetland mapped in the DEC Swan Coastal Plain Wetlands Dataset (2008) for Lots 32 and 36 Brook Rd, Wattle Rd is first evaluated using the three methods independently of each other. Then the results for each method are compared and combined into a final evaluation.

The mapping of the wetlands in DEC (2008) often partitions the extensive and continuous wetlands (palusplains) of the area into smaller separate areas. Although these areas often extend across cadastral

boundaries this mapping provides a well defined border for each wetland. The evaluations below were done by examining only the areas of each wetland that occurred within the boundaries of Lots 32 or 36, even if the total area of the wetland in question extended beyond these cadastral boundaries.

1. WETLANDS UFIs 7773 and 8029 EVALUATION

The two wetlands UFI 7773 and UFI 8029 share a common boundary in Lot 32 Brook Rd and are effectively the same palusplain area in terms of sediments, landforms and hydroperiod. They are both currently allocated to CCW in DEC (2008). UFI 8029 and the adjoining UFI 13367 show clear differences in the sediments that underlie these two areas and UFI 33367 is mapped as REW in DEC (2008). The area of UFI 8029 in Lot 32 Brook Rd is extremely small. It is not clear in DEC (2008) why UFI 8029 was split from UFI 7773 in the mapping.

Wetland UFI 7773 is a palusplain of which about 2.5ha are within Lot 32. Most of UFI 7773 is covered by native vegetation in good to very good condition. Wetland UFI 8029 is also a palusplain of which less than about 0.1 ha are in Lot 32; it has been cleared of native vegetation but the geomorphic integrity of this wetland remains unaltered. Palusplain 8029 is, in ecological terms, effectively part of palusplain 7773 and the two wetland areas are treated as one management unit in the evaluation below.

A. V & C Semeniuk Research Group (1998) questionnaire for wetland evaluation applied to wetland UFI 7773

1. Conservation Category Wetlands Criteria

Wetland type (geomorphology): A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. it is an anthropogenically unaltered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland)
2. it is a scarce wetland type
3. it is a representative wetland type (i.e., representative of its consanguineous suite)

YES. The data obtained in the current survey show that the wetland (UFIs 7773 & 8029) is an anthropogenically unaltered, seasonally-waterlogged flat (palusplain) i.e. the landform and soils have been unaltered by human activities. It is a scarce wetland type (only 6% of the former extent of palusplains remains undeveloped on the SCP; Hill *et al.*, 1996). This palusplain is representative of the Keysbrook consanguineous suite of wetlands (*i.e.* the wetlands of alluvial fans on the Pinjarra Plain).

Wetland processes: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. The wetland is subject to anthropogenically unaltered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes.)
2. the wetland exhibits unusual wetland processes
3. the wetland exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting)

YES/NO. The wetland (UFIs 7773 & 8029) is probably altered to a small degree with respect to wetland processes such as recharge and discharge mechanisms, and sedimentary processes. This change has not been quantified and it may be minor. However the clearing of the catchment area, the building of roads and other hard surfaces around this palusplain, the dredging and diversion of Yule Brook and the excavation of artificial drains along roads may be affecting the recharge and discharge of this wetland. The sediments once deposited on the wetland through the regular flooding of Yule Brook and the spread of floodwaters over the alluvial plain (that includes Lots 32 and 36) has been altered.

Wetland habitats: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland is a habitat for rare & endangered fauna
2. the wetland is a habitat for rare & endangered flora
3. the wetland exhibits a high diversity of habitats

YES. The wetland (UFIs 7773 & 8029) is a habitat for rare and endangered flora (*Eremophila glabra* subsp. *chlorella* and *Lepidosperma rostratum*), five DEC Priority Flora Species and numerous regionally significant flora species. It is also inhabited by native fauna that is uncommon in the Perth Metropolitan Area (*Varanus gouldii* and *Isoodon obesulus*) however these species are not gazetted fauna. The wetland exhibits a diversity of vegetation habitats at a small scale due to the complex stratigraphy and hydrology of the area.

Wetland functions: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland is necessary for maintenance of large faunal populations
2. the wetland is a refuge for resident fauna

3. the wetland is an important breeding, feeding or watering site for migratory populations (local and international)
4. the wetland is a significant regional component of the hydrological cycle (has an important hydrological storage, recharge or discharge function; or an hydrochemical function)

YES. The wetland (UFIs 7773 & 8029) is a refuge for resident fauna including *Varanus gouldii* and *Isoodon obesulus*. *Isoodon obesulus* is present in large populations in BFS 387, as the wetland soils, water resources and the thick vegetation of the area provide suitable habitat that is otherwise scarce on the SCP. *Varanus gouldii* is a high order predator and is particularly dependant on a large range. It preys on mammals such as *Isoodon obesulus* and smaller animals. The range area provided by this wetland contributes towards the habitat needed by this large reptile. Palusplain 7773 performs an important hydrological function in being a naturally vegetated, unaltered, low nutrient wetland located high in the groundwater catchment of other wetlands in BFS 387. The groundwater and surface water flow through palusplain 7773 contributes to the water and nutrient budgets of these other wetlands and the maintenance of the downstream biodiversity.

Wetland Biodiversity: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland exhibits unaltered wetland vegetation and fauna
2. the wetland has a scarce vegetation association or faunal association
3. the wetland has a highly diverse wetland flora or fauna

YES. The wetland (UFIs 7773 & 8029) exhibits largely unaltered and scarce vegetation of the Pinjarra Plain Vegetation Complex and FCTs 7, 8 and 10a (Threatened Ecological Communities). Some highly diverse areas of flora are present in UFI 7773.

Wetland Scientific value: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland contains scientifically significant pollen records
2. the wetland is underlain by unusual wetland sediments (indicators of wetland history)
3. the wetland has unusual geomorphology (i.e., it is situated in an unusual geomorphic setting or contains unusual geomorphic features within it)

YES. The wetland (UFIs 7773 & 8029) is underlain by wetland sediments of a Pinjarra Plain alluvial fan that are unusual on the SCP. It is part of a largely undisturbed gradient of soil and sediment types from the Darling Range Foothills to the Canning River. Each section of this continuum is of scientific importance, with the wetland sediments containing a record of the edaphic and climatic changes that the area has undergone. Each section is also host to slightly different vegetation assemblages. The current and historical processes that underpin the remarkable biodiversity of the area are poorly understood and of high scientific importance and this wetland forms an indispensible part of the story.

The criterion that was only partially satisfied above at the level of Conservation (i.e. wetland processes) was then examined below at the Resource Enhancement level.

2. Resource Enhancement Wetlands Criteria

Wetland processes: A wetland may be classed as Resource Enhancement if it satisfies the following criterion

1. The wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) but not to the degree that habitats cannot still be identified and rehabilitated

YES. The wetland (UFIs 7773 & 8029) may be partly altered with regard to wetland processes such as recharge/discharge mechanisms and sedimentary processes due to clearing of the catchment area, roads and other hard surfaces and the dredging and diversion of Yule Brook and other surface drainage in the area. However much of this modification can be remediated by the re-vegetation of the catchment area, remediation of surface drainage and the restoration of Yule Brook as a living stream.

All the wetland criteria were now satisfied so there was no need to examine the wetland at the level of Multiple Use. The scores in the categories examined were summarized (Table F1). This wetland met five to six criteria for CCW, one for REW and none for MUW. The floristic biodiversity, the regionally-significant flora and the TEC vegetation of this wetland are important features that characterize palusplains of high conservation significance on the eastern Swan Coastal Plain. Palusplains of this type are scarce on the SCP.

Table F1: Score sheet for the evaluation of part of the wetland (UFIs 7773 & 8029) on Lot 32 Brook Rd Wattle Grove by the method of V & C Semeniuk Research Group (1998)

Wetland Values	Criteria met at the	Criteria met at the level	Criteria met at the

	level of CCW	of REW	level of MUW
Wetland type	Yes		
Wetland processes	Yes/ No	Yes	
Wetland habitats	Yes		
Wetland functions	Yes		
Biodiversity of wetland	Yes		
Scientific value of wetland	Yes	n/a	n/a
Total Score	Score 5	Score 1	Score 0

The management category is allocated to the wetland according to the column above that achieves the highest score.

The Management Category allocated to the part of the wetland (UFIs 7773 & 8029) that occurs on Lot 32 Brook Rd by the method of V & C Semeniuk Research Group (1998) was thus **Conservation Category Wetland.**

B. Bulletin 686 (EPA, 1993) method of wetland evaluation for wetland UFIs 7773 & 8029

Bulletin 686 consists of a questionnaire that includes several parts that were answered for the evaluation of the part of the wetland (UFIs 7773 & 8029) that occurs on Lots 32 Brook Rd Wattle Grove as below.

Part I: Presence of Rare Species
(If the wetland includes gazetted rare flora or fauna species then the wetland is automatically allocated to CCW).
YES. The wetland (UFIs 7773 & 8029) includes the following Gazetted Rare or Priority Species:
1. *Lepidosperma rostratum* that is listed as Nationally Significant Flora (Endangered) by DEWHA (2008);

2. *Eremophila glabra* var. *chlorella* that is listed as Declared Rare Flora under the WA Wildlife Act;

3. *Austrostipa juncifolia* subsp. Southern River (B.J. Keighery 2160) a taxon of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 1;

4. *Baeckea* sp. Perth Region (R.J. Cranfield 444) a taxon of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 3;

5. *Grevillea thelemanniana* a species of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 4;

6. *Trichocline* sp. Treeton (B.J. Keighery & N. Gibson 564) a taxon of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 2;and

7. *Verticordia lindleyi* subsp. *lindleyi* a subspecies of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 4.

The Endangered Flora, Declared Rare Flora, Priority Flora that occurs here means that this wetland should be assigned the highest conservation level.

The wetland (UFIs 7773 & 8029) is thus allocated to the category of Conservation. The following questions are answered to provide further information regarding wetland management. However the answers to them do not override the CCW category allocated above.

Part II Natural Attributes
Part IIA: For permanent and seasonal wetlands with well defined boundaries.
Not applicable go to part IIB below.
Part IIB: Seasonal and episodic wetlands with poorly defined boundaries. Note: each zone of the wetland is usually scored as a separate assessment.

i. Environmental geology classification. Wetlands in the Quindalup Dunes or in river/estuary floodplain receive Score= 5; other areas Score=1.
NO. The part of The wetland (UFIs 7773 & 8029) that occurs on Lot 32 is not in these areas……**SCORE=1**

Part II Natural Attributes
ii. Adjacent wetlands. Wetlands that have no other wetlands within a 2km radius of them receive Score =3, others go to Question iii (below).
YES. There are other wetlands nearby to the part of wetland (UFIs 7773 & 8029) that occurs on Lot 32. Go to Question iii.

---

iii. Habitat diversity. If the composition and structure of the vegetation of the wetland under evaluation is significantly different to that found at other nearby wetlands, the wetland receives Score= 3; if not then Score =1.

YES. Other wetlands nearby to part of the wetland (UFIs 7773 & 8029) that occurs on Lot 32 include a range of vegetation types but they are similar to this wetland……..**SCORE= 1**

---

iv. Habitat type. Habitat types scored in this question (up to a maximum Score = 15) include vegetation and landforms typical of lakes and sumplands such as fringing rushes and sedges, extensive in-lake beds of rushes and sedges, large paperbark trees, islands, flooded grassland, permanent or seasonal open water, extensive low thickets and samphires. The high conservation value vegetation of palusplains and damplands scores very badly on this part of the questionnaire because of this flaw in the design of this method of evaluation.
YES. Only the category of fringing woodland or heath (Score=1) and scattered sedges (Score=0.5) are applicable to the wetland (UFIs 7773 & 8029)….....S**CORE= 1.5**

---

v. Drainage. This deal with drains into and/or out of the wetland that can alter water levels or water quality. Wetlands with drains directing water into or out of the wetland Score=0; if no drains Score =5.
NO. Part of the wetland (UFIs 7773 & 8029) has drains adjacent to it but it is not clear how much effect these have on the hydrology of this wetland.....……..……**SCORE= 0**

---

vi. Area of wetland modified by clearing of vegetation, landfill, paving, cultivation, irrigation, grazing, weed invasion, mining etc. Wetlands with 0-10 % modified Score= 5; 11-20 % modified Score= 4; 21-30 % modified Score= 3; 31-40 % modified Score= 2; >40 % modified Score= 1.
The wetland (UFIs 7773 & 8029) has less than 20% that could considered as modified……..……**SCORE= 4**

---

vii. Wetland size. Wetland area >100ha Score=5; 50-100ha Score =4; 25-50ha Score =3; 10-25ha Score =2; <10ha Score =1.
NO. The part of the wetland (UFIs 7773 & 8029) on Lot 32 is less than 10ha……..…….**SCORE= 1**

TOTAL NATURAL ATTRIBUTES SCORE = 8.5

Part III: Human Use Questionnaire.
i. Aesthetics.
Little if any artificial noise. YES. Score=2
Understorey mostly intact. YES. Score=2
Few buildings evident from wetland. YES. Score=2
Steep ridge visible as part of scenery. YES. Score=2
Ridge accessible giving view of wetland. NO. Score=0
Wetland is a lake and open water easy to view. No. Score=0
Section of wetland where few people visit. Yes. Score=2
.....**TOTAL SCORE=10**
ii. Historical and archaeological features.
Number of historical archaeological features. NONE…….…… **SCORE=0**
iii. Security of wetland.
Current vesting/ownership of land = private ownership……..…..……...**SCORE=1**
iv. Protection groups. NONE…….**SCORE=0**
v. Passive recreation.
Not used for passive recreation…….…….. **SCORE=0**
vi. Active recreation.
Not used for active recreation……..…….. **SCORE=0**
vii. Other human uses. None…….……**SCORE=0**
TOTAL HUMAN ATTRIBUTES SCORE =11

The Management Category allocated to the part of the wetland (UFIs 7773 & 8029) that occurs on Lot 32 Brook Rd, Wattle Grove by the method of EPA Bulletin 686 (1994) was thus **Resource Enhancement Wetland.** However the Endangered Flora, Declared Rare Flora, Priority Flora that occurs here means that this wetland should be assigned the highest conservation level.
The wetland (UFIs 7773 & 8029) is thus allocated to the category of **Conservation Category Wetland.**

C. Wetland Vegetation Condition Assessment for wetland UFIs 7773 & 8029

This vegetation of the wetland (UFIs 7773 & 8029) on Lot 32 was mainly in good condition (see vegetation description in Section 4 above). The relatively undisturbed vegetation was well in excess of 50% and in fact probably about 80% or more of the total area of the wetland. The Management Category allocated to this wetland was **Conservation Category Wetland**.

D. Conclusion for wetland UFIs 7773 & 8029.

The part of wetland (UFIs 7773 & 8029) on Lot 32 Brook Rd was evaluated by three methods (Table F2). This wetland was unequivocally a **Conservation Category Wetland.**

Table F2: Summary of wetland evaluation for UFI 7773 & 8029, Lot 32 Brook Rd

Wetland Evaluation Method	Wetland Management Category
V& C Semeniuk Research Group (1998)	CCW
EPA Bulletin 686 (1994)	CCW
Vegetation Condition	CCW

2. WETLAND UFI 13367 EVALUATION

A. V & C Semeniuk Research Group (1998) questionnaire for wetland evaluation applied to wetland UFI 13367

1. Conservation Category Wetlands Criteria

Wetland type (geomorphology): A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. it is an anthropogenically unaltered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland)
2. it is a scarce wetland type
3. it is a representative wetland type (i.e., representative of its consanguineous suite)

YES. The data obtained in the current survey show that wetland UFI 13367 is a palusplain, partly altered, but a scarce wetland (only 6% of the former extent of palusplains remain undeveloped on the SCP; Hill *et al.*, 1996). This palusplain is not representative of the Keysbrook consanguineous suite of wetlands (*i.e.* the wetlands of alluvial fans on the Pinjarra Plain) as it is partly altered by the clearing of vegetation and the dumping of landfill or the remains of a former dwelling on Lot 36.

Wetland processes: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland is subject to anthropogenically unaltered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes.)
2. the wetland exhibits unusual wetland processes
3. the wetland exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting)

NO. The clearing of the catchment area, the building of roads and other hard surfaces around this palusplain, the dredging and diversion of Yule Brook and the excavation of artificial drains along roads may be affecting the recharge and discharge of wetland UFI 13367. The sediments once deposited on the wetland through the regular flooding of Yule Brook and the spread of floodwaters over the alluvial plain (that includes Lots 32 and 36) has been altered.

Wetland habitats: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland is a habitat for rare & endangered fauna
2. the wetland is a habitat for rare & endangered flora
3. the wetland exhibits a high diversity of habitats

NO. Wetland UFI 13367 does not satisfy any of these criteria

Wetland functions: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland is necessary for maintenance of large faunal populations
2. the wetland is a refuge for resident fauna
3. the wetland is an important breeding, feeding or watering site for migratory populations (local and international)
4. the wetland is a significant regional component of the hydrological cycle (has an important hydrological storage, recharge or discharge function; or an hydrochemical function)

YES. Wetland UFI 13367 performs an important hydrological function as it is located high in the groundwater catchment of other wetlands in BFS 387. The groundwater flow through Wetland UFI 13367 contributes to the water and nutrient budgets of these other wetlands and the maintenance of the downstream biodiversity. This function is important regionally as few, if any, other undeveloped corridors along undisturbed alluvial fans exist from the Darling Range to the Canning River that are comparable to BFS 387 and Lot 36 is part of this alluvial fan system.---

Wetland Biodiversity: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland exhibits unaltered wetland vegetation and fauna
2. the wetland has a scarce vegetation association or faunal association

3. the wetland has a highly diverse wetland flora or fauna

NO. Wetland UFI 13367 does not satisfy any of these criteria

Wetland Scientific value: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland contains scientifically significant pollen records
2. the wetland is underlain by unusual wetland sediments (indicators of wetland history)
3. the wetland has unusual geomorphology (i.e., it is situated in an unusual geomorphic setting or contains unusual geomorphic features within it)

NO. Wetland UFI 13367 does not satisfy any of these criteria

The criteria that were not satisfied above at the level of Conservation (i.e. wetland processes, habitats, biodiversity) were then examined below at the Resource Enhancement level.

2. Resource Enhancement Wetlands Criteria

Wetland processes: A wetland may be classed as Resource Enhancement if it satisfies the following criterion

1. The wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) but not to the degree that habitats cannot still be identified and rehabilitated

YES. Wetland UFI 13367 satisfies this criterion. There is a small amount of landfill on Lot 36 but the palusplain sediments are still more or less intact and so groundwater recharge and discharge still function in a similar way to that prior to disturbance. The processes can be enhanced by replanting vegetation and correcting drainage works, if the latter is assessed as affecting the site.

Wetland habitats: A wetland may be classed as **Resource Enhancement** if it satisfies the following criterion

the wetland habitats are disturbed but the wetland is a habitat for rare & endangered fauna or flora, or the wetland exhibits a high diversity of habitats and for these reasons should be re-habilitated (i.e., water quality addressed, water levels naturalised, re-vegetation of communities undertaken, and re-establishment of ecological links with surrounding areas via corridors and/or buffer zones)

Yes. Wetland UFI 13367 habitat is disturbed but is part of the area of occurrence of rare flora species nearby and could be restored to suitable habitat for these rare flora species to recruit into or to be replanted into. The sediments, water quality and water levels, are not altered sufficiently in Lot 36 that re-establishment of original flora and fauna communities is not possible. Lot 36 should be restored to strengthen the ecological link of BFS 387 between the Darling Range and the Canning River.

Wetland functions: A wetland may be classed as **Resource Enhancement** if it satisfies one or more of the following criteria

1. the wetland is necessary for maintenance of specific faunal populations
2. the wetland is a breeding, feeding or watering site for migratory faunal populations (local)
3. the wetland is a fauna refuge but is degraded and requires re-vegetation or improvement of water quality
4. the wetland is a significant local component of the hydrological cycle (has an hydrological storage, recharge or discharge function; or an hydrochemical function)
5. the wetland is a regionally important hydrological or ecological link in a system
6. portion of extended wetlands is vegetated and therefore functions as an ecological corridor

YES. Wetland UFI 13367 is a significant local component of the hydrological cycle (it has a hydrological storage, recharge and discharge function for groundwater that supplies down slope areas of BFS 387).

Wetland Biodiversity: A wetland may be classed as **Resource Enhancement** if it satisfies the following criterion

1. the wetland exhibits some unaltered wetland vegetation and fauna which may be extended through re-vegetation programmes

NO. Wetland UFI 13367 does not satisfy this criterion. None of the remnant vegetation in this wetland could be described as unaltered. However most of wetland 13367 could be revegetated to extend and support the wetland vegetation of UFI 7773 that is adjacent to 13367 and in good to very good condition.

The criterion that were not satisfied above at the level of Resource Enhancement (i.e. biodiversity) was then examined below at the Multiple Use level.

3. Multiple Use Wetlands Criteria

Biodiversity: A wetland may be classed as **Multiple Use** if it satisfies the following criterion

1. the wetland has minor biodiversity, but does have ecosystem diversity and landscape diversity.

YES. Wetland UFI 13367 satisfies this criterion.

The scores in the categories examined for Wetland UFI 13367 were summarized (Table F5). This wetland met one criterion for CCW, two for REW and one for MUW. Although the wetland biodiversity and habitats of Wetland UFI 13367 have been largely lost due to the clearing of native vegetation, the wetland has conservation value because it is a scarce wetland type (palusplain on the Pinjarra Plain) and it retains some of the wetland processes and functions that are important to areas of very high conservation significance in BFS 387 down slope from it.

Table F5: Score sheet for the evaluation of part of palusplain UFI 13367
on Lots 32 and 36 Brook rd Wattle Grove by the method of V & C Semeniuk Research Group (1998)

Wetland Values	Criteria met at the level of CCW	Criteria met at the level of REW	Criteria met at the level of MUW
Wetland type	Yes		
Wetland processes	No	Yes	
Wetland habitats	No	Yes	
Wetland functions	No	Yes	
Biodiversity of wetland	No	No	Yes
Scientific value of wetland	No	n/a	n/a
Total Score	Score 1	Score 3	Score 1

The management category is allocated to the wetland according to the column above that achieves the best score.

The Management Category allocated to the part of palusplain UFI 13367 that occurs on Lots 32 and 36 Brook Rd by the method of V & C Semeniuk Research Group (1998) was thus **Resource Enhancement Wetland.**

B. Bulletin 686 (EPA, 1993) method of wetland evaluation for wetland UFI 13367

Bulletin 686 consists of a questionnaire that includes several parts that were answered for the evaluation of the part of the wetland UFI 13367 that occurs on Lots 32 and 36 Brook Rd Wattle Grove as below.

Part I: Presence of Rare Species
(If the wetland includes gazetted rare flora or fauna species then the wetland is automatically allocated to CCW).
NO. Wetland UFI 13367 does not include any Gazetted Rare Species

---

Part II Natural Attributes
Part IIA: For permanent and seasonal wetlands with well defined boundaries.
Not applicable go to part IIB below.
Part IIB: Seasonal and episodic wetlands with poorly defined boundaries.

i. Environmental geology classification. Wetlands in the Quindalup Dunes or in river/estuary floodplain receive Score= 5; other areas Score=1.
NO. The part of wetland UFI 13367 that occurs on Lot 253 is not in these areas……**SCORE=1**

Part II Natural Attributes
ii. Adjacent wetlands. Wetlands that have no other wetlands within a 2km radius of them receive Score =3, others go to Question iii (below).
YES. There are other wetlands nearby to the part of palusplain UFI 13367 that occurs nearby. Go to Question iii.

---

iii. Habitat diversity. If the composition and structure of the vegetation of the wetland under evaluation is significantly different to that found at other nearby wetlands, the wetland receives Score= 3; if not then Score =1.
NO. Other wetlands nearby to part of wetland UFI 13367 have similar vegetation……..**SCORE= 1**

---

iv. Habitat type. Habitat types scored in this question (up to a maximum Score = 15) include vegetation and landforms typical of lakes and sumplands such as fringing rushes and sedges, extensive in-lake beds of rushes and sedges, large paperbark trees, islands, flooded grassland, permanent or seasonal open water, extensive low thickets and samphires. The high conservation value vegetation of palusplains and damplands scores very badly on this part of the questionnaire because of this flaw in the design of this method of evaluation.
YES. Only category of large paperbark trees & fringing woodland/heath are applicable to this wetland…..S**CORE= 2.0**

---

v. Drainage. This deal with drains into and/or out of the wetland that can alter water levels or water quality. Wetlands with drains directing water into or out of the wetland Score=0; if no drains Score =5.
NO. Wetland UFI 13367 has drains adjacent to it but it is not clear how much effect these have on the hydrology of this wetland.....……..**SCORE= 0**

---

vi. Area of wetland modified by clearing of vegetation, landfill, paving, cultivation, irrigation, grazing, weed invasion, mining etc. Wetlands with 0-10 % modified Score= 5; 11-20 % modified Score= 4; 21-30 % modified Score= 3; 31-40 % modified Score= 2; >40 % modified Score= 1.
Wetland UFI 13367 has >40% that could considered as modified……..…… **SCORE= 1**

---

vii. Wetland size. Wetland area >100ha Score=5; 50-100ha Score =4; 25-50ha Score =3; 10-25ha Score =2; <10ha Score =1.

NO. The part of wetland UFI 13367 on Lots 32 and 36 is less than 10ha……**SCORE= 1**

TOTAL NATURAL ATTRIBUTES SCORE = 6.0

Part III: Human Use Questionnaire.

i. Aesthetics.

Little if any artificial noise. NO. Score=0
Understorey mostly intact. NO. Score=0
Few buildings evident from wetland. NO. Score=0
Steep ridge visible as part of scenery. YES. Score=2
Ridge accessible giving view of wetland. NO. Score=0
Wetland is a lake and open water easy to view. No. Score=0
Section of wetland where few people visit. NO. Score=0

.....**TOTAL SCORE=2**

ii. Historical and archaeological features.

Number of historical archaeological features. NONE…….. **SCORE=0**

iii. Security of wetland.

Current vesting/ownership of land = private ownership……..…..……...**SCORE=1**

iv. Protection groups. NONE…….**SCORE=0**

v. Passive recreation.

Not used for passive recreation…….…….. **SCORE=0**

vi. Active recreation.

Not used for active recreation……..…….. **SCORE=0**

vii. Other human uses. None……..……**SCORE=0**

TOTAL HUMAN ATTRIBUTES SCORE =3

The Management Category allocated to the part of wetland UFI 13367 that occurs on Lots 32 and 36 Brook Rd, Wattle Grove by the method of EPA Bulletin 686 (1994) was thus **Multiple Use Wetland.**

C. Wetland Vegetation Condition Assessment for wetland UFI 13367

This vegetation of the wetland UFI 13367 was degraded to completely degraded (see vegetation description in Section 4 above). The Management Category allocated to this wetland on this criterion was thus Multiple Use Wetland.

D. Conclusion for wetland UFI 13367

The part of wetland UFI 13367 that occurs in Lots 32 and 36 Brook Rd was evaluated by three methods (Table F6). UFI 13367 is a scarce wetland type (a palusplain of the Pinjarra Plain) and is therefore eligible for CCW status for this attribute. It retains some of the wetland processes and functions that are important to areas of very high conservation significance in BFS 387 down slope from it. The physical environment of the wetland is not sufficiently altered that the wetland habitats cannot be restored and replanted with much the same flora assemblages as adjacent wetlands. It can thus serve as an effective, fully-vegetated buffer zone for adjacent wetlands. This wetland, when appropriately revegetated and managed, can also provide badly needed additional habitat for a number of flora species of conservation significance that occur locally. For example, a rare species that would benefit greatly, if additional habitat was made available to it on Lot 36 within its previous natural range, is *Grevillea thelemanniana*. The latter species is currently totally confined to the wetlands of Kenwick and Wattle Grove and is threatened with a further contraction of its range due to industrial development locally. Wetland UFI 13367 is also part of a Regional Greenway between the Canning River and the Darling Range (Alan Tingay and Associates, 1998; Bush Forever, 2000; Del Marco et al., 2004)).

Wetland UFI 13367 should be replanted with native vegetation to restore additional ecological functions as a buffer zone for other wetlands of BFS 387 and as part of the Regional Greenway. This wetland was thus allocated the management category of **Resource Enhancement Wetland.** It satisfies all of the wetland criteria at the level of either CCW or REW except biodiversity and scientific value.

Table F6: Summary of wetland evaluation for UFI 13367 in Lots 32 and 36 Brook Rd, Wattle Grove

Wetland Evaluation Method	Wetland Management Category
V& C Semeniuk Research Group (1998)	REW
EPA Bulletin 686 (1994)	MUW
Vegetation Condition	MUW

APPENDIX B

Department of Water's Perth Groundwater Atlas Groundwater and Surface Contour Information

Department of Water - Perth Groundwater Atlas - Windows Internet Explorer

http://www.water.wa.gov.au/idelve/gwa/

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Department of Water - Perth Groundwater Atlas

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Perth Groundwater Atlas

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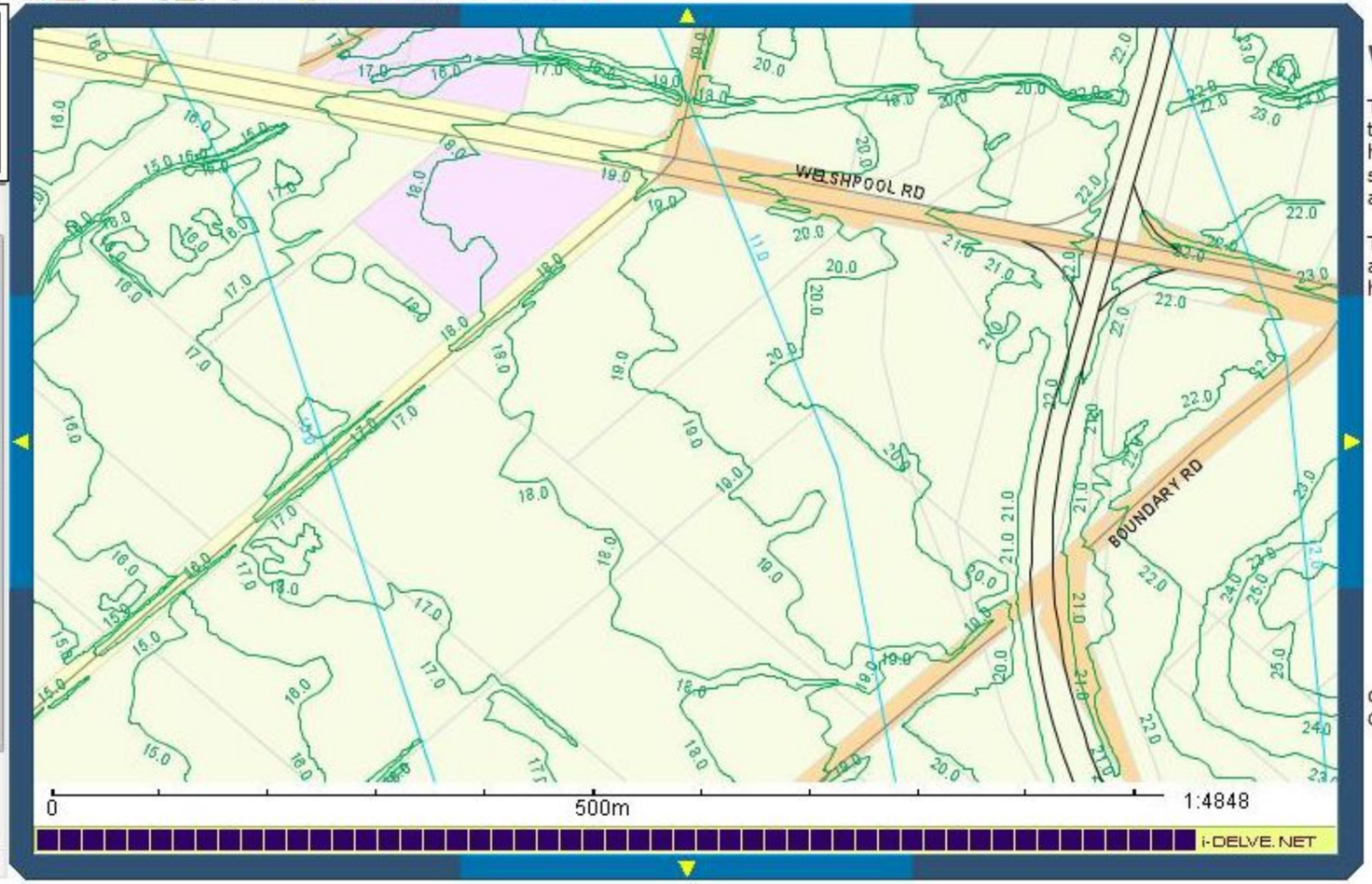

- Planning and Cadastre
- Geoscientific Information
  - Acid Sulfate - DEC
  - Darling Fault -DoW
  - GW contours, May 2003 - Do
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  - Groundwater Salinity - DoW
  - Groundwater Risk - DoW
  - Surface Geology - DoW
  - Base of Superficial Formation
  - WIN Groundwater Sites - DoW
- Inland Waters
- Elevation
  - Contours 1m - DLI
  - Contours 5m - DLI
- Utilities and Communication
- Transportation

Welcome

The *Perth Groundwater Atlas* has been designed to help water-bore drillers, irrigators, and private householders establish groundwater bores in the superficial aquifer within the Perth metropolitan area.

The aims of the Atlas are to provide the drilling and irrigation industries, and private householders, with information to:

- estimate the depth to groundwater of the superficial aquifer beneath a property,
- estimate the depth to the base of the superficial aquifer beneath a property - this is the maximum allowable bore depth permitted without an approved groundwater licence,
- give an indication of the salinity of the groundwater at the bore site, and
- indicate those areas where the use of information in the Atlas, or groundwater conditions, may present problems for development of a groundwater bore within the superficial aquifer.

Click here for a quick introduction in using the Groundwater Atlas mapping interface.

DoW Home | Groundwater Atlas

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Zoom in tool. Click and drag to zoom in.

Done | Internet | Protected Mode: On | 100%

Lots 28, 32 and 36 Brook Road, Wattle Grove

Spring Flora and Vegetation Survey and Wetland Assessment, Delineation and Classification

Final Report

Document Control Report Reference	Revision	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
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454 AE	FINAL	JT	TS	1 electronic (CD)	02/07/09

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EXECUTIVE SUMMARY

360 Environmental Pty Ltd (360 Environmental) was commissioned by Evangelous Litis Nominees Pty Ltd (the client) to undertake a spring flora and vegetation survey and wetland assessment, delineation and classification (the survey) of Lots 28, 32 and 36 Brook Road, Wattle Grove (the survey area) (Figure 1). The survey is required by the client to assess the value and conservation significance of the remnant flora and vegetation present within the survey area. This information will then be used to assess potential options for future use.

The following scope of work was undertaken within the survey area:

- A Level 2 Flora and Vegetation assessment in accordance with the Environmental Protection Authority's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. *No. 51.*
- An assessment and description of the wetlands and wetland boundaries within the site based on *A geomorphic approach to global classification for inland wetlands* (Semeniuk and Semeniuk, 1995).
- Soil sampling to map soil types. Soil type mapping was used to delineated and assist in mapping wetland boundaries.

The native flora of the survey area was found to be moderately species-rich, rich in rare flora and very rich in species of regional conservation significance including one species of DRF (*Eremophila glabra*) and six Priority flora species (Figure 5). In Lot 36, the native flora has been replaced by a species-poor, naturalized alien assemblage of pasture grasses and herbs. A total of 164 taxa (96 taxa of native vascular flora and 68 taxa of naturalised alien flora) (Appendix C) were recorded in 14 sampling sites (quadrats) (Appendix D) and in reconnaissance transects through the survey area (Figure 5). In Lots 28 and 32, there was a range of 13 to 61 taxa recorded per 10m x 10m quadrat.

When analysed, the vegetation data indicated a total of five native vegetation units are present of within the survey area (Figure 6a). All of the remnant native vegetation within the survey area was vegetation of the Guildford Vegetation Complex. Most of this vegetation was in good to very good condition (Figure 7) and although a PATN analysis undertaken on the vegetation data indicated there were no TECs present, a number of the locations did show an affinity to TECs including the federally listed Muchea Limestone TEC (Figure 6b).

The entire survey area was confirmed as being either Conservation Category Wetlands (CCW) or Resource Enhancement Wetlands (CCW) (Figure 8). The areas of CCW are generally associated with areas of remnant vegetation and the areas of REW are associated with the cleared areas of the site. These areas retained an REW

classification as they retain wetland processes and functions that support adjacent conservation significant wetlands. Although this survey found that some small changes to the DEC (2008) *Swan Coastal Plain Wetlands Dataset* may be undertaken with regard to the classification and mapping of wetlands at a fine scale, the changes are not significant and for the purposes of the proposed use no further work should be required.

This assessment was undertaken to provide information on the potential for development to occur over all or part of the survey area. The results of the survey indicate approximately half of the survey area retained remnant vegetation in degraded to very good condition while the remainder was considered completely degraded. Wetland values, processes and functions also varied across the site in close association to the presence of remnant vegetation. Patterns of regional groundwater flow, sub-surface and surface flow (in both natural drainage and constructed drains) are known to link the survey area with other areas of highly water-dependent biota in the Greater Brixton Street Wetlands (Perth Groundwater Atlas, 2008; VCSRG, 2001).

Based on the results of the survey, Lot 36 and part of Lot 32 are considered the most appropriate areas for potential development options to occur (Figure 9). Due to the close proximity of conservation significant flora, vegetation and wetland values and location of the site within BFS 387 any potential development options will need sensitive environmental planning.

The conservation values of BFS 387 are considered significant and proposals will need to ensure the protection or maintenance of the current values associated with this Bush Forever site. If planning and design ensure the maintenance of subsurface hydrological values the development of a facility, such as storage, across the cleared area should ensure minimal impact on the environment as no further clearing of vegetation will be required and wetland values will be protected.

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Table 5 Wetland Sediment Classification (adapted from Semeniuk and Semeniuk, 2004).

Table 6 Wetland Sediment Definitions (adapted from Semeniuk and Semeniuk, 2004).

Table 7 Geomorphic Classification of Wetlands (adapted from Semeniuk and Semeniuk, 1995).

Table 8 Management categories of wetlands from EPA Bulletin 686 as updated in Hill et al., (1996).

Table 9 EPA Bulletin 686 questionnaire (EPA, 1993).

Table 10 A score sheet for wetland evaluation (adapted from VCSRG, 1998).

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1. Introduction

1.1. Background and Aims

360 Environmental Pty Ltd (360 Environmental) was commissioned by Evangelous Litis Nominees Pty Ltd (the client) to undertake a spring flora and vegetation survey and wetland assessment, delineation and classification (the survey) of Lots 28, 32 and 36 Brook Road, Wattle Grove (the survey area) (Figure 1). The survey is required by the client to assess the value and conservation significance of the remnant flora and vegetation present within the survey area. This information will then be used to assess potential options for future use.

1.2. Scope of Work

1.2.1. Spring Flora and Vegetation Survey

The following scope of work was undertaken within the survey area:

- A Level 2 Flora and Vegetation assessment in accordance with the Environmental Protection Authority's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. *No. 51.*

This included:

- Quadrat-based floristic description of the vegetation types within the project area.
- Mapping of the vegetation types and extent of any significant vegetation and flora with GPS. Photographs of each vegetation type and any other significant features.
- Complete flora inventory (including weeds) of the site.
- An assessment of vegetation condition on site and mapping.

1.2.2. Wetland Assessment, Delineation and Classification

The following scope of work was undertaken for the wetland assessment, delineation and classification:

- An assessment and description of the wetlands and wetland boundaries within the site based on *A geomorphic approach to global classification for inland wetlands* (Semeniuk and Semeniuk, 1995).
- Soil sampling to map soil types. Soil type mapping was used to delineated and assist in mapping wetland boundaries.

1.3. Objectives

This investigation was undertaken in accordance with 360 Environmental's proposal 454 AB (dated 18 February 2008). This study aimed to:

- Survey and map the vegetation communities.
- Compile a comprehensive species list.
- Identify any flora and vegetation issues that may need to be addressed in any subsequent environmental approvals.
- Map sub-surface soil profiles across the site.
- Compare the results of the flora, vegetation and sub-surface soil profiles to delineate and classify wetlands present on site.

1.4. Aims

In recognition if the potential environmental values of the survey area based on discussion outlined in the EPA's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. *No. 51* the survey aimed to provide:

- A desktop review of the documented high conservation status flora and TECs in the vicinity of the project area.
- An inventory of the vascular flora observed during the field investigation of the survey area, including flora of conservation significance and naturalized alien taxa.
- A description and mapping of the small-scale vegetation units and vegetation condition in the survey area.
- Mapping of the boundaries of wetlands as determined by vegetation assemblages, shallow stratigraphy and watertable levels determined during transects through the survey area.
- An assessment of the conservation significance of the flora, vegetation units and wetlands of the areas considered above.
- Provision of recommendations based on the findings for potential options to progression of site development.

1.5. Report Format

The remainder of this report comprises the following components:

- Section 2 – Site Description
- Section 3 – Regional Setting
- Section 4 – Methodology



- Section 5 – Desktop Survey of Flora and Vegetation of Conservation Significance
- Section 6 – Field Flora Survey
- Section 7 – Field Vegetation Survey
- Section 8 – Field Wetland Survey
- Section 9 – Discussion and Conclusion
- Section 10 – Limitations
- Section 11 – References

2. Site Description

2.1. Site Location and Features

The survey area consists of Lots 28, 32 and 36 Brook Road Wattle Grove (Figure 1). The site is bound to the west by Brook Road, to the north by Welshpool Road East and other rural lots to the east and south and totals approximately 11.5 hectares.

The entire site is within Bush Forever Site 387 (Figure 2) and also contains conservation significant wetlands. Approximately half of the site is currently categorised as Conservation Category Wetland (CCW) and the other half is categorised as Resource Enhancement Wetland (REW) (Figure 3).

2.2. The Geomorphology and Geology of the Survey Area

The Swan coastal Plain (SCP) consists of a series of geomorphological elements which are sub-parallel to the present coastline (McArthur and Bettenay, 1960). Each of these geomorphic elements has distinctive geology, vegetation, topography and soils.

Wattle Grove is located on the Pinjarra Plain on the eastern side of the SCP where the soils are predominantly alluvium of the Guildford Formation overlaid in places by aeolian sands of the Bassendean Dunes (Gozzard, 1983).

3. Regional Setting

3.1. Climate

Weather records for the Gosnells City weather station for the past 17 years can be used to gain an understanding of the climate in the vicinity of the survey area (Table 1, adapted from Bureau of Meteorology, 2008). The climate in the area can be described as warm, sub-humid and Mediterranean with a pronounced annual drought for 4-5 months each year and cool, wet winters (Gentilli, 1971).

3.2. Landforms and Superficial Sediments (soils)

The surevy area is located about 2 km west of the scarp of the Darling Plateau. The eastern side of the SCP in the vicinity of the survey area comprises two landform units of regional scale (the Ridge Hill Shelf and the Pinjarra Plain) that are orientated more or less parallel to the coast, east of the Bassendean Dunes (McArthur and Bettenay, 1960).

The survey area is located within the Pinjarra Plain, in the south-west corner of Wattle Grove near a convergence of the Pinjarra Plain, the Ridge Hill Shelf and the Bassendean Dunes. The north-west boundary of Lots 32 and 36 is located where Bassendean Sands very shallowly overlie the Pinjarra Plain. The current survey area is part of a low relief wetland landscape dissected by Yule Brook; an alluvial fan complex (that includes considerable fine-scale heterogeneity of landforms and sediments) that slopes gently to the south west towards the Canning River.

The Ridge Hill Shelf geomorphic unit (also known as the Foothills unit of Churchward and McArthur, 1980), a more or less continuous platform, of about 1-3 km in width, located immediately to the west of the scarp of the Darling Range. It comprises Quaternary-aged sand, clay, conglomerate and laterite of various units including the Yoganup and Forrestfield Formations (Churchward and McArthur, 1980). The Ridge Hill Shelf is dissected by many channel wetlands (e.g. Yule Brook and Bickley Brook) that have their headwaters on the Darling Plateau and flow west onto the SCP or terminate within the foothills (Perth Groundwater Atlas, 2004).

The Pinjarra Plain comprises mainly Quaternary-age fluvial sediments of the Guildford Formation that originated on the Darling Plateau and Scarp and were deposited on to the SCP as alluvial fans of gravel, sand, loam and clay (Churchward and Mc Arthur, 1980). The sediments of the Pinjarra Plain were also subsequently re-worked in some places by channel migration and localised aeolian processes. Other materials such as Muchea Limestone and ferricrete were formed in situ on the Pinjarra Plain. There is a fine-scale hydrogeological complexity in the alluvial fan formations of the Guildford Formation that is unparalleled elsewhere on the SCP (VCSRG, 2001). The Greater

Brixton Street Wetlands are part such an alluvial fan complex that is associated with Yule Brook. The varied array of stratigraphic sequences and hydrological patterns recorded by VCSRG (2001) in the Greater Brixton Street Wetlands correlates with the rich mosaic of fine-scale vegetation assemblages in the area. The high habitat heterogeneity is undoubtedly a major factor underpinning the high biodiversity of the region.

The Bassendean Dunes geomorphic unit is an undulating plain of low-relief dunes generally composed of well-drained, deep, quartz sands (Bassendean Sands). Wetlands in the Bassendean Dunes are usually basins and there are few drainage channels in this area.

The superficial sediments (soils) of the Wattle Grove – Kenwick areas in the vicinity of Bush Forever Site (BFS) 387 have been mapped at a scale of 1:50,000 by Jordan (1986). This mapping illustrates, in general terms, a sequence of habitats that grade into each other down the gentle slope of the alluvial fan complex within BFS 387. This soil sequence in BFS 387 ranges from Lot 36 (at the upper extreme of the landscape) down to the Brixton St Reserve in Alton St, Kenwick (at the lower extreme of the landscape) (Table 2). In this sequence, Lots 28, 32 and 36 (between about 14-20 m Australian Height Datum (AHD)) were mapped as shallow Bassendean Sands over sandy clay of the Guildford Formation (S10). The area of BFS 387 that is located between Bickley Rd and Brixton St (below about 8m AHD in the alluvial fan complex) was mapped as clayey-sand soils of the Guildford Formation (Sc). The BFS 387 lands that lie in the lower part of the alluvial fan complex (south west of Brixton St and below about 6m AHD) were mapped as Guildford Formation sandy clay (Cs). The University of WA Allison Baird Reserve, mid way down the slope, can be seen to include the greatest diversity of soils (S10, Sc and S8) at this scale.

Thus the lands included in BFS 387 and adjacent lands that are part of the same alluvial fan, although they comprise a continuum of soil types, can be divided into several main zones with regard to soil type and these zones can be correlated with topography (the latter expressed as metres AHD and mapped in the Perth Groundwater Atlas, 2004). Although there are many other factors including stratigraphic sequence, depth to water table and hydroperiod that also determine plant habitats in the area, the soil zones (as above) can be seen to be correlated with vegetation assemblages and the preferred habitat of individual plant species (Goble-Garrat, 1991; Keighery, 2000; VCSRG, 2000).

3.3. Wetlands and Hydrology

The wetlands of Wattle Grove and Kenwick are part of the Keysbrook (P1) and the Mungala (B/P2) Consanguineous Wetland Suites (VCSRG, 1991; Hill et al., 1996). The Keysbrook Wetland Suite comprises palusplains (seasonally waterlogged flats), creeks (seasonally inundated channels) and floodplains (seasonally inundated flats)

within the gently sloping setting of the alluvial fan formations of the Pinjarra Plain. The Mungala Wetland Suite is set in the transitional zone where the Bassendean Dunes shallowly overlie the Pinjarra Plain and form where the alluvial fan distributaries of creeks terminate in the Bassendean sandplain. The Mungala Wetland Suite comprises lakes (permanently inundated basins), sumplands (seasonally inundated basins), floodplains and creeks. The Keysbrook Wetland Suite occurs most commonly south of Gosnells; the occurrence of wetlands of this suite in Kenwick/Wattle Grove is a northern outlier of this suite.

Palusplains comprise the largest area of wetlands on the SCP; about 66% of the wetland area between Wedge Island and Dunsborough is palusplain (Hill et al., 1996). However less than 6 % of palusplains within the eastern SCP between Gingin and Mandurah retain native vegetation (Hill et al., 1996). Thus wetlands of the Keysbrook and Mungala suites, that have been evaluated as CCW or REW in the *Geomorphic Wetlands Swan Coastal Plain Dataset* of the Department of Environment and Conservation (DEC, 2008) are subject to a high level of protection under policies of the Western Australian Environment Protection Authority.

All wetlands of the Keysbrook and Mungala Consanguineous Wetland Suites that have retained their geomorphic integrity (i.e. those wetlands that have not been infilled, excavated, mined or have not had structures built on them) particularly those with vegetation and other attributes in good condition, are of high conservation significance (Hill et al., 1996).

The hydrology of the Greater Brixton Street Wetlands is known from several main sources that are listed below.

- The geomorphic classification and mapping of geomorphic wetlands and assessment of wetland management categories for the wetlands of the area at a scale of 1:25,000 by Hill et al. (1996). These maps form the basis of the Wetland Database of the DEC (2008a).
- A fine scale stratigraphic and hydrological study of the area by the Vic and Christine Semeniuk Research Group (VCSRG) (2001). This study established an extensive monitoring system throughout the Greater Brixton Street Wetlands that has been used to track the ground and surface water levels of the area from 1999 to the present. This study forms a baseline database of the hydrology of the area at a scale that is appropriate to understanding the water requirements of the biota.
- The groundwater maps of the Perth Groundwater Atlas (2004) at a scale of 1:20,000.
- The Swan River Trust/Swan Catchment Centre (2007) monitoring of flow rates and nutrient levels in Yule Brook.

The Greater Brixton Street Wetlands (BFS 387) are located adjacent to Yule Brook, a short distance upstream from where it drains into the Canning River. The major hydrological recharge mechanisms in the Yule Brook catchment are direct precipitation, groundwater recharge via seepage from the Darling Range foothills, flow from the base of the Darling Plateau and channelled surface runoff (VCSRG, 2001). The groundwater contour lines in the Yule Brook and Bickley Brook catchment (that includes the survey area and the other wetlands of the Greater Brixton Street Wetlands) are orientated parallel to the surface topography contour lines (Perth Groundwater Atlas, 2004). The coincidence of the topographic gradient with the direction of the groundwater flow and the location of Lot 36 at the high end of the slope, above the other Greater Brixton Street Wetlands, means that the ground and surface waters at Lots 36, 32 and 28 (respectively) discharge downslope through the Greater Brixton Street Wetlands on their way towards the Canning River.

Small ridges and mounds of Bassendean Sands in the Greater Brixton Street Wetlands (the most pronounced of these being located in the UWA Allison Baird Reserve) also form small-scale localised perched water mounds that slowly discharge water laterally onto the adjacent palusplains. VCSRG (2001) described the hydrology of the small-scale seasonally waterlogged slopes (paluslopes) that are maintained by such seepages from low ridges in the Greater Brixton Street Wetlands and found artesian pressure heads in some aquifers in these settings. Paluslopes are a very uncommon on the SCP and are poorly documented in this region. Paluslopes are more prevalent in the high rainfall zone near the south coast of Western Australia in the Warren Biogeographical Region.

The sumplands within the survey area (Figure 4) are generally small basins that are of a round to elliptical shape; these are commonly referred to as claypans (Marshall, 2000) and are usually inhabited by characteristic assemblages including shrubs such as *Melaleuca lateritia* and *Melaleuca rhaphiophylla*, the grass *Amphibromus nervosus* and very species-rich assemblages of annual herbs and geophytes. There are also a number of seasonally-inundated small channels in BFS 387 (VCSRG, 2001) that drain towards Yule Brook. The natural vegetation remnants in the latter are dominated by low *Melaleuca* spp. trees and tall shrubs that can form a closed canopy over a sparse understorey of sedges. None of these channels in BFS 387 now appear to retain natural vegetation along their entire course from the foothills of the Darling Range down to the Yule Brook. Most of these channels have been excavated and/or diverted to facilitate the surface and sub-surface drainage of roads and residential areas. There are discontinuities along the course of some of these channels (such as low dunes) that appear to naturally partition these channels into a linear series of narrow elongated sumplands. There are also man-made discontinuities along the course of many of these channels, such as roads, buildings or dumped landfill, which disrupt their geomorphic integrity. However, some these channels retain both native

vegetation and natural channel geometry in a relatively undisturbed condition along short lengths of their course in BFS387 between Brook Rd and Boundary Rd (VCSRG, 2001).

In the Greater Brixton Street Wetlands, the complex natural hydrogeology is over-printed by a grid of excavated drainage channels that influence hydrological variables such as soil moisture and the depth to groundwater, and vegetation.

4. Methodology

4.1. Guiding Principles

The survey and analysis methods adopted in the flora and vegetation survey were conducted in reference to:

- The EPA's position paper with regard to terrestrial biological surveys as an element of biodiversity protection (EPA, 2002).
- The EPA's (2004) *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. *No. 51*.
- The EPA's (2006) Guidance Statement No. *10 Level of Assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 Region* (EPA, 2006).
- The EPA's (2008) *Environmental Guidance for Planning and Development*.

The survey area is located on the eastern SCP, in the *Swan Coastal Plain Biogeographical Region* (IBRA, 2000) of the South West Botanical Province of Western Australia. The current survey was conducted at Level 2 and included background research (a desktop study), a reconnaissance field survey and a comprehensive field survey (EPA, 2004b). With regard to the current regional survey project, the three components of the Level 2 search were fulfilled as below.

- Background Research. A literature review and a search of the rare flora, TECs and wetland values were carried out including searches of the relevant Federal and Western Australian Government databases. Advice and information was also sought from a number of relevant experts and stakeholders in government, scientific institutions and the community regarding the known conservation values and other environmental issues applicable to the target area.
- Reconnaissance Survey. A reconnaissance field survey was carried out in September 2008 to verify the accuracy of the background information and to obtain an overview of the range of flora, vegetation and wetland values in the area. Transects were walked through the areas that were identified from aerial photographs as retaining natural vegetation. This allowed opportunistic sampling and recording of the flora and vegetation in the more degraded areas, targeted searches of habitat that could potentially harbour rare flora and the selection of suitable sites to install quadrats for detailed sampling.
- Comprehensive Field Survey. The level of knowledge of the flora and vegetation of the target area was enhanced by a detailed, quadrat-based flora and vegetation field survey. To investigate the conservation value of the

vegetation in the current survey area a multivariate analysis of the floristic data obtained in the current survey was carried out against a baseline SCP floristic dataset of Gibson et al. (1994). This provided an indication of the similarity of the vegetation types within the survey area with previously defined Floristic Community Types (FCTs) in the context of the *Swan Coastal Plain Biogeographical Region*. The classification assisted in the objective evaluation of the conservation significance of the vegetation assemblages found in the survey area.

The four wetlands within the survey area that are mapped in the *Swan Coastal Plain Wetlands Dataset* (DEC, 2008a) were also ground truthed and re-evaluated with regard to mapping, geomorphic classification and management category during the reconnaissance and detailed survey above and subsequently (using the additional fine-scale data obtained during the flora and vegetation field survey).

4.2. Flora Sampling, Vegetation Description and Classification

The flora, vegetation and wetlands field survey was carried out from September to December 2008. Colour aerial photographs were used to interpret the vegetation patterns of the survey area prior to the reconnaissance survey. These interpretations were then verified using ground traverses to record dominant species and vegetation structure and to search for flora of conservation significance. Quadrat sites were selected to be representative of the vegetation types as interpreted above. One or more quadrats or releves were surveyed, where possible, in each vegetation type encountered in the project footprint.

A total of 14 sampling quadrats (each of area 100m2) were established in species-rich native vegetation that was in good to very good condition (Figure 5). The quadrat size in this survey was determined by that used in the previous surveys that contributed to the SCP dataset of Gibson et al. (1994). All of the vascular plant taxa in these quadrats were recorded. Voucher specimens were collected, where necessary, and identified with reference to the WA Herbarium collections. At each quadrat, a number of data were also recorded as outlined below:

- Location statement (including GPS coordinates); landform description; vegetation structure using height and foliage projective cover (in cover classes i.e. 2-10%, 30-70%, 70-100%) for dominant vascular flora taxa within the site (Table 3); presence and cover class of all vascular flora taxa in the quadrat (including naturalised alien taxa); vegetation condition (Table 4) using a scale modified from that of Keighery (1994) as in Bush Forever study (Govt of WA, 2000a); surface sediments; natural litter; and estimated time since last fire. Overstorey abundance was estimated over a larger area (approximately 400m2) encompassing the marked quadrat in each case. The shallow

stratigraphy and depth to groundwater at the time of survey were also investigated (by manual augering) in many of the quadrats above (and at a number of other sites where the vegetation did not warrant detailed study).

The nomenclature and classification of all flora taxa in the current survey were aligned with that currently used in FloraBase, the public interface of the WA Herbarium (2008). However an important feature of the current survey area was that a number of flora taxa recorded were morphological variants that are the subjects of taxonomic research. Therefore a number of synonyms and informal names allied to voucher specimens were also quoted, where necessary, to support any taxonomic concepts that required further explanation.

A multivariate analysis of the site vs. species (presence/absence only) matrix derived in the current survey of was carried out by E. A. Griffin in combination with the SCP dataset of Gibson et al., (1994) using PATN® software (Appendix A), in order to determine the FCTs of the survey area vegetation in the context of Gibson et al. (1994). The determination of FCTs in this manner was useful as part of the assessment of the conservation significance of vegetation on the SCP, as it provided a measure of objective comparison of the floristics of the vegetation of the areas with listed TECs. The classification of vegetation in this method was also useful in verifying the patterns derived intuitively in the field in this complex and species-rich vegetation. This process required that, prior to analysis, the nomenclature of the flora taxa recorded in the current survey was aligned with that used in Gibson et al. (1994). A number of taxa recorded in the survey were not recorded by Gibson et al. (1994) and the analysis method required these to be deleted from the analysis. The boundaries of the major vegetation units derived from the field observations and the detailed site data analysis were mapped onto colour aerial photography of the area at a scale of 1:2,000 (Figure 6a).

4.3. Wetland Assessment

4.3.1. Wetland identification and delineation

Identification and delineation of a wetland relies on evidence from three disciplines: hydrology, stratigraphy and vegetation (Hill et al., 1996). An introductory guide to some basic requirements in the identification and delineation of wetlands is provided in DEC (2007). The hydrology, stratigraphy and vegetation of the survey area was investigated in the identification and delineation of the wetlands in the current survey.

A limited field survey of the hydrology and shallow stratigraphy of the wetlands in the survey area was undertaken that included the manual augering of sampling sites in October to December 2008. This work was necessary in the process of identifying wetlands (i.e. distinguishing between putative wetland and upland zones) and in delineating (i.e. mapping) wetlands in the study area, in accordance with the

guidelines of DEC (2007). The detailed flora and vegetation study in the current survey also contributed to the wetlands study. A total of 22 study sites were selected to sample the vegetation, hydrology and stratigraphy of the survey area (Figure 5). Surface sediments and the presence of waterlogging or inundation of surface sediments were also recorded opportunistically elsewhere throughout the survey area from August to December. Ten of the hydrology/stratigraphy study sites (H1-H9 and H14) were located in good to very good condition vegetation and coincided with flora study quadrats (Q1-Q9 and Q10) respectively in Lots 28 and 32. An additional eight hydrology/stratigraphy study sites (H11-H13 and H15-H18) were located in areas of more degraded vegetation in the survey area. The flora species present in an area of approximately 200m2 around each of these additional augering sites were also recorded as releves, that is, without the marking out of formal flora sampling quadrats.

To determine the depth to the watertable and the stratigraphic sequence at each of the 18 study sites, holes were augered manually down to the water table (where possible). The autumn and early winter rainfall at Gosnells, the nearest weather station to Wattle Grove, was close to the long-term mean for these seasons.

The sediments from the auger holes were sampled at 10cm intervals, labelled and then examined via a low power stereoscopic microscope to assess grain size and sediment fabric. The presence of calcareous materials in the samples was determined after application of several drops of 10% hydrochloric acid to each sample. The sediments were classified and described using terms consistent with Semeniuk and Semeniuk (2004) (Tables 5 and 6).

The habitat preferences of each of the native flora species recorded at each of the hydrology/stratigraphy study sites and at each flora quadrat in the survey area were investigated by checking the habitat notes of all occurrences of these species (across the known geographical range for each of these species) as recorded on herbarium voucher labels in FloraBase (WA Herbarium, 2008), in Paczkowska and Chapman (2000), in Keighery and Keighery (2000), in Bush Forever (Government of Western Australia, 2000) and in Marchant et al. (1987) as required.

Lists of the obligate wetland flora species (those plants generally restricted to wetland habitats), the facultative wetland flora species (those plants that can occur in either wetland or upland habitats) and calcicole species (those plants that generally inhabit calcium carbonate rich habitats) that were present within the survey area were then assembled on the basis of these desk-top investigations. This list was then critically examined in the context of field data collected by the botanist in wetland flora surveys to derive a final list of wetland taxa within the survey area.

4.3.2. Geomorphic classification of wetlands

The geomorphic classification of wetlands in the survey area was conducted by examining the data from the hydrology, stratigraphy and vegetation field study and by brief observations of the topography in the field and in topographic maps (Perth Groundwater Atlas, 2004). The wetlands were then classified by the system of Semeniuk and Semeniuk (1995), (Table 7).

4.3.3. Evaluation of wetland management category

To provide guidance on the level of protection and the management objectives that are appropriate to each wetland, wetlands on the SCP have been evaluated following Hill et al. (1996) and assigned to one of three management categories (CCW, REW, or Multiple Use Wetland (MUW)) in the *Geomorphic Wetlands Swan Coastal Plain Dataset* (DEC, 2008a).

The methods for evaluating wetlands on the SCP are currently under revision (DEC, 2007). In the interim, three methods are recommended by DEC (2007) to evaluate the management category of wetlands.

The first of the methods recommended to evaluate the management category of wetlands is a questionnaire, commonly referred to as *Bulletin 686* (EPA, 1993) that was designed before the SCP wetlands were comprehensively mapped by Hill et al. (1996). The acknowledged drawback of this questionnaire is that it tends to allot the highest scores to wetlands with standing water (such as lakes and sumplands) and those wetlands that include optimum waterbird habitats (such as open water, dense vegetation, roosting trees and mud flats adjacent to open water). *Bulletin 686* does not adequately score wetland condition, floristic complexity, the presence of habitat of less conspicuous fauna and the functions and values of wetlands such as damplands and palusplains (DEC, 2007). The exceptional biodiversity, scarcity and conservation values of some of the latter wetland types on the SCP have only recently became apparent through initiatives such Hill et al.(1996) and Bush Forever (Govt of WA,2000). Methods of wetland evaluation other than, or supplementary to, EPA (1993) are required to assist in the adequate evaluation of all types of wetlands on the SCP.

The second method for wetland management category evaluation that is currently recognized by DEC (2007) is a questionnaire that was designed for the Western Australian Water and Rivers Commission by VCSRG (1998). The latter enables wetland attributes to be assessed from first principles, irrespective of wetland type.

The third method for wetland management category evaluation involves wetland vegetation condition. The vegetation condition scale of Govt of WA (2000) and guidelines regarding wetland vegetation in Hill et al. (1996) are recommended for use in this evaluation (DEC, 2007).

All of the methods above were used to evaluate the management categories of the wetlands in the current survey. The features of each of these methods are summarized below.

4.3.3.1. *Bulletin 686* (EPA, 1993) method of wetland evaluation

Bulletin 686 was designed to allocate wetlands to five categories: High Conservation, Conservation, Conservation and Recreation, Resource Enhancement, and Multiple Use, according to the graphs in EPA (1993). These management categories were updated in Hill et al. (1996) (Table 8) to the system now recognized on the SCP (DEC, 2007). *Bulletin 686* consists of a questionnaire that includes several parts, as outlined in Table 9.

In EPA *Bulletin 686*, wetland basins are evaluated as isolated units (with either sharp boundaries, or with diffuse boundaries). It is acknowledged that palusplains and damplands are not adequately evaluated by the use of *Bulletin 686* (DEC, 2007).

4.3.3.2. VCSRG (1998) method of wetland evaluation

The Water and Rivers Commission instrument designed by the VCSRG (1998), supplements Hill et al. (1997) and takes into account all of the types of wetlands (including palusplains) that have been mapped within the southern SCP. This system recognizes that evaluation demands an approach to capture the recognised natural values of all wetland types.

In this evaluation system, six classes of wetland values (wetland type, wetland processes, wetland habitats, wetland functions, biodiversity and scientific value as in Table 10) are examined and scored for the wetland in question. Essentially, each of these values is graded as high, moderate, or low for the wetland being evaluated and this is translated to the management categories of CCW, REW, or MUW, respectively. The six wetland values are first checked against the criteria that are appropriate at the level of CCW (Table 11). If the wetland does not meet the CCW criteria for at least one question in each of the six values, the wetland is then checked for these values again at the level of REW (Table 12). Then, if necessary, any values that do not meet the criteria in the latter are checked against the criteria at the level of MUW (Table 13). The wetland is then allocated to the management category (CCW, REW or REW) that achieved the best score in the questionnaire (Table 10).

4.3.3.3. Vegetation condition in the evaluation of wetland management category

The percentage of natural vegetation remaining in a wetland is another measure recommended (Hill et al., 1996; DEC, 2007) to rapidly assess the “naturalness’ of a wetland and thus provides a second tier assessment method of determining the preliminary management category for a wetland (Table 14). This method was applied

to the wetland evaluations in the current survey area in addition to the methods of VCSRG (1998) and EPA (1993), using vegetation condition as assessed in the current survey. In this survey, the vegetation condition evaluation is of particular importance because of the very high conservation significance of any remnant vegetation of the Guildford Vegetation Complex that is in good condition.

The detailed data (including photographs, flora lists and vegetation descriptions) that was used in the survey to support the vegetation condition assessment of the wetlands under evaluation is presented in the Appendices B and C. The definition of undisturbed vegetation used in the evaluation of wetland management category conformed with the categories from “pristine” to “good” in the vegetation condition scale used in Govt of WA (2000) (Table 4).

Under the vegetation condition evaluation method (Table 14) wetlands retaining at least 50% native vegetation cover were evaluated as CCW, those retaining 10-50% native vegetation cover were evaluated as REW and those retaining less than 10% native vegetation cover were evaluated as MUW.

The pattern of vegetation distribution that is present in many palusplains on the SCP presents some specific difficulties in wetland management category evaluation and in wetland management. These palusplains are usually laterally extensive and their original native vegetation has often been cleared except for small patchy remnants that are dispersed amongst larger expanses of paddocks (that may still retain other wetland values), highly modified wetlands such as drains, roads and other built structures. If such palusplains are evaluated over their entire area, the vegetation condition is, effectively, averaged out over the whole palusplain. The latter would mean that most palusplains on the SCP would not achieve the score of CCW, regardless of the high conservation significance remnants of vegetation in excellent condition that they may encompass. The alternative method of evaluation, which is more commonly used, is to evaluate parts of an extensive palusplain as several, separate entities (after defining the boundaries that are to be used in the assessment).

5. Desktop Assessment of Flora and Vegetation

5.1. Flora Desktop Study

A comprehensive search of the flora taxa of conservation significance (at the national, state and regional levels) that are known to have distributions that may include the survey area (or habitats similar to those found in these areas) was conducted in the literature and the databases of rare flora maintained by relevant agencies. The main aim of this search was to predict the occurrence of the taxa of conservation significance most likely to occur within the study area and so assist the targeted search and recognition of these taxa in the field survey. Apart from the names of these taxa and their listed conservation significance codes, other relevant information (where available) such as geographic distribution, locality records, growth form, habitat and flowering time was also included in the list compiled (Appendix B: Table A.1). The sources of these data are listed below.

- The list of Flora of National Conservation Significance was compiled from the *Threatened Flora Database* of the DEHWA (2008a).
- The list of Flora of State Significance (the taxa listed as DRF and Priority Flora in Western Australia) was compiled from searches of three WA DEC Threatened Flora Databases. The parameters for each search are shown below.

  a. The Threatened (Declared Rare) Flora Database, for records in the rectangle defined by the coordinates 320 00' 00" - 320 02'20" S and 1150 58' 00" - 1160 00' 10" E.

  b. The Western Australian Herbarium Specimen Database (WAHERB) for records in the rectangle defined by the coordinates above; and

  c. The *Declared Rare and Priority Flora List Database* for the locations Beckenham, Brixton, Cannington, Forrestfield, Gosnells, High Wycombe, Kenwick, Kewdale, Maddington, Maida Vale, Orange Grove, Perth Airport, Wattle Grove and Welshpool.
- The list of Flora of Regional Significance was compiled from the records of other field surveys conducted in the vicinity of the survey area (including Keighery and Keighery,2000; Govt of WA, 2000; Cardno BSD, 2005; Tauss, 2007; Keighery and Tauss, 2008; and Tauss and Weston, 2009). All geographical distributions were checked on FloraBase (WA Herbarium, 2008).
- Much of the data about localities, distributions and flowering times of many of these taxa were provided by the DEC database search output. Other data of form, features and habitats were added from Paczkowska and Chapman

(2000) and WA Herbarium (2008). Additional data was compiled from examination of herbarium specimens and their labels in the Western Australian Herbarium, consultations with other botanists, Marchant et al. (1987), Hoffman and Brown (1998) and relevant parts of the Flora of Australia series.

5.1.1. Flora of national conservation significance

Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Flora taxa (species, subspecies or varieties) that are listed as being of National Conservation Significance under the *EPBC Act 1999* are designated in one of the six categories (Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, Extinct in the Wild) as defined by DEWHA (2008a).

A search of DEWHA's *Threatened Species Database* (2008a) for the local government areas of Gosnells, Kalamunda and Canning showed that 14 Flora Taxa of National Conservation Significance listed under the *EPBC Act 1999* have been recorded in these areas. These taxa were *Acacia anomala* (Vulnerable), *Acacia aphylla* (Endangered), *Andersonia gracilis* (Endangered), *Anthocercis gracilis* (Endangered), *Caladenia huegelii* (Endangered), *Conospermum undulatum* (Vulnerable), *Darwinia apiculata* (Endangered), *Diuris drummondii* (Vulnerable), *Drakaea elastica* (Endangered), *Dryandra mimica* (Endangered), *Lasiopetalum pterocarpum* (syn. *Lasiopetalum* sp. Serpentine. S. Paust 1103A), *Lepidosperma rostratum* (Endangered), *Macarthuria keigheryi* (Endangered) and *Thelymitra stellata* (Endangered). Several of these taxa (*Acacia anomala,* Acacia aphylla, *Anthocercis gracilis*, *Darwinia apiculata*, *Lasiopetalum pterocarpum* and *Thelymitra stellata*) are typically restricted to rocky habitats of the Darling Plateau, thus they are unlikely to occur within the predominantly wetland settings of the current survey area.

Further searches of the literature and the databases of the DEC showed that six nationally significant flora species viz. *Andersonia gracilis* (Endangered), *Calytrix breviseta* subsp. *breviseta* (Endangered), *Diuris purdiei* (Endangered), *Eleocharis keigheryi* (Vulnerable), *Hydatella dioica* (Endangered) and *Lepidosperma rostratum* (Endangered) have been recorded in Bush Forever Site 387 (Govt. of WA). Additionally, there are also records of *Macarthuria keigheryi* (Endangered), *Tetraria australis* (Vulnerable) and *Caladenia huegelii* (Endangered) from Kenwick or nearby (WA Herbarium, 2008).

Two of the nationally significant flora taxa above (*Calytrix breviseta* subsp. *breviseta* and *Conospermum undulatum*) were recorded in Boundary Rd, Kenwick and Victoria Road, Maddington respectively by Cardno BSD (2005). *Conospermum undulatum* is also known to occur in the Clifford Road Bushland in Maddington (Bush Forever Site

53) (Bush Forever, 2000b). *Calytrix breviseta* var. *breviseta* has also been recorded from Boundary Rd in other field searches (WA Herbarium, 2008; Tauss and Weston, 2009). *Lepidosperma rostratum* and *Eleocharis keigheryi* have also been recorded by Koch (1994) in another Bush Forever Site in Kenwick, by Keighery and Tauss (2009) in BFS 387. Tauss and Weston (2009) also recorded *Lepidosperma rostratum* in Kenwick, outside of the Bush Forever site.

The flora taxa of national conservation significance that are most likely to occur in the vicinity of the survey area can thus be reduced to twelve taxa (Appendix B, Table A1). These are: *Andersonia gracilis*, *Caladenia huegelii*, *Calytrix breviseta* subsp. *breviseta*, *Conospermum undulatum*, *Diuris purdiei*, *Drakaea elastica*, *Dryandra mimica*, *Eleocharis keigheryi*, *Hydatella dioica*, *Lepidosperma rostratum*, *Macarthuria keigheryi* and *Tetraria australis*. Of these taxa, many are shrubs (*Andersonia gracilis*, *Calytrix breviseta* subsp. *breviseta*, *Conospermum undulatum*, *Banksia mimica* and *Macarthuria keigheryi*) that are either very conspicuous in flower during spring or are clearly distinguishable from other species in a vegetative state. The four EPBC listed sedge or sedge-like taxa in this list (*Eleocharis keigheryi*, *Hydatella dioica*, *Lepidosperma rostratum* and *Tetraria australis*) all occur in claypans, are difficult to distinguish in the field and are generally located only during intensive quadrat-based survey by experienced botanists. Two of the orchids are either conspicuous during their annual flowering (*Caladenia huegelii*) or have distinctive vegetative features (*Drakaea elastica*). The donkey orchid *Diuris purdiei* and the sedge *Tetraria australis* (both of which only flower after fire and otherwise have inconspicuous vegetative features) are probably the most cryptic of the rare species that could be present in the survey area.

5.1.2. Flora of state conservation significance

Wildlife Conservation Act 1950* and *Department of Environment and Conservation Priority Flora Taxa.

DRF taxa are protected under the *Wildlife Conservation Act 1950*. The list of taxa currently protected under this Act is gazetted in the *Wildlife Conservation (Rare Flora) Notice* (2007). Most DRF taxa, except recently-listed taxa, are usually also listed as Flora National Significance under the *EPBC Act 1999*. The DEC has also defined four classes of Priority Flora Taxa that are considered to be of conservation significance.

These taxa are grouped into four categories (Priority One, Priority Two, Priority Three, and Priority Four) depending on the perceived urgency of determining their formal conservation status as indicated by the degree of threat to these taxa.

10 DRF species are known from the vicinity of the current survey area (Appendix B, Table A1). These species are the same as the EPBC listed species for this area

except for *Eremophila glabra* subsp. *chlorella* that has not yet been listed at the Federal level but is expected to be listed in the near future after it undergoes the necessary assessment. In addition to the above, there are 44 Priority Species known from the area. Of these, 23 Priority Species have been recorded from Bush Forever Site 387.

5.1.3. Flora of regional conservation significance

Guidance Statement 51 (EPA, 2004b) and Bush Forever (WAPC, 2000) define several other criteria under which flora taxa or populations of these taxa may have conservation significance. In the current survey, such taxa are termed as being "regionally significant" when they occur on the eastern side of the SCP. The criteria for significance for these taxa (EPA, 2004b; WAPC, 2000) are:

- Populations that are at the limit of their known geographic range.
- Populations that are disjunct from their known geographic range.
- Taxa that are endemic to the eastern SCP.
- Taxa that are endemic to the SCP in the Perth Metropolitan Region.
- Taxa that are considered to be poorly reserved (applies to all DRF and Priority taxa).
- Populations that are significant in maintaining the regional presence of a flora taxon due to their location, population size, diversity of ages and/or health (applies to all DRF and Priority taxa).
- Taxa that are morphological variants or are otherwise significant taxonomically.
- Taxa that are uncommon in the area (generally applies to disjunct populations).
- Taxa that are significant due to their occurrence in restricted habitats of the eastern SCP.

In the current desktop survey, taxa considered regionally significant in a number of studies of the eastern SCP (including Keighery and Trudgen, 1992; Gibson et al., 1994; Keighery and Keighery, 2000; Govt of WA, 2000; Tauss, 2007; Keighery and Tauss, 2008, and Tauss and Weston, 2009) were reviewed against current known distributions on FloraBase (WA Herbarium, 2008). It was concluded that, currently, at least 80 regionally significant taxa are known from the vicinity of the survey area (Appendix B).

Most of these regionally significant taxa are confined to wetlands underlain by the Guildford Formation on the Pinjarra Plain and to the foothills of the Darling Range (on the eastern side of the SCP).

5.2. Vegetation Desktop Study

The eastern SCP is defined as the land encompassed by the McArthur and Bettenay (1960), Foothills and Pinjarra Plain geomorphic units (Govt of WA, 2000a and b). Less than 10% of the original extent of the vegetation of the eastern SCP now remains after the intensive agricultural use of the area and developments such as housing, industry and transport infrastructure (Bush Forever, 2000a and b). Therefore the native vegetation that remains on the eastern SCP is, considered to be of very high conservation significance.

Bush Forever Site 387 (The Greater Brixton St Wetlands) is the most species-rich area of all the Bush Forever Sites described in Bush Forever (WAPC, 2000) and as such is considered one of the most important conservation reserves in the *Swan Coastal Plain Biogeographical Region of Western Australia*. Currently more than 555 native plant taxa are known from the 127 ha of the Greater Brixton Street Wetlands (Keighery and Keighery, 2000).

5.2.1. Regional scale vegetation units of the Eastern Swan Coastal Plain

There have been numerous studies that have aimed to characterize, classify and/or map the vegetation types that are present within the *Swan Coastal Plain Biogeographical Region* to investigate the land-use capability of land that was covered with the native vegetation and to assess the conservation significance and reservation status of this vegetation. The terms Vegetation Systems, Vegetation Complexes and Vegetation Associations have been used to designate vegetation units mapped at various scales. All of these units are regional scale, high order units.

A. Vegetation Systems (Beard, 1979a)

Beard (1979a, 1979b, 1981) mapped the vegetation of the SCP as broad scale Vegetation Systems based on the structure of the dominant species of the canopy layer. In this mapping, the vegetation of most of the surevy area and the neighbouring area is indicated as Marri Woodland (e3Mi), of the Pinjarra Plain Vegetation System. In Beard's mapping the Pinjarra Plain extended from about Gingin to Dunsborough and was located between the Bassendean Vegetation System to the west and the Ridge Hill Shelf Vegetation System to the east. The Pinjarra Plain Vegetation System extended over soils that were optimum for pasture development and irrigation. Beard (1979a) considered that very little (if any) of this vegetation system was still extant and that any remnants were either relic trees over pasture grasses; a shrub layer with ground cover that was completely replaced by pasture plants; or ungrazed road verges that were only an indication of the nature of the original vegetation.

B. Vegetation Complexes (Heddle et al., 1980)

Heddle et al. (1980) characterized a number of vegetation units that were termed Vegetation Complexes of the Perth Region. The Vegetation Complexes were mapped on the assumption that the distribution of distinctive vegetation complexes (each complex comprising a number of plant communities aggregated in proportions characteristic of that complex) was correlated with the major geomorphic systems and soil units of the region (McArthur and Bettenay, 1960 and Churchward and McArthur, 1980, respectively).

In the vicinity of the surevy area (where the Ridge Hill Shelf, Pinjarra Plain and the Bassendean Dunes geomorphic systems are present) there were six Vegetation Complexes mapped by Heddle et al. (1980) viz. Forrestfield, Guildford, Swan, Cannington, Southern River and Bassendean Central and South. The relevant geomorphic units, the vegetation complexes associated with these geomorphic units and the percentage of native vegetation remaining within each vegetation complex in the Perth Metropolitan Area, as determined in Bush Forever (WAPC, 2000) are listed below (Table 15).

C. Vegetation Associations (Keighery and Trudgen, 1992)

In a study of the vegetation of the eastern SCP, Keighery and Trudgen (1992) identified several main Vegetation Associations within the Pinjarra Plain landform. These are listed below.

- *Corymbia calophylla* Woodland to Open Forest.
- *Casuarina obesa* Woodland to Open Forest.
- *Corymbia calophylla* and *Eucalyptus wandoo* Woodland to Open Forest.
- *Eucalyptus wandoo* Woodland to Open Forest.
- *Eucalyptus rudis* Woodland to Open Forest.
- Ephemeral Wetlands, a complex mosaic of shrublands, heaths, sedgelands and herblands.

The *Corymbia calophylla* and the *Casuarina obesa* woodlands and open forests and the wetland vegetation mosaic were considered to be the most common units prior to the large-scale clearing of the Pinjarra Plain.

5.2.2. Sub-regional scale vegetation units of the Eastern Swan Coastal Plain: Floristic Community Types

Early work to classify the vegetation of the SCP using numerical classification of floristic data was carried out by Havel (1968). Subsequent to the determination and mapping of the Vegetation Complexes of the SCP by Heddle et al. (1980), more comprehensive survey and analysis of the vegetation of the SCP was carried out by Gibson et al. (1994) to define finer-scale vegetation units than those of the regional-

scale Vegetation Systems of Beard (1979a) and the Vegetation Complexes of Heddle et al. (1980). The vegetation units derived by Gibson et al. (1994) and in subsequent updates referred to in Bush Forever (WAPC, 2000a) are known as the FCTs the SCP by Gibson et al. 1994 (SWA FCTs).

At least 15 FCTs has been identified in the City of Gosnells by Trudgen and Keighery (1995) and in the Bush Forever Sites of Cannington, Forrestfield, Kenwick, Maddington, Orange Grove, Queens Park, Southern River, Welshpool and Wattle Grove by various workers (Bush Forever, 2000b). (Some of the FCTs above were identified by inference rather than by multivariate analysis). The FCTs that have been listed in the vicinity of the survey area have been listed in Table 16.

5.2.3. Vegetation of conservation significance

Some of the native vegetation types in Western Australia that have been recognized as rare and/or threatened are listed as TECs under the *EPBC Act 1999*. Such vegetation is of National Conservation Significance under the *EPBC Act 1999* and is designated as one of six categories (Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, Extinct in the Wild) as defined by the Department of Environment, Water, Heritage and the Arts (DEWHA, 2008b). See Appendix B for definitions of the *EPBC Act 1999* categories.

The DEC also maintains a list of TECs that have been endorsed by the Western Australian Threatened Species and Communities Scientific Committee and the Environment Minister of Western Australia, but some of these are, as yet, not endorsed at the Federal level. These TECs are designated categories that are defined under the same criteria and are equivalent to the categories of TECs under the *EPBC Act 1999*. The DEC also maintains a list of TECs that have been endorsed by the Western Australian Threatened Species and Communities Scientific Committee but are yet to be endorsed by the Environment Minister of Western Australia. The latter TECs are designated as Priority Threatened Ecological Communities (PTECs).

A. Vegetation of National Significance

A search of the DEWHA's *Threatened Ecological Community Database* (2008b) for the local government areas of Gosnells, Kalamunda and Canning and further searches (including Trudgen and Keighery, 1995; Bush Forever, 2000; and the DEC *Threatened Ecological Community Database* for Cannington, Forrestfield, Kenwick, Maddington, Orange Grove, Queens Park, Southern River, Welshpool and Wattle Grove) showed that three TECs, listed under the *EPBC Act 1999* occur in this area (Table 17). These TECs were:

- SCP FCT 3a: *Eucalyptus calophylla –Kingia australis* woodlands on heavy soils (Endangered);

- SCP FCT 3b: *Corymbia calophylla Eucalyptus marginata* woodlands on sandy clay soils (Endangered); and
- Shrublands and woodlands on Muchea Limestone (Keighery and Keighery, 1995) (Endangered).

B. Vegetation of State Conservation Significance

A search of the *Threatened Ecological Communities Database* of DEC (2008b) and searches of the literature (including Trudgen and Keighery, 1995; WAPC, 2000) for Cannington, Forrestfield, Kenwick, Maddington, Orange Grove, Queens Park, Southern River, Welshpool and Wattle Grove showed that occurrences of nine TECs have been recorded in and are listed by the DEC (Table 17). These nine TECs have all been assessed under the same criteria as are used to determine TECs under the *EPBC Act 1999* and thus they are, in the scientific sense, all of national conservation significance. There were no PTECs listed by DEC (2008b) for this area.

6. Flora Field Survey

The native flora of the remnant vegetation of the survey area was found to be moderately species-rich, rich in rare flora and very rich in species of regional conservation significance. In Lot 36, the native flora has been replaced by a species-poor, naturalized alien assemblage of pasture grasses and herbs. A total of 164 taxa (96 taxa of native vascular flora and 68 taxa of naturalised alien flora) (Appendix C) were recorded in 14 sampling sites (quadrats) (Appendix D) and in reconnaissance transects through the survey area (Figure 5). In Lots 28 and 32, there was a range of 13 to 61 taxa recorded per 10m x 10m quadrat. The heath that inhabited the palusplain in the south of Lot 28 was the most species-rich vegetation type. The *Melaleuca rhaphiophylla* low open forest that inhabited the sumplands/damplands of the survey area was the least species-rich vegetation type.

The percentage of the total native flora that was comprised of native annual taxa in Lot 28 in the current survey was comparable to that known generally from the Greater Brixton Street Wetlands and more than twice that recorded by Mattiske and Associates (1992). This result probably indicates a greater intensity of survey in the current study rather than a depauperate flora in the blocks that were surveyed in Mattiske and Associates (1992). However from the current survey it was clear that Lots 28 and 32 were not as species- rich as some of the other blocks in BFS 387 (for example the UWA Allison Baird Flora Reserve in Brook Rd and Lot 106 Wanaping Rd). This relative paucity of native species in the current survey area was probably related to the relatively heterogeneous landscape rather than any degradation in Lots 28 and 32 in comparison to the very rich assemblage of soils and landforms in the UWA Reserve and Lot 106 Wanaping Rd.

Lots 28 and 32 were also found to be much richer in rare flora than was previously known (Table 18; Table 19). Mattiske and Associates (1992) recorded only one flora species of conservation significance from Lot 28 (*Grevillea thelemanniana* P4) and did not assess the regional conservation significance of the flora in the area. In the current survey, one flora species of National Conservation Significance (NES), *Lepidosperma rostratum*, was found in Lot 28. Another species, *Eremophila glabra* subsp. chlorella, which has recently been listed as DRF in Western Australia (and thus has been demonstrated to conform to the same criteria as Threatened Flora listed under the *EPBC Act 1999*), was also found in Lot 28. A third species, *Grevillea thelemanniana*, that is currently listed as Priority 4 by DEC in Western Australia (but is likely to be nominated for listing as DRF in the near future) was also found to be common in Lot 28 and Lot 32. Four other Priority Species listed by DEC in Western Australia [*Austrostipa juncifolia* subsp. Southern River (B.J. Keighery 2160) (P1); *Trichocline* sp. Treeton (B.J. Keighery and N. Gibson 564) (P2); *Baeckea* sp. Perth Region R.J. Cranfield 444 (P3); *Verticordia lindleyi* subsp. *lindleyi* (P4)] were also

found in the current survey. A further 39 taxa of the surevy area (approximately 41% of the native flora taxa) are considered to be of regional conservation significance (Bush Forever, 2000b; BJ Keighery pers.comm; see below for further details). All of the species of conservation significance found in the survey area are discussed in more detail below.

6.1. Flora of National Conservation Significance

*Lepidosperma rostratum (*Cyperaceae) also known as Beaked Lepidosperma (Plate 1) and is currently listed as Endangered under the *EPBC Act 1999* (DEWHA, 2008aandc).



Plate 1: *Lepidosperma rostratrum* habit (left) and inflorescence detail (right). (Photos: M. Owen from Keighery and Tauss, 2008)

Lepidosperma rostratum is a rather inconspicuous perennial sedge that forms small clumps less than about 0.3m in height. It is often mistaken for other sedges. *Lepidosperma rostratum* was found on Lot 28.

Prior to this survey, *Lepidosperma rostratum* was known from four blocks on Boundary Rd, Kenwick (Tauss and Weston, 2009; WA Herbarium, 2008), from wetlands adjacent to Brixton St, Kenwick (Koch, 2003; Keighery and Tauss, 2008) and from Forrestdale Lake Nature Reserve (WA Herbarium, 2008).

Lepidosperma rostratum occurrences in Kenwick (Tauss and Weston, 2009; WA Herbarium, 2008) often coincide with occurrences of another endangered species (*Calytrix breviseta* subsp. *breviseta*). *Calytrix breviseta* subsp. *breviseta* was not found in Lot 28; however the survey area does include habitat suitable for *Calytrix breviseta* subsp. *breviseta*. There is no data about the reproductive biology of

Lepidosperma rostratum. As this sedge lacks extensive rhizomes, it is likely to be an obligate re-seeding species.

6.2. Flora of State Conservation Significance

One taxon currently listed as DRF under the *Wildlife Conservation Act 1950* was found in Lot 28 and four other taxa of State Conservation Significance (that are currently listed as Priority Flora by the DEC) (Atkins, 2008) found in the current field survey of Lot 28. Two of the above Priority Taxa were also found in Lot 32. These DRF and Priority Taxa are described below.

Eremophila glabra subsp. *chlorella* (Myoporaceae) (DRF) is a shrub less than about 1.1m in height with green flowers in June-July (Plate 2). This taxon was recoded on Lot 28 (Figure 5).



Plate 2: *Eremophila glabra* susbp. *chlorella* (Photo: M. Owen from Tauss and Weston, 2009).

This subspecies of *Eremophila glabra* is known from wetlands on clay soils in a number of small populations from Dandaragan to Kenwick. Most of the records in the Perth region are from locations where it is probably no longer extant due to clearing for urban development. There is also an outlying record from Quairading in the Avon-Wheatbelt Region.

Eremophila glabra var. *chlorella* appears to be an obligate re-seeder. Lot 28 is the only location where this taxon is currently extant in BFS 387. Although the habitat of *Eremophila glabra* var. *chlorella* is poorly known, this subspecies appears to be a calcicole. The only other locations where it has been recorded on the SCP are in an occurrence of the Muchea Limestone TEC in Cannington (B.J. Keighery .pers.comm.)

and in a privately-owned block (that has calcareous sediments at depth) in Kenwick (Tauss and Weston, 2009); both locations are outside of BFS 387.

Austrostipa juncifolia subsp. Southern River (B.J. Keighery 2160) (Poaceae) (Priority 1) is a large, caespitose perennial grass (Plate 3). It was recorded in Lot 28 (Figure 5) on palusplain 7773 (Plate 3). This taxon has been recorded only once before on the SCP in the EPBC listed Muchea Limestone TEC at Passmore Road in Southern River (City of Gosnells) (WA Herbarium,2008). It is not known from BFS 387 apart from the population in Lot 28.

Trichocline sp. Treeton (B.J. Keighery and N. Gibson 564) (Asteraceae) (Priority 2) is a perennial daisy with narrow, spathulate leaves and a large white inflorescence (Plate 4). *Trichocline* sp. Treeton was recorded on Lot 28 (Figure 5). This species is inconspicuous when not in flower; it has been recorded previously in BFS 387 (Keighery and Keighery, 2000) and in Kenwick on private land (Tauss and Weston, 2009).



Plate 3: *Austrostipa juncifolia* subsp. Southern River.



Plate 4: *Trichocline* sp. Treeton (B.J Keighery and N. Gibson 564).

Baeckea sp. Perth Region R.J. Cranfield 444 (Myrtaceae) (Priority 3) is a sparse shrub less than about 1m in height that carries small pink and white flowers in summer. It occurs in wetlands in two very disjunct areas; Badgingarra and Kenwick-Oakford, and is often associated with *Banksia telmatiaea*. This taxon was common in Lots 28 and 32 in dense heath.

Grevillea thelemanniana (Proteaceae) (Priority 4) is an attractive low or prostrate shrub with dark red flowers and leaves divided into small flat leaflets. This attractive

shrub was recorded on Lots 28 and 32. There has been some confusion in the past about the taxonomy of this plant. It was previously recognised as a subspecies within the *Grevillea thelemanniana* complex but was raised to specific status in 1995 by Olde and Marriot. Further work on the *Grevillea thelemanniana* complex is continuing to recognize additional of taxa within this complex. The form of *Grevillea thelemanniana* from the Greater Brixton Street Wetlands is now considered to be confined to the Kenwick-Cannington area. A closely related taxon grows on the wetlands in the Cooljarloo area. A further taxon in the group is confined to a creekline in the Gillingarra area on the Dandaragan Plateau.

Various members of the *Grevillea thelemanniana* complex have been intensively bred by horticulturalists and are now commonly planted in gardens. However the progenitor of these horticultural icons is highly threatened in its natural habitat in Kenwick. Although this shrub is still relatively abundant in the Greater Brixton Street Wetlands, its natural range is very small and its survival depends on the conservation of the fragmented populations of this species in BFS 387. The very small range of this species qualifies it for listing as Threatened Flora (B.J. Keighery, DEC, pers.comm.). As it appears to be a bird pollinated species, its reproduction is probably also dependent on the maintenance of local bird habitats.

Verticordia lindleyi subsp. *lindleyi* (Myrtaceae) (Priority 4) is a shrub less than 0.5m in height with sprays of pretty pink flowers in late spring. This species is endemic to the eastern side of the SCP and most of its previous habitat has been cleared. The Kenwick area includes significant populations of this species in the Greater Brixton Street Wetlands. Several plants of this species were recorded on Lot 233 Bickley Road amongst heath on the edge of the palusplain.

6.3. Flora of Regional Conservation Significance

Apart from EPBC-listed, DRF and Priority Species, the EPA (2004b) and WAPC (2000b) define a third set of criteria under which flora taxa (i.e. species, sub-species or varieties) may have conservation significance. This set of criteria is referred to in this report as 'regional conservation significance'.

The survey area was found to include at least 39 flora taxa that can be considered as regionally significant under these criteria (Table 20). A description of some of the more significant of these taxa is provided in Appendix B. For further taxonomic notes, particularly for the taxa names below that have not been aligned with the current nomenclature of WA Herbarium (2008) see Appendix C.

7. Vegetation Field Survey

7.1. Vegetation Units

The vegetation data collected in the quadrats of the survey area were tabulated and then the sites were grouped into five main vegetation units that were derived very simply from the variation between quadrats with regard to dominant structural and floristic characteristics (Table 21). This provided a description of the main fine-scale vegetation units present within the survey area and facilitated the mapping of the vegetation types and the condition of each vegetation type within the survey area (Figures 6a and 7).

7.1.1. Vegetation Unit 1

Vegetation Unit 1 was the most species-rich vegetation within the survey area. It was confined to the south of Lots 28 and 32 and it was mainly in very good condition. This vegetation comprised a fine scale, complex mosaic of two main vegetation types (designated 1a and 1b below) that were very similar in floristic composition but differed in the relative abundance of certain dominant species. This mosaic could not be accurately mapped at a scale of 1:2000. Vegetation Unit 1a was more species-rich and included a number of native annuals that were not present in Vegetation Unit 1b. Vegetation Unit 1b included a number of small naturalized alien grasses that were not present in Vegetation Unit 1a. Therefore some of the floristic and abundance differences between these two vegetation types may be attributable to differing degrees of disturbance and subsequent weed invasion in the two units. There were however few signs of disturbance in this vegetation apart from some small and localized soil disturbances and a number of old dumped vehicles. The weed cover was very low in this vegetation and there were no highly invasive weeds except for one or two plants of **Asparagus asparagoides*, **Echium plantagineum*, **Sparaxis bulbifera* and **Watsonia meriana* subsp. *bulbillifera*. Most of the tracks throughout this unit were regenerating very well and showed abundant recruitment of native shrubs, annuals and geophytes, and few weeds.

The two sub units of this vegetation type are described below.

1a. Mid-dense to closed heath-scrub dominated by *Actinostrobus pyra*midalis, *Banksia telmatiaea*, *Hypocalymma angustifolium* Mud Habitats Variant (C.Tauss 1850) and *Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes, *Schoenus subfascicularis* sedges and open native annual and perennial herbs including *Brachyscome pusilla*, *Centrolepis aristata*, and *Thysanotus manglesianus*.

The *Actinostrobus pyramidalis* was up to about 4m in height in some places, and in these areas, the understorey was dominated by an atypically tall formation of dense *Hypocalymma angustifolium* Mud Habitats Variant (C.Tauss 1850) (up to about 2.3m

in height). More commonly however, this vegetation was a dense heath less than 2m in height with a number of co-dominant shrub species.

Associates of this vegetation included *Acacia lasiocarpa* var. l*asiocarpa* sens strict., *Acacia stenoptera*, *Angianthus preissianus*, *Aphelia cyperoides*, *Baeckea* sp. Perth Region (R.J. Cranfield 444), *Hakea varia*, *Melaleuca brevifolia*, *Caladenia paludosa*, *Calandrinia granulifera*, *Calothamnus hirsutus*, *Cassytha glabellla*, **Cicendia filifolia*, *Crassula colorata* var. *acuminata*, **Disa bracteata*, Drosera glanduligera, *Drosera heterophylla*, *Drosera macrantha* subsp. *macrantha*, *Drosera menziesii* subsp. *menziesii*, *Gahnia trifida*, *Goodenia micrantha*, *Grevillea thelemanniana*, *Haemodorum laxum*, **Heliophila pusilla*, *Hydrocotyle alata*, **Hypochaeris glabra*, *Isolepis stellata*, **Juncus capitatus*, *Juncus pauciflorus*, *Lepidosperma* sp. Kenwick C.Tauss 2598, *Leucopogon polymorphus*, **Lotus subbiflorus*,**Monopsis debilis*, **Parentucellia latifolia*, **Parentucellia viscosa*, *Phyllangium paradoxum*, *Pogonolepis strictus*, *Quinetia urvillei*,**Sparaxis bulbifera*, *Stylidium calcaratum*, *Thelymitra antennifera*, *Thelymitra crinita*, *Thelymitra* sp., Tribonanthes australis, *Triglochin muelleri*, *Trithuria bibracteata*, *Utricularia multifida*, *Verticordia densiflora* subsp. *densiflora*, *Verticordia plumosa* var. *brachyphylla*, *Verticordia lindleyi* subsp. *lindleyi*.

Species present in Vegetation Unit 1a but not in Vegetation Unit 1b were *Pogonolepis strictus*, *Leucopogon polymorphus*, *Melaleuca seriata*, **Sparaxis bulbifera*, *Stylidium calcaratum*, *Thelymitra crinita*, *Triglochin muelleri*, *Trithuria bibracteata* and *Utricularia multifida*.

1b. Mid-dense to closed heath of *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) - *Acacia lasiocarpa* with emergent open shrubs of *Actinostrobus pyramidalis- Melaleuca lateriflora-Melaleuca brevifolia* over open *Chaetanthus aristatus -Gahnia trifida* rushes/sedges and *Centrolepis aristata*, *Brachyscome pusilla*, *Thysanotus manglesianus* mid-dense annual herbs.

Associates of this vegetation included *Angianthus preissianus*, *Aphelia cyperoides*, *Banksia telmatiaea*, *Boronia crenulata* subsp. *viminea*, **Briza maxima*, **Briza minor*, *Caladenia paludosa*, *Calothamnus hirsutus*, *Cassytha glabellla*, *Crassula colorata* var. *acuminata, Drosera macrantha* subsp. *macrantha*, *Drosera menziesii* subsp. *menziesii* , **Echium plantagineum*, *Grevillea thelemanniana*, *Hydrocotyle alata*, **Hypochaeris glabra*, *Juncus pauciflorus*, *Lepidosperma* sp. Kenwick C.Tauss 2598,**Monopsis debilis*, **Parentucellia latifolia*, **Parentucellia viscosa*, **Pentaschistis aeroides*, *Phyllangium paradoxum*, *Podolepis gracilis*, ** Romulea rosea* var. *australis*, *Samolus junceus*, *Thelymitra antennifera*, *Thelymitra* sp., *Tribonanthes australis* and **Vulpia bromioides*.

Species present in Vegetation Unit 1b but not in Vegetation Unit 1a were **Briza maxima*, **Briza minor*, **Echium plantagineum*, **Pentaschistis aeroides*, P*odolepis gracilis, * Romulea rosea* var. *australis*, *Samolus junceus* and **Vulpia bromioides*.

7.1.2. Vegetation Unit 2

Mid-dense to closed heath of *Hypocalymma angustifolium- Acacia lasiocarpa-Actinostrobus pyramidalis* with emergent open shrubs of *Melaleuca lateriflora*-M. *brevifolia* over open *Chaetanthus aristatus - Gahnia trifida* rushes/sedges and mid-dense annual herbs dominated by *Centrolepis aristata* and *Pogonolepis strictus*.

Associates of this vegetation included **Anagallis arvensis* var. *caerulea, Aphelia cyperoides*, *Austrostipa juncifolia* subsp. Southern River (B.J. Keighery 2160), *Boronia crenulata* subsp. *viminea*, **Briza maxima*, **Briza minor*, *Calothamnus hirsutus*, *Cassytha glabellla*, *Cassytha racemosa*, **Centaurium erythraeum*, **Cicendia filifolia*, *Comesperma* aff. *polygaloides* (C. Tauss 2541), *Crassula colorata* var. *acuminata*, **Dittrichia graveolens*, *Dodonaea ceratocarpa*, *Drosera menziesii* subsp. *menziesii*, *Eremophila glabra* subsp. *chlorella*, *Goodenia micrantha*, *Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn , *Grevillea thelemanniana*, **Heliophila pusilla*, **Hordeum geniculatum*, **Hypochaeris glabra*, **Juncus capitatus*, *Juncus pauciflorus*, *Lawrencia squamata*, *Lepidosperma* sp. Kenwick C.Tauss 2598, *Lepidosperma rostratum*, **Lotus subbiflorus*, *Meeboldina roycei*,**Monopsis debilis*, **Moraea flaccida*, *Opercularia vaginata*, **Parentucellia latifolia*, **Parentucellia viscosa*, *Phyllangium paradoxum*, *Pimelea imbricata* var. major, *Podolepis capillaris*, *Podolepis gracilis* Swamp Form (GJ Keighery 12803), * *Romulea rosea* var. *australis*, *Samolus junceus*, *Scaevola lanceolata*, **Sparaxis bulbifera*, *Thysanotus manglesianus*, *Tribonanthes australis*, *Trichocline* sp. Treeton (B.J. Keighery and N. Gibson 564),. **Ursinia anthemoides*, *Verticordia densiflora* subsp. *densiflora* and **Vulpia bromioides*.

This vegetation was moderately species-rich and included most of the rare species recorded within Lot 28. This vegetation was generally a low, dense heath that was dominated by three re-seeder species *Hypocalymma angustifolium*, *Acacia lasiocarpa* and *Actinostrobus pyramidalis* and three re-sprouter species *Melaleuca lateriflora* subsp. *acutifolia*, *Melaleuca brevifolia* and *Grevillea thelemanniana*. This vegetation was distributed through the central area of Lot 28. Although it was recovering from a recent fire over most of its extent, it was generally in good to very good condition. There were few other signs of disturbance in this vegetation apart from some small and localized soil disturbances and a number of old dumped vehicles. The weed cover was very low in this vegetation and the weeds were mostly not highly invasive species (except for some small discrete patches of **Avena barbata* and **Ehrharta calycina* and sparse, occasional **Echium plantagineum*,**Gladiolus undulatus*, **Sparaxis bulbifera* and **Watsonia meriana* subsp. *bulbillifera*). Most of the tracks throughout this unit were regenerating very well and showed abundant recruitment of native shrubs, annuals and geophytes, and few weeds.

7.1.3. Vegetation Unit 3

Vegetation Unit 3 was the relatively species-poor and was confined to the edges of *Melaleuca rhaphiophylla* inhabited swales and basins in Lots 28 and 32. This vegetation comprised two structural formations scrub and heath (designated 3a and 3b respectively) that were very similar in floristic composition. The structural difference could probably be attributed to differing fire histories of the areas inhabited by these two vegetation sub-types. There were few signs of disturbance in this vegetation apart from a recent fire in some areas; some small and localized soil disturbances and a number of old dumped vehicles. The weed cover was generally very low in this vegetation (except for some patches of the grass **Cynodon dactylon* near Brook Rd in areas of soil disturbance). There were no other highly invasive weeds except for one or two plants of **Asparagus asparagoides*, **Sparaxis bulbifera* and **Gladiolus undulatus* confined to small areas. Most of the tracks throughout this unit were regenerating very well and showed abundant recruitment of native shrubs, annuals and geophytes, and few weeds.

The two sub units of this vegetation type are described below.

3a. Mid-dense scrub *of Melaleuca viminea- Actinostrobus pyramidalis* over heath of *Hypocalymma angustifolium- Acacia lasiocarpa* over sparse *Chaetanthus aristatus* rushes and sedges and sparse annual herbs

3b Mid-dense to open heath *of Melaleuca viminea- Hypocalymma angustifolium-Acacia lasiocarpa* over mid-dense *Actinostrobus pyramidalis* seedlings, open naturalized alien grasses and open annual herbs dominated by *Centrolepis aristata* and *Pogonolepis strictus*.

Associates of this vegetation included *Acacia saligna* var. *saligna, *Anagallis arvensis* var. *arvensis, Baumea juncea*,**Briza maxima*, *Cassytha glabellla*, *Cassytha racemosa*, **Cicendia filifolia*, *Comesperma* aff. *polygaloides* (C. Tauss 2541),**Dittrichia graveolens*,**Ehrharta calycina*, *Goodenia micrantha*, *Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn , *Grevillea thelemanniana*, **Heliophila pusilla*, **Hordeum geniculatum*, *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850), **Juncus capitatus*, *Juncus pauciflorus, Lawrencia squamata*,**Lolium multiflorum*, **Lotus subbiflorus*, **Lythrum hyssopifolium* , *Melaleuca brevifolia*, *Melaleuca lateriflora* subsp. *acutifolia*, *Melaleuca rhaphiophylla*,**Monopsis debilis*, **Parentucellia viscosa*, **Plantago coronopus*, *Podolepis gracilis* Swamp Form (GJ Keighery 12803), *Samolus junceus*, *Schoenus subfascicularis *Sparaxis bulbifera*, *Tecticornia lepidosperma*, *Thysanotus manglesianus*, *Tribonanthes australis*, *Viminaria juncea*,**Vulpia bromioides* and *Wilsonia backhousei*.

7.1.4. Vegetation Unit 4

Vegetation Unit 4 was *Melaleuca rhahiophylla* low open forest to woodland over *Melaleuca viminea* low open shrubs, sparse sedges and open grasses.

This vegetation was relatively species-poor and was confined to shallow swales and basins in the surevy area. There were some moderate signs of disturbance in much of this vegetation with localized soil disturbances; a number of old dumped vehicles and weed invasion of the understorey. The weed cover was generally sparse to moderate (except on Lot 36 where the native understorey was dominated by pasture herbs, grasses and other weeds).and comprised naturalized alien grasses including **Cynodon dactylon*, **Ehrharta calycina*,**Ehrharta longiflora* and **Pennisetum clandestinum*.

Associates of this vegetation included *Acacia saligna* var. *saligna*, **Asparagus asparagoides*, *Astartea affinis*, *Banksia littoralis*, *Baumea juncea*,**Bromus diandrus*, **Briza maxima*, *Cassytha racemosa*, *Centrolepis aristatus*, *Eucalyptus rudis* subsp. *rudis*, **Euphorbia terracina*, *Ficinia nodosa*, *Gahnia trifida, *Gladiolus undulatus*, *Hypocalymma angustifolium* Mud Habitat Variant (C.Tauss 1850), *Jacksonia sternbergiana*, *Lepidosperma longitudinale*, **Lolium multiflorum*, *Lobelia anceps*,**Lotus subbiflorus*, **Lythrum hyssopifolium*, *Melaleuca brevifolia*, **Phytolacca octandra*,**Rumex crispus*, *Schoenus subfascicularis* **Sparaxis bulbifera*, *Viminaria juncea* and **Vulpia bromioides*.

7.1.5. Vegetation Unit 5

Vegetation Unit 5 was *Corymbia calophylla* (Marri) low woodland over pasture grasses and herbs. There were only two small areas of this vegetation (in Lots 32 and 36) and both had a degraded understorey dominated by pasture grasses and herbs. Associates of this unit included *Acacia pulchella* var. glaberrima, *Schoenus subfascicularis* and Xanthorrhoea brunonis.

7.2. Conservation Significance of the Vegetation

All of the remnant native vegetation that was recorded within the survey area is part of the Guildford Vegetation Complex. This was clear from several lines of evidence. Firstly, the stratigraphy and hydrology of all of the study sites in the survey area (except potentially H16 and H18) was characteristic of the alluvial fan deposits of the Pinjarra Plain. Secondly the floristic composition of the vegetation (that comprised assemblages with overwhelming numbers of taxa that are either confined to the eastern SCP or are regionally significant on the eastern SCP) was characteristic of the Guildford Vegetation Complex. Thirdly, when the floristic data matrix collected in the current survey (Appendix D) was analysed via cluster analysis by Griffin and Associates (Appendix A), the sites of the current survey clustered with other sites

recorded from the Guildford Vegetation Complex in the study of Gibson et al. (1994). As most of the original vegetation of the Guildford Vegetation Complex has been cleared, with only 6% or less of the former area of this vegetation now remaining uncleared (WAPC, 2000), all of the native vegetation remaining in Lots 28 and 32 is considered to be of, at least, regional conservation significance.

The range of fine-scale vegetation units that were determined within the survey area was compared (Tables 22, 23 and 24) to units that have been mapped previously (at a similar scale) within the Greater Brixton Street Wetlands (in Mattiske and Associates, 1992; the various studies collated by Marshall, 2000; and the study of VCSRG, 2001; respectively). This comparison was carried out to gain a general appreciation of the similarities and differences between the vegetation of the survey area and other areas of the City of Gosnells and the Greater Brixton Street Wetlands. The latter was important as a 'first pass' check to determine if there were any vegetation types that are present in the survey area that may not be represented locally within the conservation estate of Bush Forever.

The comparison of the vegetation units recorded in the current survey with those mapped in a nearby area surveyed by Mattiske and Associates (1992) (Table 22), showed little similarity. As the latter survey was conducted at essentially a reconnaissance level and the field work was done in early summer (when many wetland taxa of BFS 387 are largely inconspicuous).

The comparison of the vegetation units recorded in the current survey with those collated from all previous surveys of BFS 387 by Marshall (2000) (Table 23) showed that four of the main vegetation units recorded in the current survey (Units 1, 2, 4 and 5) had some affinity with the vegetation units recorded by others in BFS 387 in the habitats of water-filled depressions and seasonally waterlogged or inundated flats. The Marri unit of the current survey was a degraded and very small remnant and therefore not of conservation significance. There was insufficient floristic or habitat information in Marshall (2000) to assess the extent to which the other three vegetation units of Lots 28 and 32 were represented elsewhere in BFS 387. On the very limited data provided in Marshall (2000) it appeared that Vegetation Unit 3 that was recorded in the survey (*Melaleuca viminea/Actinostrobus pyramidalis* heath and scrub) has not been previously recorded or mapped in BFS 387.

The comparison of the vegetation units recorded in the survey with those recorded in VCSRG (2001) was a little less difficult than the preceding comparisons as the survey used the same terminology for recording landforms and habitats as VCSRG (2001). From this, it could be seen that four of the main vegetation units recorded in the survey (Units 1, 2, 4 and 5) had close affinity with the vegetation units and habitat units as recorded by VCSRG (2001). As before, Vegetation Unit 5, the Marri unit could be discounted as it was degraded and very small remnant and therefore not of conservation significance.

There was also significant similarity between Vegetation Units 3a and 3b in the survey and the *Melaleuca uncinata* inhabited dampland channels recorded by VCSRG (2001) in the area between Brook and Boundary Rd in the east of BFS 387. This *Melaleuca* vegetation unit was not recorded previously in BFS 387. As the taxonomy of *Melaleuca uncinata* in the Perth Region has been unclear for many years and has only recently become resolved, it is possible that *Melaleuca viminea* may have been misidentified as *Melaleuca uncinata* in VCSRG (2001). The taxon that was formerly known as *Melaleuca uncinata* in the Perth Region has now been determined as *Melaleuca osullivanii* (WA Herbarium, 2008). The latter taxon was confirmed by Tauss and Weston (2009) on the banks of Yule Brook not far from the current survey area. However, it is probable that Vegetation Unit 3 is a rather uncommon vegetation unit in BFS 387 that is either confined entirely to the current survey area or perhaps extends a little further into the adjacent blocks in BFS 387.

The multivariate analysis conducted of the floristic data matrix collected in the current survey (Appendix E) in combination with the SCP dataset of Gibson et al. (1994) (to determine the similarity between the survey sites and the FCTs of the latter), produced a number of insights into the conservation values of vegetation in the survey area (Appendix A). However, this analysis encountered a number of common methodological problems. The sites of the current survey did not fit the FCTs of the SCP very well and two possible reasons for this were proposed by Griffin (Appendix A). The first reason was that the survey area may have been subject to disturbance (such as loss of native species and/or the addition of weed species to quadrat data) and this disturbance may have altered the floristic composition of the survey sites significantly in comparison to the sites that Gibson et al. (1994) may have sampled in closely related vegetation. The second possible reason was that the survey area included vegetation that was poorly sampled (or not sampled at all) in Gibson et al. (1994) and thus there was little or no basis for true comparison of the two datasets.

From the field survey it was evident that some of the sites in the survey were surveyed in largely undisturbed vegetation at sites such as Q1, Q2 and Q4 and some of the sites were sampled in relatively disturbed vegetation e.g. the sites at Q9 and Q14. However it was also evident that many of the sites in the current survey included a significant proportion of flora taxa that were not encountered or rarely encountered in the sample of the SCP vegetation collected by Gibson et al. (1994). The latter automatically reduced the statistical similarity between such sites in the current survey and the sites of Gibson et al. (1994) as these taxa were eliminated from the survey dataset before analysis. This decreased the likelihood of the survey sites clustering with known FCTs of the SCP.

The results of the analysis with regard to the individual sites in the current survey are briefly discussed below to explain the conclusions arrived at with regard to the

affinities of the vegetation in the current survey and the FCTs and TECs known from the vicinity of the survey area (Tables 25 and 26; Figure 6b).

7.2.1. Site Q1

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q3 and Q8 in the current study, Ellen-1 (FCT 8), Q11and Q5 in the current study, Ellen-2 (FCT 8), Q12 in the current survey, Ellen-5(FCT 8) and Q13 in the current survey. This site was in very good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q1 in the Kenwick – Wattle Grove area. This site is considered to have affinity to SCP FCT 8 (Herb-rich Shrublands in Claypans) which is listed as a Vulnerable TEC by the DEC.

7.2.2. Site Q2

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q5, Q4, Q11, Q14, Q3, Q7, Q10, Q1, Q6, Q8 in the current survey rather than any of the sites in Gibson et al., (1994). This site was in very good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q2 in the Kenwick – Wattle Grove area. As sites dominated by *Actinostrobus pyramidalis* are rare on the SCP and were not well sampled in Gibson et al., (1994), palusplains were also poorly sampled and Q2 is not a weed dominated wetland; the provisional result of the analysis (FCT 6) was rejected.

7.2.3. Site Q3

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q4, Q13, Q1, Q5, Q10, Q11, Q12, Q8, Q14, Q9, FL-3 (FCT 8), Ellen-5 (FCT 8), Q2 in the current study and Bull-8 (FCT 7). This site was in good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q3 in the Kenwick – Wattle Grove area. This site is thus considered to have affinity to SCP FCT 8 (Herb-rich Shrublands in Claypans) which is listed as a Vulnerable TEC by the DEC. The occurrence of a number of calcicole flora species in this site and adjacent areas indicates that this may also be an occurrence of the Muchea Limestone EPBC listed TEC.

7.2.4. Site Q4

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q3, Q1, Q5, Q11, Q13, Q12, Q8, Q10 in the current study, Bull-6 (FCT 7), Q2, Ellen-1 (FCT8), Koolj-6 (FCT 10a), FL-3 (FCT 8), Gingin-2 (FCT 7), and Q14 in the current study. This site was in very good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q4 in the Kenwick – Wattle Grove area. This site is considered to have affinity to SCP FCT 7 (Herb-rich Saline Shrublands in Claypans) and SCP FCT 8 (Herb-rich Shrublands in Claypans) which are both listed as Vulnerable TEC by the DEC.

7.2.5. Site Q5

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q11,Q13,Q14, Q3, Q4, Q2, Q12, Q8,Q10, Q9, Q1 in the current study, Bull-8 (FCT 7), Bull-6 (FCT 7), Yule-4 (FCT 10a), Q6 in the current study. This site was in good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q5 in the Kenwick – Wattle Grove area. This site is thus considered to have affinity to SCP FCT 7 (Herb-rich Saline Shrublands in Claypans) which is listed as a VulnerableTEC by the DEC.

7.2.6. Site Q6

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q9, Q2, Q10, Q7, Q12, Twin-4 (FCT 6), Q14, Water-2 (FCT 13), Q5, Q13 in the current study, Twin-10 (FCT 15), Possum 2 (FCT 16), Ellen-7 (FCT 6), Paga- 5 (FCT 17), Paga -2 (FCT13). This site was in good to degraded condition and therefore it is likely that some of the differences between this site and the most similar sites in Gibson et al. (1994) were due to degradation. However it could also be representative of vegetation that was not well sampled in Gibson et al., (1994). The hydrological and stratigraphic data from this site and the calcicole species that inhabit this area and the adjacent vegetation indicate that this may be an occurrence of the Muchea Limestone EPBC-listed TEC. Therefore the provisional result of the analysis (FCT 6) was rejected.

7.2.7. Site Q7

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q10 in the current survey,cool-01 (FCT 17), Q2,Q6 in the current survey, Paga-5 (FCT 17), Ellis-1 (FCT 17), Q9 in the current survey, Possum-2 (FCT 16), MTB-5 (FCT 17), cool-11 (FCT 17), Ellis-1 (FCT 18), FL- 10 (FCT 12), Water- 2

(FCT 13), Twin- 4 (FCT 6), low 10b (FCT 11). This site was in good to degraded condition and therefore it is likely that some of the differences between this site and the most similar sites in Gibson et al. (1994) were due to degradation. However it could also be representative of vegetation that was not well sampled in Gibson et al., (1994). The vegetation is similar to the *Melaleuca rhaphiophylla- Gahnia trifida* seasonal wetlands FCT 17 (as suggested by the multivariate analysis) but as the latter is confined to coastal calcareous settings, Q7 is more likely to be representative of a vegetation type not sampled in Gibson et al. (1994).

7.2.8. Site Q8

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q14, Q11, Q13, Q3, Q12, Q5 Q4, Q10 in the current study, Yule-4 (FCT 10a), Q9, Q2, Bull -8 (FCT7), Bull -7 (FCT5), Bull -6 (FCT7). This site was in good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q8 in the Kenwick – Wattle Grove area. This site is considered to have affinity to SCP FCT 10a: Shrublands on Dry Clay Flats which is listed as an Endangered TEC by the DEC.

7.2.9. Site Q9

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q13, Q14, Q3, Q5, Q6, Q11, Q7, Q12, Q10, Q1, Q4, Twin-4 (FCT 6). This site was in degraded condition and therefore it seems likely that the differences between this site and the most similar sites in Gibson et al. (1994) may have been due to degradation. However it could also be a degraded example of an FCT not sampled in Gibson et al. (1994).

7.2.10. Site Q10

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q11, Q12, Q13, Q3, Q14, Q5, Q4, Q8, Q7, Q1, Q2, Q6, Twin-4 (FCT 6). This site was in good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q10 in the Kenwick – Wattle Grove area. The provisional result of the analysis (FCT 6) was rejected.

7.2.11. Site Q11

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q5, Q13, Q8, Q10, Q14, Q3, Q4, Q12, Q1, Q2, Q9 in the current survey, Ellis-1 (FCT 17), Bull -6 (FCT 7). This site was in good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson

et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q11 in the Kenwick – Wattle Grove area. This site was considered to have affinity to SCP FCT 7 (Herb-rich Saline Shrublands in Claypans) which is listed as a Vulnerable TECs by the DEC and *Melaleuca rhaphiophylla-Gahnia trifida* seasonal wetlands FCT 17. Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.

7.2.12. Site Q12

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q14, Q10, Q13, Q3, Q8, Q5, Q11, Q4, Q1 in the current survey, Bull-8 (FCT 7), Bull-6 (FCT 7). This site was in good condition and dominated by *Melaleuca viminea* therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q12 in the Kenwick – Wattle Grove area. From data available of BFS 87, this vegetation is probably an uncommon vegetation assemblage of BFS 387 (see discussion with regard to Table 24 above) with affinity to SCP FCT 7 (Herb-rich Saline Shrublands in Claypans) which is listed as a Vulnerable TEC by the DEC.

7.2.13. Site Q13

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q11,Q14, Q5, Q10, Q3, Q12, Q9, Q8, Q4, Q1 in the current study, Bull-6 (FCT 7), Bull-8 (FCT 7), Q2 in this survey, Gingin-3 (FCT 7). This site was in good condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to the fact that the latter study did not sample vegetation closely comparable to Q13 in the Kenwick – Wattle Grove area. This site was considered to have affinity to SCP FCT 7 (Herb-rich Saline Shrublands in Claypans) which is listed as a Vulnerable TECs by the DEC. However it includes a number of calcicole species and is possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.

7.2.14. Site Q14

In the nearest neighbour analysis, this site was most similar (in decreasing order of similarity) to Q8, Q12, Q13, Q5, Q10, Q3, Q9, Q1, Q2, Q4 in the current study, FL-7 (FCT 8), Pearce -1 (FCT 6), Bull-8 (FCT 7).

This site was in degraded condition and therefore it is likely that the differences between this site and the most similar sites in Gibson et al. (1994) were due to this degradation or due to the fact that the latter study did not sample vegetation closely comparable to Q14 in the Kenwick – Wattle Grove area. The vegetation was similar to the TEC: Herb-rich Shrublands in Clay Pans (Vulnerable)/ Weed dominated

wetlands on heavy soil/ Herb-rich Saline Shrublands in Clay Pans (Vulnerable). It is a *Melaleuca viminea* dominated FCT and thus not sampled in Gibson et al. (1994) and from data available of BFS 387, probably an uncommon vegetation assemblage of BFS 387. It is possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.

8. Wetlands Field Survey

There are currently four wetland areas (three areas of palusplain and one area of sumpland) within the survey area that have been identified and mapped under numbers known as Unique Function Identifiers (UFIs) in the *Geomorphic Wetlands Swan Coastal Plain Dataset* of the DEC (2008a) (Table 27; Figures 3 and 4).

The boundaries of wetlands in DEC (2008a) are not constrained within cadastral boundaries. In some cases however, where a wetland is very extensive (> 70 ha) and it is not classified as a lake or a sumpland) and parts of it have been disturbed, separate management categories and UFIs have been assigned to parts of the wetland as appropriate to the varying remnant values of each part. Although the wetlands of the survey area and the Greater Brixton Street Wetlands are mapped in the *Geomorphic Wetlands Swan Coastal Plain Dataset* as discrete areas, it is important to understand that the alluvial fan complex that includes all of the land between Roe Highway and Tonkin Highway in Kenwick and Wattle Grove (including the Greater Brixton Street Wetlands) effectively forms one extensive, wetland ecosystem. In this ecosystem the individual wetland areas mapped under separate UFI are interconnected by such factors as groundwater flow, subsurface water flows along impermeable layers and channelled surface water flows (Perth Groundwater Atlas, 2004; VCSRG, 2001). In general, the only parts of Kenwick and Wattle Grove that are not wetlands are relatively small dunes where deeper Bassendean Sands overlie the muddy sediments of the Guildford Formation, or where fill has been imported to construct roads, houses or other structures in the wetlands.

8.1. Identification and Delineation of Wetlands

The identification and delineation of a wetland is reliant upon characteristics of hydrology, hydric soils and wetland vegetation (Hill et al., 1996). A general guide for the identification and delineation of wetlands is provided in DEC (2007). In accordance with the requirements of DEC (2007) the wetland status was investigated in detail at each study site and also more generally at other points of the current survey area, to distinguish between putative wetland and upland zones.

A limited field survey of the hydrology and shallow stratigraphy of wetlands 7773, 8029, 7775 and 13367 that are mapped in DEC (2008a) in the survey area was undertaken in addition to the detailed flora and vegetation study. Obligate and facultative wetland flora species at each study site in the survey area and elsewhere were noted during the flora and vegetation survey (Appendix F) and the preferred habitat of these was investigated by checking the habitat notes of all occurrences of these species as recorded on herbarium voucher labels in FloraBase (WA Herbarium,

2008), and in Keighery and Keighery (2000), Paczkowska and Chapman (2000) and Marchant et al. (1987), as required.

Despite the late winter drought during 2008 there was ample evidence of hydric soils and high water tables indicative of wetland conditions in most of the sample sites chosen to be representative of the survey area in the survey area (Table 28). The native vegetation of the three blocks was comprised of predominantly obligate wetland species. The vegetated areas of Lots 28 and 32 were all clearly wetlands under all of three criteria (hydrology, hydric soils and wetland vegetation). Similarly, the cleared area of Lot 32 was mostly wetland (on the criteria of hydric soils and hydrology) except for some drifts of deeper Bassendean Sands near Brook Rd. Lot 36 was largely cleared of native vegetation, however there were several remnant mature obligate wetland species (*Melaleuca rhaphiophylla* and *Eucalyptus rudis*) present. There were only two sites (in Lot 32 at H16 and in Lot 36 at H18) that did not include unequivocal evidence of wetland conditions. At the latter, there were no hydric soils encountered during augering, the water table was very low and the sites were cleared of native vegetation except a few Marri trees. In the centre of Lot 36, there was also an area where a small amount of brick rubble was encountered in the superficial sediments when augering was attempted. The latter was probably either imported fill or the remains of a demolished building. It was not possible to determine the watertable depth, the depth of the imported material or the superficial sedimentary sequence in the latter area by manual augering.

The wetlands determined by the process above were thus demonstrated to encompass the entire survey area (except for small areas on Lot 32 and Lot 36 near Brook Rd and along the eastern border of Lot 36 where deep Bassendean Sands were found to overlie the Guildford Formation Sediments (Figure 8).

The identification of wetlands of the Endangered EPBC –listed TEC: Shrublands and woodlands on Muchea Limestone (Keighery and Keighery, 1995) also rely on stratigraphic, hydrological and vegetation evidence. This TEC occurs on a geological unit known as Muchea Limestone or Plain Limestone in the Urban Geology Map Series (Gozzard 1982). This unit occurs as low emergent mounds or subaerial lenses of limestone, in a discontinuous distribution from Muchea to Benger along the eastern side of the SCP. These mounds are Pleistocene in age and are thought to have formed from the precipitation of carbonates from artesian waters. The Muchea Limestone TEC includes a range of landforms (such as well-drained, low limestone ridges, damplands and sumplands) that provide a variety of plant habitats. The vegetation assemblages that have been found in this TEC are quite varied and include calcicole plants such as *Melaleuca huegelii*, *Eucalyptus decipiens* and *Casuarina obesa* (Keighery and Keighery 1995). There were a number of flora species recorded in the survey area that are generally considered to be calcicole species. Such species are common in near-coastal areas of the SCP in calcareous sands of the Quindalup

and Spearwood Dunes. However on the Pinjarra Plain, they are usually only found in wetlands underlain by Muchea Limestone. The calcicole species recorded at Lots 28 and 32 included *Austrostipa juncifolia* subsp. Southern River (B.J. Keighery 2160), *Eremophila glabra* subsp. *chlorella*, *Ficinia nodosa*, *Gahnia trifida*, *Lawrencia squamata*, *Melaleuca brevifolia*, *Samolus junceus* and *Wilsonia backhousei*. There were two sites in the current survey where traces of calcareous materials were encountered in the stratigraphic profile. These sites were H12 in Lot 28 and H17 in Lot 32. In addition to this, there were two sites (Q6 and H11) in Lot 28 where the groundwater table was very high in late spring. The latter wetlands may be maintained by confined aquifers associated with Muchea Limestone.

8.2. Geomorphic Classification of Wetlands

The wetlands within the survey area were classified according to the geomorphic system of Semeniuk (1987) in which the hydroperiod and geomorphic features of wetlands were the sole determinants of wetland class (regardless of wetland biota or the factors that maintain wetland conditions). Most of the existing classifications and mapping of the wetlands of the surevy area in DEC (2008a) were confirmed in the current field survey, except for several small possible modifications (Table 29; Figure 8).

Most of the study sites surveyed in the survey area were located in an undulating plain that was underlain by shallow aquitards and were waterlogged in the late winter and early spring of 2008 (Table 29). These areas were all mapped as palusplains UFIs 7773, 8029 and 13367 in the DEC SCP Wetlands Dataset (2008a) and were confirmed as palusplains in the current field survey. However within palusplain UFI 7773 there were three small basins or swales (at Q7, H11 and H12) that may need to be reclassified and remapped. Sumpland UFI 7775 was confirmed with regard to classification but a somewhat altered boundary was proposed. The latter sumpland is probably hydrologically linked to other small basin/swale wetlands in Lots 28 and 32 that were investigated at Q7, H11 and H12. Similarly within Lot 36 there were two small basins/swales at H13 and H14 that may need to mapped as damplands or sumplands within the existing palusplain UFI 13367.

8.2.1. Palusplains 7773, 8029 and 13367 on Lots 28 and 32: mostly no changes to DEC (2008) noted in current survey.

Most of the study sites surveyed in the surevy area (Q1-Q5, Q8-Q14, H15, and H17) were located in an undulating plain and were waterlogged in the late winter and early spring of 2008 with rainwater perched by the superficial sediments (Table 28). These areas are mapped as palusplains UFIs 7773, 8029 and 13367 in the DEC SCP

Wetlands Dataset (2008a) and were clearly confirmed as palusplains in the current field survey (Table 29; Figure 8).

8.2.2. Sumpland 7775 on Lots 28 and 30: increased area of sumpland noted in current survey.

In DEC (2008a) the area of *Melaleuca rhaphiophylla* low forest in the vicinity of Site Q6-H6 and H12 was mapped as sumpland 7775. The areas including these sites were confirmed as sumpland in the current field survey (Table 29) (Figure 8). However as a result of the current investigations at Q6, H11 and H12, the border of the wetland was altered somewhat to more accurately coincide with the *Melaleuca rhaphiophylla* inhabited areas on Lots 28 and 30 near Brook Rd (Figure 8).

Site Q6 was located in a shallow swale near Brook Rd on Lot 28. In late winter Site Q6 was shallowly inundated. On October 19, 2008 when Site Q6 was augered the water table was at 36 cm below the ground surface. This water table was much higher than that in the adjacent wetlands of Lot 28 on the same date. Another watertable was also present at Q6 about 180cm below the ground surface. A layer of peat at the surface and the mottled soil in the sediment profile about 20 cm below the surface of the ground indicated that the water table was habitually high at this site. The Melaleuca rhaphiophylla low forest that is currently present at the site tolerates inundation in the winter. Calcicole plant species found nearby were *Austrostipa juncifolia* subsp. Southern River (B.J. Keighery 2160), *Ficinia nodosa*, *Gahnia trifida*, *Lawrencia squamata*, *Melaleuca brevifolia*, *Samolus junceus* and *Wilsonia backhousei*.

Site H11 presented a similar stratigraphic profile, hydrology and vegetation as Q6 – H6, although the area was influenced by a recent fire. On October 18, 2008 when the site was augered the water table was at 16 cm below the ground surface. There was also another water table at about 170cm below the ground surface. There was peat at 50cm below the ground surface at H11 and this indicated that the water table was habitually high at this site. The wetlands at Q6 and H11 are probably expressions of the same aquifer(s).

At Site H12, the surface sediments were muddy sand with some calcareous nodules below 30cm. As calcareous material is very uncommon on the Pinjarra Plain, except in association with Muchea Limestone, these nodules provide an indication (additional to the hydrological evidence obtained at Q6 and H11) that Muchea Limestone is probably present in Lot 28. H12 was waterlogged in late winter but on October 18, 2008 when the site was augered the sediments were moist down to a hardpan at 70cm below the ground surface but a water table was not present. The remnant taxa present were obligate wetland species such as *Melaleuca rhaphiophylla* and *Banksia littoralis* and calcicoles such as *Austrostipa juncifolia* subsp. Southern River (B.J.

Keighery 2160), *Gahnia trifida*, *Melaleuca brevifolia* and *Samolus junceus* present nearby.

H12 had a strong similarity to Q6 and H11 in terms of its wetland vegetation. It is likely that the wetlands at Sites Q6, H11 and H12 may be expressions of the same aquifer(s). Wetlands associated with Muchea Limestone and the EPBC-listed Muchea Limestone TEC has been demonstrated recently to occur in Kenwick adjacent to BFS 387 (Tauss and Weston, 2009). However Muchea Limestone (and the TEC associated with this hydrogeological feature) have not previously been found in BFS 387. The sumpland encompassing Q6, H11 and H12 also has high conservation value, despite the presently degraded condition of some of the vegetation. The wetland attributes present here distinguish this wetland from the majority of other wetlands in BFS 387. Since areas of high water table in dry seasons are rare in BFS 387, this wetland could play a vital role in the maintenance of the native fauna of the area.

8.2.3. Palusplain 7773 in the vicinity of Q7-H7 in Lot 32: dampland noted in current survey.

In DEC (2008a) the area of Q7 was mapped as part of palusplain 7773. The investigations in Q7-H7 in the current survey showed that this area is probably a dampland (seasonally waterlogged basin). The surface sediments at Q7 were peaty sand and the ground surface was waterlogged in early spring. On October 18, 2008 when the site was augered the sediments were moist down to water table at 230cm below the ground surface. In years of average or above winter rainfall, it is considered that the muddy layers from about 60 cm below the ground surface would perch rainwater for an extended period in winter and spring. There was obligate wetland vegetation (*Melaleuca rhaphiophylla* low forest) at the site; however this was somewhat at odds with the relatively low water table currently present at this site.

In this survey it is considered that the wetland at Q7 was actually a part of the channel (swale) that is mapped as sumpland UFI 8028 in DEC (2008a) on the adjacent block on Boundary Rd (Figure 8). The wetland at Q7 and 8028 may also be maintained by hydrological systems associated with 7775. It is probable that there has been some disruption of the hydrology of this system of wetland channels.

8.2.4. Palusplain 13367 in the vicinity of H13 and H14 on Lot 36: damplands noted in current survey.

In DEC (2008a) the area encompassing H13 and H14 was mapped as part of palusplain 13367. In the finer scale investigation in the current survey, both of these areas were found to be seasonally waterlogged shallow swales and thus the classification of dampland would probably be more appropriate for these areas.

At H13, the surface was waterlogged in winter but on November 30, 2008 when the site was augered the sediments were moist down to water table at 280cm below the surface. The peaty layer found at the ground surface, the rusty mottles of the sediments at about 70cm below the ground surface and the obligate wetland vegetation present on the site were all indications that a much higher water table (causing inundation of the soil surface at times) was present seasonally at this site in the past. In years of average or above winter rainfall the muddy sediments from 80cm below the ground surface may perch rainwater. There may also have been other factors that maintained a high water table in this location in the past (such as surface or sub-surface run off) that may now be disrupted.

At H14 the surface was also waterlogged in winter but when augered the sediments were moist down to the water table at 150cm below the ground surface. In years of average or above winter rainfall, it is considered that the watertable would be considerably above the level recorded in this survey. The surface soils would be waterlogged or inundated in such circumstances and this would enable the development of the obligate wetland vegetation that is currently present at the site.

8.3. Evaluation of Wetland Management Categories

The five wetland areas (UFIs 7773, 8029, 7775 and 13367) that are mapped in the DEC's *Swan Coastal Plain Wetlands Dataset* (2008a) were evaluated in the current survey using the three methods that are recommended by DEC (2007) for this purpose (Appendix G). The values of each wetland that contributed to these evaluations are summarised below.

8.3.1. Palusplain UFIs 7773/ 8029: CCW

The topography and hydrology of this wetland is largely unaltered by human activities. It is a palusplain located on the Pinjarra Plain and thus a scarce wetland type. This palusplain is part of a unique larger area that is representative of the wetlands of the Keysbrook Consanguineous Suite in the Kenwick –Wattle Grove area at a specific elevation along the topographical gradient of the alluvial system associated with Yule Brook between the Darling Range and the Canning River. In the current survey, it was confirmed that this palusplain extends over the entire area of Lot 28 (except for a small sumpland UFI 7775 near Brook Rd) and about half of the area of Lot 32.

The palusplain is partly altered with regard to wetland processes such as recharge and discharge mechanisms and sedimentary processes due to the clearing of the catchment area, roads and other hard surfaces and the dredging and diversion of Yule Brook and other surface drainage in the area.

This palusplain is habitat for rare flora of NES (*Lepidosperma rostratum*) that is gazetted under the *EPBC Act 1999* (DEWHA, 2008) and rare flora of state conservation significance (*Eremophila glabra* subsp. *chlorella*) gazetted under the *Wildlife Conservation Act 1950*, five DEC Priority Flora Species (including *Grevillea thelemanniana*, a species that is also considered eligible for listing as nationally significant threatened flora, pending the resolution of taxonomic issues) and numerous regionally significant flora species. The wetland exhibits a diversity of vegetation habitats at small scale due to the complex stratigraphy and hydrology of the area.

The wetland soils, water resources and the thick vegetation that are present in this wetland are uncommon in the Perth Metropolitan Area and they provide a refuge for native fauna including large numbers of Quenda, native birds and *Varanus gouldii*, a high order predator that is particularly dependant on adequate habitat in this largely urban setting. Palusplain 7773/8029 is a naturally vegetated area that is located high in the groundwater catchment area compared to the rest of the BFS 387 wetlands. It thus performs another important wetland function in maintaining the hydrological regime (in terms of quality and quantity of groundwater) in the other wetlands in BFS 387 that are located downslope.

Palusplain 7773 exhibits largely unaltered and scarce vegetation of the Pinjarra Plain Vegetation Complex of SCP FCT 7, 8 and 10; these vegetation types are TECs and they include highly species-rich areas of flora. This palusplain is underlain by wetland sediments of a Pinjarra Plain alluvial fan that are unusual on the SCP. There are indications in this wetland that it is underlain by Muchea Limestone, a rare formation on the SCP. It is part of a largely-undisturbed gradient of soil and sediment types from the Darling Range Foothills to the Canning River.

In the evaluation of this wetland by the method of VCSRG (1998), this wetland satisfied the criteria for CCW for wetland type, wetland habitats, wetland functions, biodiversity and scientific value. For wetland processes, it satisfied the criteria for REW. Therefore, overall, under this method palusplain 7773/8029 was evaluated as a CCW.

In the evaluation of this wetland by the method of Bulletin 686 (EPA, 1993) palusplain 7773/8029 scored 17 points for Natural Attributes (using Part IIB of the questionnaire appropriate for seasonal wetlands with poorly defined boundaries). It also scored 15 points in Part III for Human Use Attributes. These scores meant that the wetland satisfied the criteria for REW. However this wetland included gazetted rare flora and this value takes precedence over all other wetland attributes in EPA (1993). Therefore palusplain 7773 was evaluated as a CCW.

Palusplain 7773/8029 included vegetation in good to very good condition and native vegetation covered almost all of the area of these wetlands. This also supported the allocation of the management category of CCW to this area.

8.3.2. Sumpland UFI 7775: CCW

The unusual hydrology of this wetland, the peaty-sandy surface sediments and high water table in summer, and the dense canopy of Paperbark trees were all uncommon wetland features in the BFS 387 area and were important features of this wetland regionally. Overall the wetland was evaluated as CCW.

In the wetland evaluation system of VCSRG (1998) this wetland met five criteria for CCW and the remaining wetland criterion was met at the level of REW.

In the evaluation of this wetland by the method of Bulletin 686 (EPA, 1993), sumpland 7775 was transitional between REW and MUW on the Natural Attributes/Human Use Attributes scores. However this wetland included several species of regional conservation significance when they occur on the Pinjarra Plain (*Gahnia trifida*, *Hypocalymma angustifolium* Mud Habitats Variant. (C.Tauss 1850), *Ficinia nodosa* and *Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn) and therefore sumpland 7775 was evaluated as an REW by this method.

Sumpland 7775 included vegetation in good to degraded condition and more or less undisturbed native vegetation covered more than half of the area of the wetland. This supported the allocation of the management category of CCW to this area.

Sumpland 7775 in Lot 28 is a scarce wetland type (only 6% of the total former extent of wetlands on the Pinjarra Plain remain undeveloped, Hill et al., 1996). This wetland has unusual hydrogeological features in the context of BFS 387 and the SCP in general and it may be an example of a wetland maintained by a confined aquifer associated with Muchea Limestone.

This wetland has not been altered with regard to wetland processes such as recharge/discharge mechanisms or sedimentary processes. The water table was still high in this wetland at the end of spring, unlike most of the other areas investigated in Lot 28. There are recharge processes involved in this wetland (the most likely being artesian upwelling possibly associated with subsurface Muchea Limestone deposition) that are different to those present in the prevailing palusplain landscape of Lot 28 and the remainder of BFS 387. These processes are unusual for the Pinjarra Plain. There is no evidence that these processes have been altered by land uses in the area.

The wetland is not a habitat for rare and endangered flora. The fauna of the area have not been surveyed in detail. Sumpland provides a diversity of habitats such as large Paperbark trees in an area generally dominated by shrubs; shady, moist, peaty-sand soils; and a high watertable that are not commonly available elsewhere in BFS 387 in

summer. It thus provides important resources for the maintenance of the large numbers of Quenda in the area and possibly other fauna in summer drought.

Although sumpland 7775 includes vegetation of the Pinjarra Plain Vegetation Complex, this vegetation is in a partly degraded condition and does not include species rich flora. The wetland exhibits some unaltered wetland vegetation which may be extended through re-vegetation programmes. The understorey of the wetland will regenerate its biodiversity given protection from further disturbance and some weed control.

Sumpland 7775 has scientific value as it is underlain by wetland sediments of a Pinjarra Plain alluvial fan which are unusual on the SCP. It is also likely to be underlain by Muchea Limestone which is even more unusual and of high scientific value.

8.3.3. Palusplain UFI 13376: REW

Although the vegetation of the part of wetland 13367 that occurs in Lots 32 and 36 was degraded to completely degraded, this wetland was allocated the management category of REW. This decision was made in the current survey because this wetland is a scarce wetland type (a palusplain on the Pinjarra Plain that is part of the Keysbrook Consanguineous Wetland Suite) and it retains some of the wetland processes and functions that are important to areas of conservation significance in BFS 387 down slope from it.

The area of Lots 32 and 36 is part of a regional hydrological/ecological link (part of Greenways 98, 102, 106; WAPC 2000a, Map 7) that supports a nationally significant system of wetlands (Alan Tingay and Associates, 1998).

The management category allocated to the part of palusplain 13367 that occurs on Lots 32 and 36 by the method of VCSRG (1998) was REW. The management category allocated to the wetland by the method of EPA Bulletin 686 (1994) was Multiple Use Wetland (MUW).

The vegetation of the wetland was degraded to completely degraded and thus the management category allocated to this wetland on the basis of vegetation condition was also MUW.

The clearing of the catchment area, the building of roads and other hard surfaces around this palusplain, the dredging and diversion of Yule Brook and the excavation of artificial drains along roads may be affecting the recharge and discharge of palusplain 13367. The natural pattern of sediment deposition on this wetland from the regular flooding of Yule Brook and the spread of floodwaters over the alluvial plain (that includes Lots 32 and 36) has been altered by development. The wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes).

9. Discussion and Conclusions

This assessment was undertaken to provide information for the potential for development to occur over all or part of the survey area. The results of the survey indicate approximately half of the survey area retained remnant vegetation in degraded to very good condition while the remainder was considered completely degraded. Wetland values, processes and functions also varied across the site in close association to the presence of remnant vegetation. Patterns of regional groundwater flow, sub-surface and surface flow (in both natural drainage and constructed drains) are known to link the survey area with other areas of highly water-dependent biota in the Greater Brixton Street Wetlands (Perth Groundwater Atlas, 2008; VCSRG, 2001).

Specifically, the results of the survey indicate a number of conservation significant values of national, state and regional significance were found within the survey area, including Priority flora and DRF, and vegetation with an affinity to state and commonwealth listed TECs. All of the remnant native vegetation of Lots 28 and 32 was vegetation of the Guildford Vegetation Complex. Most of this vegetation was in good to very good condition and may be considered of conservation significance. Most of the native flora taxa recorded in the current survey was highly dependent on surface waters and/or groundwater.

From the stratigraphical sampling that was conducted on site, it was evident that the natural distribution of sediments (both laterally and vertically) over the survey area is complex. Although unable to confirm its presence, evidence of the EPBC-listed Muchea Limestone TEC was observed and this is not currently known to be represented elsewhere in the Greater Brixton Street Wetlands.

Although this survey found that some small changes to the DEC (2008) *Swan Coastal Plain Wetlands Dataset* may be undertaken with regard to the classification and mapping of wetlands at a fine scale, the changes are not significant and for the purposes of the proposed use no further work should be required.

9.1. Potential for Site Development

Based on the results of this investigation, environmental constraints associated with the proposed development across the entire survey area include the value of remnant flora and vegetation, current wetland classification and listing of the survey area within BFS 387. As the results of the survey indicated variation across the survey area, the potential for development to occur on each lot has been briefly discussed.

9.1.1. Lot 28

The results of the survey indicated Lot 28 contains a number of conservation significant flora species including a number of Priority flora and the DRF species, *Eremophila glabra*. The vegetation of this area of the site was also generally in good to very good condition. This included a number of locations that although are not considered to be TECs did show an affinity to TECs and may be considered of conservation significance as Lot 28 is located within the Greater Brixton Street wetlands.

The wetland values assessed for the area within this lot were also considered to be of high conservation value. Based on the results of the assessment and overlying policy constraints such as Bush Forever and wetland mapping other potential options for the site are more likely than development.

9.1.2. Lot 32

Approximately half of Lot 32 retains remnant vegetation in a degraded-good to good condition and included examples of Priority 3 and Priority 4 flora species. The vegetation on the remainder of Lot 32 was considered to be completely degraded with no examples of conservation significant flora species.

The wetland values of this lot generally differed in accordance with the areas of vegetation. The area retaining remnant vegetation was considered to be a CCW and the remainder of the site was mapped as REW because it retains some of the wetland processes and functions that support adjacent CCW wetland, otherwise it would be considered a MUW.

Potential development options for this site are likely to be limited to the area where vegetation is considered completely degraded. Bush Forever and wetland policy constraints exist that will be required to be addressed and it is considered more likely a development option would be considered if it is part of a submission that includes Lot 36.

9.1.3. Lot 36

The vegetation of Lot 36 is generally considered to be completely degraded and contains no flora species of conservation significance. The remaining wetland values of this lot are associated with some wetland processes and functions that support adjacent conservation significant wetlands and is the reason it was mapped as REW instead of MUW.

This lot contains the least environmental issues and may be considered appropriate for development if environmental policy constraints such as Bush Forever and wetlands of conservation significance are appropriately addressed.

9.2. Survey Limitations

The EPA's (2004) *Guidance for the Assessment of Environmental Factors - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51* identified the main factors that can limit and constrain such surveys. The current project was evaluated against these factors and several significant constraints and limitations were found to be present. The constraints and limitations identified by this process are discussed below.

Scope, intensity, competency and experience of personnel, and availability of resources in the survey

No limitations were present with regard to the flora and vegetation survey.

The scope of the survey was very wide as flora, vegetation and wetlands were to be investigated at a detailed level. A high intensity and level of survey (Level 2) was used for the current flora and vegetation survey as was appropriate to the high conservation value of the flora, vegetation and wetlands of the area and in accordance with EPA recommendations. This survey added considerably to what was previously known about the area. For example, two species of rare and threatened flora and four Priority Flora taxa were recorded in the current survey that were not known previously from this part of BFS387. One of these flora species, *Austrostipa juncifolia* subsp. Southern River (P1) was not known previously from BFS 387. The vegetation was mapped in detail after quadrat-based survey at a high level of taxonomic accuracy and TEC occurrences were identified within the site. All of the latter data were previously not available for this area.

The botanist who carried out the survey was a qualified botanist, specializing in the taxonomy of wetland and monocot taxa, with postgraduate research training in wetland ecology, over 16 years experience in WA, recent experience in five other surveys in BFS387 and/or the adjacent vegetation, and the evaluation of over 70 wetlands in the area. The technical assistants both had prior experience in wetland and flora surveys.

Disturbances that affected the results of the survey

Significant limitations were encountered due to anthropogenic disturbance of the survey area and also due to the erratic climate patterns experienced in 2008.

Most of the survey area had been burnt recently but it was regenerating well. The pattern of this fire was not consistent with wildfire. The floristic composition of the sites where there had been recent fire was dominated by species that re-seed profusely after fire such as *Actinostrobus pyramidalis*. Many of these species do not persist in the vegetation when it has not been burnt for many years and this may have confounded the multivariate analysis of the data, to some extent, and made it difficult

to allot survey sites to FCTs of Gibson et al. (1994), as the reference sites in the latter may have been sampled in vegetation with a different fire history.

The lack of late winter and spring rain in 2008 did not allow the ground and surface water levels to rise to the levels expected in the Perth Region during the time planned for the survey between about August and November. Although almost the entire survey area was waterlogged and some areas were shallowly inundated when the survey reconnaissance was started in August, the wetlands dried out rapidly. By early October, when the wetlands are usually experiencing peak water levels and the shallow auguring was conducted (as planned) there was no standing water in the sumplands. It was also not possible to auger down to the groundwater table at some sites as the sediments were relatively dry by this stage. This weather pattern exacerbated the difficulty involved in attempting to classify wetlands within the short period allocated to this task. However the floristic indicators of long term wetland conditions were intact over most of the area (except Lot 36) and this enabled a reliable, comprehensive, wetland delineation, assessment of wetland type and wetland management category to be made in most cases.

Availability of contextual information for the survey data

Although no limitations were encountered in the flora and vegetation survey, a minor limitation was encountered in the vegetation analysis due to the lack of contextual data about fine scale vegetation patterns on the SCP. There were abundant data of collections of individual taxa in the literature and in FloraBase (WA Herbarium, 2008) that assisted greatly in the interpretation of the flora survey. However the interpretation of vegetation significance was constrained by the insufficient data available to conclusively define the conservation significance of some types of vegetation on the SCP.

The process described by Bush Forever (WAPC, 2000) to determine the conservation values of remnant vegetation on the SCP in areas such as the current survey area, involves the comparison of floristic data from a survey area (the survey dataset) with data from Gibson et al. (1994) (the SCP dataset). The use of appropriate software to define clusters of sites using indices of similarity in floristic composition can be part of this process. These clusters of sites are called FCTs. Some of the FCTs determined in Gibson et al. (1994) have been listed as TECs of the SCP, after assessment (according to the Federal and international criteria) by the Threatened Species and Communities Scientific Committees at the Federal and/or WA State level. TECs have conservation status at both State and Federal level that provides additional legal protection over that already afforded under the *Environmental Protection Act 1986* and its associated clearing regulations. The limitation inherent in this process is that, although Gibson et al. (1994) was a very large regional scale survey, it fell short of being a truly representative sample of the vegetation types of the very diverse vegetation of the SCP. Thus subsequent survey data of rare vegetation types, that

were not included in Gibson et al. (1994), when compared statistically with the SCP dataset, often show low levels of similarity with all of the sites in the SCP dataset. In many cases, where the survey dataset has not shown close similarity with any TECs defined by Gibson et al. (1994), many botanists have concluded that no vegetation of conservation significance was present in their survey.

Completeness

Minor limitations/constraints were experienced in the current flora and vegetation survey. The flora and vegetation survey collected significant field data, analysed to the extent possible given the available contextual data and presented all of the above in this report. The only aspects that constrained the flora and vegetation survey were fire history and climatic conditions. These constraints may have affected the completeness of the flora inventory as some annual flora species may have been present within the survey area but may not have been evident at the time of the survey. However the percentage of the total flora in the current survey that was comprised of annuals was not greatly below that recorded over many years of intensive flora recording and collecting in BFS 387. The latter is an indication that the annual flora of the survey area was considerably developed in the current survey area in spring 2008, despite the late winter-early spring drought of that year. The flora inventory of this survey area presented in Appendix C is likely to be reasonably complete.

10. Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

In the preparation of this report, 360 Environmental has relied upon documents, information, data and analyses ("client's information") provided by the client and other individuals and entities. In most cases where client's information has been relied upon, such reliance has been indicated in this report. Unless expressly set out in this report, 360 Environmental has not verified that the client's information is accurate, exhaustive or current and the validity and accuracy of any aspect of the report including, or based upon, any part of the client's information is contingent upon the accuracy, exhaustiveness and currency of the client's information. 360 Environmental shall not be liable to the client or any other person in connection with any invalid or inaccurate aspect of this report where that invalidity or inaccuracy arose because the client's information was not accurate, exhaustive and current or arose because of any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to 360 Environmental.

Aspects of this report, including the opinions, conclusions and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

This report has been prepared for the sole use and benefit of Prime West Management Ltd. Any reliance placed on the whole or any part of this report by any person or organisation other than Prime West Management Ltd shall be at the sole risk of that person or organisation.

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Figures

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6458200 6458000 6457800 6457600

Welshpool Road

Brook Road

Lot 36

Lot 32

Lot 28

N

Legend

- Site Boundary
- Cadastral Boundary

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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- CADASTRES SOURCED FROM LANDGATE 2007
- BUSH FOREVER SITES SOURCED FROM DP1 2003
- LOCALITY MAP SOURCED FROM LANDGATE 2007

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Metres

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LOCALITY MAP



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Lots 28, 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Site Location
Figure 1



Legend

- Site Boundary
- Bush Forever Site

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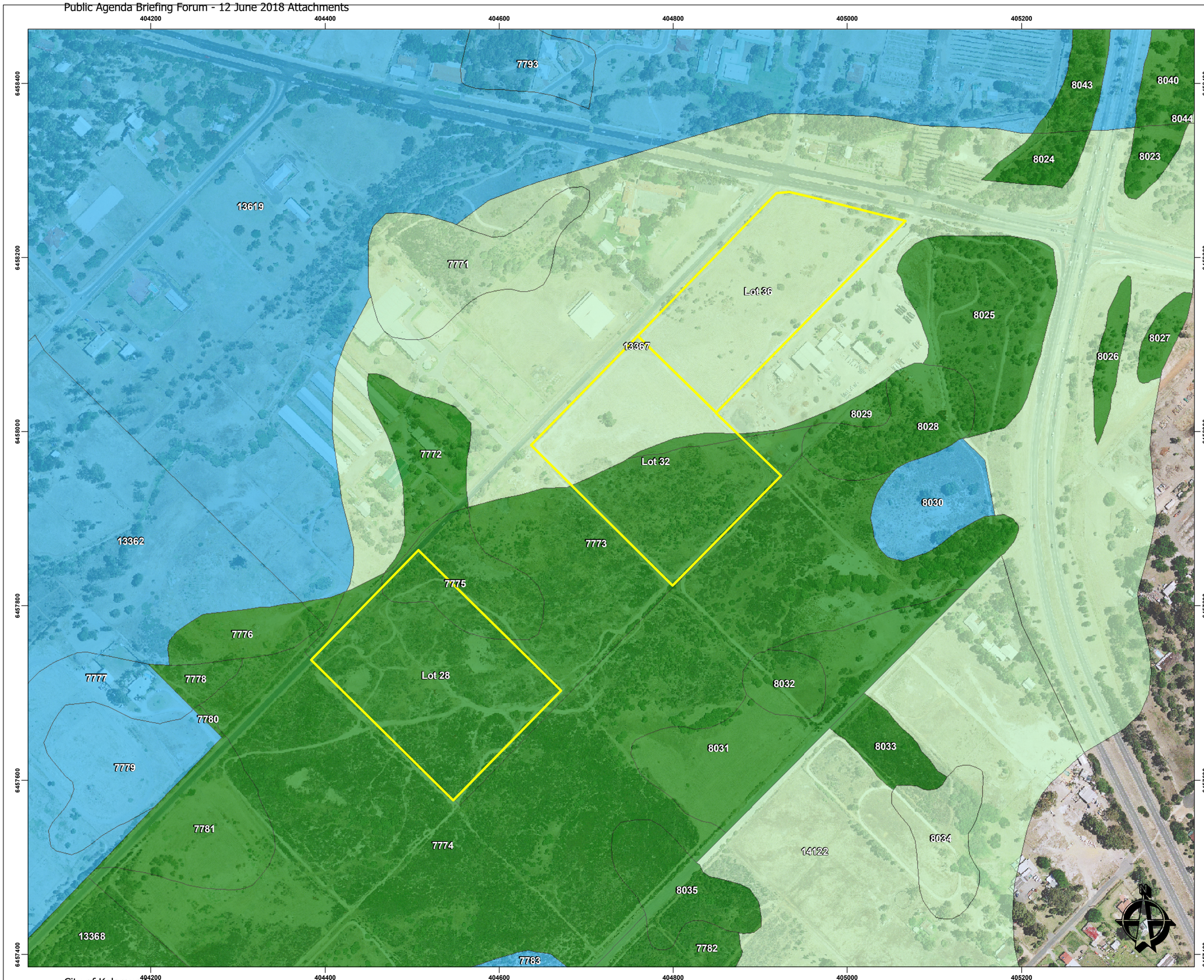
Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Bush Forever
Figure 2

529



Legend

- Site Boundary
- Conservation
- Resource Enhancement
- Multiple Use

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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- GEOMORPHIC WETLANDS SOURCED FROM DEC 2008
- LOCALITY MAP SOURCED FROM LANDGATE 2007

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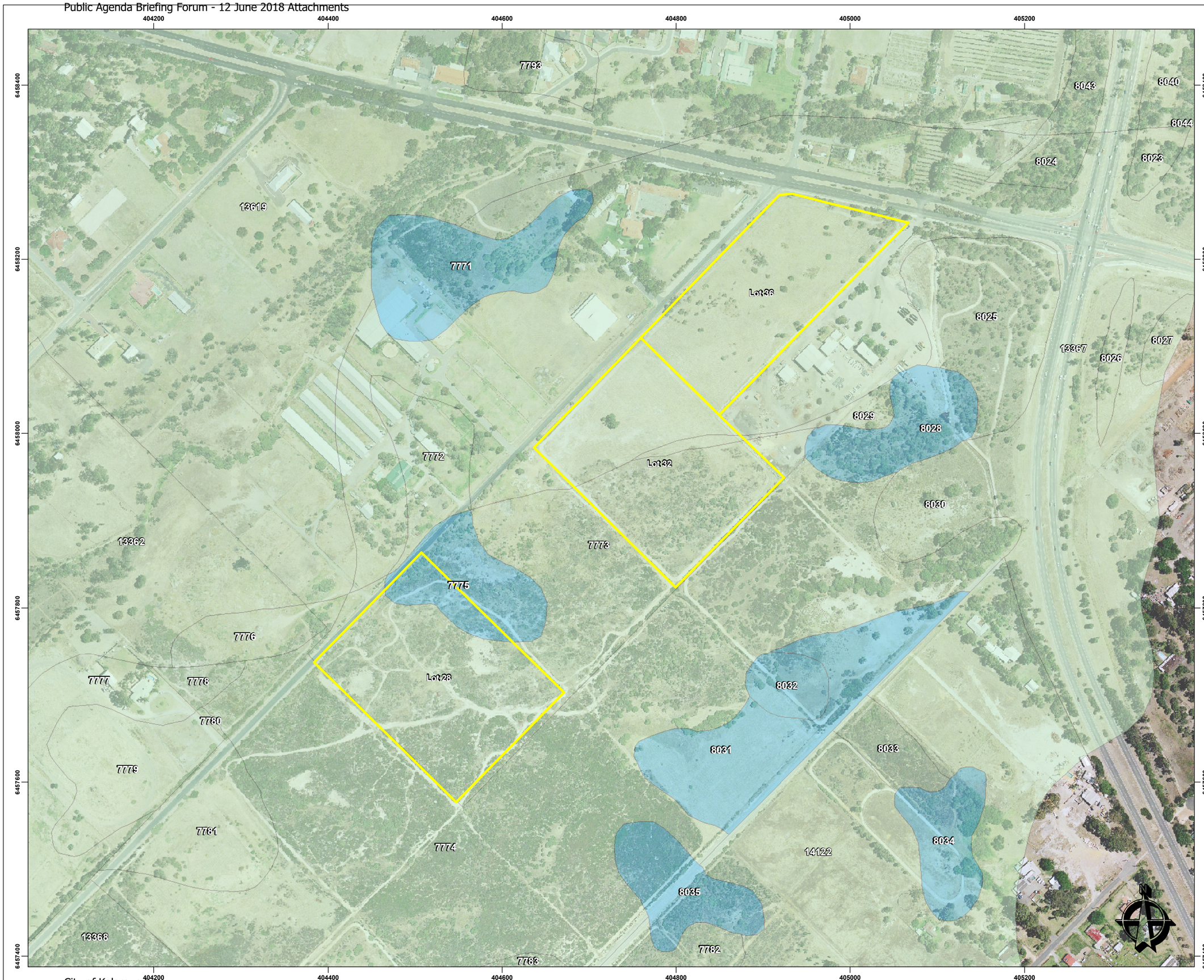
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
DEC Wetland Management Categories
Figure 3



City of Kalamunda

Legend

- Site Boundary

Geomorphic Wetlands

- Palusplain
- Sumpland

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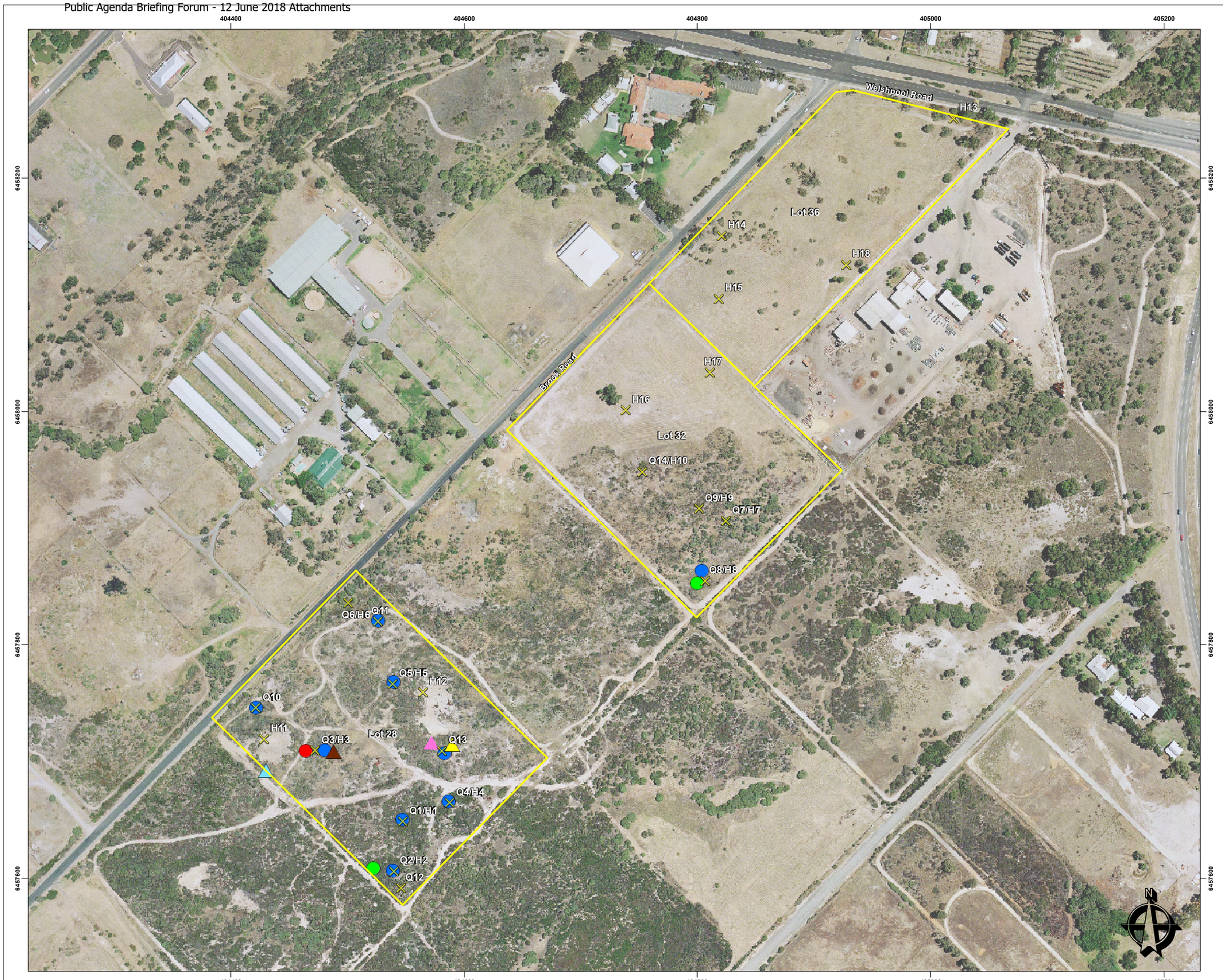
Lots 28, 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
DEC Geomorphic Wetland Classifications
Figure 4



Legend

- Site Boundary
- Quadrat and Auger Location

Priority and DRF Location

- Antrostipa juncigolia subsp. Southern River (B.J. Keighery 2160)
- Baeckea sp. Perth Region (R.J. Cranfield 444)
- Eremophila glabra subsp. chlorella
- Grevillea thelemanniana
- Lepidosperma rostratum
- Tricholine sp. Treeton (B.J. Keighery & N. Gibson 564)
- Verticordia lindleyana subsp. lindleyana

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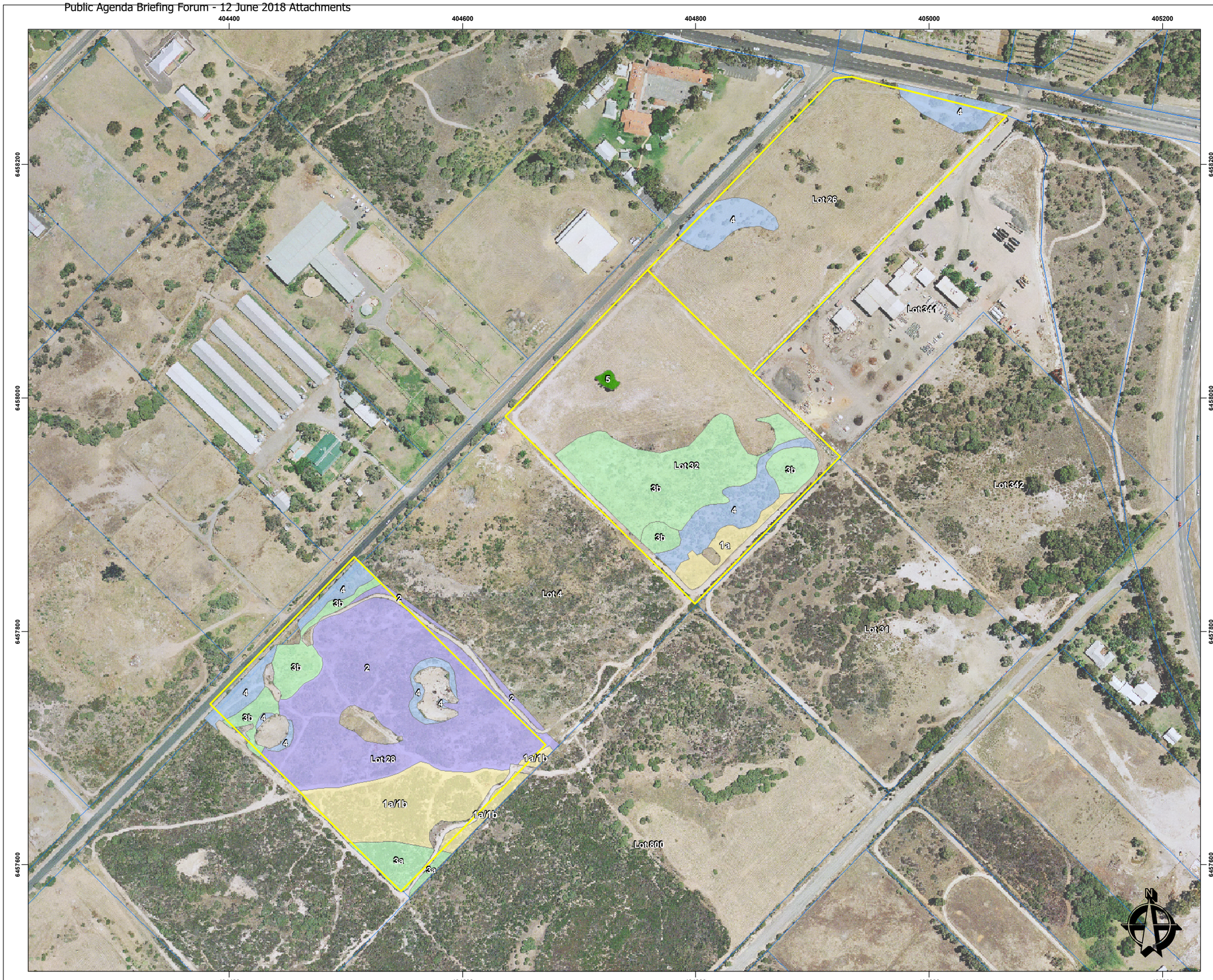
Evangelous Litis Nominees Pty Ltd
Lots 28, 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Locations of Sampling and Flora of Conservation Significance
Figure 5

532



Legend

- Site Boundary
- Cadastral Boundary

Vegetation Communities

- 1a & 1b
- 2
- 3a & 3b
- 4
- 5

Vegetation Description

1a. Mid-dense to closed heath-scrub o *Actinostrobus pyramidalis-Banksia telmatiaea Hypocalymma angustifolium- Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes and open native annual herbs; and

1b. Mid-dense to closed heath of *Hypocalymma angustifolium- Acacia lasiocarpa* with emergen open shrubs of *Actinostrobus pyramidalis Melaleuca lateriflora-M. brevifolia* over oper *Chaetanthus aristatus-Gahnia trifida* rushes/sedges and mid-dense annual herbs.

2. Mid-dense to closed heath of *Hypocalymma angustifolium- Acacia lasiocarpa- Actinostrobus pyramidalis* with emergent open shrubs o *Melaleuca lateriflora-M. brevifolia* over oper *Chaetanthus aristatus - Gahnia trifida* rushes/sedges and mid-dense annual herbs.

3a. Mid-dense scrub of *Melaleuca viminea-Actinostrobus pyramidalis* over heath o *Hypocalymma angustifolium- Acacia lasiocarpa* over sparse *Chaetanthus aristatus-Juncus pauciflorus* rushes/sedges and sparse annual herbs.

3b. Mid-dense to open heath of *Melaleuca viminea-Hypocalymma angustifolium- Acacia lasiocarpa* over mid-dense *Actinostrobus pyramidalis* seedlings, open naturalized alien grasses and op annual herbs.

4. *Melaleuca rhaphiophylla* low woodland ove *Melaleuca viminea* low open shrubs, sparse sedges and naturalized alien grasses

5. *Corymbia calophylla* low woodland over dens naturalized alien grasses.

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- CADASTRAL BOUNDARY SOURCED FROM LANDGATE 2008
- LOCALITY MAP SOURCED FROM LANDGATE 2007

SCALE

0 15 30 60 90 120

Metres

1:3,000 @A3

LOCALITY MAP



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100%	MGA ZONE 50
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GDA 94	N/A

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DATE	**REVISION**	**DRAWING NO.**
17.12.08	1	454.07a

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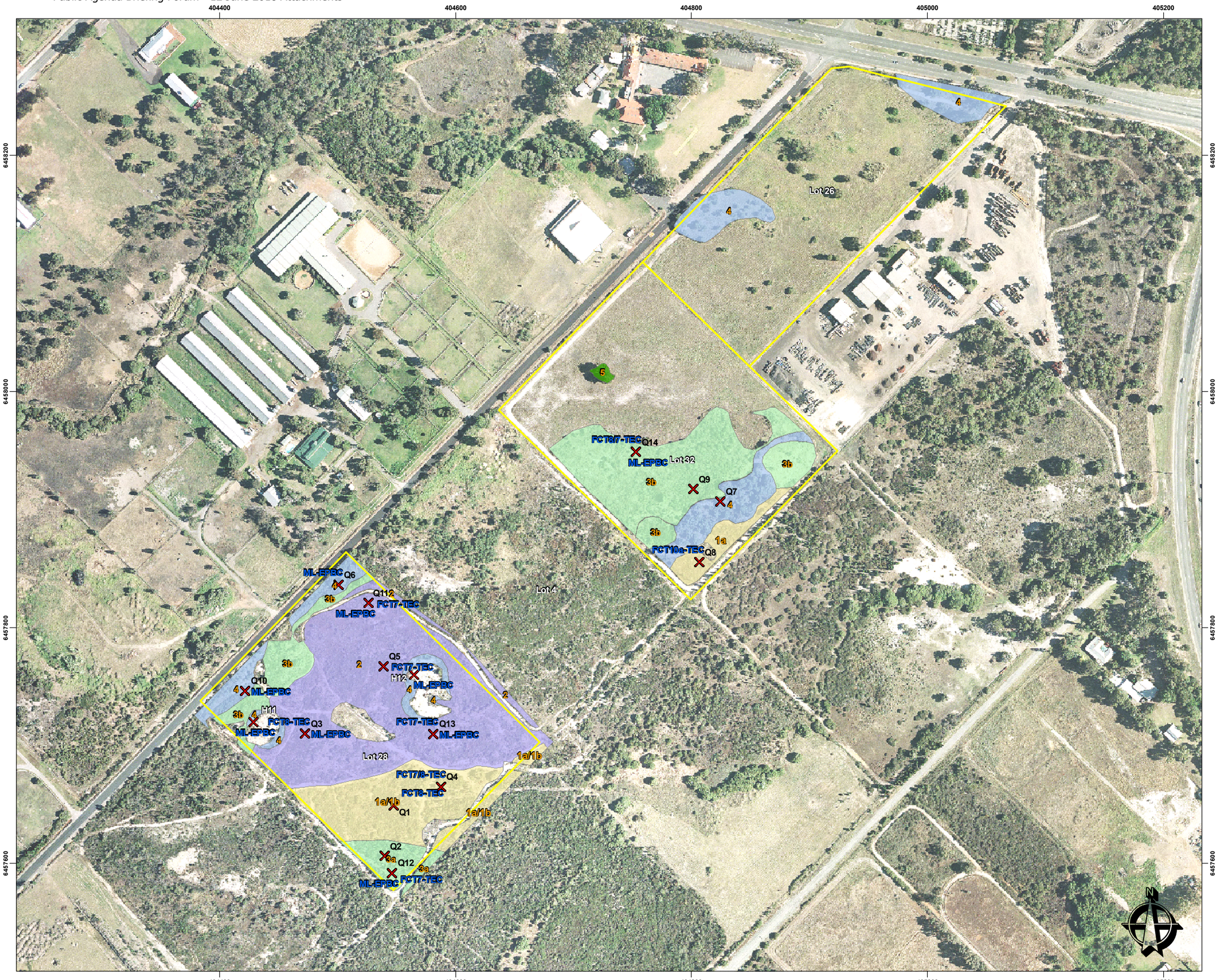
Lots 28, 32 and 36 Brook Road
WATTLE GROVE

Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Vegetation Communities
Figure 6a



Legend

- Quadrat Location
- Site Boundary

Vegetation Units (as per Figure 3)

- 1a & 1b
- 2
- 3a & 3b
- 4
- 5

LOCATIONS WITH AN AFFINITY TO TECs

KEY:

EPBC-Listed, Muchea Limestone TEC:
ML-EPBC

Vegetation also referable to DEC -Listed SWA TECs (Gibson *et al*. 1994; DEC 2008):
FCT7-TEC: Herb-rich Saline Shrublands in Clay Pans (Vulnerable)
FCT8-TEC: Herb-rich Shrublands in Clay Pans (Vulnerable)
FCT10a-TEC: Shrublands on Dry Clay Flats (Endangered)

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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SCALE

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Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Vegetation Communities - FCT and TEC Locations
Figure 6b

404400 404600 404800 405000 405200

6458200

6458000

6457800

6457600

Lot 28

Lot 32

Lot 4

Lot 28

Lot 344

Lot 342

Lot 31

Lot 800

N

Legend

- Site Boundary

Vegetation Condition

- Good - Very Good
- Good
- Degraded - Good
- Degraded
- Completely Degraded - Degraded
- Completely Degraded

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
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- LOCALITY MAP SOURCED FROM LANDGATE 2007

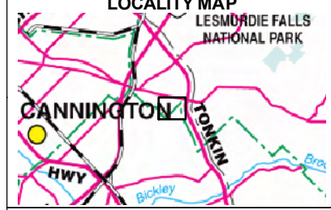
SCALE

0 15 30 60 90 120

Metres

1:3,000 @A3

LOCALITY MAP



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Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Vegetation Condition
Figure 7

535

404400 404600 404800 405000 405200

6458200

6458000

6457800

6457600

Welshpool Road

Brook Road

Dampland REW

Lot 36
Dampland REW

Palusplain
13367 REW

Not
Wetland

Lot 32

Palusplain
13367 REW

Palusplain
7773 CCW

Sumpland/Dampland
(likely to be part of 8028)

Palusplain
7773 CCW

Sumpland
7775 CCW

Sumpland
7775 CCW

Lot 28

Sumpland
7775 CCW

Palusplain
7773 CCW

N

City of Kalamunda

404400 404600 404800 405000 405200

Legend

- Site Boundary

Geomorphic Wetlands

- Dampland
- Palusplain
- Sumpland

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
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SCALE

0 15 30 60 90 120

Metres

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Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Wetland Mapping From Spring 2008
Figure 8

404400 404600 404800 405000 405200

6458200 6458000 6457800 6457600

Welshpool Road

Brook Road

Lot 36

Lot 32

Lot 28

N

Legend

- Site Boundary
- Potential Development Area

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2009
- LOCALITY MAP SOURCED FROM LANDGATE 2007

SCALE

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Metres

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GWa	BP	
DATE	**REVISION**	**DRAWING NO.**
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Spring Flora & Vegetation Survey and Wetland Assessment, Delineation and Classification
Locations of Potential Development Area
Figure 9

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Tables

TABLE 1: Climatic Data from Gosnells City Weather Station (1991-2008).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE (1991-2008)												
Mean daily max (°C)	32.7	32.7	30.3	26.2	22.6	19.5	18.7	19.1	20.6	23.5	27.4	30.1
Mean daily min (°C)	18.1	18.5	17.1	14.6	12.1	9.8	9.0	8.8	10.0	11.3	14.4	16.0
RAINFALL (1961-2008). Mean annual rainfall: **835.4 mm** Total rainfall in 2008, up to and including 15.12.08: **883.8 mm**												
Mean monthly rainfall (mm)	11.9	16.2	15.4	45.4	107.0	178.7	164.6	129.2	80.8	48.2	27.8	10.7
Monthly rainfall 2008 (mm)	0	31.6	12.9	170.8	103.9	142.5	195	21.5	85.2	47.8	59.0	13.6

TABLE 2: Soils of the slope down the alluvial fan complex of BFS 387 (adapted from Jordan, 1986).

Soil Unit	Descriptors Applicable to Soil Unit	Landform
Sand over sandy clay (Qpb/ Qpa: S10)	Shallow (Pleistocene) Bassendean Sands over Pleistocene alluvium of the Guildford Formation	Palusplains of Pinjarra Plain at approx. 20-10m AHD (Lots 28, 32 and 36 and most of the lands from Welshpool Rd to Bickley Rd inc. parts of the UWA Allison Baird Reserve)
Clayey sand (Qpa: Sc)	Pleistocene alluvium of the Guildford Formation	Palusplain- floodplains of Pinjarra Plain at approx. 7-10m AHD in the Allison Baird Reserve and Lots 48 and Pt 35 Brixton St, Kenwick (between Brixton St and Bickley Rd)
Sandy clay (Qpa: Cs)	Pleistocene alluvium of the Guildford Formation	Palusplains- floodplain of Pinjarra Plain at < 7m AHD approx. (Brixton St Reserve)
Deep Bassendean Sands (Qpb: S8)	Deep (Pleistocene) aeolian sands: Bassendean Sands	Dunes at 12-14m AHD approx. in UWA Allison Baird Reserve

TABLE 3: Vegetation Structure Classification (adapted from Bush Forever, Govt of WA 2000).

LIFE FORM and HEIGHT	CANOPY COVER			
	Dense 70% - 100%	Mid Dense 30% - 70%	Open 10% - 30%	Sparse 2% - 10%
Trees 10-30m Trees < 10m	Closed forest Low closed forest	Open forest Low open forest	Woodland Low woodland	Open woodland Low open woodland
Shrubs > 2m Shrubs < 2m	Closed scrub Closed heath	Scrub Heath	Open scrub Open heath	Tall open shrubs Low open shrubs
Grasses, Herbs Rushes or Sedges	Closed grasses, herbs, rushes or sedges	Grasses, herbs, rushes or sedges	Open grasses, herbs, rushes or sedges	Sparse grasses, herbs, rushes or sedges

TABLE 4: Bushland Vegetation Condition (adapted from Bush Forever, Govt of WA 2000).

Code	Condition	Description of Vegetation
P	Pristine	No obvious signs of disturbance.
E	Excellent	Vegetation structure characteristic of the vegetation type remains intact, disturbance affects individual species only, and weeds are non-aggressive species.
VG	Very Good	Vegetation structure altered somewhat; obvious signs of disturbance, but recovering. Some highly invasive weeds may be present at low abundance.
G	Good	Vegetation structure modified significantly by very obvious multiple disturbances but ability to regenerate is retained (by e.g. recruitment of native species from abundant soil seed bank).
D	Degraded	Vegetation structure severely impacted by disturbance; scope for regeneration but not to a state approaching good (sic) condition without intensive management
CD	Completely Degraded	Vegetation structure no longer intact; the area almost completely without native species e.g. isolated native trees or shrubs over pasture ('parkland cleared').
TC	Totally Cleared	No native vegetation remaining on site.

TABLE 5: Wetland Sediment Classification (adapted from Semeniuk and Semeniuk, 2004).

Descriptor	Diameter of Grains
gravel	>2mm
coarse to very coarse sand	0.5-2mm
fine to medium sand	0.125-0.5mm
very fine sand	0.063-0.125mm
mud or peat	<0.063mm

TABLE 6: Wetland Sediment Definitions (adapted from Semeniuk and Semeniuk, 2004).

Sediment	Definition
sand	Sand grain supported sediment with minor or no interstitial mud
humic sand	Sand grains coated with a thin layer of fine organic particles
muddy sand or peaty sand	Sand grain supported sediment with interstitial mud, or peat
sandy mud or sandy peat	Mud (or peat) supported sediment with floating sand grains
mud (or peat)	Mud (or peat) dominant (i.e. <10% sand)

TABLE 7: Geomorphic Classification of Wetlands (adapted from Semeniuk and Semeniuk, 1995).

	Channel	Basin	Slope	Flat	Hill
Permanent inundation	river	lake	-	-	-
Seasonal inundation	creek	sumpland	floodplain	-	-
Seasonal waterlogging	trough	dampland	palusplain	paluslope	palusmont
Intermittent inundation	wadi	playa	balkarra	-	-

Table 8: Management categories of wetlands from EPA Bulletin 686 as updated in Hill et al., (1996).

Management Category	General Description	Management Objective
H – High Conservation (incorporates EPA Bulletin 686 categories H and C)	Wetlands which support a high level of attributes and functions.	To preserve wetland attributes and functions through reservation in national parks, crown reserves and state owned land and protection under Environmental Protection Policies.
R - Resource Enhancement (incorporates EPA Bulletin 686 categories O and R)	Wetlands which may have been partly modified but still support substantial attributes and functions.	To restore wetlands through maintenance and enhancement of wetland attributes and functions by protection in crown reserves and state or local government owned land and by Environmental Protection Policies or in private property by sustainable management.
M - Multiple Use (aligned with EPA Bulletin 686 category M)	Wetlands with few attributes which still provide important wetland functions.	Use, development and management should be considered in the context of water, town (land use) and environmental planning through land care.

Table 9: EPA Bulletin 686 questionnaire (EPA, 1993).

Part I: Presence of Rare Species

If the wetland includes gazetted rare flora or fauna species then the wetland is automatically allocated to CCW.

If this is the case, it is recommended that the questions in Part I and Part II of the questionnaire should still be answered to provide additional management information. However the scores arrived at in Part II and Part III for a wetland that includes rare species will not alter the allocation of the H category to this wetland.

Part II: Natural Attributes

Part IIA: For permanent and seasonal wetlands with well defined boundaries

i. Environmental geology classification: wetlands in the QuindalupDunes or in river/estuary floodplain receive the highest score.

ii. Adjacent wetlands. Wetlands that have no other wetlands within a 2km radius of them receive the highest score.

iii. Habitat diversity. If the composition and structure of the vegetation of the wetland under evaluation is significantly different to that found at other nearby wetlands, the wetland receives the highest score.

iv. Drought refuge. Wetlands that are major drought refuges for birds receive the highest score.

v. Area of wetland. Wetlands greater the 100ha in area receive the highest score.

vi. Habitat type. Vegetation and landforms typical of lakes and sumplands are scored (fringing rushes and sedges, extensive in lake beds of rushes and sedges, large paperbark trees, islands, flooded grassland, permanent or seasonal open water, low thickets and samphires).

vii. Emergent vegetation. Wetlands with a moderate cover (40-60%) of emergent vegetation receive the highest score as both open water and vegetation are as wetlands with both are considered best waterbirds habitat.

viii. Adverse water quality. Oil slicks, algal blooms or botulism that have been observed or reported from the wetland in the last two years lower the score received by the wetland.

ix. Drainage. This deal with drains into and/or out of the wetland that can alter water levels or water quality. Wetlands with few drains entering the wetland receive the highest score. Wetlands with outlet drains constructed to maintain water levels receive the highest score, whilst outlet drains constructed to dry out the wetland receive the lowest score.

x. Adjacent nutrient scores. Wetlands with more than one nutrient source lower the score received by the wetland.

xi. Area of wetland modified. Wetlands with 0-10 % of area modified receive the highest score.

xii. Reserve Area. The ratio of the area of wetland to the area of reserve around the wetland is considered in this question. The lowest wetland to reserve ratio (< 0.1) receives the highest score.

iii. Native vegetation buffer. Wetlands with 90-100% of the wetland perimeter of at least 50m of buffer vegetation receive the highest score.

Part IIB: For seasonal and episodic wetlands with poorly defined boundaries (each zone of the wetland is usually scored as a separate assessment)

The questions above for environmental geology classification, adjacent wetlands, habitat diversity, habitat type, drainage, area of wetland modified are scored as above. Wetland size is also considered, and wetlands >100ha in area receive the highest score in the latter question.

Part III: Human Use Questionnaire

Wetlands that have attributes such as aesthetic values, historical and archaeological features, reserve status, community group involvement, passive and active recreation usage, and other uses such as agriculture, mining or water supply receive the highest scores.

Table 9: EPA Bulletin 686 questionnaire (EPA, 1993) (continued).

Part IV: Supplementary Questions

These questions concern the occurrence of rare, but ungazetted, flora andfaunaspecies, the effect of wetlands on nearby land values, the frequency of human use of wetlands and the importance othe wetland to the owner. This section is usually only evaluated if the management category obtained by the uses ofParts I, II and III above produces falls in one of the transitional zones between categories on the EPA (1994) graph.

If the wetland undergoing the evaluation does not include gazetted rare species, two graphs are provided at the end the Bulletin 686 questionnaire to determine management category. These graphs display the total Part II scores received by the wetlands that were evaluated in the process of designing this evaluation instrument versus their total Part III scores. The first graph applies to "permanent and seasonal wetlands with well defined boundaries". The second graph applies to "seasonal and episodic wetlands with poorly defined boundaries". The graphs are both divided up into five areas. Each of these areas delineates one of the five wetland management categories (H, C, O, Rand M) as defined by the EPA (1993). The appropriate graph from Bulletin 686 is used to plot Part I scores vs. Part II scores for each wetland under evaluation to determine its management category.

TABLE 10: A score sheet for wetland evaluation (adapted from VCSRG, 1998).

Six classes of wetland values	Criteria met at the level of CCW	Criteria met at the level of REW	Criteria met at the level of MUW
1.Wetland type	Yes /No	Yes /No	Yes /No
2.Wetland processes	Yes /No	Yes /No	Yes /No
3.Wetland habitats	Yes /No	Yes /No	Yes /No
4.Wetland functions	Yes /No	Yes /No	Yes /No
5.Biodiversity of wetland	Yes /No	Yes /No	Yes /No
6.Scientific value of wetland	Yes /No	n/a	n/a
Total Score	Best score = 6	Best score = 5	Best score = 5

TABLE 11: Conservation Category Wetlands criteria checklist for wetland evaluation (VCSRG, 1998).

Wetland type: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. it is an anthropogenically unaltered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland) 2. it is a scarce wetland type 3. it is a representative wetland type (i.e., representative of its consanguineous suite)
Wetland processes: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland is subject to anthropogenically unaltered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes,) 2. the wetland exhibits unusual wetland processes 3. the wetland exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting)
Wetland habitats: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland is a habitat for rare and endangered fauna 2. the wetland is a habitat for rare and endangered flora 3. the wetland exhibits a high diversity of habitats
Wetland functions: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland is necessary for maintenance of large faunal populations 2. the wetland is a refuge for resident fauna 3. the wetland is an important breeding, feeding or watering site for migratory populations (local and international) 4. the wetland is a significant regional component of the hydrological cycle (has an important hydrological storage, recharge or discharge function; or an hydrochemical function)
Wetland Biodiversity: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland exhibits unaltered wetland vegetation and fauna 2. the wetland has a scarce vegetation association or faunal association 3. the wetland has a highly diverse wetland flora or fauna
Wetland Scientific value: A wetland may be classed as Conservation if it satisfies one or more of the following criteria 1. the wetland contains scientifically significant pollen records 2. the wetland is underlain by unusual wetland sediments (indicators of wetland history) 3. the wetland has unusual geomorphology (i.e., it is situated in an unusual geomorphic setting or contains unusual geomorphic features within it)

TABLE 12: Resource Enhancement Category Wetlands criteria checklist for wetland evaluation (VCSRG, 1998).

Wetland type: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. it is an anthropogenically altered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland) but retains its natural geomorphology and natural, if modified, hydrological mechanisms.
Wetland processes: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. the wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) but not to the degree that habitats cannot still be identified and rehabilitated
Wetland habitats: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. the wetland habitats are disturbed but the wetland is a habitat for rare and endangered fauna or flora, or the wetland exhibits a high diversity of habitats and for these reasons should be re-habilitated (i.e., water quality addressed, water levels naturalised, re-vegetation of communities undertaken, and re-establishment of ecological links with surrounding areas via corridors and/or buffer zones)
Wetland functions: A wetland may be classed as Resource Enhancement if it satisfies one or more of the following criteria 1. the wetland is necessary for maintenance of specific faunal populations 2. the wetland is a breeding, feeding or watering site for migratory faunal populations (local) 3. the wetland is a fauna refuge but is degraded and requires re-vegetation or improvement of water quality 4. the wetland is a significant local component of the hydrological cycle (has an hydrological storage, recharge or discharge function; or an hydrochemical function) 5. the wetland is a regionally important hydrological or ecological link in a system 6. portion of extended wetlands is vegetated and therefore functions as an ecological corridor
Wetland Biodiversity: A wetland may be classed as Resource Enhancement if it satisfies the following criterion 1. the wetland exhibits some unaltered wetland vegetation and fauna which may be extended through re-vegetation programmes

TABLE 13: Multiple Use Category Wetlands criteria checklist for wetland evaluation (VCSRG, 1998).

Wetland type: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. it is an anthropogenically altered wetland type and retains its natural geomorphology but has highly modified, hydrological mechanisms.
Wetland processes: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. the wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) to the degree that habitats can no longer be identified and rehabilitated
Wetland habitats: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. the wetland habitats are disturbed such that re-vegetation is possible but not rehabilitation (i.e., sediments, water quality and water levels, are altered so that re-establishment of original flora and fauna communities is not possible)
Wetland functions: A wetland may be classed as Multiple Use if it satisfies one or more of the following criteria 1. the wetland is necessary for maintenance of low numbers of faunal populations 2. the wetland is a feeding or watering site for local migratory faunal populations (usually in association with a number of other wetlands as no single wetland is sufficient to maintain species) 3. the wetland is a component of the hydrological cycle and therefore to catchment management (has an hydrological storage, recharge or discharge function; or an hydrochemical function, albeit a minor function)
Biodiversity: A wetland may be classed as Multiple Use if it satisfies the following criterion 1. the wetland has minor biodiversity, but does have ecosystem diversity and landscape diversity

Table 14: Vegetation status assessment in the evaluation of the management category of wetlands (adapted from Hill *et al.*, 1996, Table 3).

Category	General Description	Vegetation status assessment
C–Conservation	Wetlands which support a high level of attributes and functions.	>50% vegetation undisturbed
R - Resource Enhancement	Wetlands which may have been partly modified but still support substantial attributes and functions.	10-50% vegetation undisturbed
M - Multiple Use	Wetlands with few attributes which still provide important wetland functions.	<10% vegetation undisturbed

Table 15: Vegetation Complexes (Heddle et al., 1980) in the vicinity of the survey area.

Foothills (Ridge Hill Shelf) Vegetation Complexes 1. Forrestfield Vegetation Complex (9% remaining) Open forest of *Corymbia calophylla– Eucalyptus wandoo- E. marginata* to open forest of *E. marginata- Corymbia calophylla – Allocasuarina fraseriana- Banksia* spp. Fringing *Eucalyptus rudis* low forest in the gullies that dissect this landform.
Pinjarra Plain Vegetation Complexes 1. Guildford Vegetation Complex (6% remaining) A mosaic of open forest to tall open forest of *Corymbia calophylla- Eucalyptus wandoo- E. marginata and woodland of E. wandoo* (with rare occurrences of *E. lane-poolei*). Minor components include *E. rudis- Melaleuca rhaphiophylla.* 2. Swan Vegetation Complex (11% remaining) Fringing woodland of *Eucalyptus rudis- Melaleuca rhaphiophylla* with localised occurrences of low open forest of *Casuarina obesa* and *Melaleuca cuticularis.* 3. Cannington Vegetation Complex (1% remaining) A mosaic of the vegetation of the Bassendean, Karrakatta, Southern River and Vasse vegetation complexes.
Bassendean Dunes Vegetation Complexes 1. Southern River Vegetation Complex (17% remaining) Open woodland of *Corymbia calophylla-Eucalyptus marginata- Banksia* spp. with fringing woodlands of *E. rudis- Melaleuca rhaphiophylla* along creek banks. 2. Bassendean Central and South Vegetation Complex (24% remaining) Woodland of *Eucalyptus marginata- Allocasuarina fraseriana- Banksia spp* to low woodland of *Melaleuca* spp. and sedgelands on the moister sites.

Table 16: The Floristic Community Types of the Swan Coastal Plain that have been listed in Bush Forever Sites in the vicinity of the current survey area.

Supergroup 1: Foothills and Pinjarra Plain FCTs FCT 2: Southern wet shrublands (Dundas Road, Forrestfield). FCT 3a: Eucalyptus calophylla –Kingia australis woodlands on heavy soils (Dundas Rd,Forrestfield; Brixton Street Wetlands, Kenwick). FCT 3b: Corymbia calophylla – Eucalyptus marginata woodlands on sandy clay soils (Clifford Road, Maddington).
Supergroup 2: Seasonal Wetland FCTs FCT 4: Melaleuca preissiana damplands (Queens Park Bushland). FCT 7: Herb rich saline shrublands in claypans (Greater Brixton Street Wetlands;Kenwick Road, Kenwick). FCT 8: Herb rich shrublands in claypans (Greater Brixton Street Wetlands and Kenwick Road, Kenwick). FCT 10a: Shrublands on dry clay flats (Greater Brixton Street Wetlands, in Yule Brook Reserve). FCT 12: Melaleuca teretifolia/Astartea shrublands. FCT 13: Deeper wetlands on heavy soils. S2: Northern *Pericalymma ellipticum* dense low shrublands (Hartfield Park, Forrestfield).
Supergroup 3: Uplands centred on Bassendean Dunes (or Dandaragan Plateau) FCTs FCT 20a: Banksia attenuata woodlands over species-rich dense shrublands (Dundas Road, Forrestfield; Pioneer Park, Forrestfield; Queens Park Bushland; Bougainvillea Avenue, Forrestfield; Hartfield Park, Forrestfield; Welshpool Road, Wattle Grove; and White Road, Orange Grove). FCT 20b: Eastern Banksia attenuata and/or Eucalyptus marginata woodlands (Clifford Road, Maddington) FCT 21c: Low lying Banksia woodlands or shrublands (Greater Brixton Street Wetlands in Yule Brook Reserve). FCT 23a: Central Banksia attenuata –B. menziesii woodlands (Greater Brixton Street Wetlands in Yule Brook Reserve; Queens Park Bushland and Hartfield Park, Forrestfield).
Restricted Floristic Community Type Mosaic Shrublands and woodlands on Muchea Limestone (Passmore Street, Southern River; Carousel Wetlands).

TABLE 17: Vegetation of Conservation Significance known from the vicinity of the survey area.

SCP FCT	Name of TEC	Occurrences in vicinity of current survey area	Conservation Status (WA) DEC, 2008	Conservation Status (Federal) EPBC Act
2	Southern wet shrublands	Dundas Road, Forrestfield	Endangered EN B) ii)	
3a	*Eucalyptus calophylla –Kingia australis* woodlands on heavy soils	Dundas Road, Forrestfield and Greater Brixton Street Wetlands	Critically Endangered CR B) ii)	Endangered
3b	*Corymbia calophylla Eucalyptus marginata* woodlands on sandy clay soils	Clifford Road, Maddington	Vulnerable VU B)	Endangered
7	Herb rich saline shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)	
8	Herb rich shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)	
10a	Shrublands on dry clay flats (Greater Brixton Street Wetlands, in Yule Brook Reserve)	Greater Brixton Street Wetlands, in Yule Brook Reserve	Endangered EN B) ii)	
20a	*Banksia attenuata* woodlands over species-rich dense shrublands	Hartfield Park, Dundas Road, Pioneer Park, Bougainvillea Avenue, Forrestfield; Queens Park Bushland; Welshpool Road, Wattle Grove and White Road, Orange Grove	Endangered EN B) ii)	
20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands	Clifford Road, Maddington	Endangered EN B) i) EN B) ii)	
n/a	Shrublands and woodlands on Muchea Limestone (Keighery and Keighery,1995)	Passmore Street, Southern River Carousel Wetland, Cannington	Endangered EN B) ii)	Endangered

TABLE 18: Species-richness and native annual species-richness of Lot 28 and 32 Brook Rd compared with other areas of high conservation significance flora nearby.

Survey Area (area does not include completely degraded lands)	Total native taxa	Total native annual taxa (% of total native taxa)	Total current EPBC/DRF Taxa	Total current Priority Taxa
Greater Brixton Street Wetlands (BFS387) (<126.7 ha). Keighery and Keighery (2000)	555+	140 (25.2%)	7	26
Lot 106 Wanaping Rd, Kenwick (BFS387) (8ha). Keighery and Tauss (2008)	220	44 (19.9%)	2	6
Lots 17-33, 36,340 and 341 Brook Rd – Boundary Rd. (BFS387) (>40ha of bushland) Mattiske and Assoc. (1992)	97	11 (11.3%)	1 (0 in Lots 28,32 and 36)	1 (1 in Lots 28,32 and 36)
Lot 28 Brook Rd (BFS387) (3ha). This survey	90	24 (26.0%)	2	5
Lots 105A Brixton St and 107 Kenwick Rd (4ha). Koch (2003).	67	8 (11.9%)	1	2
Lot 32 Brook Rd (BFS387) (1.5ha of bushland). This survey.	44	4 (9.1%)	0	2

TABLE 19: Summary of the Flora of National and State Significance recorded in the survey area.

Species	Status	Notes	Location
Lepidosperma rostratum	Endangered (EPBC Act) DRF (WA Wildlife Act)		Lot 28
Eremophila glabra var. *chlorella*	DRF (WA Wildlife Act)	Fits criteria for future EPBC listing as Threatened Flora	Lot 28
Austrostipa juncifolia subsp. Southern River (B.J. Keighery 2160)	P1		Lot 28
Trichocline sp. Treeton (B.J. Keighery and N. Gibson 564)	P2		Lot 28
Baeckea sp. Perth Region (R.J. Cranfield 444)	P3		Lot 28 and Lot 32
Grevillea thelemanniana	P4	Fits criteria for future DRF and EPBC listing as Threatened Flora	Lot 28 and Lot 32
Verticordia lindleyi subsp. *lindleyi*	P4		Lot 28

TABLE 20: Other Flora of Conservation Significance (Flora of Regional Significance) recorded in the survey area.

KEY	1.Taxa that are significant on SCP due to geographical location		
Code	Description		
r	Populations at the northern (N) or southern (S) limit of their known geographic range, limit indicated as follows. Example: r (N or S, Locality, Region).		
d	Populations disjunct from their known geographic range		
p	Poorly reserved *i.e.* known from only a few populations in reserves (applies to all Declared Rare Flora and Priority Taxa)		
s	Significant populations in reference to location, population size, diversity of ages and/or health (applies to all Declared Rare Flora and Priority taxa)		
u	Uncommon in the area (generally applies to disjunct populations)		
	2. Taxa that are significant on SCP due to regional endemicity and occurrence in restricted habitats		
eSWA	Taxa endemic to the Swan Coastal Plain		
eSWA(P)	Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region		
h	Habitat Example: h (wetlands)		
	3. Taxa that are significant for taxonomic reasons		
t	Morphological variant, significant taxonomically		
	4. Codes to major landform units of Swan Coastal Plain and nearby		
QD	Quindalup Dunes	F	Foothills
SP	Spearwood Dunes	R	Riverine
BD	Bassendean Dunes	Es	Estuarine
PP	Pinjarra Plain	DR	Darling Range

Taxon	Conservation Significance Code
Acacia lasiocarpa var. *lasiocarpa sens. strict.*	s, u, h (wetland PP) t
Actinostrobus pyramidalis	s, h (wetlands PP)
Anigozanthos viridis subsp. *viridis*	s, u, h (palusplains PP)
Angianthus preissianus	u, h(wetlands, QD/PP)
Banksia telmatiaea	r (S,?Serpentine, SWA), p, s, u, h (wetlands PP)
Boronia crenulata subsp. *viminea*	r (N, Kenwick SWA) s, u, d, h (wetlands PP/BD)
Brachyscome pusilla	s, u, h (muddy wetlands PP/SD/Es)
Calandrinia sp. Kenwick (G.J. Keighery 10905) [syn. C. aff. *composita*]	h(wetlands PP), t
Calothamnus hirsutus	s, h (palusplains, PP)
Chaetanthus aristatus	s, h (wetlands PP)
Chorizandra enodis	s, h (mud wetlands PP)
Comesperma aff. *polygaloides* (C. Tauss. 2541)	s, u, h (palusplains PP) t
Dodonaea ceratocarpa	d, u,s h (palusplains PP), ?t
Drosera menziesii subsp. *menziesii*	u, s, h (palusplains PP)
Ficinia nodosa	d, u, s, h (saline-calcareous or muddy wetlands/ QD, R, Es)
Gahnia trifida	h (saline/ calcareous palusplains)
Goodenia pulchella subsp. Coastal Plain B (M. Hislop 634) pn	h(wetland PP) t
Hydrocotyle alata	h (palusplains, PP)
*Hypocalymma angustifolium (*Mud Habitat Variant. C.Tauss 1850)	s, h (palusplains, PP), t
Kunzea micrantha subsp. *micrantha*	s, h (wetlands PP/F)
Lawrencia squamata	d, s, u r (S, Kenwick SWA), h

	(saline/calcareous wetlands/PP)
Lepidosperma sp. Kenwick. C.Tauss 2598	h (?palusplains, PP) t
Melaleuca brevifolia	p, s, u, h (wetlands, PP)
Melaleuca lateriflora subsp. *acutifolia*	h (wetland, PP)
Neurachne alopecuroidea	h (PP/F)
Pimelea imbricata var. major	p, s, u, eSWA, h (mud palusplains and sumplands PP)
Podolepis capillaris	d, s, u, h (palusplains PP) ?t
Podolepis gracilis sens. lat. (Swamp form GJ Keighery 13 255)	s, u, h (mud sumplands and palusplains PP) t
Pogonolepis stricta	h (mud sumplands and palusplains PP)
Samolus junceus	s, u, h(wetlands calcareous, saline, SD/PP/Est /R)
Scaevola lanceolata	h (palusplains, PP)
Schoenolaena juncea	u, s, h (sumplands/palusplains PP/BD)
Schoenus rigens	p, s, u, eSWA, h (mud and peaty wetlands PP/BD)
Tecticornia lepidosperma	s, u, h(palusplain/floodplain PP/R)
Thelymitra antennifera	s, h (palusplains PP)
Trithuria bibracteata	s, h (palusplains/mud sumplands PP)
Utricularia multifida	u, s, h(wetlands PP/F/R)
Verticordia plumosa var. *brachyphylla*	h (palusplains, PP/F)
Wilsonia backhousei	d, s, u, h (saltmarsh, calcareous, palusplain PP/Est/R)

TABLE 21: Classification (by structure and dominant species) of vegetation recorded in the field survey.

MAP UNIT No.	VEGETATION SUMMARY	LOTS	STUDY SITES	VEGETATION CONDITION
	Mid dense to dense heaths and scrubs			
1a	*Actinostrobus pyramidalis-Banksia telmatiaea-Hypocalymma angustifolium- Melaleuca seriata* dense over *Chaetanthus aristatus* –Schoenus fascicularis rushes, sedges and native annual herbs	Lots 28 and 32	Q1, Q2,Q5, Q8	Good to Very Good
1b	*Hypocalymma angustifolium- Acacia lasiocarpa* with emergent *Actinostrobus pyramidalis- Melaleuca lateriflora-M. brevifolia* mid dense scrub over *Chaetanthus aristatus -Gahnia trifida* rushes, sedges and annual herbs.	Lots 28	Q4, Q13	Good to Very Good
2	*Hypocalymma angustifolium- Acacia lasiocarpa- Actinostrobus pyramidalis* dense heath with emergent *Melaleuca lateriflora-M. brevifolia* over *Chaetanthus aristatus - Gahnia trifida* rushes, sedges and annual herbs.	Lot 28	Q3, Q5	Good to Very Good
3a	*Melaleuca viminea- Actinostrobus pyramidalis* mid-dense scrub over *Hypocalymma angustifolium- Acacia lasiocarpa* over *Chaetanthus aristatus* rushes, sedges and annual herbs	Lots 28	Q12	Good to Very Good
3b	*Melaleuca viminea- Hypocalymma angustifolium- Acacia lasiocarpa* mid-dense heath over *Actinostrobus pyramidalis* seedlings, grasses and annual herbs.	Lots 28 and 32	Q9, Q10, Q11, Q14	Good to Degraded
	Low Forest and Woodland			
4	*Melaleuca rhaphiophylla* low forest over *Melaleuca viminea* over sedges and open grasses.	Lots 28, 32 and 36	Q6, Q7, H11, H12,H13,H14	Good to degraded
5	*Corymbia calophylla* (Marri) low open woodland over pasture grasses and herbs.	Lots 32 and 36	H18	Degraded, isolated trees only.

TABLE 22: Vegetation units found in the current survey area in the context of units mapped in Mattiske and Associates (1992).

Mapped area	Mattiske and Associates (1992) vegetation units	Current Survey
Lots 28 and 32	Low open woodland of *M. rhaphiophylla-M. preissiana* with occasional *B. littoralis* over tall mixed Myrtaceae-Proteaceae spp.-*A. pyramidalis* over sedges.	No *M. preissiana* present- this is probably taxonomic error in Mattiske and Assoc (1992). Otherwise similar to Unit 4 in current survey
Lot 28	Closed heath Myrtaceae spp. - Proteaceae spp.-*A. pyramidalis* over sedges	Similar to Unit 1a/1b in current survey
Lots 28 and32	Halophytic complex of *Sarcocornia quinqueflora* and sedges	There was no *S. quinqueflora* present in entire survey area- this is probably taxonomic error in Mattiske and Assoc (1992). No units equivalent to that of Mattiske and Assoc (1992) in current study. The area mapped in Mattiske and Assoc (1992) is now a dense heath dominated by *Hypocalymma, Acacia lasiocarpa, Melaleuca lateriflora* and *M. brevifolia.*
Lot 28	Tall shrubland of *Acacia saligna-Cytisus proliferus* over mixed *Melaleuca lateritia* and *Myrtaceae* spp. over dense *Lepidosperma longitudinale.*	No **Cytisus proliferus* and *Melaleuca lateritia* in this area now: these species were probably taxonomic errors in Mattiske and Assoc (1992). No units equivalent to that of Mattiske and Assoc (1992) in current study. The area mapped in Mattiske and Assoc (1992) is now a dense heath dominated by *Hypocalymma, Acacia lasiocarpa, Melaleuca lateriflora* and *M. brevifolia.*
Lots 32 and 36	Disturbed areas dominated by weeds and grasses with occasional sedges, *Hypocalymma* and *Eucalyptus* spp.	Equivalent to the completely degraded areas of Lots 32 and 36 in current study.

TABLE 23: Vegetation units found in the current survey area in the context of assemblages and habitat attributes of the Greater Brixton St Wetlands (Marshall, 2000).

Habitat (Marshall, 2000).	Local Scale Vegetation Units (Marshall, 2000).	Occurrence in current survey area
Water-filled depressions	1. *Melaleuca rhaphiophylla* low woodland 2. *Eucalyptus rudis- M. rhaphiophylla* open woodland to low open woodland 3. *Melaleuca rhaphiophylla- M. preissiana-Banksia littoralis* low woodland 4. *Melaleuca lateritia* shrubland-*Amphibromus nervosus* grassland 5. *Pericalymma* open heath 6. Halophytic complex 7. *Chaetanthus* flats 8. Sedgelands	**Yes= Unit 4** **Yes=Unit 4** No No No No. No No
Seasonally waterlogged or inundated flats	1. *Viminaria juncea* tall shrubland 2. *Actinostrobus* scrub 3. *Pericalymma- Tremulina* scrub 4. *Hypocalymma angustifolium* – Myrtaceae spp. open heath 5. Myrtaceae spp. – Proteaceae spp.-*Actinostrobus pyramidalis* closed heath 6. *Verticordia plumosa – Hypocalymma angustifolium* closed heath 7. Myrtaceae species mixed open heath 8. *Acacia saligna* tall shrubland 9. *Verticordia plumosa-V. densiflora- V. acerosa* low closed heath	**Yes = parts of Unit 2** **Yes = Unit 1a** No **Yes= Units 1a/1b and Unit 2** **Yes = Units 1a/1b** **Yes= Unit 1a in area adjoining Q8** ? No No
Dry or occasionally waterlogged flats	1. Mixed low shrubland 2. *Pericalymma* shrubland 3. Mixed scrub 4. Tall scrub 5. Eremaea scrub 6. Closed heath of Myrtaceae-Proteaceae ssp.	No dry flats in winter in Lots 28, 32 and 36 except Marri areas as below.
Uplands	1. *Corymbia calophylla* woodlands 2. *Banksia* woodland or low open woodland 3. *Eremaea* low shrubland	**Yes= degraded unit 5** No No

TABLE 24: Vegetation units found in the current survey area in the context of assemblages and habitat attributes of the Greater Brixton St Wetlands (after VCSRG, 2001).

Habitat in VCSRG (2000). (and same nomenclature used in current survey)	Vegetation units in BFS387 in VCSRG (2001).	Vegetation units in current survey.
High sand ridges	*Banksia menziesii*	No
Low sand ridges	*Eremaea pauciflora*	No
Dry sand mounds	*Corymbia calophylla*	Yes= Unit 5
Wet mounds	*Viminaria juncea*	Yes, very limited areas in Unit 2 (not mapped)
Sandy paluslopes	*Pericalymma ellipticum, Tremulina tremula;* or *Viminaria juncea*	No
Sand flats	*Acacia lasiocarpa, Calytrix breviseta*	Yes=Unit 2 , but no *Calytrix breviseta* present
Sandy palusplains	*Pericalymma ellipticum* (in gradation between basin and paluslope); or *Viminaria juncea*	No
Mud flats	*Banksia telmatiaea, Actinostrobus pyramidalis*	Yes=Unit 1a-1b
Muddy palusplains	*Meeboldina cana* (transitional area between two veg. units)	No
Muddy floodplains	*Halosarcia* (= ?*Tecticornia lepidosperma*) (transitional area between two veg. units)	No
Channels	*Melaleuca uncinata*	This unit in VCSRG (2001) may be equivalent to Unit 3a/3b in the current study as the landform and location of the VCSRG unit is comparable to that in current study mapped as *Melaleuca viminea.*
Sumplands	*Melaleuca lateritia/Meeboldina cana*	No
Damplands	*Melaleuca rhaphiophylla, Melaleuca viminea*	Yes = Unit 4

TABLE 25: Floristic Community Types of the SCP determined in the current survey area.

Survey Site Number	FCT suggested by multivariate analysis of floristic data only	Affinity of survey site to FCTs and TECs of the Swan Coastal Plain as evidenced by the habitat, floristic and structural data recorded in the current survey (Figure 6b).
Q1	8	Vegetation similar to the TEC: Herb-rich Shrublands in Clay Pans (Vulnerable).
Q2	?6	FCT not sampled in Gibson et al. (1994) and likely to be, at least, equivalent in conservation value to other TECs of the SCP.
Q3	8	Vegetation similar the TEC: Herb-rich Shrublands in Clay Pans (Vulnerable) and the Muchea Limestone EPBC-listed TEC
Q4	7/8	Vegetation similar the TECs: Herb-rich Saline Shrublands in Clay Pans (Vulnerable)/ Herb-rich Shrublands in Clay Pans (Vulnerable)
Q5	7	Vegetation similar the TEC: Herb-rich Saline Shrublands in Clay Pans (Vulnerable)
Q6	?6	FCT not sampled in Gibson et al. (1994) and likely to be, at least, equivalent in conservation value to other TECs of the SCP. Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.
Q7	?17	Vegetation similar to the *Melaleuca rhaphiophylla- Gahnia trifida* seasonal wetlands FCT 17 but more probably a vegetation type not sampled in Gibson et al. (1994) and likely to be, at least, equivalent in conservation value to the TECs of the SCP.
Q8	?10a	Vegetation similar to the TEC: Shrublands on Dry Clay Flats (Endangered)
Q9	?6	A degraded example of a *Melaleuca viminea* dominated FCT not sampled in Gibson et al. (1994) and from data available of BFS387, probably an uncommon vegetation assemblage of BFS387 (see discussion with regard to Table 27 above)
Q10	?6	A *Melaleuca viminea* dominated FCT not sampled in Gibson et al. (1994) and from data available of BFS387, probably an uncommon vegetation assemblage of BFS387 (see discussion with regard to Table 27 above) and equivalent in conservation value to other TECs of the SCP. Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC closely linked to that at Q6.
Q11	?17/7	Vegetation similar to the *Melaleuca rhaphiophylla- Gahnia trifida* seasonal wetlands FCT 17 and the TEC: Herb-rich Saline Shrublands in Clay Pans (Vulnerable) but more probably a vegetation type not sampled in Gibson et al. (1994) and likely to be, at least, equivalent in conservation value to the TECs of the SCP. Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.
Q12	7	Vegetation similar to the TEC: Herb-rich Saline Shrublands in Clay Pans (Vulnerable) However it is likely to be a *Melaleuca viminea* dominated FCT not sampled in Gibson et al. (1994) and from data available of BFS387, probably an uncommon vegetation assemblage of BFS387 (see discussion with regard to Table 27 above) and equivalent in conservation value to other TECs of the SCP. Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.
Q13	7	Vegetation similar to the TEC: Herb-rich Saline Shrublands in Clay Pans

Survey Site Number	FCT suggested by multivariate analysis of floristic data only	Affinity of survey site to FCTs and TECs of the Swan Coastal Plain as evidenced by the habitat, floristic and structural data recorded in the current survey (Figure 6b).
		(Vulnerable). Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.
Q14	8/?6/7	Vegetation similar to the TEC: Herb-rich Shrublands in Clay Pans (Vulnerable)/ ?Weed dominated wetlands on heavy soil/ Herb-rich Saline Shrublands in Clay Pans (Vulnerable). A *Melaleuca viminea* dominated FCT not sampled in Gibson et al. (1994) and from data available of BFS387, probably an uncommon vegetation assemblage of BFS387 (see discussion with regard to Table 27 above) and equivalent in conservation value to other TECs of the SCP. Possibly an occurrence of a wetland of the Muchea Limestone EPBC listed TEC.

TABLE 26: Vegetation of conservation significance (TECs) found in the current survey compared to the regional distribution of TECs.

SCP FCT	Name of TEC	Occurrences in vicinity of current survey area	Conservation Status (WA) DEC, 2008	Conservation Status (Federal) EPBC Act	Occurrence of TECs in current survey area
2	Southern wet shrublands	Dundas Road, Forrestfield	Endangered EN B) ii)		No
3a	*Eucalyptus calophylla –Kingia australis* woodlands on heavy soils	Dundas Road, Forrestfield and Greater Brixton Street Wetlands	Critically Endangered CR B) ii)	Endangered	No
3b	*Corymbia calophylla Eucalyptus marginata* woodlands on sandy clay soils	Clifford Road, Maddington	Vulnerable VU B)	Endangered	No
7	Herb rich saline shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)		Yes at Q4, Q5, Q11, Q12, Q13, Q14
8	Herb rich shrublands in claypans	Greater Brixton Street Wetlands and Kenwick Road, Kenwick	Vulnerable VU B)		Yes at Q1, Q3, Q4, Q14
10a	Shrublands on dry clay flats	Greater Brixton Street Wetlands, in Yule Brook Reserve	Endangered EN B) ii)		Yes at Q8
20a	*Banksia attenuata* woodlands over species-rich dense shrublands	Hartfield Park, Dundas Road, Pioneer Park, Bougainvillea Avenue, Forrestfield; Queens Park Bushland; Welshpool Road, Wattle Grove and White Road, Orange Grove	Endangered EN B) ii)		No
20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands	Clifford Road, Maddington	Endangered EN B) i) EN B) ii)		No
n/a	Shrublands and woodlands on Muchea Limestone (Keighery and Keighery,1995)	Passmore Street, Southern River Carousel Wetland, Cannington	Endangered EN B) ii)	Endangered	Probably Yes at Q3, Q6, H11, H12 but requires further study

Table 27: Wetlands mapped in *Geomorphic Wetlands Swan Coastal Plain Dataset* in the current survey area.

Lot Number	Wetland UFI	Geomorphic Classification in DEC (2008)	Management Category in DEC (2008)
28	7773	palusplain	CCW
28	7775	sumpland	CCW
32	7773	palusplain	CCW
32	8029	palusplain	CCW
32	13367	palusplain	REW
36	13367	palusplain	REW

Table 28: Study sites and wetland identification within the survey area.

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
Q1-H1 Lot 28	Surface waterlogging in winter	Shallow muddy sands perch rainwater.	25 taxa inc. *Act pyr, Hyp ang*, *Cha ari*, *Gah tri.*	20 taxa inc.*Vim jun Sch sub*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation; dominated by wetland taxa (61% of taxa O or F).	Palusplain 7773
Q2-H2 Lot 28	Surface waterlogging, in winter and also deeper WT	Shallow muddy sands perch rainwater, and other mottled clay layers.	9 taxa inc. UU *Aca las*. *var.las,*. *Act pyr, Ban tel, Hyp ang.*	5 taxa inc. *Aca sal* var. *sal, Mel vim* subsp. *vim, Sch sub*	1. Hydric soils: shallow aquitard, mottling. 2. Hydrology: waterlogged surface in winter. 3. Vegetation: dominated by wetland taxa (74% of taxa O or F).	Palusplain 7773
Q3-H3 Lot 28	Surface waterlogging in winter. Probably inundated in some years.	Shallow muddy sands perch rainwater.	16 taxa inc. UU*Aca las* var. *las, Act pyr, Cha ari*, *Gah tri, Hyp ang* ,Mel *lat* subsp. *acu*	5 taxa inc. *Sam jun,Thy man*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation: dominated by wetland taxa (64% of taxa O or F)	Palusplain 7773
Q4-H4 Lot 28	Surface waterlogging in winter.	Shallow muddy sands perch rainwater.	15 taxa inc. UU*Aca las* var. *las, Act pyr, Ban tel, Cha ari*, *Gah tri, Hyp ang, Mel lat* subsp. *acu.*	12 taxa inc. *Bor cre* subsp. *vim, Sam jun, Thy man.*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (64% of taxa O or F)	Palusplain 7773
Q5-H5 Lot 28	Surface waterlogging in winter.	Shallow muddy sands perch rainwater and mottling.	14 taxa inc. UU*Aca las* var. *las.., Act pyr, Ban tel, Hyp ang.*	3 taxa inc. *Mel vim* subsp. *vim, Bor cre* subsp. *vim..*	1. Hydric soils: shallow aquitard, mottling. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (77% of taxa O or F)	Palusplain 7773

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
Q6-H6 Lot 28	Shallowly inundated in winter. WT -36 cm after spring drought	Peat and humic sand to -20cm, mottling from -20cm and below.	6 taxa inc. *Mel rha*	6 taxa inc. *Aca sal* var. *sal*, *Mel vim* subsp. *vim*, *Sch sub*	1. Hydric soils: peat at surface and mottled shallow sediments. 2. Hydrology: inundated in winter and high WT through spring drought. 3. Vegetation: dominated by wetland taxa (75% of taxa O or F)	Sumpland 7775
Q7-H7 Lot 32	Surface waterlogging in winter.	Peaty sand at surface over muddy sand from –60cm, mud from–140cm.	5 taxa inc. *Mel rha* ,*Gah tri*, *Mel bre*, *Lep lon*	2 taxa *Aca sal* var. *sal*, *Mel vim* subsp. *vim*	1. Hydric soils: peaty sand, shallow aquitard. 2. Hydrology: waterlogged in winter. 3. Vegetation dominated by wetland taxa (50% of taxa O or F)	Currently palusplain 7773, may prove to be dampland/ sumpland with further study.
Q8-H8 Lot 32	Surface waterlogging in winter.	Shallow muddy sands perch rainwater	20 taxa inc. UU*Aca las* var. *las*, *Act pyr*, *Ani vir* subsp. *vir*, *Cha ari*, *Gah tri*, *Gre the*, *Hyp ang*.	5 taxa inc. *Bau jun*, *Sam jun*, *Sch sub*, *Ver den* subsp. *den*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (78% of taxa O or F)	Palusplain 7773
Q9-H9 Lot 32	Surface waterlogging in winter.		6 taxa inc. UUUU*Aca las* var. *las*, *Cha ari*, *Gah tri*, *Mel lat* subsp. *acu*, *Mel rha*.	2 taxa M*el vim* subsp. *vim*, *Sch sub*.	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (50% of taxa O or F)	Palusplain 7773
Q10 Lot 28	Surface waterlogging in winter.	Surface muddy sand perches rainwater	11 taxa inc. UUUU*Aca las* var. *las*, *Cha ari*, *Gah tri*,	4 taxa *Aca sal* var. *sal*, M*el vim* subsp. *vim*, *Sam*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa	Palusplain 7773

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
			Gre the, Hyp ang, Mel rha.	*jun, Vim jun*	(58% of taxa O or F)	
Q11 Lot 28	Surface waterlogging in winter.	Surface muddy sand perches rainwater	13 taxa inc. UUUU*Aca las* var. *las., Act pyr, Ban tel, Cha ari, Gah tri, Gre the, Hyp ang,. Mel lat* subsp. *acu, Pog stri*	5 taxa inc. *Bau jun, Ver den* subsp. *den.*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (61% of taxa O or F)	Palusplain 7773
Q12 Lot 28	Surface waterlogging in winter.	Surface muddy sand perches rainwater	7 taxa inc. UUUU*Aca las* var. *las. Act pyr, Cha ari, Gah tri, Hyp ang, Pog stri.*	4 taxa *Aca sal* var. *sal, Bau jun, ,Mel vim* subsp. *vim, Sch sub, Vim jun*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (55% of taxa O or F)	Palusplain 7773
Q13 Lot 28	Surface waterlogging in winter.	Surface muddy sand perches rainwater	16 taxa inc. UUUU*Aca las* var. *las, Act pyr, Ban tel, Cha ari, Cho eno, Gah tri, Gre the, Hyp ang, Mee roy, Mel lat* subsp. *acu, Pog str.*	5 taxa inc. M*el vim* subsp. *vim, Sam jun.*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (58% of taxa O or F)	Palusplain 7773
Q14-H10 Lot 32	Surface waterlogging in winter.	Shallow mud at -25cm perches rainwater	8 taxa inc. *Aca las* var. *las.*, Act *pyr, Cha ari, Gah tri, Hyp ang.*	3 taxa inc. *Aca sal* var. *sal*, *Mel vim* subsp. *vim, Tec lep*	1. Hydric soils: shallow aquitard. 2. Hydrology: waterlogged surface in winter. 3. Vegetation dominated by wetland taxa (58% of taxa O or F)	Palusplain 7773
H11 Lot 28	Inundation in winter. WT at -	Peat over clay over sand	*Mel rha, Ast aff, Hyp ang.,*	*Sch sub, Cen ari.*	1. Hydric soils: peat and shallow aquitard. 2. Hydrology: inundation in winter.	Currently palusplain

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
	16cm in spring and also a deeper WT at -160cm.				3. Vegetation dominated by obligate wetland taxa	7773 but may prove to be a sumpland on further study.
H12 Lot 28	Surface waterlogged or inundated in winters of average rainfall	Muddy sand over calcareous nodules below 30cm referable to Muchea Limestone.	*Mel rha, Ast aff, Ban lit*	*Sch sub, Cen ari*	1. Hydric soils: shallow aquitard calcareous nodules. 2. Hydrology: inundation in winter. 3. Vegetation dominated by obligate wetland taxa	Currently palusplain 7773 but may prove to be a sumpland on further study.
H13 Lot 36	Surface waterlogged in winter. WT in late spring at -280cm.	Peaty sand at surface over mottled sand at -70cm , muddy sand and deep sand	*Mel rha*		1. Hydric soils: peat and mottled sand. 2. Hydrology: waterlogging in winter. 3. Vegetation dominated by obligate wetland species.	Palusplain 1337 but may prove to be a dampland on further study.
H14 Lot 36	Surface waterlogged in winter. WT in late spring at -150 cm.	Sandy peat over sand	*Mel rha, Gah tri.*	*Mel vim* subsp. *vim.*	1. Hydric soils: peat. 2. Hydrology: waterlogging in winter. 3. Vegetation dominated by obligate wetland species.	Currently palusplain 13367 but may prove to be a sumpland on further study.

Site	Water table (WT) relative to ground surface (cm)	Stratigraphic indicators of wetland conditions	Number of obligate wetland indicators (O) and some of these taxa	Number of facultative wetland indicators (F) and some of these taxa	Wetland criteria met by site	Wetland Type and UFI in DEC(2008) and recommended in this study
H15 Lot 36	Surface waterlogged in winter. WT in late spring at -160 cm.	Peaty sand over muddy sand over muddy sand with quartz gravel.	No native vegetation remains	none	1. Hydric soils: peaty sand and shallow aquitard. 2. Hydrology: waterlogging in winter. .	Palusplain 13367
H16 Lot 32	WT in late spring at -210 cm.	Deeper Bassendean Sand overlies the Guildford Formation here than is present over most of Lot 36.	No native vegetation remains except a few *Cor cal*	none	Hydric soils at -160cm indicated by mottling and deeper aquitard present. No evidence surface waterlogging or inundation. Vegetation mostly cleared so insufficient data.	Currently palusplain 13367, but this small, localized area of deeper sand within palusplain is not wetland
H17 Lot 32	Surface waterlogging in winter.	Shallow sandy mud perches rainwater	No native vegetation remains	none	1. Hydric soils: shallow aquitard andcalcareous nodules. 2. Hydrology: waterlogging in winter. 3. Vegetation cleared so insufficient data.	Palusplain 13367
H18 Lot 36	WT in late spring at -240 cm.	Deeper Bassendean Sand overlies the Guildford Formation here than is present over most of Lot 36.	No native vegetation remains except a few *Cor cal*	none	No evidence of hydric soils, surface waterlogging or inundation, vegetation cleared so insufficient data.	Currently palusplain 13367, but this small, localized area of deeper sand within palusplain is not wetland

Table 29: Wetland classifications within the survey area.

Area	Current Classification	Hydroperiod	Landform	Proposed change
Lot 28	Palusplain 7773	Surface waterlogging observed in winter at Q1 to Q5 and Q10 to Q13.	Plain	No change
Lot 28	Palusplain 7773	H11: Inundation, persistent high water table. H12: Shallow inundation in winter. Vegetation indicating habitual inundation. These basins may be ecologically linked to UFI7775	Shallow basins.	Change to sumplands, but require further study
Lot 28	Sumpland 7775	Inundation, persistent high groundwater table in late spring at Q6. Vegetation indicating habitual inundation.	Shallow basin/swale	No change, also requires further study
Lot 32	Palusplain 7773	Surface waterlogging observed in winter at Q8,Q9 and Q14	Plain	No change
Lot 32	Palusplain 7773	Q7: Surface waterlogging observed in winter. Vegetation indicating inundation. Probably part of sumpland 8029 and possibly also linked hydrologically to sumpland 7775.	Shallow basin/swale	Sumpland/ dampland, requires further study.
Lot 32	Palusplain 8029	Surface waterlogging observed in winter	Plain	No change
Lot 32	Palusplain 13367	Surface waterlogging observed in winter H17	Plain	No change.
Lot 32	Palusplain 13367	Small areas of deeper sand drifts in some places that probably remain dry except in wetter than average winter at H16.	Plain	Not wetland
Lot 36	Palusplain 13367	Surface waterlogging observed in winter. H13 and H14	Shallow basin/swale	Change to dampland.
Lot 36	Palusplain 13367	Surface waterlogging observed in winter. H15	Plain	No change.
Lot 36	Palusplain 13367	H18. Small areas of deeper sand drifts in some places that probably remain dry except in wetter than average winter.	Plain	Not wetland

Appendices

Appendix A

Floristic Community Type – PATN Statistical Analysis

1.0 INTRODUCTION

1.1 Purpose of this report

The current report is intended to help clarify the assignment of Floristic Community type (FCT) designation to vegetation community (site) data. FCTs were defined by Gibson et al (1994) based on site data collected from vegetation on the Swan Coastal Plain. In particular, the potential that a Threatened Ecological Community (English and Blyth 1997) is represented by the data collected needs to be clarified.

1.2 Location of Brook Road Wattle Grove Sites

The sites were from Lots 28 and 32 Brook Rd Wattle Grove that were surveyed in Tauss (2008).

1.3 Brief background to floristic analysis of vegetation on the Swan Coastal Plain

Floristic analysis (ie., analysis of variation in vegetation based on the species present, rather than description of structural variation and dominance) as a significant component of the understanding of the variation present in the native vegetation of the Swan Coastal Plain dates to Gibson *et al* (1994 – all references to the SCP survey in the current report refer to this publication), the first publication to document the floristics of the vegetation of a large part of the Swan Coastal Plain. While the SCP survey is based on a very significant amount of work, it must be viewed as a "first pass" survey, limited, in the context of the great variety of vegetation present in the very large area surveyed, by the relatively limited number (509) of sites (quadrats) it is based on. To a limited degree, this limitation has subsequently been addressed in an "update" to the work of the SCP survey (which describes additional units). However, there is no detailed publication of the results of this update available and the additional data used are not readily available in an appropriate form (ie., one that would enable ready comparison of new data to the overall data set).

The units described by the SCP survey are a series of "floristic community types", a "unit" whose rank is defined by the use within a study. The SCP survey surveyed a very large survey area and defined a relatively small number of floristic community types. Consequently, the floristic community types they have described are of a very high order (see Trudgen 1999, volume 1, for further discussion of this point). This is an extremely important point to fully grasp in interpreting the analysis presented by the SCP survey and in understanding the meaning of analysis of other data sets when they are compared to the floristic community types of the SCP survey.

The important effects of the limited size data set used by the SCP survey and of the relatively small number of floristic community types defined by them, can be summarised by the following points:

1. the definition of all but two of the Threatened Ecological Communities for vegetation on the Swan Coastal Plain (English and Blyth 1997) has been based on the floristic community types of the SCP survey. It therefore follows, that with two exceptions, only vegetation units from one study that are different at a very high order of floristics are treated as rare by Government. No account is taken of other important differences, such as differences in structure and dominance;

2. for the definition of floristic community types to be robust, a sufficient sized database is needed to give adequate precision in their definition. About half of the floristics community types (or sub types) of the SCP survey are based on less than 10 sites. It is likely that with a larger data set there would be significant alteration in the classification of those floristic community types from the SCP survey based on small numbers of sites.

3. as noted above, many (if not most) of the floristic community types defined by the SCP survey are very broad. They contain very significant variation in floristics, structure and dominance. Some (or in more highly cleared parts of the Swan Coastal Plain much) of this variation may be rare by any reasonable definition, but it is currently "buried" within larger groups;
4. there is likely to be significant variation not sampled by the SCP survey. This includes some variation at a high level of floristic difference (see Trudgen 1999, volume 1, for an example of this) and undoubtedly quite significant (large!) amounts of variation at "medium" and "low" levels.

5. the document, and its use by Government, has focussed attention in the environmental impact assessment process on the high level of units described, deflecting attention from the layers of variation beneath these units that also have significant conservation value.

From these points it is obvious that there is a need for a major "upgrade" to the floristic analysis of the vegetation of the Swan Coastal Plain to provide a more detailed floristic classification that considers not only more of the variation present, but explicitly recognises more of the variation present in formally described units.

Obviously, such a reworking would have some effect on what vegetation is considered rare on the Swan Coastal Plain. It needs to be stressed that it would be very unlikely to find that any of the vegetation currently considered to be rare on the basis of the SCP survey*'s* classification was not rare. On the other hand, it is likely that such a review would very probably consider to be rare some vegetation which is not currently considered rare.

1.4 Data provided

It is very important in comparing different sets of floristic data that they are comparable in the application of names, in the intensity of the survey (ie., the effort of searching resulting in similar proportion of the flora at sites being recorded) and in the size of the site recorded. If the data from different data sets is not comparable in these ways, it reduces the clarity of the results of the analyses carried out. If the discrepancy in the comparability of the data sets is large, the results may become meaningless.

A brief observation of the from Brook Road Wattle Grove, compared to other datasets of the flora of the SCP indicates that the Brook Road Wattle Grove sites above may be low in the numbers of geophytes (eg orchid) and annual species recorded.

2.0 METHODS

2.1 Data Preparation

The data from the Brook Road Wattle Grove sites were provided into a standard MS Access based database designed for this type of data. One virtue of the database is that the species recorded at each site are stored against standard codes (numbers, those used by the Western Australian Herbarium) for each species. This facilitates ready comparison of data from different surveys stored in the same system.

After the data were incorporated into the database (containing the data from other projects), a process of reconciliation of flora species names with those used in the SCP survey was undertaken. This step was necessary at least because of changes in nomenclature over the last ten years and the potential of survey specific variations in the application of names. The reconciliation involved:

- reducing some infra-specific names to the relevant species name,
- combining some taxa where confusion is known to have occurred in field observations and identifications, and
- omitting some names (mostly, where a species had only been identified to genus).

The reconciliation process was relatively straight forward as most of the names had already been standardised. Most reconciliation was to conform with the methods that the SCP survey used to manage confusing taxa plus some nomenclatural changes (see Appendix).

2.2 Comparability of datasets

It was concluded that the some of the sites in the dataset were probably only modestly compatible to obtain reliable determinations.

2.3 Comparisons made

Two sets of data were evaluated. The data from the 14 sites plus the 509 sites from the SCP survey of the southern part of the Swan Coastal Plain (south of Gingin) were combined.

The main purpose was intended to assign the individual sites to the Floristic Community Types (FCTs) defined in the SCP survey.

These data are provided in CT_Brook Road Wattle Grove.mdb.)

2.4 Analyses carried out

The approach was the use of numerical classification techniques (PATN) based on the similarity of the floristic composition of the Brook Road Wattle Grove sites to sites in the SCP survey data set.

2.4.1 PATN

Several modules of the numerical classification package PATN (Belbin 1987) were used for the analyses. The parameter values were the same as used by the SCP survey used to ensure consistency of analysis with that study.

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification based on the results of ASO), DEND (representation of classification) and NNB (determination of sites most similar to each site – nearest neighbours). The results of the analyses were imported into a database (BM_TimsThicket.mdb) so that site characteristics and previous classifications (eg., Floristic Community Types derived in earlier classifications) could be associated and various analyses based on these data could be performed.

The assignment of floristic community types to the Brook Road Wattle Grove sites was made by summarising the results of two different methods:

- the classification, and
- the twenty nearest neighbours.

Experience demonstrates that the results of these are likely to vary, but that from nearest neighbours is likely to make more sense.

To the classification dendrogram of the combined dataset the FCT assigned by the SCP survey was associated with the SCP survey sites. The apparent FCTs were assigned to the Brook Road Wattle Grove sites by interpreting the position of these sites in the dendrogram (particularly by the way they joined to the SCP sites.

The 20 sites in the combined data set that were most similar to each of the Brook Road Wattle Grove sites were obtained from the nearest neighbour method (NNB). By associating those nearest neighbours from the SCP survey, the most likely FCTs for each of the Brook Road Wattle Grove sites were determined.

An attempt was then made to reconcile these different assignments of a Floristic Community Type.

3.0 LIMITATIONS

It has been found in earlier projects that the addition of new sites to the SCP survey data set to produce a combined classification disrupts the original classification. The more data added, the higher the level of the disruption. This problem can make it difficult to assign Floristic Community Types to new sites using this method.

Secondly, it is common for new data to group to their cohorts. In some cases this has proven to result from common deficiencies in the data, ie. whole groups of species missing. This absence tends to draw them together. The more sites in the added batch, the tighter they draw together.

The analyses are conducted without personal knowledge of the sites and no photographs were provided. It was noted that some sites had been disturbed.

4.0 RESULTS

4.1 Determination of floristic community type by classification

The classifications was unable to suggest any relationships as all the new sites grouped together at the end of the dendrogram. This suggested that the sites are significantly difference from the SCP quadrats. The likely reason for this is the degree of disturbance with most new sites having shared 'absences'. One site (Q1) was relatively rich but its geographic proximity may have contributed to it being grouped with its cohorts.

Figure 1. Relevant portions of Dendrogram all Quads and Releves

site	FCT from NNB	sp	dendrogram
Q01	8	63	
Q03	8	33	
Q04	7/8	37	
Q05	7	20	
Q11	?17/7	21	
Q13	7	33	
Q08	?10a	28	
Q14	8/?6/7	16	
Q10	?6	24	
Q12	7	23	
Q02	?6	16	
Q07	?17	11	
Q06	?6	13	
Q09	?6	14	

(Brook Road Wattle Grove sites Q*)

4.2 Determination of floristic community type using Nearest Neighbour method

The nearest neighbour analysis also suggests that the sites do not fit the FCTs well. This is a relatively common phenomenon when adding largely dampland sites to the SCP dataset. This is for two reasons; these sites can be very different and the SCP dataset has a low number of wetland types and those defined as FCTs are relatively generalised. A common occurrence is that new dampland sites tend to disrupt the SCP FCT classification.

Table 1. Results of Nearest Neighbour analysis

s	s1	fct1	v1	s2	fct2	v2	s3	fct3	v3	s4	fct4	v4	s5	fct5	v5
Q01	Q04		0.35	Q03		0.49	Q08		0.55	ELLEN-1	8	0.57	Q11		0.61
Q02	Q05		0.54	Q04		0.64	Q11		0.66	Q14		0.67	Q03		0.68
Q03	Q04		0.34	Q13		0.48	Q01		0.49	Q05		0.5	Q10		0.50
Q04	Q03		0.34	Q01		0.35	Q05		0.51	Q11		0.52	Q13		0.56
Q05	Q11		0.33	Q13		0.45	Q14		0.47	Q03		0.5	Q04		0.51
Q06	Q09		0.66	Q02		0.70	Q10		0.71	Q07		0.71	Q12		0.75
Q07	Q10		0.64	cool 01	17	0.65	Q02		0.69	Q06		0.71	PAGA-5	17	0.72
Q08	Q14		0.42	Q11		0.44	Q13		0.53	Q03		0.53	Q12		0.54
Q09	Q13		0.52	Q14		0.57	Q03		0.61	Q05		0.62	Q06		0.66
Q10	Q11		0.45	Q12		0.46	Q13		0.47	Q03		0.50	Q14		0.53
Q11	Q05		0.33	Q13		0.38	Q08		0.44	Q10		0.45	Q14		0.48
Q12	Q14		0.44	Q10		0.46	Q13		0.52	Q03		0.52	Q08		0.54
Q13	Q11		0.38	Q14		0.45	Q05		0.45	Q10		0.47	Q03		0.48
Q14	Q08		0.42	Q12		0.44	Q13		0.45	Q05		0.47	Q11		0.48

s	s6	fct6	v6	s7	fct7	v7	s8	fct8	v8	s9	fct9	v9	s10	fct1	v10
Q01	Q05		0.63	ELLEN-2	8	0.64	Q12		0.64	ELLEN-5	8	0.65	Q13		0.65
Q02	Q07		0.69	Q10		0.7	Q01		0.70	Q06		0.70	Q08		0.72
Q03	Q11		0.51	Q12		0.52	Q08		0.53	Q14		0.54	Q09		0.61
Q04	Q12		0.57	Q08		0.58	Q10		0.59	BULL-6	7	0.61	Q02		0.64
Q05	Q02		0.54	Q12		0.55	Q08		0.56	Q10		0.58	Q09		0.62
Q06	TWIN-4	6	0.76	Q14		0.76	WATER-2	13	0.78	Q05		0.8	Q13		0.8
Q07	ELLIS-1	17	0.72	Q09		0.73	Possum2	16	0.75	MTB-5	17	0.76	cool 11	17	0.76
Q08	Q01		0.55	Q05		0.56	Q04		0.58	Q10		0.60	YULE-4	10a	0.66

s	s6	fct6	v6	s7	fct7	v7	s8	fct8	v8	s9	fct9	v9	s10	fct1	v10
Q09	Q11		0.69	Q08		0.7	Q07		0.73	Q12		0.76	Q10		0.78
Q10	Q05		0.58	Q04		0.59	Q08		0.60	Q07		0.64	Q01		0.65
Q11	Q03		0.51	Q04		0.52	Q12		0.56	Q01		0.61	Q02		0.66
Q12	Q05		0.55	Q11		0.56	Q04		0.57	Q01		0.64	BULL-8	7	0.71
Q13	Q12		0.52	Q09		0.52	Q08		0.53	Q04		0.56	Q01		0.65
Q14	Q10		0.53	Q03		0.54	Q09		0.57	Q01		0.67	Q02		0.67

s	s11	fct1	v11	s12	fct1	v12	s13	fct1	v13	s14	fct1	v14	s15	fct1	v15
Q01	Q10		0.65	ELLEN-3	8	0.66	AUSTB-2	7	0.66	BULL-6	7	0.66	Q14		0.67
Q02	TWIN-2	6	0.72	TWIN-4	6	0.74	Q13		0.77	ELLEN-7	6	0.79	TWIN-3	6	0.79
Q03	FL-3	8	0.67	ELLEN-5	8	0.67	FL-7	8	0.68	Q02		0.68	BULL-8	7	0.69
Q04	ELLEN-1	8	0.65	KOOLJ-6	10a	0.66	FL-3	8	0.67	GINGIN-2	7	0.67	Q14		0.68
Q05	Q01		0.63	BULL-8	7	0.70	BULL-6	7	0.78	YULE-4	10a	0.78	Q06		0.8
Q06	TWIN-10	15	0.80	Possum2	16	0.81	ELLEN-7	6	0.82	PAGA-5	17	0.82	PAGA-2	13	0.83
Q07	ELLIS-3	18	0.77	FL-10	12	0.77	WATER-2	13	0.77	TWIN-4	6	0.81	low10b	11	0.82
Q08	Q09		0.7	Q02		0.72	BULL-8	7	0.73	BULL-7	5	0.75	BULL-6	7	0.75
Q09	Q01		0.83	Q04		0.83	TWIN-4	6	0.83	ELLEN-7	6	0.83	PEARCE-1	6	0.83
Q10	Q02		0.7	Q06		0.71	TWIN-4	6	0.74	ELLEN-7	6	0.74	BULL-8	7	0.75
Q11	Q09		0.69	ELLIS-1	17	0.75	BULL-6	7	0.75	BULL-8	7	0.77	MTB-5	17	0.77
Q12	BULL-6	7	0.72	Q06		0.75	MUD-3	8	0.75	FL-7	8	0.75	Q09		0.76
Q13	BULL-6	7	0.73	BULL-8	7	0.74	Q02		0.77	GINGIN-3	7	0.78	TWIN-2	6	0.78
Q14	Q04		0.68	FL-7	8	0.72	PEARCE-1	6	0.73	BULL-8	7	0.75	Q06		0.76

s	s16	fct1	v16	s17	fct1	v17	s18	fct1	v18	s19	fct1	v19	s20	fct2	v20
Q01	AUSTB-7	7	0.67	low09a	5	0.67	KOOLJ-6	10a	0.68	MUD-6	8	0.68	AUSTB-8	7	0.69
Q02	BAMBUN-	7	0.82	CARAB-3	11	0.82	BULL-8	7	0.82	AUSTB-6	5	0.83	ELLEN-5	8	0.83
Q03	MUD-2	8	0.69	BULL-6	7	0.70	ELLEN-1	8	0.70	MUD-6	8	0.72	MUD-3	8	0.72
Q04	MUD-2	8	0.68	ELLEN-5	8	0.7	BULL-7	5	0.70	ELLEN-3	8	0.71	BULL-8	7	0.71
Q05	YULE-5	7	0.80	KOOLJ-7	10a	0.81	WONN-3	9	0.82	TWIN-2	6	0.82	C58-4	10a	0.83
Q06	PB-3	29b	0.83	Q08		0.84	TWIN-2	6	0.84	CARAB-1	15	0.84	Q03		0.85
Q07	PAGA-2	13	0.82	WOODP-1	30a	0.82	McLART-1	13	0.82	CAPEL-9	12	0.83	Q14		0.84
Q08	BRIX-1	8	0.76	ELLEN-7	6	0.76	BRIX-3	8	0.77	MUD-3	8	0.77	TWIN-2	6	0.77
Q09	Q02		0.86	FL-10	12	0.86	WATER-3	3c	0.88	NAVB-4	24	0.88	Possum2	16	0.88
Q10	CARAB-2	7	0.77	BULL-6	7	0.77	ELLIS-1	17	0.77	PAGA-5	17	0.77	ELLEN-3	8	0.77
Q11	BULL-7	5	0.78	C58-4	10a	0.78	YULE-4	10a	0.79	hymus01	11	0.80	BAMBUN-1	7	0.80
Q12	ELLEN-7	6	0.77	YULE-5	7	0.77	ELLEN-2	8	0.78	ELLEN-3	8	0.79	FL-3	8	0.80
Q13	FL-7	8	0.78	Q06		0.8	AUSTB-8	7	0.8	YULE-5	7	0.80	TWIN-3	6	0.80
Q14	ELLEN-7	6	0.78	ELLEN-4	8	0.79	TWIN-2	6	0.80	BULL-6	7	0.81	FL-10	12	0.81

s – the site being compared
s1 to s20 – the 1st to 20th most similar sites
f1 to f20 – the FCT of the similar sites (only for SCP sites)
v1 to v20 – the dissimilarity value between the site and the similar sites (values above 0.6 tend to indicate low similarity)

4.3 Combining the results

The interpretation for the nearest neighbour analysis is presented in Figure 1. This allows a degree of comparison between the two methods which are modestly consistent.

Much of the uncertainty suggested in these analyses is likely to be a product of the sites being wetland related communities. The intrinsic diversity of these communities coupled to the relatively small number of communities in the SCP data lead commonly to high uncertainty with this style of analysis.

Table 2 is a summary of the richness of the new sites in relation to the putative FCTs. In general terms, most sites appear to be low total richness and low in plant families commonly overlooked in cursory examination or more vulnerable to loss in disturbed areas.

Table 2 Richness of sites and FCTs

			selected plant families																		
					x	x	x	x	x	x	x	x		x				x	x	x	
site	fct	#spp	031	032	054B	054C	054D	054E	054F	054J	054L	066	090	143	163	165	273	281	341	343	345
	10a	51	2.5	5.9		0.3	0.1		1.4	0.5	0.4	2.8	2.9	2.6	0.8	1.9	4.6	1.4	1.4	3.0	2.9
	17	14	0.9	2.9		0.1			0.1			0.1			0.3	0.6	1.9	0.8			1.3
	6	26	3.4	1.8		0.6	0.2	0.2	0.8	0.3		1.2	0.9	2.0	0.6	0.8	3.1	0.2	0.1	0.4	2.7
	7	46	3.9	4.6		0.2		0.1	1.2	0.7	0.1	1.3	0.1	2.2	0.2	1.1	2.9	2.1	0.8	1.8	6.9
	8	52	5.4	6.0	0.0	0.3	0.3		2.0	0.8	0.6	1.3	0.9	2.0	0.7	1.9	3.5	1.0	1.3	2.1	4.1
Q01	8	63	4	3					1			5	3	4	2	2	5	1	1	1	6
Q02	?6	33	1		1				1				2		1		5				1
Q03	8	37	3	1					1				1		1	2	3		1		3
Q04	7/8	20	4	1					1			2	1	2	1		4	1			5
Q05	7	21		2					1				2		1		6			1	2
Q06	?6	33	3	1	1										2		3				
Q07	?17	28	2	2	1												2				
Q08	?10a	16	2	4									1	1	2	1	6				1
Q09	?6	24	4	2											1	1	3				
Q10	?6	23	4	2									1		1	1	3		1		1
Q11	?17/7	16	2	2									2		1	1	5		1		1
Q12	7	11	3	3											1	1	2		1		3
Q13	7	13	6	3									1		1	1	4		2		3
Q14	8/?6/7	14	1	1											2	1	3				2

These sites are difficult to assign to any FCTs, probably due to disturbance but possibly they represent communities not in the FCT data. Site condition assessment may be used to distinguish between these possibilities.

4.0 REFERENCES

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5.0 APPENDIX

Appendix 1 Species combinations made to assist in reconciling taxonomic changes and identification difficulties between this survey and SCP data.

FCODE	name	lookup
031	Austrostipa juncifolia	omitted
031	Avena barbata	Avena barbata/fatua
031	Hordeum geniculatum	Hordeum leporinum
031	Pennisetum clandestinum	omitted
031	Pentaschistis aeroides	Pentaschistis airoides/pallida
031	Tribolium uniolae	omitted
032	Isolepis nodosa	omitted
039	Leptocarpus aristatus	Chaetanthus aristatus
039	Leptocarpus canus	omitted
039	Leptocarpus roycei	Meeboldina roycei
039	Lyginia imberbis	Lyginia barbata
054B	Myrsiphyllum asparagoides	Asparagus asparagoides
054F	Thysanotus manglesianus	Thysanotus patersonii/manglesianus
060	Gladiolus undulatus	omitted
060	Romulea rosea var. australis	Romulea rosea
066	Monadenia bracteata	Disa bracteata
066	Thelymitra sp.	omitted
090	Grevillea thelemanniana	Grevillea thelemanniana subsp. obtusifolia
090	Grevillea thelemanniana subsp. preissii	omitted
090	Petrophile media var. juncifolius Ms	omitted
103	Rumex acetosella	omitted
103	Rumex crispus	omitted
109	Phytolacca octandra	omitted
111	Calandrinia sp. Wattle Grove (G.J. Keighery 10905)	Calandrinia granulifera
143	Drosera macrantha subsp. macrantha	Drosera macrantha (Swan coastal plain form BJK & NG 228)
149	Crassula colorata var. acuminata	Crassula colorata
163	Acacia lasiocarpa var. lasiocarpa	Acacia lasiocarpa
163	Acacia saligna var. saligna	Acacia saligna
165	Lotus subbiflorus	Lotus suaveolens
165	Nemcia capitata	omitted
175	Boronia crenulata subsp. viminea	Boronia crenulata
183	Comesperma aff. polygaloides	omitted
221	Lawrencia squamata	omitted
273	Astartea affinis	Astartea aff. fascicularis
273	Eucalyptus calophylla	omitted
273	Melaleuca brevifolia	Melaleuca bracteosa
273	Melaleuca viminea subsp. viminea	Melaleuca viminea
273	Verticordia plumosa var. brachyphylla	Verticordia plumosa
288	Leucopogon sp.	omitted
293	Anagallis arvensis var. caerulea	Anagallis arvensis
310	Echium plantagineum	omitted
316	Bellardia trixago	omitted
326	Eremophila glabra subsp. chlorella	Eremophila glabra
329	Plantago coronopus	Plantago major
341	Goodenia pulchella subsp. Coastal Plain B (L.W. Sage 2336)	Goodenia pulchella
345	Angianthus pygmaeus	Angianthus preissianus
345	Brachyscome pusilla	Brachyscome bellidioides
345	Lagenifera huegelii	omitted
345	Podolepis capillaris	omitted

Appendix B

Results of the desktop flora search for species of conservation significance

APPENDIX B

Desktop Study: Flora of Conservation Significance. Lots 28, 32 and 36 Brook Rd Wattle Grove

Note: The names of taxa in Tables A1 and A2 below are those current on Florabase at WA Herbarium (2008). Where there is variation within a currently published taxon as listed on Florabase, the abbreviations *sens lat.* (in the broad sense) or *sens. strict.* (in the strict sense) are added after the current Florabase name. Voucher specimen details for morphological variants that are significant in the vicinity of the current survey area are also provided, where necessary. (See also the taxonomic notes and synonyms in Appendix B).

DEFINITIONS OF CONSERVATION SIGNIFICANCE

1. Flora of National Significance (Federal EPBC Act, 1999) (TABLE A1 below)

Critically Endangered

Taxa that have been thoroughly surveyed and found to have been subject to a major contraction in area or which were originally of limited distribution and are now facing severe modification or destruction throughout their range in the immediate future.

Endangered

Taxa that have been adequately surveyed and found to have been subject to a major contraction in area or which were originally of limited distribution and are now in danger of significant modification throughout their range in the near future.

Vulnerable

Taxa that have been adequately surveyed and found to be declining and/or have declined in distribution and/or condition and whose ultimate security has not been assured or taxa that are still widespread but are believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

2. Flora of State Significance: Declared Rare Flora (WA Wildlife Conservation Act) (TABLE A1 below)

DRF: Declared Rare Flora – Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

3. Flora of State Significance: Priority Flora Taxa (WA Department of Environment & Conservation) (Atkins, 2008) (TABLE A1 below)

P1: Priority One – Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

P2: Priority Two – Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

P3: Priority Three – Poorly Known Taxa

Taxa which are known from several populations and the taxa are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.

P4: Priority Four – Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa are considered to require monitoring every 5-10 years.

4. Flora of Regional Significance (EPA, 2004) (TABLE A2 below)

Apart from EPBC-listed, DRF and Priority Species, Guidance Statement 51 (EPA, 2004B) and Bush Forever (Government of Western Australia, 2000) define other criteria under which flora taxa (i.e. species, sub-species or varieties) or populations of these taxa may have conservation significance. In the current survey of Lots 28, 32 and 36 Brook Rd, Wattle Grove, such taxa and populations are termed "regionally significant". The criteria for significance of these elements of the flora are discussed in Section 4.1.3 in the main body of the report.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

KEY

Nationally Significant Flora (DEWHA, 2008)
CE Critically Endangered
EN Endangered
VU Vulnerable

State Significant Flora (Atkins, 2008)
DRF Declared Rare Flora – Extant Taxa
P1 Priority One – Poorly Known Taxa
P2 Priority Two – Poorly Known Taxa
P3 Priority Three – Poorly Known Taxa
P4 Priority Four – Rare Taxa

d Populations disjunct from their known geographic range
eSCP Taxa endemic to the eastern Swan Coastal Plain
eSCP(P) Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region
p Taxa considered to be poorly reserved (applies to all DRF and Priority taxa)
r Populations at or near limit of their known geographic range
s Significant populations in maintaining regional presence of a flora taxon
t Significant taxonomically, morphological variant
u Uncommon in area (generally applies to disjunct populations)

(Note: MKSEA is Maddington-Kenwick Strategic Employment Area as in Tauss & Weston ,2008)

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Acacia oncinophylla subsp. *patulifolia*	P2	Darling Scarp Forrestfield- Gosnells	Sep-Oct		Tall shrub- low tree with yellow flowers on laterite, granite.
Andersonia gracilis	DRF EN p, s, d	Kenwick, Cannington, Badgingarra, Nambung, Cataby, Swan View	(Sep-) Oct-Nov	*	Slender erect or open straggly shrub, 0.1–0.5 (–1) m tall; flowers white, pink, purple. White/grey sand, sandy clay, gravelly loam; winter-wet areas.
Anthotium junciforme	P4 p, s	Kenwick, Albany Upper Swan, Serpentine, Busselton, Scott River Plain,	Dec-Mar	*	Grass-like tufted herb <40 cm tall; fls purple to pale blue (rarely white or pink), terminal on stalks > than lves. Low in landscape in eucalypt woodlands or winter-wet flats.
Aponogeton hexatepalus	P4	Kenwick, Pinjarra, Capel, Bunbury, Boyanup, Nannup	Aug-Sep	*	Rooted aquatic herb, leaves straplike, floating part of leaf broader than the submerged part. Shallow winter pools on clay soils, rivers.
Asteridea gracilis	P3	Darling Range, Gordon River, Gosnells (DR), Bindoon	Sep-Oct		White flowering annual daisy – clay and clay over granite.
Baeckea sp. Perth Region (R.J. Cranfield 444) (syn. *B. tenuifolia)*	P3 p, s, d	Kenwick, Moora, Cannington, Lancelin, Mogumber, MKSEA	Jan-Mar	*	Erect open shrub 40-70cm tall; flowers white, pink. Sand and clayey soils; winter-wet depressions.
Banksia mimica	DRF VU	Wattle Grove, Kalamunda, Whicher Range, Gingin	Dec-Jan		Low, semi-prostrate shrub; flowers yellow. White or grey sand over laterite, sandy loam.
Byblis gigantea (syn. B. lindleyi)	P2 p, d, r, eSCP(P)	Kenwick, Cannington, Jandakot, Brookton Highway	Sep-Jan	*	Perennial herb to 60cm tall; leaves terete, long, with glandular hairs, insectivorous; flowers blue/pink/purple. Seasonally wet soils, sandy clay, swampy areas.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Calytrix breviseta subsp. *breviseta*	DRF EN p, s , eSCP(P)	Kenwick (Gosnells, Bellevue), MKSEA	Sep-Oct	*	Shrub 0.4–1m tall; flowers purple, blue. Sandy clay, swampy flats.
Caladenia huegelii	DRF EN p, s , eSCP	Capel, Banjup, Canning Vale, Melville, Yallingup, Queens Park, Malaga	Sep-Oct		Geophytic orchid to about 0.4m in height. Large red and white flowers with very long fringe on labellum. Banksia woodland on dunes and around wetlands.
Calothamnus rupestris	P4	Ellis Bk, Boyagin Rk, Gosnells, Darling Range, Southern R, MKSEA	Sep-Oct		Large shrub with pink-red flowers. Darling Range and scarp, watercourses. Granite and clay.
Centrolepis caespitosa	P4 p, s	Kenwick (Yule Brook), South Stirling, Pearce, Meckering, (Byford)	Nov (Oct-Dec)	*	Tufted annual, herb (forming a rounded cushion up to 25mm across). White sand, clay; salt flats, wet areas.
Chamaescilla gibsonii (syn. *Chamaescilla* sp. Ellen Brook (GJK 12501)	P3 s , eSCP	Kenwick, Mogumber, Capel, Muchea,	Sep	*	Tuberous herb; flowers blue. Clay -sandy clay; winter-wet flats, claypans.
Comesperma rhadinocarpum	P2 p, s ,d	Kenwick, Mullewa, Cataby, (Greenough R, Irwin R)	Oct-Nov	*	Herb; flowers blue. Sandy soils.
Conospermum undulatum	DRF VU p, s , eSCP(P)	Kenwick, Forrestfield, Orange Grove, Newburn, Lesmurdie, MKSEA	Aug-Nov	*	Erect, narrow shrub to 2m tall; leaves broad with undulate margins. Grey or yellow-orange clayey sand.
Cyathochaeta teretifolia	P3 p, s, u	Bullsbrook, MKSEA, Pinjar, Blackwood,			Tall sedge, on SCP usually associated with artesian springs or seepage from dune aquifers. Significant number of recorded locations on SCP no longer extant although more common in Jarrah Forest & Warren regions.
Diuris drummondii	DRF EN	Albany, Lake Muir, Bunbury, Mandurah, Gingin	Nov-Jan		Tall donkey orchid with pale yellow flowers, amongst sedges under Paperbarks in peaty damplands and on margins of sumplands.
Diuris purdiei	DRF VU p, s, eSCP	Perth - Waroona, Busselton	Sep-Oct		Slender donkey orchid with 5-10 narrow, spirally twisted leaves. Seasonally wet, recently burnt shrublands, usually *Regelia* and/or *Pericalymma*. On sand over clay.
Drosera occidentalis subsp. *occidentalis*	P4 p, s	Kenwick, Gingin-Pinjarra, Palgarup, Darling Range, Wattle Grove,	Nov-Dec	*	Pygmy sundew with sparse, open rosette of red leaves and white to very pale pink flowers. In white peaty sand of margins of winter wet swamps
Drakaea elastica	DRF EN	Capel to Cataby	Sep-Nov		Small hammer orchid with small, glossy, pale green leaf being the most conspicuous and distinctive feature for most of the growing season. In humic sands on margins of peaty wetlands.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Eleocharis keigheryi	DRF VU	Kenwick, Lesueur, Ellenbrook, Boyanup	Aug-Nov	*	Rhizomatous, clumped perennial grass-like sedge to 40cm tall; flowers green. Clay, sandy loam; emergent in freshwater: creeks, claypans.
Eremophila glabra subsp. *chlorella* ms	DRF p, s, u	Kenwick-Cannington, Moora, Cataby, Mogumber, MKSEA	Jul-Aug	*	Shrub to 1m tall; flowers green, yellow. Sandy clay, sumplands.
Eryngium pinnatifidum subsp. *palustre* ms	P3 p, s	Kenwick, Forrestdale, Gingin, Capel, Arrowsmith	Sep-Nov	*	Herb to 50cm tall; flowers white, pale blue. *Melaleuca* shrublands and low open vegetation on winter-wet sandy-clay flats.
Eryngium subdecumbens ms	P3 p, s	Kenwick, Ruabon, Busselton, Kooljerrenup	Oct-Nov	*	Prostrate perennial, herb, to 15cm high; stems tubular; flowers white, green. Clay, grey sand; seasonally wet flats, claypans, swamps.
Grevillea thelemanniana	P4 p, s, eSCP(P)	Kenwick, MKSEA	Jun-Sep	*	Dense spreading shrub <1m; branchlet indumentum appressed, sparse or absent; leaves glabrous above, not pitted; flower pink-red, limb cream. Winter-wet heathland on grey sand.
Haemodorum loratum	P3 p, s, d	Wattle Grove, Cockleshell Gully, Mogumber, Eneabba, Bullsbrook, Boonanaring	Sep-Nov		Grey or yellow sand, gravel.
Halgania corymbosa	P3	Darling scarp and plateau. Gosnells, Susannah Brook, Red Hill	Oct		Small shrub with bright blue flowers. Sandy clay over granite near watercourses.
Haloragis aculeolata	P2 p, s, d	Gingin, N Bannister, Yalgorup, Albany	Nov-Dec		Decumbent herb of seasonal wetlands. Sand or clay over limestone. Flowers yellow-brown.
Haloragis tenuifolia	P3 p, s	Ruabon, Collie, Gingin, Maddington, Woorooloo, Harvey	Sep-Nov		Decumbent herb of clay seasonal wetlands. Flowers brown-red.
Hydrocotyle lemnoides	P4 p, s	Kenwick, Perth-Bolgart, Lane Poole, Eneabba	Aug-Oct	*	Aquatic annual herb; flowers purple. Seasonal swamps.
Hydatella dioica	DRF EN	Kenwick, Upper Swan, (Midland)	Sep-Nov	*	Dioecious, tufted subaquatic herb 5cm tall; flowers red. Muddy clay, seasonal swamps.
Isopogon drummondii	P3 p, s, d	Forrestfield, Wattle Grove, Orange Grove, Moora, Midland, Mt Lesueur	Feb-Jun	*	Erect, lignotuberous shrub, 0.4–1m tall; flowers yellow, cream. White, grey or yellow sand, often over laterite.
Lepidosperma rostratum	DRF EN p, s, eSCP(P)	Kenwick, Forrestdale Lake NR, MKSEA	Jun-Aug	*	Erect tufts to 0.5m tall; base fibrous, dull pale brown; inflorescence erect, spicate. Palusplain grey clay to sandy clay, peaty sand.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Macarthuria keigheryi	DRF EN p, s, d	Perth airport, Forrestfield, Queens Park, Kenwick, Cooljarloo, Moora	Sep-Mar		Low soft shrub with hairy branches, small cream flowers. In sand, or sand over clay in Banksia woodland or sometimes on fringes of Marri-Kingia.
Meeboldina decipiens subsp. *decipiens* B.G. Briggs ms	P3 r ,u, eSCP	Capel, Waroona, Cannington		?	Tall dioecious rush, of muddy palusplains. Poorly known. CA Gardner record from 'Cannington' probably from UWA Allison Baird Reserve on Brook Rd.
Olax scalariformis	P3 p, s, d	Eneabba-Esperance	Oct-Dec		Shrub 30-80 cm tall; flowers cream, white. Sand, sandy loam.
Pimelea imbricata var. major	eSCP, s	Moore River – Yalgorup, Kenwick, MKSEA	Oct-Feb	*	Erect shrub (0.1–) 0.2–0.8(–1) m tall; flowers white. Sand or sandy clay; seasonally waterlogged depressions, watercourses.
Ptilotus sericostachyus subsp. *roseus*	P1	Cannington, Armadale, Pinjarra, Kelmscott	?		Poorly known. May now be extinct in the Cannington area.
Rhodanthe pyrethrum	P3 d	Kenwick, Forrestdale, Bullsbrook-Boyanup-Denmark, Capel	Sep-Oct (-Dec)	*	Erect, slender, succulent-stemmed herb to 20cm tall; flowers white, yellow. Clay, sandy-clay, winter wet depressions, clay pans, swamps.
Schoenus benthamii	P3 p, s	Kenwick, Mogumber, Busselton, Manypeaks, Cape Arid	Oct-Nov	*	Tufted perennial sedge 15-45cm tall; flowers brown. White, grey sand, sandy clay, winter wet flats, swamps.
Schoenus capillifolius	P2 p, s	Kenwick, Carousel, Waroona, Pearce, Waterloo, Beaufort River, Beverley.	Sep-Nov	*	Semi-aquatic, tufted annual sedge 5cm tall; flowers green. Brown mud, claypans.
Schoenus natans	P4	Pinjarra, Cannington, Gingin, Lake Muir, Busselton, Beaufort R, W. Dale	Aug-Nov		Aquatic annual grass-like sedge 30cm high; flowers brown. Winter-wet depressions.
Schoenus pennisetis	P1 p, s	Kenwick, MKSEA, Forrestdale, Pinjarra, Busselton, Byford, Wongan Hills	Aug-Dec	*	Annual sedge to 15cm tall; flowers dark purple, black. Grey or peaty sand, sandy clay, winter wet depressions.
Schoenus sp. Waroona (GJ Keighery 12235)	P3, p, s, eSCP	Kenwick, Harvey, Waroona	Oct	*	Small tufted annual. Clay or sandy clay, winter-wet flats.
Stachystemon axillaris	P4, r	Kalbarri, Eneabba to Forrestfield	Jul-Oct		Sparse shrub< 1.2m tall, flowers greenish. Banksia woodland, sand.
Stylidium longitubum	P3 p, s	Pinjarra, Pinjar, Ellenbrook, Kenwick, Yoongarillup	Oct-Feb		Slender annual herb, flowers white-pink. Clay wetlands.
Tetraria australiensis	DRF VU p, s, eSCP	Ambergate, Mundijong, Ruabon, Yarloop ,Cardup, ?Cannington	Nov-Dec?		Tufted perennial sedge, occasionally to 1.2 x 0.5m. Leaves hairy at base. Bases of culms not bulbous. Flowers after fire.
Tetratheca sp. Granite (S Patrick 1224)	P3	Kalamunda to Wungong	Sep-Oct		Small shrub with pink flowers. Quartz sand over granite.

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

TABLE A1: Flora of National and State Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	DISTRIBUTION	FL	BFS 387 or 53	FORM/FEATURES/HABITATS
Thelymitra magnifica	P3	Norwood Reserve, Maida Vale, Crystal Brook	Oct		Orchid with brown-yellow flowers. Clay and clay over granite. Foothills, scarp and plateau of Darling Range.
Triglochin stowardii	P3	Moora, Highbury, Meckering	Sep-Oct		Tufted annual, herb, to 10cm tall. Clay, sand; swamps, salt lakes.
Trichocline sp. Treeton (B.J. Keighery & N. Gibson 564)	P2 s, p	Beaufort R, Augusta-Perth, Kenwick, MKSEA	Oct-Nov	*	Tuberous, perennial, herb. Sand clay over ironstone; seasonally wet flats.
Tripterococcus paniculatus sp. W. R. Barker ms	P1 p, s	Pinjar, Ruabon, Canning Vale, Badjingarra, Busselton	Nov-Feb		Tuberous herb to about 1m or more in height. Flowers greenish-yellow. Margins of seasonal wetlands.
Verticordia lindleyi subsp. *lindleyi*	P4 p, s	Murray R - Moore R, Forrestdale, Kenwick, Cannington, Muchea, Gingin MKSEA	May, Nov-Jan	*	Erect, more or less open shrub to 75cm tall; flowers pink, purple. Sand, sandy clay, winter wet depressions.
Villarsia submersa	P4	Kenwick, Forrestdale, Boyanup-Denmark, Frankland R, Lane Poole	Sep-Oct	*	Floating elliptic leaves and white fringed flowers. Shallow seasonal pools on clay depressions.

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove.

KEY

Locations

QD Quindalup Dunes
SD Spearwood Dunes
BD Bassendean Dunes
PP Pinjarra Plain
F Foothills
R Riverine
Es Estuarine
DR Darling Range

Criteria for regional conservation significance of taxa occurring on the Eastern Swan Coastal Plain.

d SCP populations that are disjunct from their main geographic range in other regions
eSCP Taxa endemic to the Swan Coastal Plain
eSCP(P) Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region
p Taxa considered to be poorly reserved on the SCP (applies to all DRF and Priority taxa)
r Taxa in the survey area at limit or close to limit of their known geographic range on the SCP [*e.g.* r (S, Kenwick SWA)means that the southern end of the taxon's range is at Kenwick in the IBRA(2000) Swan Coastal Plain Bioregion]
s Significant populations (due to size, genetic factors or other) for maintenance of taxa on the SCP
t Significant taxonomically; morphological or genetic variants that require further study
u Uncommon on the SCP (generally applies to disjunct populations but could also be due to rare habitat, lack of collections etc.)
h Confined to specific and restricted habitats *e.g.* h (claypans PP) = confined to claypans of the Pinjarra Plain

(Note: MKSEA is Maddington-Kenwick Strategic Employment Area as in Tauss & Weston,2008)

SPECIES/TAXON	CONSERVATION SIGNIFICANCE CODE	Previously recorded in BFS 387	NOTES
Acacia lasiocarpa var. *lasiocarpa sens. strict.*	s, u, h (wetland PP) t	*	Previously (in error) called *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (GJ Keighery 5026) in Marshall (2000). Known from Kenwick and? Midland. Geographical range requires further study.
Acanthocarpus canaliculatus	s, u, h (wetlands PP)	*	Low shrub-like monocot with small white flowers.
Actinostrobus pyramidalis	s, h (wetlands PP)	*	Columnar conifer with dark foliage to about 10m in height killed by fire and slows to regrow from seed.
Amphibromus nervosus	s, h (mud sumplands PP)	*	Tall grass of claypans, flowers in early spring when inundated
Anarthria laevis	s, u, r(N, Wattle Grove, SWA) h (palusplians, PP)	*	Tufted, dioecious rush. On SCP only known from Allison Baird Reserve Kenwick-Wattle Grove, MKSEA and Ruabon. More common in WAR and ESP Bioregions.
Anigozanthos bicolor subsp. *bicolor*	u, s, r (S, Kenwick) h(palusplains PP)	*	Pearce Airport, Talbot Rd, Brixton St are only locations on SCP. More common in Jarrah Forest
Anigozanthos viridis subsp. *viridis*	s, u, h (palusplains PP)	*	Green-flowered Kangaroo Paw. Yoongarillup to Gingin
Angianthus preissianus	u, h(wetlands, QD/PP)	*	Tiny annual daisy of saline coastal wetlands (Rottnest, Creery Is.) and muddy clay palusplains (Gingin to Mandurah)
Austrostipa mollis	h (PP/F)	*	Tall grass with long dense hairy inflorescence
Banksia telmatiaea	r (S,?Serpentine, SWA), p, s, u, h (wetlands PP)	*	Shrub to about 2m in height with brown flowers –forms dense stands. Most southern population may be no longer extant so Kenwick may bevery close to southern range end. Subject to threats and poorly conserved.
Boronia crenulata subsp. *viminea*	r (N, Kenwick SWA) s, u, d, h (wetlands PP/BD)	*	Small fragrant-leaved shrub with deep pink flowers

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONSERVATION SIGNIFICANCE CODE	Previously recorded in BFS 387	NOTES
Borya scirpoidea	s, u, h (wetlands PP/F)	*	Low grass-like monocot to about 10cm tall with white flowers, uncommon on SCP
Borya sphaerocephala	s, u, h (wetlands PP/F)	*	Low grass-like monocot to about 10cm tall with white flowers, uncommon on SCP
Brachyscome pusilla	s, u, h (muddy wetlands PP/SD/Es)	*	Conspicuous annual daisy with white ray florets. Uncommon from Lancelin to Yalgorup in muddy wetlands inc. estuarine setting at Alfred Cove and palusplains at Kenwick, Guildford and Caversham.
Burchardia bairdiae	r (S, Serpentine River SWA), s, u, h (peat/mud wetlands PP/R/BD) eSCP	*	Robust geophytic herb with white flowers. Peaty or muddy damplands, palusplains, paluslopes. Regan's Ford to Serpentine R.
Burchardia multiflora	u, s, h (mud wetlands PP/F)	*	Geophytic herb with pink markings on flowers. More common in WAR and JF Bioregions
Calandrinia sp. Kenwick (G.J. Keighery 10905) [syn. C. aff. *composita*]	h(wetlands PP), t	*	Tiny prostrate succulent annual herb; flowers pink. Eneabba-Esperance
Calectasia grandiflora subsp. *grandiflora* RL Barrett ms	u, s, h(mud palusplains PP)	*	Large-flowered Tinsel Lily. Restricted to a few location son eastern SCP at Mundijong, Serpentine and Brixton St Wetlands.
Calothamnus hirsutus	s, h(palusplains, PP)	*	Cooljarloo to Byford on PP. Also in Geraldton Sandplains Region
Caesia micrantha sens. lat. (Large Swamp Form B.J. Keighery & N. Gibson 122)	eSCP ?, t, h (wetlands PP)	*	Tuberous herb with pale blue flowers, may be confined to eastern SCP, requires more study
Centrolepis mutica	h (wetlands PP)	*	Minute sedge-like clumps
Chaetanthus aristatus	s, h (wetlands PP)	*	Dioecious, perennial rush with rusty brown inflorescences. Usually forms large dense populations
Chorizandra enodis	s, h (mud wetlands PP)	*	Perennial sedge with glaucous terete culms, globular inflorescences and a prominent involucral bract
Comesperma aff. *polygaloides* (C. Tauss. 2541)	s, u, h (palusplains PP) t		Sub-shrub to about 30cm with suckering habit and mauve-pink flowers in early to mid summer. First recorded in MKSEA (Tauss and Weston, 2008).
Conospermum huegelii	p, s, u, h (wetlands PP/F)	*	Low smoke bush with globular, white and blue inflorescences
Conostylis festucacea subsp. *festucacea*	s, u, h (palusplains PP)	*	Perennial stilted herb with woolly yellow flowers- usually forms dense clumps
Cyathochaeta equitans	s, u, d, h (sand dunes PP/F/S/BD)		Robust perennial sedge with inflorescence to about 1.5m or more in height. Eneabba to Esperance. Uncommon on SCP; records inc. Ambergate, Pinjarra, BFS 53, Hawkevale, Koondoola, MKSEA (Tauss & Weston,2008)
Cytogonidium leptocarpoides	r (N, Gingin SWA), s, u, h (wetlands, PP)	*	Small tufted dioecious rush, uncommon on SCP.
Darwinia citriodora	d, u, s, h(creek banks PP/F)		Recorded at Yule Brook near Welshpool Rd (Tauss & Weston, 2008; Tauss, 2007). Most of the (few) records on SCP are old and from areas where it is probably no longer extant e.g. Guildford. Abundant in DR and scarp.

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS 387	NOTES
Dasypogon obliquifolius	s, d, u, h(sand dunes PP/F)		Robust perennial rhizomatous herb. Glaucous leaves, globular inflorescences on scapes to 1m in length. In BFS 53 Clifford Rd, Maddington Disjunct distribution: Jurien-Badgingarra-Lancelin & Maida Vale-Wattle Grove, MKSEA (Tauss & Weston,2008)
Dichopogon preissii	h (palusplains, PP)	*	Dainty lily with pink-mauve, pendulous flowers in spring
Dielsia stenostachya	d, u, eSCP(P) h(peaty damplands - floodplains BD/PP)		Intricate rush with hairy rhizomes. Peaty sand damplands usually in Bassendean Dunes. Recorded in MKSEA (Tauss & Weston, 2008) in a wetland maintained by an active Muchea Limestone spring.
Dodonaea ceratocarpa	d, u, s h(palusplains PP), ?t	*	Dioecious, 4-merous, hopbush with horned wings on fruit and narrow simple leaves. May be morphological variant.
Drosera macrantha sens. lat.(Swan Coastal Plain form BJK & NG 228)	? eSCP, h (wetland, PP), ?t	*	Tall, many-flowered climber. Clay wetlands. Requires taxonomic study.
Drosera bulbosa subsp. *bulbosa*	u, s, h(wetlands PP/F)	*	Sundew with large flat rosette and white flowers. Probably poorly collected.
Drosera heterophylla	r (S, Mundijong, SWA) u, s, h (palusplains PP)	*	Small erect/climbing sundew with crescent-shaped leaves, early spring flowering, white flowers.
Drosera menziesii subsp. *menziesii*	u, s, h (palusplains PP)	*	Small erect/climbing sundew with round red leaves and red stems, large bright pink flowers
Drosera neesii subsp. *neesii*	u, s, h (wetlands PP/BD)	*	Medium climbing sundew Cooljarloo, Muchea, Kenwick, Serpentine to Ambergate Reserve.
Drosera rosulata	H(wetlands PP)	*	Flat rosette sundew. Midland to Busselton.
Drosera tubaestylis	u, h(wetland PP)	*	Sundew with flat leaf rosette and white flowers in autumn
Eucalyptus decipiens subsp. *decipiens*	d, s, u (ML wetland PP)		Mallee usually confined to coastal Tamala Limestone but found in association with Muchea Limestone outcrops in the MKSEA (Tauss & Weston, 2008;) and at Southern River (Trudgen & Keighery 1994)
Gahnia trifida	h (saline/ calcareous palusplains)	*	Robust clumping sedge to over 1m in height with sharp edged leaves and dark brown, dense inflorescences, usually coastal.
Goodenia pulchella subsp. Coastal Plain B (M. Hislop 634)pn	h(wetland PP) t	*	Dainty perennial herb with yellow flowers. Generally limited to clay wetlands on eastern side of SCP.
Hakea ceratophylla	r (N, Kewdale SWA) u, s, h (palusplains PP)	*	Shrub to about 1.2m with brown flowers, uncommon on SCP and associated with TEC 3a. Widespread and common in Warren Region.
Hakea sulcata	h (palusplains,PP)	*	Sparse shrub to about 1.2 m in height with terete leaves and small, short- beaked woody fruits
Haemodorum simplex	h (palusplains,PP)	*	Geophytic herb with black inflorescence
Hydrocotyle alata	h (palusplians, PP)	*	Small herb, Bullsbrook to Ruabon. Also in Tuart Forest.

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS 387	NOTES
Hypocalymma angustifolium sens. lat. (Mud Habitat Variant. C.Tauss 1850)	s, h (palusplains, PP),t	*	Shrub to 2m when unburnt, white flowers. Common dominant species of heaths in Kenwick inc. MKSEA (Tauss & Weston, 2008). Part of the *H. angustifolium* complex. Taller and with flatter leaves than the more common (peaty sand habitat) *H. angustifolium* that is prevalent on SCP. Requires taxonomic and biogeographical study
Isotoma pusilla	s, h (muddy sumplands, PP)	*	Tiny, purple flowering herb that forms large populations in muddy sumplands and flowers as they dry out.
Isotoma scapigera	d, u, h (mud sumplands &palusplains ,PP)	*	Small purple flowered herb not often recorded from SCP.
Jacksonia alata	d, s, u (PP/F)		Small shrub less than about 40cm in height. Yellow pea flowers. Widespread in SW WA but very uncommon on SCP.
Kunzea micrantha subsp. *micrantha*	s, h (wetlands PP/F)	*	Shrub to about 1m in height with small pink globular inflorescences. Caversham to Dunsborough .Only 1-2 records off the ESCP (in Warren -Jarrah Forest)
Lambertia multiflora var. *darlingensis*	p, s, h (colluvium)		Shrub to 2m, flowers yellow. Deep sands or loamy, clayey or gravelly soils, laterite, granite; base of scarp, rocky hills, plateaus. Maddington (Clifford St BFS 53), lower Darling Scarp, Whicher Range
Lawrencia squamata	d, s, u r (S, Kenwick SWA), h (saline/calcareous wetlands/PP)	*	Occurs in only 2 disjunct areas on SCP: Bullsbrook and Cannington-Kenwick. Otherwise widespread in semi arid and arid regions.
Lepidosperma scabrum sens. lat. (Eastern Terete Form. BJ Keighery &N Gibson 232)	t, s, h (palusplains, PP)	*	Requires more study to determine distribution, taxonomy and conservation status
Lepidosperma sp. Kenwick. C.Tauss 2598	h(?palusplains, PP) t		An undescribed sedge taxon of taxonomic significance. More study required to determine distribution but may be confined to palusplains on eastern SCP. Recorded from MKSEA (Tauss and Weston,2008)
Leucopogon strictus	s, d, h (palusplains PP)		Generally prevalent in Daring Range, uncommon on SCP. Recorded in MKSEA (Tauss & Weston,2008)
Melaleuca brevifolia	p, s, u, h (wetlands)	*	Erect shrub or tree (rarely), 0.5–4m tall; flowers white, cream. White or grey sand, sandy loam, clay; swampy areas, drainage lines, salt lakes. Eneabba-Esperance, MKSEA
Melaleuca lateriflora subsp. *acutifolia*	h (wetland, PP)	*	Shrub to about 3m
Melaleuca osullivanii (syn. *M. uncinata)*	h (palusplains-floodplains PP/R)	*	Shrub to about 2m. Recorded on banks of Yule Brook in MKSEA (Tauss & Weston, 2008)
Mesomelaena tetragona	u, s, h(palusplains PP/F)	*	Robust semaphore sedge with prominent dark leaf bases. Uncommon on SCP.
Myriocephalus occidentalis	h (muddy sumplands PP)	*	Annual herb, flowers as wetlands dry in late spring
Neurachne alopecuroidea	h (PP/F)	*	Perennial grass with short, grey dense inflorescences
Patersonia juncea	s, u, r(N, ?Norwood Reserve SWA) h (wetlands PP/F)	*	Small perennial herb with purple Iris-like flowers. Old record from Midland probably no longer extant, therefore Norwood Reserve northern range limit.

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS 387	NOTES
Petrophile juncifolia (syn. Petrophile media var. *juncifolia*	u, s, h(palusplains PP)	*	Low shrub with long narrow +/- terete leaves
Petrophile seminuda	d, s, u, h (palusplains PP)	*	Shrub to about 1.2m with short cylindrical yellow inflorescences
Philydrella drummondii	h (palusplains PP)	*	Small herb with yellow flowers
Philydrella pygmaea subsp. *pygmaea*	h (palusplains PP)	*	Small herb with yellow flowers
Pimelea imbricata var. major	p, s, u, eSWA, h (mud palusplains and sumplands PP)	*	Erect shrub (0.1–) 0.2–0.8(–1) m tall; flowers white. Sand or sandy clay; seasonally waterlogged depressions, watercourses. Moore River – Yalgorup, Kenwick, MKSEA
Podolepis capillaris	d, s, u, h (palusplains PP) ?t	*	Annual daisy with wiry stems, small flowers (yellow ray florets). Very uncommon on SCP (only records from BFS387) but widespread in the drier inland areas of SW WA. ESCP form may be wetland variant.
Podolepis gracilis sens. lat. (Swamp form GJ Keighery 13 255)	s, u, h (mud sumplands & palusplains PP) t	*	Large white-pink flowering annual daisy.
Pogonolepis stricta	h (mud sumplands & palusplains PP)	*	Tiny, white flowering annual daisy – often a dominant species of the ground layer at mid –dense cover.
Prasophyllum drummondii	s, u, r(N, ?Kenwick SWA) h (wetlands PP/BD)	*	Medium height leek orchid with brownish-green flowers in spring in the absence of previous fire. Known range Muchea-Bullsbrook to Pinjarra but northern records are very old so it may no longer be extant north of Kenwick
Samolus junceus	s, u, h(wetlands calcareous, saline, SD/PP/Est /R)	*	Perennial herb with leafless stems and white-pink flowers. Tamala Limestone atYalgorup, Ludlow, Dunsborough & ML at Bootine, Gingin. Also widespread in other regions.
Scaevola lanceolata	h (palusplains, PP)	*	Low to prostrate perennial herb with long spikes of white flowers
Schoenolaena juncea	u, s, h(sumplands/palusplains PP/BD)	*	Pinjar to Ludlow mainly on ESCP. Tall perennial, geophytic herb with white flowers in summer.
Schoenus andrewsii	d, s, h (palusplains PP)	*	Tufted perennial sedge usually about 20cm in height with viscid culms. Occurs in wetlands in Geraldton Sandplains Region. On SCP only in BFS 387 (except old Maylands collection- but probably not extant there now)
Schoenus asperocarpus	h (palusplains PP)	*	Low annual tufted sedge
Schoenus bifidus	h (palusplains PP)	*	Small perennial sedge with small dark terminal inflorescence
Schoenus elegans	u, s, r (N, Kenwick, SWA) h (muddy wetlands/PP)	*	Only seven locations known on Florabase (Kenwick, Tuart Forest near Busselton, Helena River, Calingiri, Scott River Plain, Warren and an old Bayswater record that is probably no longer extant). Further study and upgrade to Priority Flora required.
Schoenus odontocarpus		*	

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS	NOTES
Schoenus plumosus	h (palusplains and clay sumplands PP)	*	Inconspicuous small annual sedge with woolly perianth segments
Schoenus rigens	p, s, u, eSWA, h (mud and peaty wetlands PP/BD)	*	Perennial sedge endemic to the eastern SCP.
Schoenus subflavus subsp. *subflavus*	u, s, r (N, Kenwick, SWA) h (muddy wetlands/PP)		Perennial sedge. On SCP only recorded from Kenwick (MKSEA) and Ruabon.
Schoenus unispiculatus	u, s, h (muddy palusplains and colluvium PP/F)	*	On the SCP known form only a handful of sites Pinjarra, Mundijong, Capel, Waroona, Talbot Rd, Kenwick and Carbarup. More occurrences on Darling Range and scarp
Schoenus variicellae	h (palusplains/sumplands PP)	*	Tiny annual sedge
Stylidium ecorne	h (palusplains/sump- lands PP)	*	Small annual trigger plant about 10cm in height
Stylidium petiolare	h(wetlands PP)	*	Small annual trigger plant about 10cm in height with white flowers
Stylidium roseo-alatum	p, s h(wetlands PP)	*	Slender annual (ephemeral) herb 3-7cm tall; flowers pink, red. Loam, clay loam, peaty sand; winter-wet depressions, swamps, creek beds. Kenwick, Toodyay, Bolgart, Armadale
Stylidium utricularioides	s, h(wetlands PP)	*	Slender annual herb to 15cm; flowers pink-white. Clay wetlands, granite. Kenwick, Helena Valley, Forrestdale, Capel, Byford, Ellenbrook, Bullsbrook
Synaphea acutiloba	s, u, h (palusplains PP/F)	*	Kenwick, Talbot Rd Bush, Darling Ranges, Walyunga NP, Byford
Tecticornia lepidosperma	s, u, h(palusplain/floodplain PP/R)	*	On SCP only known from Pinjarra, Bennett Brook, Kenwick and Burswood Island .Widespread in other regions.
Thelymitra antennifera	s, h (palusplains PP)	*	Small yellow flowering orchid (geophyte).
Thomasia macrocarpa	d, u, s, h(creek banks PP/F)		Shrub approx 1m in height with large pink flowers. Recorded on banks of Yule Brook near Welshpool Rd (Tauss, 2007a). Uncommon on SCP, abundant on Darling Scarp/Plateau
Thysanotus dichotomous	d, s, h(creek banks PP)		Intricate robust perennial herb to over 1m in height, almost leafless, with large mauve flowers. Seasonally waterlogged clay or granite. Widespread in SW but few records on SCP inc. Yule Brook (Tauss, 2007a), Byford (Tauss, 2007b).
Thysanotus rectantherus	u, s r(S, Wungong, SWA) h(palusplains PP/F)	*	Widespread in Jarrah Forest and semi-arid WA north-east Perth. Only SCP only known at Kenwick and Wungong.
Tremulina tremula	d, p, s, u, h (sumplands/ palusplains PP)	*	Robust dioecious rush with flat culms and small dark dense spikelets. Male spikelets pendulous.
Tribonanthes brachypetala	h (palusplains PP/F)	*	Tuberous perennial herb with yellow, reflexed perianth. Flowers in Aug-early Sept. Hybridizes with other *Tribonanthes.*

TABLE A2: Flora of Regional Conservation Significance known from the Eastern Swan Coastal Plain in the vicinity of Lots 28, 32 and 36 Brook Rd, Wattle Grove

SPECIES/TAXON	CONS CODE	Previously recorded in BFS	NOTES
Tribonanthes uniflora (currently included in *T. longipetala sens. lat.*)	h (mud sumplands PP)	*	Geophytic herb with large white flowers with inflorescence usually a single flower
Tribonanthes violacea	h (wetland PP/R)	*	Small pale mauve early flowering tuberous herb.
Tricoryne humilis		*	Yellow flowering perennial herb
Tricoryne aff. *elatior* (C.Tauss 1905)	u, h (wetland PP),t		Robust herb with very scabrous stems and yellow flowers recorded from MKSEA (Tauss & Weston, 2008)
Triglochin muelleri	p, s, u, eSWA, h (clay sumplands PP)	*	Small annual herb in species-rich wetlands. Often grows with several other *Triglochin* species. Patchy records from Cooljarloo to Fish Rd Reserve near Busselton
Trymalium odoratissimum subsp. *odoratissimum* (*syn. T. floribundum* subsp. *floribundum)*	d, u, s, h(creek banks PP/F)		Shrub to about 2m in height. Abundant white flowers in spring. Yule Brook near Welshpool Rd (Tauss, 2007) and MKSEA (Tauss & Weston, 2008). Uncommon on SCP, abundant on Darling Scarp/Plateau
Trithuria bibracteata	s, h (palusplains/mud sumplands PP)	*	Minute tufted sedge-like plant, leaves in a rosette
Utricularia inaequalis	u, s h(wetlands PP)	*	Bladderwort with large lavender flowers. On SCP only recorded at Ellenbrook /Bullsbrook, Ruabon, Kenwick, Waroona ,Midland
Utricularia multifida	u, s h(wetlands PP/F/R)	*	Small bladderwort pink flowers. Bullsbrook to Ruabon, Alfred Cove on SCP. Widespread in other regions.
Utricularia violacea	u, s h(wetlands PP/F/R)	*	Tiny bladderwort purple flowers. Bullsbrook to Yoongarillup on SCP. More common in Warren –Jarrah Forest
Velleia trinervis sens. lat. (G.J. Keighery 10429)	r (N, Cooljarloo SWA), s, u, h (muddy sumplands PP) t	*	Pale yellow flowering perennial herb. Flowers in Aug-early Sept. Plentiful at Kenwick but uncommon elsewhere. One of a number of taxa thought to be included currently in the *V .trinervis* complex.
Villarsia capitata	s, h(muddy sumplands PP)	*	Small perennial herb with yellow flowers that forms large populations in shallow muddy pools.
Verticordia acerosa var. *preissii*	s, h (wetland, PP/F)	*	Small shrub with dainty, spidery perianth. Cream flowers aging to pink.
Verticordia huegelii var. *huegelii*	h (wetland, PP/F)	*	Small shrub with attractive bright yellow flowers.
Verticordia plumosa var. *brachyphylla*	h (palusplains, PP/F)	*	Small shrub with attractive pink-purple flowers. Very similar to *Verticordia plumosa.*
Wilsonia backhousei	d, s, u, h(saltmarsh, calcareous, palusplain PP/Est/R)	*	Small succulent mat plant. Kenwick is only location on SCP not on the coast. Widespread in other regions in calcareous, saltmarsh, estuarine settings.
Wurmbea dioica subsp. aff. *alba* = *Wurmbea dioica* subsp. Brixton (GJ Keighery 12803) =	r (N, Cervantes, SWA), s, u, h (mud sumplands PP)	*	Monoecious, geophytic herb to about 30-40 cm in height with large white flowers and sometimes pink-purple nectaries. Confined to mud sumplands where it flowers in early spring whilst plants are partially inundated. The informal name used for it creates confusion. Requires further taxonomic study.
Wurmbea dioica subsp. *alba*	h (palusplains PP)		Dioecious, geophytic herb to about 10 cm in height with small white flowers. Does not grow in sumplands.

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Appendix C

Vascular flora recorded in the spring 2008 field survey

APPENDIX C
Vascular flora recorded in the field survey of Lot 28, 32 and 36 Brook Rd, Wattle Grove.

KEY TO TABLE B

Column 1: Taxon Name.
A list of families, genera, species, subspecies and varieties of vascular plants recorded in the current field survey, in alphabetical order by family. The nomenclature used conforms to current usage in FloraBase (WA Herbarium, 2009) except for a small number of taxa listed under informal names including the abbreviations as below and/or C.Tauss collection numbers. Voucher specimens of the taxa that are listed under informal names will be lodged in the WA Herbarium and will thus be available for further inspection.
Abbreviations:

- ***** preceding a name indicates a naturalized alien taxon (weed).
- 'aff.' (*affinis*): akin to, having an affinity (with) but not identical (to) (Lincoln *et. al.* 1982
- 'cf.' (*confer)*: compare (with) (Lincoln *et. al.* 1982)
- *'sens. lat.'* (*sensu lato):* in the broad sense (Lincoln et. al. 1982). Refers to specimens of taxa that are known to be broadly circumscribed and may be subdivided on further study.
- *'sens. strict.'* (*sensu strictus*)*:* in the narrow sense (Lincoln et. al. 1982). Refers to specimens that conform closely to the published type concept

Columns 2, 3, 4: Location.
Taxa recorded from the three areas of the current field survey (Lot 28, Lot 32 and Lot 36) are listed separately in these columns.

Column 5: Taxa not previously recorded in BFS 387.
Taxa found in the current field survey but NOT listed in Mattiske and Associates (1992) for Brook Rd; or for Bush Forever Site 387 by Keighery and Keighery (2000); or do not appear in searches of FloraBase (WA Herbarium, 2009) using the search terms "Cannington", "Canning", "Kenwick", "Wattle Grove" and "Brixton" are also listed below.

Column 6: Notes/Other Names.
Synonyms and other issues regarding the names of taxa in the list are noted in this column.

Columns 7, 8, 9: Conservation Significance Codes at National, State and Regional Levels.
Column 7: Taxa currently gazetted under the Federal EPBC Act have **National Conservation Significance** in the categories of Critically Endangered (**CE**), Endangered (**EN**) and Vulnerable (**VU**). (See Appendix A for definitions of these categories).

Column 8: Taxa currently gazetted under the WA Wildlife Act, and listed in the DEC Priority Lists (Atkins, 2008) have **State Conservation Significance** in the categories **DRF**, and **P1**, **P2**, **P3**, **P4** respectively. (See Appendix A for definitions of these categories).

Column 9: Other taxa that have Regional Conservation Significance are defined by EPA (2004); many of the latter categories that are relevant to the Eastern Swan Coastal Plain are listed in Bush Forever (2000b). See also Appendix A for a comprehensive current list of these taxa known from the literature in the vicinity. These taxa are listed below with the codes **d, p, r, s**, **u**, **and t.** These codes and the categories they refer to are defined below. (These codes are also added to the taxa marked in Column 7 and 8 as they provide additional information about these taxa relevant to their occurrence at Brook Rd in the ESCP).

Column 9 (cont.);

Codes and criteria for regional conservation significance of taxa occurring on the Eastern Swan Coastal Plain

d SCP populations that are disjunct from their known geographic range.

eSCP Taxa endemic to the Swan Coastal Plain.

eSCP(P) Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region.

p Taxa considered to be poorly reserved on the SCP (applies to all DRF and Priority taxa).

r Taxa in the survey area at limit or close to limit of their known geographic range on the SCP (e.g. **r (S, Kenwick SWA)** indicates that the southern end of the taxon's range is at Kenwick in the IBRA (2000) Swan Coastal Plain Bioregion).

Locations
D Quindalup Dunes
SD Spearwood Dunes
BD Bassendean Dunes
PP Pinjarra Plain
Foothills
R Riparian
Es Estuarine
DR Darling Range

s Significant populations (due to size or other factors) for maintenance of taxa on the SCP.

t Significant taxonomically; morphological or genetic variants that require further study.

u Uncommon on the SCP (generally applies to disjunct populations but could also be due to rare habitat, lack of collections etc.).

h Confined to specific and restricted habitats *e.g.* h (claypans PP) = confined to claypans of the Pinjarra Plain.

TABLE B: Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Anacardiaceae								
**Schinus terebinthifolius*			x	x	Brazilian Pepper Tree			
Anthericaceae								
Thysanotus manglesianus	x				Climbing Fringe Lily			
Apiaceae								
**Foeniculum vulgare*			x		Fennel			
Hydrocotyle alata	x							h (palusplains PP)
Schoenolaena juncea	x							u, s, h (sumplands/ palusplains PP/BD)
Asclepidaceae								
**Gomphocarpus fruticosus*			x		Swan Plant			
Asparagaceae					Bridal Creeper			
**Asparagus asparagoides*	x	x	x					
Asteraceae								
Angianthus preissianus	x							u, h (wetlands, QD/PP)
**Arctotheca calendula*	x	x	x		Cape Weed			
Brachyscome pusilla	x							s, u, h (muddy wetlands PP/SD/Es)
**Conyza sumatriensis*	x	x	x		Fleabane			
**Cotula coronopifolia*	x							
**Dittrichia graveolens*	x	x	x		Stinkwort			
**Hypochaeris glabra*	x	x	x		Flatweed			
Podolepis capillaris	x	x						d, s, u, h (palusplains PP) ?t
Podolepis gracilis sens lat.	x				=*Podolepis gracilis* Swamp Form (G.J. Keighery 13126)			s, u, h(mud sumplands & palusplains PP) t

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Asteraceae cont.								
Pogonolepis stricta	X	X						h (mud sumplands & palusplains PP)
Quinetia urvillei	X							
Siloxerus humifusis	X							
**Sonchus oleraceus*	X	X	X		Milk Thistle			
Trichocline sp. Treeton (B.J. Keighery & N. Gibson 564)	X				Native Gerbera		**P2**	s, p, r(N Kenwick, SWA)
**Ursinia anthemoides*	X	X	X					
Boraginaceae								
**Echium plantagineum*	X	X			Paterson's Curse			
Brassicaceae								
**Heliophila pusilla*	X			X				
**Raphanus raphanistrum*	X	X	X		Wild Turnip			
Callitrichaceae								
**Callitriche stagnalis*	X			X				
Centrolepidaceae								
Aphelia cyperoides	X							
Centrolepis aristata	X	X						
Centrolepis polygyna	X							
Chenopodiaceae								
Tecticornia lepidosperma	X	X			syn. *Halosarcia lepidosperma*			s, u, h(palusplain/floodplain PP/R)
Convolvulaceae								
Wilsonia backhousei	X							d, s, u, h(saltmarsh, calcareous, palusplain PP/Es/R)

v

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Crassulaceae								
Crassula colorata var. *acuminata*	X	X						
**Crassula natans* var. *minus*	X							
Cupressaceae								
Actinostrobus pyramidalis	X	X			Swamp Cypress			s, h (wetlands, PP)
Cyperaceae								
Baumea juncea	X	X						
Chorizandra enodis	X							h (wetland PP)
**Cyperus tenellus*	X							
Ficinia nodosa	X			X				d, u, s, h (saline-calcareous or muddy wetlands/ QD, R, Es)
Gahnia trifida	X	X	X					h (saline/calcareous wetlands, PP)
Isolepis cernua var. *setiformis*	X							
**Isolepis marginata*	X	X						
**Isolepis hystrix*	X							
Isolepis oldfieldiana	X							
Isolepis stellata	X							
Lepidosperma longitudinale	X	X						
Lepidosperma rostratum	X				Beaked Lepidosperma	**Endangered**	**DRF**	r(N, Kenwick, SWA) p, s, u, eSWA(P), h (palusplains, PP)
Lepidosperma sp. Kenwick C.Tauss 2598	X	X		X	Undescribed taxon (pers. comm. R.L Barrett)			s, u, ?eSWA(P), h(palusplains, PP) t
Schoenus rigens	X	X						p, s, eSCP, h (wetland PP/BD)
Schoenus subfascicularis	X	X						

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Droseraceae								
Drosera glanduligera	X							
Drosera heterophylla	X							r (S, Mundijong, SWA) u, s, h (palusplains PP)
Drosera macrantha subsp. *macrantha*	X				Pink Rainbow			
Drosera menziesii subsp. *menziesii*	X							u, s, h (palusplains, PP)
Epacridaceae								
Leucopogon polymorphus	X							u, d, s, h (sand over limestone SD/BD)
Euphorbiaceae								
**Euphorbia terracina*			X	X				
**Ricinus communis*			X					
Gentianaceae								
**Centaurium erythraeum*	X	X						
**Cicendia filiformis*	X				*=C. filifolia*			
Goodeniaceae								
Goodenia micrantha	X							
Goodenia pulchella subsp. Coastal Plain (M. Hislop 634) pn	X	X			= *Goodenia pulchella* subsp. Coastal Plain (L.W Sage 2336) pn			s, h (wetlands, PP) t
Scaevola lanceolata	X	X						s, h (wetlands, PP)
Haemodoraceae								
Anigozanthos viridis subsp. *viridis*	X	X			Green Kangaroo Paw			s, u, h (palusplains PP)
Haemodorum laxum	X							
Tribonanthes australis	X	X			Flannel Flower			h (palusplains PP/F)
Hydatellaceae								
Trithuria bibracteata	X							h (palusplains PP/F)

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Iridaceae								
**Gladiolus undulatus*	X							
**Moraea flaccida*	X	X	X		Cape tulip			
**Romulea rosea* var. *australis*	X	X			Guildford Grass			
**Romulea rosea* var. *communis*	X	X			Guildford Grass			
**Sparaxis bulbifera*	X	X						
**Watsonia meriana* var. *bulbillifera*	X				=*W. bulbillifera,* Watsonia			
Juncaceae								
**Juncus bufonius*	X							
**Juncus capitatus*	X							
Juncus pauciflorus	X							
Juncus pallidus		X						
Juncus planifolius	X							
Juncaginaceae								
Triglochin muelleri	X				=*T. calcitrapum subsp. recurvum ms.* =*T. aff. calcitrapum*			p, s, eSWA, h (clay sumplands PP)
Lauraceae								
Cassytha glabella	X	X			Dodder			
Cassytha racemosa	X	X			Dodder			
Lentibulariaceae								
Utricularia multifida	X				=*Polypompholyx multifida* Pink Petticoats			s, h(wetlands PP/F/R)
Lobeliaceae								
Lobelia anceps	X				=*L. alata*			
**Monopsis debilis*	X	X						
Loganiaceae								
Phyllangium paradoxum	X							

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Lythraceae								
**Lythrum hyssopifolia*	X	X						
Malvaceae								
Lawrencia squamata	X							d, s, r (S, Kenwick SWA), h (calcareous saline wetlands/ PP)
Meliaceae								
**Melia azederach*					Cape Lilac			
Mimosaceae								
Acacia lasiocarpa var. *lasiocarpa sens strict.*	X	X			The form of *Acacia lasiocarpa* var. *lasiocarpa* recorded in this survey (and other specimens from BFS387 in WA Herbarium,2008) closely match the type concept of *A. lasiocarpa* var. *lasiocarpa* and, in the strict sense, this taxon appears to be restricted to the eastern SCP (Tauss & Weston 2008, after B. Maslin pers. comm.). At BFS387, this taxon has been called previously (in error) *Acacia lasiocarpa* var. *bracteolata* Long Peduncle Variant (GJ Keighery 5026), (B. Maslin pers. comm.). *A. l.* var. *bracteolata* is not known to occur in BFS387 or Kenwick –Wattle Grove (WA Herbarium, 2008).			s,h (wetlands PP) ?t
Acacia pulchella var. glaberrima		X			Prickly Moses			
Acacia saligna subsp. *saligna* ms	X	X			Orange Wattle			
Acacia stenoptera	X	X						
Myoporaceae								
Eremophila glabra subsp. *chlorella*	X						**DRF**	s, u, p, h (wetlands PP)
Myrtaceae								
Astartea affinis	X							
Baeckea sp. Perth Region (R.J. Cranfield 444)	X	X		X	=*Baeckea tenuifolia*		**P3**	s, p, d, r (S, Kenwick SWA)
Calothamnus hirsutus	X							s, h(palusplains, PP)
Corymbia calophylla		X	X		=*Eucalyptus calophylla*, Marri			
Eucalyptus rudis subsp. *rudis*	X	X	X		Flooded Gum			

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Myrtaceae cont.								
Hypocalymma angustifolium Mud Habitat Variant (C.Tauss 1850)	x	x		x	Part of *Hypocalymma angustifolium* complex but varies from the more common form of *H. angustifolium* that is prevalent on margins of peaty- sand wetlands throughout the Bassendean Dunes and other areas of SCP.			s, h (palusplains, PP),t
Kunzea micrantha subsp. *micrantha*	x							s, h (wetlands PP/F)
Melaleuca brevifolia	x	x						p, s, u, h (wetland PP)
Melaleuca lateriflora subsp. *acutifolia*	x				=*Melaleuca lateriflora* subsp. *alternifolia*			h (wetland, PP)
Melaleuca rhaphiophylla	x	x	x		Freshwater Paperbark			
Melaleuca seriata sens. lat.	x	x						
Melaleuca viminea subsp. *viminea*	x	x	x					
Verticordia densiflora var. *densiflora*	x	x						
Verticordia lindleyi subsp. *lindleyi*	x						**P4**	p, s
Verticordia plumosa var. *brachyphylla*		x						h (palusplains, PP/F)
Onagraceae								
**Oenothera stricta subsp. stricta*		x			Evening Primrose			
Orchidaceae								
Caladenia paludosa	x				Spider Orchid			
**Disa bracteata*	x				=*Monadenia bracteata*			
Thelymitra antennifera	x				Yellow Sun Orchid			s, h (palusplains PP)
Thelymitra crinita	x				Blue Sun Orchid			
Thelymitra sp.	x							
Orobanchaceae								
**Orobanche minor*	x	x						
Papilionaceae								
Jacksonia sternbergiana			x		Stinkbush			
**Lotus subbiflorus*	x	x	x		=L. *suaveolens.*			

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

x

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Papilionaceae cont.								
**Lupinus cosentinii*	X	X	X		Blue Lupin			
**Lupinus luteus*		X			Yellow Lupin			
**Trifolium angustifolium*	X	X						
**Vicia sativa*	X	X	X		Vetch			
Viminaria juncea	X							
Phytolaccaceae								
**Phytolacca octandra*			X		Red Ink Plant			
Plantaginaceae								
**Plantago coronopus* subsp. *commutatus*	X							
Poaceae								
**Arundo donax*			X		Bamboo			
Austrostipa juncifolia subsp. Southern River (B.J. Keighery 2160)	X						**P1**	r (N, Wattle Grove; S, Southern River, SWA) p, s, u, h (calcareous muddy wetlands PP-BD), t.
**Avena barbata*	X	X	X		Wild Oats			
**Briza maxima*	X	X	X		Blowfly Grass			
**Briza minor*	X	X						
**Bromus diandrus*	X	X	X					
**Cortaderia selloana*			X		Pampus Grass			
**Cynodon dactylon*	X	X	X		Couchgrass			
**Ehrharta calycina*	X	X	X		Perennial Veldt Grass			
**Ehrharta longiflora*	X	X	X		Annual Veldt Grass			
**Eragrostis curvula*	X	X	X		Love Grass			
**Hordeum leporinum*	X	X						
**Hyparrhena hirta*	X	X	X		Tambookie Grass			
**Lolium multiflorum*	X	X	X		Rye Grass			
**Paspalum dilatatum*	X							
**Pennisetum clandestinum*	X		X		Kikuyu			
**Pentaschistis airoides* subsp. *airoides*	X			X	Shivery Grass			
**Polypogon monspeliensis*	X	X						

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x

TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Poaceae cont.								
**Tribolium uniolae*	X	X	X					
**Vulpia bromoides*	X	X	X	X	Squirrel Tail			
Polygalaceae								
Comesperma aff. *polygaloides* (C. Tauss. 2541)	X	X		X	Sub-shrub, clonal growth, mauve flowers in mid summer. First recorded in Tauss & Weston (2008) in Kenwick.			s, u, h (palusplains PP) t
Polygonaceae								
**Rumex crispus*		X	X		Dock			
Portulacaceae								
Calandrinia sp. Kenwick (G.J. Keighery 10905)	X				=C. aff. c*omposit*a			h(wetlands PP), t
Primulaceae								
**Anagallis arvensis* var. *caerulea*	X	X			Blue Pimpernel			
**Anagallis arvensis* var. *arvensis*	X	X			Scarlet Pimpernel			
Samolus junceus	X	X						s, u, h (wetlands, calcareous, saline, SD/PP/ Es /R)
Proteaceae								
Banksia littoralis	X							
Banksia telmatiaea	X	X						r (S, ?Serpentine,SWA), p, s, u, h (wetlands PP)
Grevillea thelemanniana	X	X					**P4**	p, s, eSCP(P) h (palusplains PP)
Hakea varia	X							
Restionaceae								
Chaetanthus aristatus	X	X						s, h (wetlands PP)
Lyginia imberbis		X						
Meeboldina roycei	X							

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TABLE B (cont.): Inventory of Flora recorded in the Lots 28, 32 and 36 Brook Rd Field Survey

Family/Taxon Name (FloraBase, 2008)	Lot 28	Lot 32	Lot 36	Not in BFS 387	Notes/Other Names	National Cons. Sig EPBC Act	State Cons. Sig.	Regional Cons Sig.
Rubiaceae								
Opercularia vaginata	x							
Rutaceae								
Boronia crenulata subsp. *viminea*	x							r (N, Kenwick SWA) s, u, d, h (wetlands PP/BD)
Sapindaceae								
Dodonaea ceratocarpa	**x**				Hop Bush			d,u, s, h(palusplains, PP), ?t
Scrophulariaceae								
**Parentucellia latifolia*	x							
**Parentucellia viscosa*	x	x						
Stylidiaceae								
Levenhookia stipitata	x							
Stylidium calcaratum	x							
Thymeliaceae								
Pimelea imbricata var. *major*	x							p, s, u, eSWA, h (mud palusplains and sumplands PP)
Xanthorrhoeaceae								
Xanthorrhoea preissii	x				Grass Tree			

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Appendix D

Flora, vegetation and wetlands site data (Spring 2008) (Tauss, 2008)

Site Q1-H1

Vegetation description: Closed heath of Actinostrobus *pyramidalis-Banksia telmatiaea-Hypocalymma angustifolium-Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes and annual and perennial herbs (Table C1, Plate 6). This site was part of the vegetation mapped as a mosaic of Vegetation Unit 1a (Figure 3).

Table C1: Vegetation in Q1 (dominant species in each vegetation layer (underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs >2m	<1%	*Viminaria juncea*
Shrubs 1-1.5 m	>70%	*Actinostrobus pyramidalis* (30-70%), *Banksia telmatiaea* (10-30%), *Hakea varia* (2-10%), *Hypocalymma angustifolium Mud* Habitats Variant (C.Tauss 1850) (30-70%), *Melaleuca brevifolia* (2-10%), *Melaleuca seriata (*2-10%),
Shrubs <0.5m	10-30%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (2-10%), *Acacia stenoptera* (<2%), *Actinostrobus pyramidalis* (2-10%), *Boronia crenulata* subsp. *viminea* (2-10%), *Calothamnus hirsutus* (10-30%), *Cassytha glabellla* (<1%), *Grevillea thelemanniana (*2-10%), *Hypocalymma angustifolium* Mud Habitats Variant (C. Tauss 1850) (2-10%), *Leucopogon polymorphus* (<2%), *Verticordia densiflora* subsp. *densiflora* (2%).
Perennial rushes and sedges	2-10%	*Chaetanthus aristatus* (<2%), *Gahnia trifida* (<2%), *Juncus pauciflorus* (<2%), *Lepidosperma* sp. Kenwick C.Tauss 2598 (<2%), *Schoenus subfascicularis* (2-10%).
Perennial herbs and geophytes	2-10%	*Caladenia paludosa* (<1%), **Disa bracteata* (<1%), *Drosera macrantha* subsp. *macrantha* (<2%), *Drosera menziesii* subsp. *menziesii* (<2%), *Drosera heterophylla* (<1%), *Haemodorum laxum* (<1%), **Sparaxis bulbifera* (<1%), *Thelymitra antennifera* (<1%), *Thelymitra crinita* (1%), *Thelymitra* sp. (<1%), *Thysanotus manglesianus* (2-10%), *Tribonanthes australis* (<1%), *Utricularia multifida* (<1%).
Grasses	<2%	**Briza maxima* (<1%), **Briza minor* (<1%), **Pentaschistis aeroides* (<1%), **Vulpia bromioides* (<1%).
Annual herbs	2-10%	*Aphelia cyperoides* (<1%), *Angianthus preissianus* (<1%), *Brachyscome pusilla* (<2%), *Calandrinia granulifera* (<1%), *Centrolepis aristata* (2-10%), **Cicendia filifolia* (<1%), *Crassula colorata* var. *acuminata* (<1%), *Drosera glanduligera* (<2%), *Goodenia micrantha* (<1%), **Heliophila pusilla* (<1%), *Hydrocotyle alata* (<1%), **Hypochaeris glabra* (<1%), *Isolepis stellata* (<1%),**Lotus subbiflorus* (<2%), *Pogonolepis stricta* (<2%), *Quinetia urvillei* (<1%),**Monopsis debilis* (<1%). *Phyllangium paradoxum* (<1%), **Juncus capitatus* (<1%),**Parentucellia latifolia* (<1%), **Parentucellia viscosa* (<1%), *Stylidium calcaratum* (<1%), *Triglochin muelleri* (<1%), *Trithuria bibracteata* (<1%)

Adjacent species: *Samolus junceus, Tecticornia lepidosperma*



Plate 6. Vegetation Q1-H1

Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01325303380; 115.98932383900.
Sample: Quadrat of area 100m^2. Flora surveyed on 09.09.08, 18.10.08 and 09.11.08

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

Site Q1-H1 cont.

SCP Floristic Community Type:
FCT 8: Herb-rich Shrublands in Claypans. WA DEC-listed TEC (Vulnerable).

Vegetation condition: Very good to excellent (61 taxa in 100m^2). Species-rich vegetation with intact structure. No signs of recent or frequent fire; *Actinostrobus pyramidalis* is generally 1-1.5m in height and this represents a cohort of this slow-growing species that recruited after a fire probably 7-10 years ago. Some rubbish dumping in the past – mainly old car bodies. Small excavations by Quenda (*Isoodon obesulus*) common. Excellent native fauna habitat; small excavations by Quenda (*Isoodon obesulus*) common and the large mature monitor lizard (*Varanus gouldii*) (over 1m in length) sighted nearby on 6.12.08.
Naturalised alien taxa: No aggressively invasive species except **Sparaxis bulbifera* at very low abundance; weeds <2% total cover.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible. Surface sediments: Humic quartz sand over muddy sand over hardpan at -65cm (Table C2).
Water Table(s): Surface waterlogged on 09.09.08. On 18.10.08, when the hole H1 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer of mud or laterite at about -65cm that prevented augering to the watertable.

Table C2: Shallow stratigraphy at H1.

Depth below ground level (cm)	Sediments
0-10	Pale grey, humic medium quartz sand
10-20	Slightly muddy, pale grey, medium quartz sand
20-30	Slightly muddy, cream, quartz sand
30-60	Pale grey, muddy sand
60-65	Cream muddy sand

Site Q2-H2

Vegetation description: Closed scrub of *Actinostrobus pyramidalis -Hypocalymma angustifolium* over sparse perennial herbs and sedges (Table C3, Plate 7). Part of the vegetation mapped as Vegetation Unit 1a (Figure 3).

Table C3: Vegetation in Quadrat 2 (dominant species in each vegetation layer (underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 2-4m	>70%	*Actinostrobus pyramidalis* (30-70%), *Hypocalymma angustifolium* Mud Habitat Variant (C.Tauss 1850) (30-70%), *Melaleuca viminea* subsp. *viminea* (2-10%) *juncea*
Shrubs 1-2 m	2-10%	*Acacia saligna* var. *saligna* (<2%), *Banksia telmatiaea* (2-10%), *Calothamnus hirsutus* (<2%)
Shrubs <0.5m	<2%	*Grevillea thelemanniana*
Perennial rushes and sedges	<2%	*Juncus pauciflorus* (<2%), *Schoenus subfascicularis* (<2%)
Perennial herbs and geophytes	2-10%	**Asparagus asparagoides* (<1%), **Sparaxis bulbifera* (<1%), *Thysanotus manglesianus* (2-10%), *Tribonanthes australis* (<1%)
Grasses	<2%	**Briza maxima* (<1%),**Ehrharta calycina* (<1%),
Annual herbs	<1%	**Hypochaeris glabra*

Adjacent species: *Baeckea* sp. Perth Region (R.J. Cranfield 444), *Tecticornia lepidosperma*

Location: Lot 28 Brook Rd Wattle Grove**. GPS lat/long:** -32.01363883440; 115.98923640800
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 18.10.08, 09.11.08

SCP Floristic Community Type: Allied to FCT 8: Herb-rich Shrublands in Claypans WA DEC-listed TEC (Vulnerable).

Site Q2-H2 cont.



Plate 7. Vegetation Q2-H2

Vegetation condition: Very good with the vegetation structure and floristics indicative of a mature stand of the slow growing conifer *Actinostrobus pyramidalis* (a re-seeder species after fire).This dense scrub is naturally species poor (16 taxa in 100m^2) due to closed vegetation structure and not due to degradation. This vegetation is excellent native fauna habitat. Some small, localized areas of soil disturbance
Naturalized alien taxa: Invasive species at very low abundance; weeds <2% total cover.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible. Surface sediments: shallow quartz sand over muddy quartz sand, clay, clay with ironstone gravel, clay and muddy quartz sand (Table C4). Water Table(s): Waterlogged at surface 09.09.08. On 18.10.08, when the hole H2 was augered (after a winter with a well below average rainfall), the sediments were moist down to a clay layer at -50cm and then continued to be moist to the water table at -150cm. Another water table was present at) -290 cm.

Table C4: Shallow Stratigraphy at H2

Depth below ground level (cm)	Sediments	Depth below ground level (cm)	Sediments
0-20	Pale grey medium quartz sand	170-190	Dark brown clay
20-40	Slightly muddy cream quartz sand	190-200	Mid brown clay
40-50	Pale brown, muddy, medium quartz sand	200-210	Mid brown clay with ferruginous gravel
50-120	Pale brown clay	210-220	Dark grey clay
120-150	Mid brown clay with orange mottles	220-290	Medium to fine, grey, muddy quartz sand
150-170	Brown –orange clay		

Site Q3-H3

Vegetation description: Closed heath of *Hypocalymma angustifolium- Acacia lasiocarpa- Actinostrobus pyramidalis* with emergent open shrubs of *Melaleuca lateriflora subsp. acutifolia* over open *Chaetanthus aristatus - Gahnia trifida* rushes/sedges and open annual herbs (Table C5, Plate 8). This site was part of the vegetation mapped as Vegetation Unit 2 (Figure 3).

Table C5: Vegetation in Quadrat 3: (dominant species in each vegetation layer (underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs <1 m	2-10%	*Melaleuca lateriflora* subsp. *acutifolia* (2-10%), *Viminaria juncea (<1%),*
Shrubs <0.5m	>70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (30-70%), *Actinostrobus pyramidalis* (10-30%), *Boronia crenulata* subsp. *viminea* (<1%), *Cassytha glabella* (<2%), *Eremophila glabra* subsp. *chlorella* (<1%), *Grevillea thelemanniana* (10-30%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (30-70%), *Lawrencia squamata* (<1%), *Melaleuca brevifolia* (<2%), *Opercularia vaginata* (<1%), *Pimelea imbricata* var. *major* (<1%).
Perennial rushes and sedges	10-30%	*Chaetanthus aristatus* (10-30%), *Gahnia trifida* (<1%), *Juncus pauciflorus* (<2%).
Perennial herbs and geophytes	2-10%	**Moraea flaccida* (<1%), ** Romulea rosea* var. *australis (<1%),*Sparaxis bulbifera* (<1%), *Thysanotus manglesianus* (<2%), *Tribonanthes australis* (<2%).
Grasses	<2%	**Briza maxima* (<1%), **Briza minor* (<1%), **Vulpia bromioides* (<1%).
Annual herbs	10-30%	*Centrolepis aristata* (2-10%), *Goodenia micrantha* (<1%), **Heliophila pusilla* (<1%), **Lotus subbiflorus* (2-10%), **Monopsis debilis* (<1%), **Parentucellia viscosa* (<2%), *Podolepis capillaris* (<1%), *Podolepis gracilis* (<2%), **Ursinia anthemoides* (<1%).

Adjacent species: *Samolus junceus, Scaevola lanceolata.* Opportunistic record nearby: *Trichocline* sp. Treeton (B.J. Keighery & N. Gibson 564).



Plate 8. Vegetation Q3-H3

SCP Floristic Community Type: FCT 8: Herb-rich Shrublands in Claypans. WA DEC-listed TEC (Vulnerable).

Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01269926750; 115.98853511900
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 18.10.08, 09.11.08, 20.12.08.

Site Q3-H3 cont.

Vegetation condition: Good. Vegetation structure is regenerating well after recent fire. The species richness of this vegetation is moderate (33 taxa in $100m^{2)}$ however it includes relatively few annuals and geophytes when compared to the areas around Q1. It also retains some very distinctive and rare floristic elements. The area is adjacent to a large species-rich expanse of wetlands in very good condition, it has low weed cover and the soil has not been disturbed. Without further disturbance it is therefore likely to be re-colonized by a suite of native annuals over time.

Naturalized alien taxa: No aggressively invasive species except **Sparaxis bulbifera* and the latter is at very low abundance; weeds <2% total cover.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments: Shallow quartz sand over mud.
Water Table(s): Surface waterlogged on 09.09.08. On 18.10.08, when the hole at H3 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer of mud or laterite at about -50cm that prevented augering to the watertable

Table C6: Shallow Stratigraphy in H3

Depth below ground level (cm)	Sediments
0-20	Pale grey, medium to fine, quartz sand
20-40	Pale grey to cream, muddy quartz sand.
40-50	Pale grey to cream mud

Site Q4-H4

Vegetation description: Closed heath of Actinostrobus *pyramidalis-Banksia telmatiaea-Hypocalymma angustifolium*-over sparse *Chaetanthus aristatus* rushes and annual and perennial herbs (Table C7, Plate 9). This site was part of the vegetation mapped as Vegetation Unit 1b (Figure 3).

Table C7: Vegetation in Quadrat 4 (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 2-3m	<2%	*Melaleuca lateriflora* subsp. *acutifolia*
Shrubs 1-2 m	10-30%	*Actinostrobus pyramidalis* (<2%), *Banksia telmatiaea* (2-10%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (2-10%), *Melaleuca brevifolia* (2-10%).
Shrubs <1m	30-70%	*Actinostrobus pyramidalis* (2-10%), *Boronia crenulata* subsp. *viminea* (<2%), *Calothamnus hirsutus* (2-10%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (10-30%).
Shrubs <0.5m	10-30%	*Acacia lasiocarpa* var. *lasiocarpa sens. strict.* (2-10%), *Calothamnus hirsutus* (2-10%), *Grevillea thelemanniana (*2-10%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (2-10%).
Perennial rushes and sedges	2-10%	*Chaetanthus aristatus* (10-30%), *Gahnia trifida* (<1%), *Juncus pauciflorus* (<2%), *Lepidosperma* sp. Kenwick C.Tauss 2598 (<2%).
Perennial herbs and geophytes	2-10%	*Caladenia paludosa* (<1%), *Drosera macrantha* subsp. *macrantha* (<1%), *Drosera menziesii* subsp. *menziesii* (<2%), * *Romulea rosea* var. *australis* (<1%),**Samolus junceus* (<2%), *Thelymitra* sp. (<1%), *Thysanotus manglesianus* (2-10%), *Tribonanthes australis* (<1%).
Annual Grasses	<2%	**Briza maxima* (<1%), **Briza minor* (<1%), **Pentaschistis aeroides* (<1%), **Vulpia bromioides* (<1%).
Annual herbs	10-30%	*Aphelia cyperoides* (<1%), *Angianthus preissianus* (<1%), *Brachyscome pusilla* (2-10 %), *Centrolepis aristata* (10-30%), *Crassula colorata* var. *acuminata* (<1%), **Echium plantagineum* (<1%), *Hydrocotyle alata* (<1%), **Hypochaeris glabra* (<1%), **Monopsis debilis* (<1%), *Phyllangium paradoxum* (<1%),**Parentucellia latifolia* (<1%),**Parentucellia viscosa* (<2%), *Podolepis gracilis* Swamp Form (G.J. Keighery 13 255) (<1%), **Ursinia anthemoides* (<1%).

Site Q4-H4 cont.



Plate 9: Vegetation at Q4-H4

SCP Floristic Community Type: Allied to FCTs 7 and 8: Herb-rich Saline Shrublands in Claypans, and Herb-rich Shrublands in Claypans. WA DEC-listed TECs (Vulnerable).

Vegetation condition: Very good. Moderately species-rich vegetation (39 taxa in 100m^2) with intact structure. No disturbance evident. No signs of recent fire. Excellent fauna habitat. **Naturalized alien taxa:** No aggressively invasive species; weeds <2% total cover.

Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01311369000; 115.98974909100

Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 18.10.08, 09.11.08

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat).
Slope: Negligible.
Surface sediments: Shallow quartz sand over muddy sand over hardpan.
Water table: Surface waterlogged on 9.09.08. On 18.10.08, when the hole at H4 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer at about -110cm that prevented augering to the watertable.

Table C8: Shallow Stratigraphy in H4

Depth from ground level (cm)	Sediments
0-20	Cream-grey, medium, quartz sand
20-50	Slightly muddy, medium, cream sand
50-110	Cream, muddy, medium, quartz sand

Site Q5-H5

Vegetation description: Mid-dense heath of Banksia *telmatiaea-Hypocalymma angustifolium- Melaleuca seriata* over sparse *Chaetanthus aristatus* rushes and annual herbs (Table C9). Part of the vegetation mapped as Vegetation Unit 2 (Figure 3).

Table C9: Vegetation in Quadrat 5 (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs <1m	30-70%	*Astartea affinis (<2%)*, *Banksia telmatiaea* (10-30%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (30-70%), *Melaleuca brevifolia* (<2%), *Melaleuca lateriflora* subsp. *acutifolia* (<2%), *Melaleuca viminea* subsp. *viminea* (<2%).
Shrubs <0.5m	10-30%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (2-10%), *Actinostrobus pyramidalis* (2-10%), *Boronia crenulata* subsp. *viminea* (<2%), *Calothamnus hirsutus* (<2%), *Cassytha glabellla* (<1%), *Grevillea thelemanniana (*2-10%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (2-10%).
Perennial rushes and sedges	2-10%	*Baumea juncea* (<2%), *Chaetanthus aristatus* (<2%), *Gahnia trifida* (<2%).
Annual herbs	2-10%	*Centrolepis aristata* (2-10%), *Crassula colorata* var. *acuminata* (<1%), *Podolepis gracilis* (<2%), *Pogonolepis strictus* (<2%), *Stylidium calcaratum* (<1%).



Plate 10. Vegetation at Q5-H5

SCP Floristic Community Type: FCT 7: Herb-rich Saline Shrublands in Claypans. DEC-listed TEC (Vulnerable).

Vegetation condition: Good. Vegetation structure is regenerating well after recent fire. Relatively low species richness (21 taxa in 100m^2) particularly of annuals and geophytes when compared with Q1 but retains floristic elements of high conservation significance. The area is adjacent to a large species-rich expanse of wetlands in very good condition, is free of weeds and the soil has not been disturbed. It is therefore likely to be colonized by a suite of native annuals over time. Good native fauna habitat. **Naturalized alien taxa:** No highly invasive alien species recorded.

Location: Lot 28 Brook Rd, Wattle Grove. **GPS lat/long:** -32.01218927070; 115.98924434100

Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Site Q5-H5 cont.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat).
Slope: negligible.
Surface sediments: Very shallow quartz sand over muddy sand over sandy mud over gravelly mud over clay.
Water Table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at site H5 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer of grey-brown clay at about -180cm that prevented augering to the watertable.

Table C10: Shallow Stratigraphy in H5

Depth below ground level (cm)	Sediments
0-10	Pale grey, medium, quartz sand
10-60	Pale grey, muddy, sand
60-80	Pale grey, muddy, sand with rusty mottles
80-120	Pale grey, muddy sand.
120-130	Pale brown-orange muddy sand
130-140	Pale grey, muddy sand.
140-170	Mid brown sandy mud
170-180	Mid brown sandy mud with ironstone gravel
180	Grey-brown clay hardpan

Site Q6-H6

Vegetation description: *Melaleuca rhaphiophylla* low open forest over *Melaleuca viminea* low open shrubs, sparse sedges and naturalized alien grasses (Table C11). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Table C11: Vegetation in Quadrat 6 (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Trees <6m	30-70%	*Melaleuca rhaphiophylla* (30-70%), *Viminaria juncea* (<2%)
Shrubs 1-2m	30-70%	*Acacia saligna* var. *saligna* (2-10%), *Hypocalymma angustifolium Mud* Habitat Variant (*C.* Tauss 1850) (10-30%), *Melaleuca viminea* subsp. *viminea* (30-70%).
Shrubs <0.5m	<2%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.*
Perennial rushes and sedges	2-10%	*Schoenus subfascicularis*
Perennial herbs and geophytes	<2%	**Asparagus asparagoides* (<1%), **Gladiolus undulatus* (<1%), **Sparaxis bulbifera* (<1%).
Grasses	10-30%	**Bromus diandrus* (2-10%), **Cynodon dactylon* (10-30%) **Pennisetum clandestinum* (2-10%)
Annual herbs	<2%	*Lobelia anceps*

Also in this vegetation unit nearby: *Actinostrobus pyramidalis*, *Astartea affinis*, *Baumea juncea*, *Ficinia nodosa*, *Gahnia trifida*, *Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop 634 pn, *Pogonolepis stricta.*

SCP Floristic Community Type: The results of the floristic analysis for Q6 relative to the SCP survey sites of Gibson et al., (1994) were not conclusive (see Appendix E). As Q6 occurs on the eastern side of the SCP in habitats that are now mostly developed, it is probably an uncommon, poorly-reserved vegetation type that is now mainly represented by weed -invaded sites.

Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01156120510; 115.98884478800
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Site Q6-H6 cont.



Plate 11: Vegetation adjacent to Q6-H6.
(Q6 is in the low forest of Freshwater Paperbark on the LHS of this photo).

Vegetation condition: Good to degraded. Canopy structure intact, deep natural litter layer and low species richness (14 taxa in 100m^2) typical of closed canopy vegetation. However some small localized areas are cleared and/or excavated. Some rubbish dumping has occurred in the past – mainly old rusty car bodies that are now growing over with vegetation. A fire several years ago burned the periphery of the sumpland but the vegetation structure is regenerating well. Excellent native fauna habitat.
Naturalized alien taxa: The understorey includes an open cover of perennial alien grasses that are limited by the shade and deep litter layer.

Landforms/Sediments/Hydrology: Seasonally inundated basin (sumpland). This sumpland has a narrow, elongated shape and appears to be part of a discontinuous channel that is comprised of several such sumplands (in the area between Boundary Rd and Yule Brook) all orientated parallel to the direction of groundwater discharge from the Darling Range to the Canning River.
Surface sediments: Peat and muddy sand over shallow mud.
Water Table: Shallow standing water on 09.09.08. On 19.10.08, when the hole at H6 was augered (after a winter with a well below average rainfall) the water table was at -36 cm. This water table was very high in this wetland compared to that in the adjacent wetlands of Lot 28 on the same date. Another watertable was present at about -180cm.

Table C12: Shallow Stratigraphy in H6

Depth from ground level (cm)	Sediments
0-10	Peat
10-20	Grey humic quartz sand
20-50	Pale brown, rusty- mottled, muddy sand
50-70	Pale brown, sandy mud
70-90	Orange sandy mud
90-180	Pale brown mud with dark brown mottles

Site Q7-H7

Vegetation description: *Melaleuca rhaphiophylla* low closed forest over *Melaleuca viminea* low open shrubs, sparse sedges and naturalized alien grasses (Table C13). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Table C13: Vegetation in Quadrat 7 (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Trees <4.5m	>70%	*Melaleuca rhaphiophylla.*
Shrubs 1-2m	2-10%	*Acacia saligna* var. *saligna* (<2%), *Cassytha racemosa* (<2%), *Melaleuca viminea* subsp. *viminea* (<2%), *Melaleuca brevifolia* (<2%),**Phytolacca octandra* (<2%).
Perennial rushes and sedges	2-10%	*Gahnia trifida* (<2%), *Juncus pauciflorus* (<2%), *Lepidosperma longitudinale* (<2%)
Perennial herbs and geophytes	<2%	**Asparagus asparagoides* (<1%), **Rumex crispus* (<2%)
Grasses	10-30%	**Ehrharta calycina* (10-30%), **Ehrharta longiflora* (10-30%)



Plate 12: Vegetation adjacent to Q7-H7.
(Q7 is in the low forest of Freshwater Paperbark in the background of this photo).

SCP Floristic Community Type: The multivariate analysis (see Appendix E) of this vegetation was not conclusive. Q7 is most likely to be an eastern SCP floristic type that was not well sampled in Gibson *et al.*, (1994). As Q7 occurs on the eastern side of the SCP and is underlain by wetland sediments characteristic of the Pinjarra Plain (a habitat that is now mostly developed) it is probably an uncommon, poorly-reserved vegetation type.

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01095315390; 115.99228015400
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Vegetation condition: Good (13 taxa in 100m^2). Canopy structure intact, deep natural litter layer and low species richness of annuals and geophytes typical of this type of vegetation. Vegetation structure is regenerating well. Excellent native fauna habitat.
Naturalized alien taxa: The understorey includes an open cover of perennial alien grasses are limited by shade and deep litter layer.

Site Q7-H7 cont.

Landforms/Sediments/Hydrology: Dampland/sumpland (seasonally waterlogged and intermittently inundated basin). This dampland has a narrow, elongated shape and appears to be part of a discontinuous channel that is comprised of several wetlands similar to this one (in the area between Boundary Rd and Yule Brook) that are orientated parallel to the direction of groundwater discharge from the Darling Range to the Canning River.
Surface sediments: peaty sand. Water Table: waterlogged at surface on 09.09.08. On 19.10.08, when the hole at H7 was augered (after a winter with a well below average rainfall) the sediments were moist down to water table at -230 cm. In wetter years this basin is probably inundated for short periods.

Table C14: Shallow Stratigraphy in H7

Depth from ground level (cm)	Sediments
0-50	Grey, medium, peaty, quartz sand
50-60	Pale brown, medium, quartz sand
60-90	Pale brown, medium, slightly muddy quartz sand
90-120	Pale yellow-brown muddy quartz sand
120-140	Pale grey muddy sand
140-180	Grey sandy mud
180-190	Grey mud
190-200	Grey –cream sandy mud
200-230	Grey muddy sand

Site Q8-H8

Vegetation description: Mid dense, patchy heath of *Actinostrobus pyramidalis-Verticordia densiflora* subsp. *densiflora-Baeckea* sp. Perth Region (R.J. Cranfield 444) over sparse *Chaetanthus aristatus* rushes and annual and perennial herbs (Table C15). Part of vegetation mapped as Vegetation Unit 1a (Figure 3).

Table C15: Vegetation in Quadrat 8: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 1-2 m	<2%	*Actinostrobus pyramidalis*
Shrubs <0.5m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (2-10%), *Acacia stenoptera* (<1%), *Actinostrobus pyramidalis* (10-30%), *Baeckea* sp. Perth Region (R.J. Cranfield 444) (2-10%), *Calothamnus hirsutus* (<1%), *Cassytha glabellla* (<1%), *Grevillea thelemanniana (*2-10%), *Hypocalymma angustifolium* Mud Habitats Variant (C. Tauss 1850) (2-10%), *Verticordia densiflora* subsp. *densiflora* (10-30%).
Perennial rushes and sedges	2-10%	*Baumea juncea* (<2%), *Chaetanthus aristatus* (2-10 %), *Gahnia trifida* (<2%), *Lepidosperma* sp. Kenwick C.Tauss 2598 (<2%), *Lyginia imberbis* (<1%), *Schoenus subfascicularis* (2-10%).
Perennial herbs and geophytes	2-10%	*Anigozanthos viridis* subsp. *viridis* (2-10%), *Drosera menziesii* subsp. *menziesii* (<1%), *Samolus junceus* (<2%), *Tribonanthes australis* (2-10%).
Grasses	2-10%	**Briza maxima* (<2%), **Ehrharta calycina* (2-10%)
Annual herbs	2-10%	*Centrolepis aristata* (2-10%), **Lotus subbiflorus* (<2%), **Juncus capitatus* (<1%), **Parentucellia viscosa* (<1%)

SCP Floristic Community Type: FCT 10a: Shrublands on Dry Clay Flats. WA DEC-listed TEC (Endangered).

Vegetation condition: Good. Vegetation structure is regenerating well after recent fire, retains rare floristic elements of high conservation significance. The area is adjacent to a large species-rich expanse of wetlands in very good condition, has a low total cover of weeds and the soil has not been disturbed, except for small localized areas. It is therefore likely to be colonized by a suite of native annuals over time. Good native fauna habitat.

Naturalized alien taxa: A small mid-dense area of **Ehrharta calycina* forms less than 10% total cover of this vegetation.

Site Q8-H8 cont.



Plate 13: Vegetation at Q8-H8

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01085749460; 115.99203748000
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat).
Slope: Negligible. Surface sediments: Muddy quartz sand over shallow hardpan.
Water Table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H8 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer at about -50cm that prevented augering to the watertable.

Table C16: Shallow Stratigraphy in H8

Depth below ground level (cm)	Sediments
0-20	Pale brown-cream, slightly muddy medium quartz sand
20-50	Brown-cream muddy quartz sand

Site Q9-H9

Vegetation description: Mid dense heath of *Melaleuca viminea* subsp. *viminea* – *Melaleuca lateriflora* subsp. *acutifolia* over mid dense naturalized alien grasses and sparse *Schoenus subfascicularis* – *Gahnia trifida* sedges (Table C17). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Table C17: Vegetation in Quadrat 9: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 2-3m	2-10%	*Melaleuca lateriflora* subsp. *acutifolia* (2-10%), *Melaleuca rhaphiophylla* (2%)
Shrubs <2m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (<2%), *Cassytha glabella* (<2%), *Melaleuca brevifolia* (<2%), *Melaleuca viminea* subsp. *viminea* (30-70%), *Melaleuca lateriflora* subsp. *acutifolia* (<2%)
Perennial rushes and sedges	2-10%	*Chaetanthus aristatus* (<2%), *Gahnia trifida* (<2-10%), *Schoenus subfascicularis* (2-10%).
Perennial herbs and geophytes	<2%	* *Moraea flaccida* (<2%),**Sparaxis bulbifera* (<1%)
Grasses	30-70%	**Avena barbata* (10-30%), * *Ehrharta calycina* (10-30%), **Lolium multiflorum* (10-30%), **Tribolium uniolae* (<2%)

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

Site Q9-H9 cont.



Plate 14. Vegetation at Q9-H9

SCP Floristic Community Type: The multivariate analysis of this vegetation was not conclusive. Q9 is likely to be an eastern SCP floristic type that was not adequately sampled and therefore not identified by Gibson *et al.*, (1994). As this site is located on the eastern SCP it is also likely be poorly reserved and of high conservation value.

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01141623200; 115.99208614100

Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 19.10.08, 09.11.08

Vegetation condition: Degraded to good. Understorey includes mid dense naturalized alien grasses except for small patches where low native shrubs and sedges remain abundant. Relatively species-poor (15 taxa in 100m^2) over much of this vegetation unit. This area has experienced a number of controlled fires that have been contained within the cadastral boundary of the block. The vegetation is however still capable of regenerating naturally. It is adjacent to a large, species-rich expanse of wetlands in very good condition and the soil has not been disturbed. It is therefore likely to be colonized by a suite of native annuals over time.

Naturalized alien taxa: Mid-dense naturalized alien grasses including some invasive species such as **Ehrharta calycina.*

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: Negligible.

Surface sediments: Shallow quartz sand over muddy sand over dark grey clay.
Water Table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H9 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer of clay at about -100cm that prevented augering to the watertable.

Table C18: Shallow Stratigraphy in H9

Depth from ground level (cm)	Sediments
0-30	Grey medium quartz sand
30-40	Dark grey muddy sand
40-50	Dark grey clay
50-100	Dark grey muddy sand

Site Q10

Vegetation description: Patchy closed heath of *Melaleuca viminea* subsp. *viminea-Hypocalymma angustifolium* over mid-dense *Actinostrobus pyramidalis* seedlings, mid-dense *Chaetanthus aristatus –Gahnia trifida* rushes and sedges and annual herbs (Table C19, Plate 15). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Table C19: Vegetation in Quadrat 10: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 2-4m	<2%	*Melaleuca rhaphiophylla* (<1%), *Viminaria juncea* (<2%)
Shrubs 0.5-2m	30-70%	*Acacia saligna* var. *saligna* (10-30%), *Hypocalymma angustifolium Mud* Habitat Variant (C.Tauss 1850) (30-70%), *Melaleuca viminea* subsp. *viminea* (30-70%)
Shrubs <0.5m	30-70%	*Actinostrobus pyramidalis* (30-70%), *Cassytha glabellla* (10-30%), *Cassytha racemosa* (<2%), *Grevillea thelemanniana (*<2%).
Perennial rushes and sedges	30-70%	*Chaetanthus aristatus* (30-70%), *Gahnia trifida* (2-10%), *Juncus pauciflorus* (<1%)
Perennial herbs	2-10%	*Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn (<2%), *Samolus junceus* (<2%)
Grasses	2-10%	**Briza maxima* (<1%),**Cynodon dactylon* (<2%), **Ehrharta calycina* (<1%),**Vulpia bromioides* (2-10%).

SCP Floristic Community Type: The multivariate analysis of this vegetation was not conclusive. Q10 is likely to be an eastern SCP floristic type that was not adequately sampled and therefore not identified by Gibson *et al.*, (1994). As this FCT is located on the eastern SCP it is likely be poorly reserved and of high conservation value.

Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01236667000; 115.98800000000
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 20.10.08, 10.11.08

Vegetation condition: Good. The vegetation structure is regenerating well after recent fire and will regain very good condition in time. The current species richness is relatively low (total of 18 taxa in 100m^2) which can be typical of this type of vegetation (even when in very good condition). The vegetation retains floristic elements of high conservation significance, it is adjacent to a large, species-rich expanse of wetlands in very good condition, is relatively free of weeds and there are only small localized areas of soil disturbance (*i.e.* a fire break that has mostly regenerated to native vegetation).
Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible. Surface sediments: muddy sand. Water Table: waterlogged at surface 09.09.08. Site not augered.



Plate 15. Vegetation at Q10

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

Site Q11

Vegetation description: Mid dense heath of *Acacia lasiocarpa- Actinostrobus pyramidalis- Hypocalymma angustifolium* less than 0.5m in height with emergent open shrubs of *Melaleuca lateriflora-M. brevifolia* to about 1m in height over open *Chaetanthus aristatus - Gahnia trifida* rushes/sedges and *Pogonolepis strictus* mid-dense annual herbs (Table C21, Plate 16). Part of the vegetation mapped as Vegetation Unit 2 (Figure 3).

Table C20: Vegetation in Quadrat 11 (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs <1m	2-10%	*Melaleuca lateriflora* subsp. *acutifolia*
Shrubs <0.5m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict* (2-10%), *Actinostrobus pyramidalis* (30-70%), *Banksia telmatiaea* (2-10%), *Calothamnus hirsutus* (<2%), *Comesperma* aff. *polygaloides* (C. Tauss 2541)(<1%), *Cassytha racemosa* (<2%), *Grevillea thelemanniana* (2-10%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850)(30-70%), *Melaleuca brevifolia*(2-10%), *Verticordia densiflora* subsp. *densiflora* (<1%).
Perennial rushes and sedges	2-10%	*Baumea juncea (<2%) Chaetanthus aristatus* (2-10%), *Gahnia trifida* (2-10%)
Perennial herbs and geophytes	2-10%	*Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn (2-10%), *Samolus junceus* (<2%)
Grasses	2-10%	**Briza maxima* (<2%), **Vulpia bromioides* (2-10%).
Annual herbs	2-10%	*Centrolepis aristata* (2-10%),**Lotus subbiflorus* (<2%), *Pogonolepis strictus* (2-10%),

SCP Floristic Community Type: Allied to FCT 7: Herb-rich Saline Shrublands in Claypans. DEC-listed TEC (Vulnerable).
Vegetation condition: Good. The vegetation structure is regenerating well after recent fire and will regain very good condition in time. There is abundant natural regeneration from the soil seed bank evident, it is adjacent to a large, species-rich expanse of wetlands, there are nor aggressively invasive weeds, total weed cover is low (< 10%) and the soil has not been disturbed. The current species richness of this site is relatively low (total of 21 taxa in 100m^2) but it retains floristic elements of high conservation significance.
Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01170497920; 115.98911628600
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 20.10.08, 10.11.08
Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible. Surface sediments: shallow sand over muddy sand. Water Table: waterlogged at surface 09.09.08. Site not augered.



Plate 16. Vegetation at Q11

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

Site Q12

Vegetation description: Open scrub of *Melaleuca viminea-Actinostrobus pyramidalis* over mid-dense heath of *Hypocalymma angustifolium* over sparse *Chaetanthus aristatus-Schoenus subfascicularis* rushes/sedges and sparse annual herbs (Table C21, Plate 17). Part of the vegetation mapped as Vegetation Unit 3a (Figure 3).

Table C21: Vegetation in Quadrat 12: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 2-4m	10-30%	*Actinostrobus pyramidalis (10-30%), Melaleuca viminea* subsp. *viminea 30-70%) Viminaria juncea (2-10%).*
Shrubs 0.5-2 m	30-70%	*Acacia saligna* (<2%), *Hypocalymma angustifolium Mud* Habitat Variant (*C.* Tauss 1850) (10-30%), *Melaleuca viminea* subsp. *viminea* (10-30%)
Shrubs <0.5m	<1%	*Comesperma* aff. *polygaloides* (C. Tauss 2541)
Perennial rushes and sedges	2-10%	*Baumea juncea* (<2%), *Chaetanthus aristatus* (2-10%), *Gahnia trifida* (<2%), *Schoenus subfascicularis* (2-10%).
Annual Grasses	2-10%	**Briza maxima* (<2%), **Briza minor* (<2%), **Pentaschistis aeroides* (<2%)
Annual herbs	2-10%	**Anagallis arvensis* var. *arvensis* (<1%), *Centrolepis aristata* (2-10%), **Dittrichia graveolens* (<2%), **Lythrum hyssopifolium* (<1%), **Plantago coronopus* (<1%), *Podolepis gracilis* Swamp Form (GJ Keighery 12803) (<2%), *Pogonolepis strictus* (2-10%).



Plate 17. Vegetation at Q12

SCP Floristic Community Type: FCT 7: Herb-rich Saline Shrublands in Claypans, a DEC-listed TEC (Vulnerable). **Vegetation condition:** Very good. Vegetation structure intact. No signs of recent fire. Low species richness (21 taxa in 100m^2) but this is probably characteristic of this type of scrub in the absence of frequent fire. Excellent native fauna habitat. **Naturalised alien taxa:** No aggressively invasive species; weeds <10% total cover.

Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01376967300; 115.98930333400
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 20.10.08, 10.11.08

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible. Surface sediments: shallow cream quartz sand over cream clay. Water Table: waterlogged at surface 09.09.08. Site not augered.

Site Q13

Vegetation description: Mid dense heath of *Banksia telmatiaea-Hypocalymma angustifolium- Acacia lasiocarpa* var. *lasiocarpa with emergent tall open Melaleuca lateriflora* subsp. *acutifolia shrubs over open* Chaetanthus *aristatus-Gahnia trifida* rushes, open perennial and annual grasses and open *Centrolepis aristata-Pogonolepis strictus* annual herbs (Table C22, Plate 18). Part of the vegetation mapped as Vegetation Unit 2 (Figure 3).

Table C22: Vegetation in Quadrat 13: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 1-2.5 m	2-10%	*Melaleuca lateriflora* subsp. *acutifolia*
Shrubs <1m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (2-10), *Actinostrobus pyramidalis* (2-10%), *Cassytha glabellla* (2-10%), *Banksia telmatiaea* (2-10%), *Grevillea thelemanniana* (2-10%), *Hypocalymma angustifolium Mud* Habitats Variant (C. Tauss 1850) (10-30%), *Melaleuca brevifolia* (2-10%), *Melaleuca viminea* subsp. *viminea* (<2%).
Perennial rushes and sedges	10-30%	*Chaetanthus aristatus* (2-10%), *Chorizandra enodis* (<2%), *Gahnia trifida* (2-10%), *Lepidosperma* sp. Kenwick C.Tauss 2598 (<2%)
Perennial herbs and geophytes	2-10%	*Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn (<2%), *Samolus junceus* (<2%), *Scaevola lanceolata* (<2%), **Sparaxis bulbifera* (<1%).
Grasses	2-10%	*Austrostipa juncifolia* subsp. Southern River (B.J. Keighery 2160) (<2%), **Avena barbata* (<2%), **Briza maxima* (<2%), **Ehrharta calycina* (<2%), **Hordeum geniculatum* (<2%),**Vulpia bromioides* (2-10%).
Annual herbs	10-30%	**Anagallis arvensis* var. *caerulea* (<1%), *Aphelia cyperoides* (<1%), **Centaurium erythraeum* (<1%), *Centrolepis aristata* (2-10%), *Centrolepis polygyna* (<1%), * *Dittrichia graveolens* (<1%), **Lotus subbiflorus* (<2%), *Podolepis gracilis* Swamp Form (GJ Keighery 12803) (<2%), *Pogonolepis strictus* (2-10%).

Opportunistic records nearby: *Dodonaea ceratocarpa, Lepidosperma rostratum, Meeboldina roycei.*

SCP Floristic Community Type: FCT 7: Herb-rich Saline Shrublands in Claypans. DEC-listed TEC (Vulnerable).

Location: Lot 28 Brook Rd Wattle Grove. **GPS lat/long:** -32.01271052480; 115.98968606900
Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 20.10.08, 10.11.08



Plate 18. Vegetation at Q13

Tauss, C. (2008). Lots 28, 32 and 36 Brook Rd, Wattle Grove: Flora, Vegetation, Wetlands.

Site Q13 cont.

Vegetation condition: Good to very good. The vegetation structure at Q13 is regenerating after a recent fire. This vegetation includes a relatively low species richness of annuals and geophytes when compared with Q1 (29 taxa in 100m^2) but it retains floristic elements of high conservation significance, is relatively free of weeds and the soil has not been disturbed. Excellent native fauna habitat. **Naturalised alien taxa:** Few aggressively invasive species, all at low cover; <10% total weed cover.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible. Surface sediments: slightly muddy quartz sand. Water Table: waterlogged at surface 09.09.08. Site not augered.

Site Q14-H10

Vegetation description: *Melaleuca viminea* subsp. *viminea* mid dense heath over open *Chaetanthus aristatus – Gahnia trifida* rushes and annual and *Centrolepis aristatus –Pogonolepis strictus* sparse perennial herbs (Table C23, Plate 19). Part of the vegetation mapped as Vegetation Unit 3b (Figure 3).

Table C23: Vegetation in Quadrat14: (dominant species in each vegetation layer underlined)

Vegetation layer	Total projected foliage cover	Species in layer
Shrubs 1-2 m	10-30%	*Acacia saligna* var. *saligna* (<2%), *Melaleuca brevifolia* (<2%), *Melaleuca viminea* subsp. *viminea* (10-30%)
Shrubs <1m	30-70%	*Acacia lasiocarpa* var. *lasiocarpa sens strict.* (2-10%), *Actinostrobus pyramidalis* (10-30%), *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850) (10-30%), *Cassytha glabellla* (2-10%), *Tecticornia lepidosperma* (<2%).
Perennial rushes and sedges	2-10%	*Chaetanthus aristatus* (<2%), **Ehrharta calycina* (<2%), *Gahnia trifida* (2-10%
Grasses	2-10%	**Briza maxima* (<1%), **Vulpia bromioides* (2-10%).
Annual herbs	2-10%	*Centrolepis aristata* (2-10%), **Dittrichia graveolens (<2%), Juncus capitatus* (<1%), **Lotus subbiflorus* (<2%), **Parentucellia viscosa* (<1%), *Pogonolepis strictus* (2-10%).

SCP Floristic Community Type: Allied to FCT 7: Herb-rich Saline Shrublands in Claypans. DEC-listed TEC (Vulnerable).

Vegetation condition: Good to degraded but much of it retains the potential to naturally regenerate to good condition bushland. **Naturalised alien taxa:** **Ehrharta calycina,* an aggressively- invasive naturalized alien grass occurs in this vegetation in patchy stands up 30% cover in some areas. The areas in better condition include annual grass weeds but also retain a native herbs and an open cover of *Actinostrobus pyramidalis* seedlings that will, as they mature and create shade, reduce the abundance of weeds.

Location: Lot 32 Brook Rd Wattle Grove. **GPS lat/long:** -32.01056779680; 115.99152813600

Sample: Quadrat of area 100m^2. Dates surveyed: 09.09.08, 30.11.08

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments: Shallow quartz sand over cream sandy mud.
Watertable: Surface waterlogged on 9.09.08. On 30.11.08 when the hole at H10 was augered (after a winter with a well below average rainfall) the sediments were dry down to a hardpan at -25cm and a water table was not reached.

Table C24: Shallow Stratigraphy in H10

Depth from ground level (cm)	Sediments
0-20	Pale yellow-brown muddy quartz sand
20-25	Cream sandy mud

Site Q14-H10 cont.



Plate 19. Vegetation Q14-H10

Site H11

Vegetation description: *Melaleuca rhaphiophylla* sparse low trees surrounding a burnt area almost devoid of vegetation. Associates included sparse shrubs of *Astartea affinis* and *Hypocalymma angustifolium* Mud Habitat Variant (C. Tauss 1850), patchy clumps of the rhizomatous sedge *Schoenus subfascicularis* and sparse annual herbs dominated by *Centrolepis aristatus.* There were few, if any, weeds colonizing the bare burnt areas. This area around the bare wetland was part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Location: Lot 28 Brook Rd, Wattle Grove. **GPS lat/long:** -32.01260819110; 115.98807255300

Landforms/Sediments/Hydrology: Sumpland (seasonally inundated basin) (Plate 19). Water Table: Shallow standing water on 09.09.08. On 18.10.08, when the hole at H11was augered (after a winter with a well below average rainfall) the water table was at 16 cm below the ground. There was also another water table at about -170cm.

Table C25: Shallow Stratigraphy in H11

Depth below ground level (cm)	Sediments
0-10	Pale brown, medium , muddy, quartz sand
10-20	Dark brown sandy mud
20-30	Dark brown mud with ferruginous gravel
30-50	Dark brown sandy peat
50-60	Brown muddy sand
60-70	Cream- grey sandy mud
70-90	Pale grey slightly muddy sand
90-120	Cream, muddy quartz sand
120-160	Cream-grey medium quartz sand
160-170	Cream-grey muddy quartz sand

SCP Floristic Community Type: Although some regeneration of the vegetation is occurring, it was not possible to do a detailed floristic assessment of this wetland. This area has recently experienced a severe fire that resulted in the removal of most of the vegetation and some of the surface organic sediments of this wetland. The fire did not affect the high conservation value of this wetland as the geomorphic and hydrological attributes of the wetland (that are the primary factors in its value as a scarce wetland type) remain intact.
The remnant vegetation at H11 indicates that this wetland was originally fringed by a wetland assemblage similar to that remaining at Site Q6. The central area was probably inhabited by a species-rich assemblage of herbs, rushes and sedges allied to FCT 8.



Plate 20. Small basin at H11 showing vegetation loss due to recent severe fire.

Site H12

Vegetation description: *Melaleuca rhaphiophylla* sparse low trees/shrubs a surrounding a severely burnt area almost devoid of vegetation (Plate 21). Associates included sparse shrubs of *Astartea affinis, Banksia littoralis* and *Hypocalymma angustifolium* Mud Habitat Variant (C.Tauss 1850), patches of the rhizomatous sedge *Schoenus subfascicularis* and sparse annual herbs (mainly *Centrolepis aristata*). There were few, if any, weeds colonizing the bare burnt areas. The remaining vegetation around the bare wetland was mapped as Vegetation Unit 4 (Figure 3).

SCP Floristic Community Type: Although some regeneration of the vegetation is occurring, it was not possible to do a detailed floristic assessment of this wetland. This area has recently experienced a severe fire that resulted in the removal of most of the vegetation and some of the surface organic sediments of this wetland. The fire did not affect the high conservation value of this wetland as the geomorphic and hydrological attributes of the wetland (that are the primary factors in its value as a scarce wetland type) remain intact. The remnant vegetation indicates that this wetland was originally fringed by a wetland assemblage similar to that remaining at Site Q6. The central area was probably inhabited by a species-rich assemblage of herbs, rushes and sedges allied to FCT 8.

Location: Lot 28 Brook Rd, Wattle Grove. **GPS lat/long:** -32.01225552500; 115.98951904000

Landforms/Sediments/Hydrology: Sumpland (seasonally inundated basin). Surface sediments: muddy sand with calcareous nodules. Water Table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H12 was augered (after a winter with a well below average rainfall) the sediments were moist down to a hard layer at -70cm that made it impossible to auger to the water table(s) (Table C26).

Table C26: Shallow Stratigraphy at H12

Depth below ground level (cm)	Sediments
0-10	Pale brown muddy coarse sand
10-20	Pale brown muddy coarse sand with ferruginous gravel
20-30	Pale brown sandy mud with calcareous nodules
30-50	Pale brown sandy mud with ferruginous gravel
50-60	Pale brown sandy mud with calcareous nodules
60-70	Pale brown sandy mud



Plate 21. Landscape at H12 showing vegetation regeneration after recent severe fire.

Site H13

Vegetation description: *Melaleuca rhaphiophylla* low closed forest over naturalized alien grasses**.**
Associates included *Jacksonia sternbergiana, *Ehrharta calycina, *Euphorbia terracina* (Plate 22).
Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Location: Lot 36 Brook Rd, Wattle Grove adjacent to Welshpool Rd.
GPS lat/long: -32.00785911160; 115.99437998600
Vegetation condition: Degraded to completely degraded.

SCP Floristic Community Type: Due to vegetation condition it was not appropriate to do a detailed floristic analysis of this wetland. The remnant vegetation indicates that the original vegetation of this wetland was similar to that remaining at Site Q6 in Lot 28.

Landforms/Sediments/Hydrology: Sumpland (seasonally inundated basin). Landform: Shallow swale.
Surface sediments: peaty sand over muddy sand over deep sand.
Water table(s): Surface waterlogged on 22.09.08. On 30.11.08, when the hole at H13 was augered (after a winter with a well below average rainfall) the sediments were moist down to the water table at -280cm (Table C27).

Table C27: Shallow Stratigraphy in H13

Depth below ground level (cm)	Sediments
0-10	Black peaty sand
10-30	Pale brown, humic, medium, quartz sand
30-60	Pale yellow-brown medium, quartz sand
60-80	Pale yellow-brown medium, quartz sand with rusty mottles
80-100	Pale grey muddy quartz sand
100-120	Pale grey slightly muddy quartz sand
120-280	Pale grey quartz sand



Plate 22. Landscape at H13

Site H14

Vegetation description: *Melaleuca rhaphiophylla* low open woodland over *Melaleuca viminea* subsp. *viminea* sparse low shrubs, *Gahnia trifida* sparse sedges and closed naturalized alien grasses (Plate 23). Part of the vegetation mapped as Vegetation Unit 4 (Figure 3).

Location: Lot 36 Brook Rd, Wattle Grove.
GPS lat/long: -32.00875000000; 115.99226670000

Vegetation condition: Degraded.

SCP Floristic Community Type: Due to vegetation condition it was not appropriate to do a detailed floristic analysis of this wetland. The remnant vegetation indicates that the original vegetation of this wetland was similar to that remaining at Site Q6 in Lot 28.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments: Sandy peat over quartz sand. (Table C28).
Water table: Surface waterlogged on 09.09.08. On 19.10.08, when the hole at H14 was augered (after a winter with a well below average rainfall) the water table was at -150cm

Table C28: Shallow Stratigraphy in Hole 14

Depth below ground level (cm)	Sediments
0-10	Dark brown sandy peat
10-20	Peaty medium quartz sand
20-40	Humic quartz sand
40-80	Medium grey quartz sand
80-90	Grey slightly muddy quartz sand
90-150	Medium grey quartz sand



Plate 23. Landscape at H14

Site H15

Vegetation description: Naturalized alien pasture grasses and herbs. (Plate 24).

Location: Lot 36 Brook Rd, Wattle Grove.

GPS lat/long: -32.00923333000; 115.99223330000

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this wetland.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments: Peaty quartz sand over muddy sand over muddy sand with quartz gravel. (Table C29).
Water table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H15 was augered (after a winter with a well below average rainfall) the sediments were moist down to a watertable at -160cm.

Table C29: Shallow Stratigraphy in H15

Depth below ground level (cm)	Sediments
0-20	peaty, medium grey quartz sand
20-40	Cream slightly muddy quartz sand
40-60	Cream-grey muddy sand with rusty mottles
60-90	Pale yellow –grey muddy quartz sand
90-110	Grey muddy medium quartz sand
110-160	Grey, muddy medium quartz sand with quartz gravel



Plate 24. Landscape H15

Site H16

Vegetation description: naturalized alien pasture grasses and herbs. (Plate 25).

Location: Lot 32 Brook Rd, Wattle Grove.
GPS lat/long: -32.01009189030; 115.99137827300

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this area. This area was probably Marri woodland originally (judging by the adjacent remnant vegetation).

Landforms/Sediments/Hydrology: Low sand dune adjacent to palusplain. Slope: negligible.
Water table: mottles at -160cm indicate maximum water table. On 30.11.08 water table at -210 cm.

Surface sediments: Deep quartz sand over muddy sand (Table C30).
Water table: Surface waterlogged on 9.09.08. On 19.10.08, when the hole at H16 was augered (after a winter with a well below average rainfall) the sediments were moist down to the watertable at about -210 cm

Table C30: Shallow Stratigraphy in H16

Depth below ground level (cm)	Sediments
0-30	Grey quartz sand
30-40	Yellow medium quartz sand
40-160	Pale grey quartz sand
160-200	Pale grey quartz sand with rusty mottles
200-210	Muddy pale grey quartz sand



Plate 25. Landscape at H16

Site H17

Vegetation description: naturalized alien pasture grasses and herbs. (Plate 26).

Location: Lot 36 Brook Rd, Wattle Grove.
GPS lat/long: -32.00980802500; 115.99214910200

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this wetland.

Landforms/Sediments/Hydrology: Palusplain (seasonally waterlogged flat). Slope: negligible.
Surface sediments and water table(s): Humic sand quartz sand over shallow sandy mud. Surface waterlogged on 9.09.08. On 30.11.08 when the hole at H17 was augered it not possible to auger past dry mud layer at – 70cm (Table C31).

Table C31: Shallow Stratigraphy in H17

Depth below ground level (cm)	Sediments
0-10	Grey-brown medium humic sand
20-30	Pale yellow medium quartz sand
30-40	Cream-grey sandy mud
40-50	Cream-grey sandy mud with white calcareous nodules
50-70	Pale grey sandy mud



Plate 26. Landscape at H17

Site H18

Vegetation description: Scattered low *Corymbia calophylla* trees over naturalized alien pasture grasses and herbs (Plate 27).

Location: Lot 36 Brook Rd, Wattle Grove.
GPS lat/long: -32.00898182860; 115.99339376500

Vegetation condition: Completely degraded.

SCP Floristic Community Type: Due to the completely degraded vegetation condition it was not possible to do a floristic analysis of this area. This area was probably Marri woodland originally (judging by the adjacent remnant vegetation).

Landforms/Sediments/Hydrology: Low sand dune adjacent to palusplain. Slope: negligible.
Surface sediments and water table(s): Humic sand quartz sand over deep sand. Surface dry on 9. 09 .08. On 30.11.08 when the hole at H18 was augered the water table was at –240cm.

Table C32: Shallow Stratigraphy in Hole 18

Depth from ground level (cm)	Sediments
0-10	Grey humic quartz sand
10-240	Pale grey quartz sand



Plate 27. Landscape H18

Appendix E
Multivariate Analysis
Species vs sites matrix

APPENDIX E

Taxa vs Study Sites Matrix Lot 28,32 &36 Brook Rd Wattle Grove (as used in Floristic Community Type analysis)

For explanations of names of taxa see Appendix B

Q1 = Quadrat 1, etc.; * before a name indicates a naturalised alien taxon

Taxa NOT found in quadrats of Gibson et.al (1994) (**indicated in bold type)** or not fully determined in current survey were not able to be included in the FCT analysis.

Taxon Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Acacia lasiocarpa var. lasiocarpa *sens. strict* .	*		*	*	*	*		*	*		*	*	*	*
Acacia saligna var. *saligna*		*				*	*			*				*
Acacia stenoptera	*							*						
Actinostrobus pyramidalis	*	*	*	*	*			*		*		*	*	*
**Anagallis arvensis var. arvensis*										*		*		
**Anagallis arvensis var. caerulea*													*	
Angianthus preissianus	*			*										
Anigozanthus viridis subsp. *viridis*								*						
Aphelia cyperoides	*			*									*	
**Asparagus asparagoides*		*				*	*							
Astartea affinis					*									
***Austrostipa juncifolia* subsp. Southern River (B.J.Keighery 2160)**													*	
**Avena barbata*									*				*	
Baeckea sp. Perth Region (R.J. Cranfield 444)		*						*						
Banksia telmatiaea	*	*			*									
Baumea juncea					*			*				*		
Boronia crenulata subsp. *viminea*	*		*	*										
Brachyscome pusilla	*			*										
**Briza maxima*	*		*	*				*		*	*	*	*	*
**Briza minor*	*		*	*								*		
**Bromus diandrus*						*								
Caladenia paludosa	*			*										
Caladenia sp.	*			*										
Calandrinia sp. Kenwick (G.J. Keighery 10905)	*													
Calothamnus hirsutus	*	*		*	*						*			
Cassytha glabella	*		*		*			*	*	*			*	*
Cassytha racemosa							*			*	*			
Centaurium erythraea													*	
Centrolepis aristata	*		*	*	*			*		*	*	*	*	*
Centrolepis polygyna													*	
Chaetanthus aristatus	*		*	*	*			*		*	*	*	*	
Chorizandra enodis													*	

Taxon Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
**Cicendia filifolia*	*													
Comesperma aff. polygaloides (C. Tauss. 2541)											*	*		
Crassula colorata var. *acuminata*	*			*	*									
Cynodon dactylon						*				*				
Disa bracteata	*													
Dittrichia graveolens								*				*	*	*
Dodonaea ceratocarpa													*	
Drosera glanduligera	*													
Drosera heterophylla	*													
Drosera macrantha subsp*. macrantha*	*			*										
Drosera menziesii subsp. menziesii	*			*				*						
**Echium plantagineum*				*										
**Ehrharta calycina*							*		*	*			*	*
**Ehrharta longiflora*		*					*							
**Eragrostis curvula*								*						
Eremophila glabra subsp. *chlorella*			*											
Gahnia trifida	*		*	*	*		*	*	*	*	*	*	*	*
****Gladiolus undulatus***						*								
Goodenia micrantha	*		*									*		
Goodenia pulchella subsp. Coastal Plain (M .Hislop) pn										*	*		*	
Grevillea thelemanniana	*	*	*	*	*			*		*	*	*	*	
Hakea varia	*													
Haemodorum laxum	*													
**Heliophila pusilla*	*		*											
Hordeum geniculatum													*	
Hydrocotyle alata	*			*										
Hypocalymma angustifolium Mud Habitat Variant (C.Tauss 1850)	*	*	*	*	*	*		*		*	*	*	*	*
**Hypochaeris glabra*	*	*		*										
Isolepis cernua														
Isolepis oldfieldiana										*				
Isolepis stellata	*													
**Juncus capitatus*	*							*						*
Juncus pauciflorus	*	*	*	*			*			*				
Lawrencia squamata			*											
Lepidosperma longitudinale							*							
Lepidosperma rostratum													*	
Lepidosperma sp. Kenwick. (C.Tauss 2598)	*			*				*					*	
Leucopogon poymorphus	*													

Taxon Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Lobelia anceps						*								
**Lolium multiflorum*									*					
**Lotus subbiflorus*	*		*					*	*		*		*	*
Lyginia imberbis								*						
**Lythrum hyssopifolia*												*		
Meeboldina roycei													*	
Melaleuca brevifolia	*	*	*	*	*			*	*		*		*	*
Melaleuca lateriflora subsp. *acutifolia*			*	*	*				*		*		*	
Melaleuca rhaphiophylla						*	*			*				
Melaleuca seriata	*							*						
Melaleuca viminea subsp. *viminea*		*			*	*	*		*	*		*	*	*
**Monopsis debilis*	*		*	*						*				
**Moraea flaccida*			*						*					
Opercularia vaginata			*											
**Parentucellia latifolia*	*			*										
**Parentucellia viscosa*	*		*	*				*		*		*		*
Pennisetum clandestinum						*								
**Pentaschistis aeroides*	*			*								*		
Phyllangium paradoxum	*			*										
**Phytolacca octandra*							*							
Pimelea imbricata var. *major*			*											
Podolepis capillaris	*		*											
Podolepis gracilis S wamp Form (GJ Keighery 13126)			*	*	*							*	*	
**Plantago coronopus*												*		
Quinetia urvillei	*													
**Romulea rosea* var. *australis*			*	*										
Rumex crispus							*							
Samolus junceus	*			*				*		*	*	*	*	
Scaevola lanceolata													*	
Schoenus rigens								*						
Schoenus subfascicularis	*					*		*	*			*		
**Sparaxis bulbifera*	*		*			*			*				*	
Stylidium calcaratum	*				*									
Tecticornia lepidosperma	*	*												*
Thelymitra antennifera	*													
Thelymitra crinita	*													
Thelymitra sp.	*			*										
Thysanotus manglesianus	*	*	*	*	*									

Taxon Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8		Q9	Q10	Q11	Q12	Q13	Q14
Tribolium uniolae										*					
Tribonanthes australis	*	*	*	*					*						
Triglochin muelleri	*														
Trithuria bibracteata	*														
**Ursinia anthemoides*			*	*											
Utricularia multifida	*														
Verticordia densiflora var. *densiflora*	*								*			*			
Verticordia plumosa var. brachyphylla									*						
Viminaria juncea	*		*								*		*		
**Vulpia bromioides*	*		*	*							*	*		*	

Appendix F

Wetland flora taxa recrded during the spring 2008 survey

APPENDIX F

Obligate and Facultative Wetland Taxa in Lot 28,323 and 36 Brook Rd Quadrats

For explanations of names of taxa see Appendix B

Q1 = Quadrat 1, etc.; * before a name indicates a naturalised alien taxon

For other taxa that occur in the survey area, there is either insufficient habitat data to decide wetland status, or there are no records of wetland habitat for them in sources used.

Taxon Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Obligate Wetland Taxon (O)	Facultative Wetland Taxon (F)
Acacia lasiocarpa var. lasiocarpa *sens. strict* .	*		*	*	*	*		*	*		*	*	*	*	O	
Acacia saligna var. *saligna*		*				*	*			*				*		F
Acacia stenoptera	*							*								F
Actinostrobus pyramidalis	*	*	*	*	*			*		*		*	*	*	O	
Angianthus preissianus	*			*												F
Anigozanthus viridis subsp. *viridis*								*							O	
Astartea affinis					*										O	
Austrostipa juncifolia subsp Southern River B.J. Keighery 2160													*			F
Baeckea sp. Perth Region (RJ Cranfield 444)		*						*								F
Banksia telmatiaea	*	*			*										O	
Baumea juncea					*			*				*			O	
Boronia crenulata subsp. *viminea*	*		*	*												F
Brachyscome pusilla	*			*											O	
Caladenia paludosa	*			*											O	
Calandrinia sp. Kenwick (G.J. Keighery 10905)	*															F
Calothamnus hirsutus	*	*		*	*						*				O	
Centrolepis aristata	*		*	*	*			*		*	*	*	*	*		F
Centrolepis polygyna													*			F
Chaetanthus aristatus	*		*	*	*			*		*	*	*	*		O	
Chorizandra enodis													*		O	
**Cicendia filifolia*	*														O	
Crassula colorata var. *acuminata*	*			*	*											F
Drosera macrantha subsp. *macrantha*	*			*												F
Drosera menziesii subsp. menziesii	*			*				*							O	
**Eragrostis curvula*								*								F
Eremophila glabra subsp. *chlorella*			*												O	
Gahnia trifida	*		*	*	*		*	*	*	*	*	*	*	*	O	
Goodenia micrantha	*		*									*			O	
Goodenia pulchella subsp. Coastal Plain (M .Hislop 634) pn										*	*		*		O	
Grevillea thelemanniana	*	*	*	*	*			*		*	*	*	*		O	

Taxon Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Obligate Wetland Taxon (O)	Facultative Wetland Taxon (F)
Hakea varia	*														O	
Haemodorum laxum	*															F
Hydrocotyle alata	*			*												F
Hypocalymma angustifolium Mud Habitat Variant (C.Tauss 185	*	*	*	*	*	*		*		*	*	*	*	*	O	
**Hypochaeris glabra*	*	*		*												F
Isolepis cernua																F
Isolepis oldfieldiana										*					O	
Isolepis stellata	*															F
**Juncus capitatus*	*							*						*		F
Juncus pauciflorus	*	*	*	*			*			*					O	
Lawrencia squamata			*													F
Lepidosperma longitudinale							*								O	
Lepidosperma rostratum													*		O	
Lepidosperma sp. Kenwick. (C.Tauss 2598)	*			*				*					*		O	
Lobelia anceps						*									O	
**Lolium multiflorum*									*							
**Lotus subbiflorus*	*		*					*	*		*		*	*	O	
Lyginia imberbis								*								F
**Lythrum hyssopifolia*												*			O	
Meeboldina roycei													*		O	
Melaleuca brevifolia	*	*	*	*	*			*	*		*		*	*	O	
Melaleuca lateriflora subsp. *acutifolia*			*	*	*				*		*		*		O	
Melaleuca rhaphiophylla						*	*			*					O	
Melaleuca seriata	*							*								F
Melaleuca viminea subsp. *viminea*		*			*	*	*		*	*		*	*	*	O	
**Monopsis debilis*	*		*	*						*						F
Phyllangium paradoxum	*			*												F
Pimelea imbricata var. *major*			*												O	
*Podolepis gracilis S*wamp Form (GJ Keighery 13126)			*	*	*							*	*		O	
Samolus junceus	*			*				*		*	*	*	*			F
Scaevola lanceolata													*			F
Schoenus rigens								*							O	
Schoenus subfascicularis	*					*		*	*			*			O	
Tecticornia lepidosperma	*	*												*		F
Thelymitra antennifera	*															F

Taxon Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Obligate Wetland Taxon (O)	Facultative Wetland Taxon (F)
Thelymitra crinita	*															F
Thysanotus manglesianus	*	*	*	*	*											F
Tribonanthes australis	*	*	*	*				*								F
Triglochin muelleri	*														O	
Trithuria bibracteata	*														O	
Utricularia multifida	*														O	
Verticordia densiflora var. *densiflora*	*							*			*					F
Verticordia plumosa var. brachyphylla								*							O	
Viminaria juncea	*		*							*		*			O	

Appendix G

Evaluation of wetland management categories

Appendix G
Evaluation of Wetland Management Categories for Lots 28, 32 and 36 Brook Rd, Wattle Grove

To provide guidance on the level of protection and the management objectives that are appropriate to each wetland, wetlands on the Swan Coastal Plain have been evaluated and assigned to one of three management categories (Conservation, Resource Enhancement, or Multiple Use) in the Geomorphic Wetlands Swan Coastal Plain Dataset (DEC, 2008).

Conservation Category Wetlands (CCW) are intended to be managed for conservation to protect their very high value attributes and functions. Alteration to wetlands in this category is strongly discouraged by State and Federal environmental regulatory agencies. These wetlands are usually recommended for reservation into various classes of conservation reserve to protect them from any man-induced deterioration.

Resource Enhancement Category Wetlands (REW) have a priority management objective to maintain the wetland natural attributes and functions, and wherever possible to enhance the ecological status of the wetland by such activities as improving water quality or re-vegetating cleared areas with endemic, site-appropriate species.

Multiple Use Category Wetlands (REW) have a priority management objective to maintain multiple uses of the wetland, including ecological functions. This necessitates *maintaining the geomorphic integrity of the wetland.* It excludes destruction of the wetland through processes such as infilling, excavation, mining, or emplacing urban structures such as roads or buildings.

Four wetlands are currently mapped in the Swan Coastal Plain Wetlands Dataset (DEC, 2008) in Lots 28, 32 and 36 Brook Rd, Wattle Grove as the following UFIs (and wetland classifications, and management categories):
7773 (palusplain, CCW) of which approximately 6ha is within the current survey area;
7775 (sumpland, CCW) of which less than 1ha is within the current survey area;
8029 (palusplain, CCW) of which less than 0.1 ha is within the current survey area; and
13367(palusplain, REW) of which approximately 5.5 ha is within the current survey area.

These four wetland areas are evaluated below using three methods:
1. The questionnaire of V & C Semeniuk Research Group (1998) that was designed for the Western Australian Water and Rivers Commission;
2. The questionnaire in Bulletin 686 of the Western Australian Environmental Protection of Authority (EPA, 1994); and
3. Assessment of wetland vegetation condition (see Section 4 of the report above and Appendix C).

The methods above are currently recommended by DEC (2007) for the evaluation of wetlands. The EPA Bulletin 686 questionnaire tends to result in high scores for lakes and sumplands that include habitats suitable for waterbirds and low scores for palusplains, damplands and other types of wetlands. EPA (1994) was, effectively, a preliminary attempt to evaluate the important wetlands of the region; it was designed before the wetlands of the region were comprehensively surveyed and mapped in Hill *et al.*, (1996). The questionnaire of the V & C Semeniuk Research Group was based on the large body of data collected in Hill *et al.*, (1996) and was specifically designed to capture the recognised natural wetland values of all types of wetlands that are present in the region. When used in combination, the three methods above provide a way to evaluate wetlands that represents the best consensus available between the scientific literature, the current policies of government agencies and the general attitudes of the Western Australian community.

In the evaluations below, each wetland mapped in the DEC Swan Coastal Plain Wetlands Dataset (2008) for Lots 28, 32 and 36 Brook Rd, Wattle Rd is first evaluated using the three methods independently of each other. Then the results for each method are compared and combined into a final evaluation.

The mapping of the wetlands in DEC (2008) often partitions the extensive and continuous wetlands (palusplains) of the area into smaller separate areas. Although these areas often extend across cadastral boundaries this mapping provides a well defined border for each wetland. The evaluations below were done by examining only the areas of each wetland that occurred within the boundaries of Lots 28, 32 or 36, even if the total area of the wetland in question extended beyond these cadastral boundaries.

1. WETLANDS UFIs 7773 and 8029 EVALUATION

The two wetlands UFI 7773 and UFI 8029 share a common boundary in Lot 32 Brook Rd and are effectively the same palusplain area in terms of sediments, landforms and hydroperiod. They are both currently allocated to CCW in DEC (2008). UFI 8029 and the adjoining UFI 13367 show clear differences in the sediments that underlie these two areas and UFI 33367 is mapped as REW in DEC (2008). The area of UFI 8029 in Lot 32 Brook Rd is extremely small. It is not clear in DEC (2008) why UFI 8029 was split from UFI 7773 in the mapping.

Wetland UFI 7773 is a palusplain of which about 6ha are within Lots 28 and 32. Most of UFI 7773 is covered by native vegetation in good to very good condition. Wetland UFI 8029 is also a palusplain of which less than about 0.1 ha are in Lot 32; it has been cleared of native vegetation but the geomorphic integrity of this wetland remains unaltered. Palusplain 8029 is, in ecological terms, effectively part of palusplain 7773 and the two wetland areas are treated as one management unit in the evaluation below.

A. V & C Semeniuk Research Group (1998) questionnaire for wetland evaluation applied to wetland UFI 7773

1. Conservation Category Wetlands Criteria

Wetland type (geomorphology): A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. it is an anthropogenically unaltered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland)
2. it is a scarce wetland type
3. it is a representative wetland type (i.e., representative of its consanguineous suite)

YES. The data obtained in the current survey show that the wetland (UFIs 7773 & 8029) is an anthropogenically unaltered, seasonally-waterlogged flat (palusplain) i.e. the landform and soils have been unaltered by human activities. It is a scarce wetland type (only 6% of the former extent of palusplains remains undeveloped on the SCP; Hill *et al.*, 1996). This palusplain is representative of the Keysbrook consanguineous suite of wetlands (*i.e.* the wetlands of alluvial fans on the Pinjarra Plain).

Wetland p rocesses: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. The wetland is subject to anthropogenically unaltered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes.)
2. the wetland exhibits unusual wetland processes
3. the wetland exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting)

YES/NO. The wetland (UFIs 7773 & 8029) is probably altered to a small degree with respect to wetland processes such as recharge and discharge mechanisms, and sedimentary processes. This change has not been quantified and it may be minor. However the clearing of the catchment area, the building of roads and other hard surfaces around this palusplain, the dredging and diversion of Yule Brook and the excavation of artificial drains along roads may be affecting the recharge and discharge of this wetland. The sediments once deposited on the wetland through the regular flooding of Yule Brook and the spread of floodwaters over the alluvial plain (that includes Lots 28, 32 and 36) has been altered.

Wetland habitats: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland is a habitat for rare & endangered fauna
2. the wetland is a habitat for rare & endangered flora
3. the wetland exhibits a high diversity of habitats

YES. The wetland (UFIs 7773 & 8029) is a habitat for rare and endangered flora (*Eremophila glabra* subsp. *chlorella* and *Lepidosperma rostratum*), five DEC Priority Flora Species and numerous regionally significant flora species. It is also inhabited by native fauna that is uncommon in the Perth Metropolitan Area (*Varanus gouldii* and *Isoodon obesulus*) however these species are not gazetted fauna. The wetland exhibits a diversity of vegetation habitats at a small scale due to the complex stratigraphy and hydrology of the area.

Wetland fu nctions: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland is necessary for maintenance of large faunal populations
2. the wetland is a refuge for resident fauna
3. the wetland is an important breeding, feeding or watering site for migratory populations (local and international)
4. the wetland is a significant regional component of the hydrological cycle (has an important hydrological storage, recharge or discharge function; or an hydrochemical function)

YES. The wetland (UFIs 7773 & 8029) is a refuge for resident fauna including *Varanus gouldii* and *Isoodon obesulus*. *Isoodon obesulus* is present in large populations in BFS 387, as the wetland soils, water resources and the thick vegetation of the area provide suitable habitat that is otherwise scarce on the SCP. *Varanus gouldii* is a high order predator and is particularly dependant on a large range. It preys on mammals such as *Isoodon obesulus* and smaller animals. The range area provided by this wetland contributes towards the habitat needed by this large reptile. Palusplain 7773 performs an important hydrological function in being a naturally vegetated, unaltered, low nutrient wetland located high in the groundwater catchment of other wetlands in BFS 387. The groundwater and surface water flow through palusplain 7773 contributes to the water and nutrient budgets of these other wetlands and the maintenance of the downstream biodiversity.

Wetland Biodiversity: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland exhibits unaltered wetland vegetation and fauna
2. the wetland has a scarce vegetation association or faunal association
3. the wetland has a highly diverse wetland flora or fauna

YES. The wetland (UFIs 7773 & 8029) exhibits largely unaltered and scarce vegetation of the Pinjarra Plain Vegetation Complex and FCTs 7, 8 and 10a (Threatened Ecological Communities). Some highly diverse areas of flora are present in UFI 7773.

Wetland Scientific value: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland contains scientifically significant pollen records
2. the wetland is underlain by unusual wetland sediments (indicators of wetland history)
3. the wetland has unusual geomorphology (i.e., it is situated in an unusual geomorphic setting or contains unusual geomorphic features within it)

YES. The wetland (UFIs 7773 & 8029) is underlain by wetland sediments of a Pinjarra Plain alluvial fan that are unusual on the SCP. It is part of a largely undisturbed gradient of soil and sediment types from the Darling Range Foothills to the Canning River. Each section of this continuum is of scientific importance, with the wetland sediments containing a record of the edaphic and climatic changes that the area has undergone. Each section is also host to slightly different vegetation assemblages. The current and historical processes that underpin the remarkable biodiversity of the area are poorly understood and of high scientific importance and this wetland forms an indispensible part of the story.

The criterion that was only partially satisfied above at the level of Conservation (i.e. wetland processes) was then examined below at the Resource Enhancement level.

2. Resource Enhancement Wetlands Criteria

Wetland processes: A wetland may be classed as Resource Enhancement if it satisfies the following criterion

1. The wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) but not to the degree that habitats cannot still be identified and rehabilitated

YES. The wetland (UFIs 7773 & 8029) may be partly altered with regard to wetland processes such as recharge/discharge mechanisms and sedimentary processes due to clearing of the catchment area, roads and other hard surfaces and the dredging and diversion of Yule Brook and other surface drainage in the area. However much of this modification can be remediated by the re-vegetation of the catchment area, remediation of surface drainage and the restoration of Yule Brook as a living stream.

All the wetland criteria were now satisfied so there was no need to examine the wetland at the level of Multiple Use. The scores in the categories examined were summarized (Table F1). This wetland met five to six criteria for CCW, one for REW and none for MUW. The floristic biodiversity, the regionally-significant flora and the TEC vegetation of this wetland are important features that characterize palusplains of high conservation significance on the eastern Swan Coastal Plain. Palusplains of this type are scarce on the SCP.

Table F1: Score sheet for the evaluation of part of the wetland (UFIs 7773 & 8029) on Lot 28 and 32 Brook Rd Wattle Grove by the method of V & C Semeniuk Research Group (1998)

Wetland Values	Criteria met at the level of CCW	Criteria met at the level of REW	Criteria met at the level of MUW
Wetland type	Yes		
Wetland processes	Yes/ No	Yes	
Wetland habitats	Yes		
Wetland functions	Yes		
Biodiversity of wetland	Yes		
Scientific value of wetland	Yes	n/a	n/a
Total Score	Score 5	Score 1	Score 0

The management category is allocated to the wetland according to the column above that achieves the highest score.

The Management Category allocated to the part of the wetland (UFIs 7773 & 8029) that occurs on Lots 28 and 32 Brook Rd by the method of V & C Semeniuk Research Group (1998) was thus **Conservation Category Wetland.**

B. Bulletin 686 (EPA, 1993) method of wetland evaluation for wetland UFIs 7773 & 8029

Bulletin 686 consists of a questionnaire that includes several parts that were answered for the evaluation of the part of the wetland (UFIs 7773 & 8029) that occurs on Lots 28 and 32 Brook Rd Wattle Grove as below.

Part I: Presence of Rare Species
(If the wetland includes gazetted rare flora or fauna species then the wetland is automatically allocated to CCW).
YES. The wetland (UFIs 7773 & 8029) includes the following Gazetted Rare or Priority Species:
1. *Lepidosperma rostratum* that is listed as Nationally Significant Flora (Endangered) by DEWHA (2008);

2. *Eremophila glabra* var. *chlorella* that is listed as Declared Rare Flora under the WA Wildlife Act;

3. *Austrostipa juncifolia* subsp. Southern River (B.J. Keighery 2160) a taxon of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 1;

4. *Baeckea* sp. Perth Region (R.J. Cranfield 444) a taxon of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 3;

5. *Grevillea thelemanniana* a species of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 4;

6. *Trichocline* sp. Treeton (B.J. Keighery & N. Gibson 564) a taxon of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 2;and

7. *Verticordia lindleyi* subsp. *lindleyi* a subspecies of State Significance, and listed in Western Australia by the Department of Environment & Conservation (Atkins, 2008) as Priority 4.

The Endangered Flora, Declared Rare Flora, Priority Flora that occurs here means that this wetland should be assigned the highest conservation level.

The wetland (UFIs 7773 & 8029) is thus allocated to the category of Conservation. The following questions are answered to provide further information regarding wetland management. However the answers to them do not override the CCW category allocated above.

Part II Natural Attributes
Part IIA: For permanent and seasonal wetlands with well defined boundaries.
Not applicable go to part IIB below.
Part IIB: Seasonal and episodic wetlands with poorly defined boundaries. Note: each zone of the wetland is usually scored as a separate assessment.

i. Environmental geology classification. Wetlands in the Quindalup Dunes or in river/estuary floodplain receive Score= 5; other areas Score=1.
NO. The part of The wetland (UFIs 7773 & 8029) that occurs on Lots 28 and 32is not in these areas……**SCORE=1**

Part II Natural Attributes
ii. Adjacent wetlands. Wetlands that have no other wetlands within a 2km radius of them receive Score =3, others go to Question iii (below).
YES. There are other wetlands nearby to the part of wetland (UFIs 7773 & 8029) that occurs on Lots 28 & 32. Go to Question iii.

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iii. Habitat diversity. If the composition and structure of the vegetation of the wetland under evaluation is significantly different to that found at other nearby wetlands, the wetland receives Score= 3; if not then Score =1.
YES. Other wetlands nearby to part of the wetland (UFIs 7773 & 8029) that occurs on Lots 28 & 32 include a range of vegetation types but they are similar to this wetland……..**SCORE= 1**

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iv. Habitat type. Habitat types scored in this question (up to a maximum Score = 15) include vegetation and landforms typical of lakes and sumplands such as fringing rushes and sedges, extensive in-lake beds of rushes and sedges, large paperbark trees, islands, flooded grassland, permanent or seasonal open water, extensive low thickets and samphires. The high conservation value vegetation of palusplains and damplands scores very badly on this part of the questionnaire because of this flaw in the design of this method of evaluation.
YES. Only the category of fringing woodland or heath (Score=1) and scattered sedges (Score=0.5) are applicable to the wetland (UFIs 7773 & 8029)….....**SCORE= 1.5**

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v. Drainage. This deal with drains into and/or out of the wetland that can alter water levels or water quality. Wetlands with drains directing water into or out of the wetland Score=0; if no drains Score =5.
NO. Part of the wetland (UFIs 7773 & 8029) has drains adjacent to it but it is not clear how much effect these have on the hydrology of this wetland.....……..……**SCORE= 0**

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vi. Area of wetland modified by clearing of vegetation, landfill, paving, cultivation, irrigation, grazing, weed invasion, mining etc. Wetlands with 0-10 % modified Score= 5; 11-20 % modified Score= 4; 21-30 % modified Score= 3; 31-40 % modified Score= 2; >40 % modified Score= 1.
The wetland (UFIs 7773 & 8029) has less than 20% that could considered as modified……..……**SCORE= 4**

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vii. Wetland size. Wetland area >100ha Score=5; 50-100ha Score =4; 25-50ha Score =3; 10-25ha Score =2; <10ha Score =1.
NO. The part of the wetland (UFIs 7773 & 8029) on Lots 28 &32 is less than 10ha……..…….**SCORE= 1**

TOTAL NATURAL ATTRIBUTES SCORE = 8.5

Part III: Human Use Questionnaire.
i. Aesthetics.
Little if any artificial noise. YES. Score=2
Understorey mostly intact. YES. Score=2
Few buildings evident from wetland. YES. Score=2
Steep ridge visible as part of scenery. YES. Score=2
Ridge accessible giving view of wetland. NO. Score=0
Wetland is a lake and open water easy to view. No. Score=0
Section of wetland where few people visit. Yes. Score=2
.....**TOTAL SCORE=10**
ii. Historical and archaeological features.
Number of historical archaeological features. NONE……..……. **SCORE=0**
iii. Security of wetland.
Current vesting/ownership of land = private ownership……..…..……...**SCORE=1**
iv. Protection groups. NONE…….**SCORE=0**
v. Passive recreation.
Not used for passive recreation…….…….. **SCORE=0**
vi. Active recreation.
Not used for active recreation……..…….. **SCORE=0**
vii. Other human uses. None……..……**SCORE=0**
TOTAL HUMAN ATTRIBUTES SCORE =11

The Management Category allocated to the part of the wetland (UFIs 7773 & 8029) that occurs on Lot 28 &32 Brook Rd, Wattle Grove by the method of EPA Bulletin 686 (1994) was thus **Resource Enhancement Wetland.** However the Endangered Flora, Declared Rare Flora, Priority Flora that occurs here means that this wetland should be assigned the highest conservation level.
The wetland (UFIs 7773 & 8029) is thus allocated to the category of **Conservation Category Wetland.**

C. Wetland Vegetation Condition Assessment for wetland UFIs 7773 & 8029

This vegetation of the wetland (UFIs 7773 & 8029) on Lots 28 & 32 was mainly in good to very good condition (see vegetation description in Section 4 above). The relatively undisturbed vegetation was well in excess of 50% and in fact probably about 80% or more of the total area of the wetland. The Management Category allocated to this wetland was **Conservation Category Wetland**.

D. Conclusion for wetland UFIs 7773 & 8029.

The part of wetland (UFIs 7773 & 8029) on Lots 28 & 32 Brook Rd was evaluated by three methods (Table F2). This wetland was unequivocally a **Conservation Category Wetland.**

Table F2: Summary of wetland evaluation for UFI 7773 & 8029, Lots 28 & 32 Brook Rd

Wetland Evaluation Method	Wetland Management Category
V& C Semeniuk Research Group (1998)	CCW
EPA Bulletin 686 (1994)	CCW
Vegetation Condition	CCW

2. WETLAND UFI 7775 EVALUATION

A. V & C Semeniuk Research Group (1998) questionnaire for wetland evaluation applied to wetland UFI 7775

1. Conservation Category Wetlands Criteria

Wetland type (geomorphology): A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. it is an anthropogenically unaltered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland)
2. it is a scarce wetland type
3. it is a representative wetland type (i.e., representative of its consanguineous suite)

YES. Sumpland 7775 in Lot 28 is a scarce wetland type (only 6% of the total former extent of wetlands on the Pinjarra Plain remain undeveloped, Hill *et al.*, 1996) and it may be underlain by Muchea Limestone (an even rarer wetland formation on the SCP). It is not known if it is representative because there is so little data about this type of wetland.

Wetland processes: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland is subject to anthropogenically unaltered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes.)
2. the wetland exhibits unusual wetland processes
3. the wetland exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting)

YES. Wetland UFI 7775 in Lot 28 is not altered with regard to wetland processes such as recharge/discharge mechanisms or sedimentary processes. The water table was still high in this wetland at the end of spring, unlike most of the other areas investigated in Lot 28. There are recharge processes involved in this wetland (the most likely being artesian upwelling possibly associated with subsurface Muchea Limestone deposition) that are different to those present in the palusplain at Lot 28. These processes are unusual for the Pinjarra Plain. There is no evidence that these processes have been altered by land uses in the area.

Wetland habitats: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland is a habitat for rare & endangered fauna
2. the wetland is a habitat for rare & endangered flora
3. the wetland exhibits a high diversity of habitats

YES. Wetland UFI 7775 is not a habitat for rare and endangered flora and fauna. It does exhibit a diversity of vegetation habitats as it includes habitat that is rare elsewhere in BFS387. This wetland includes shady, moist peaty-sand soils and a high watertable that are not commonly available elsewhere in BFS 387 in summer. It also provides large Paperbark trees in an area generally dominated by shrubs.

Wetland functions: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland is necessary for maintenance of large faunal populations
2. the wetland is a refuge for resident fauna
3. the wetland is an important breeding, feeding or watering site for migratory populations (local and international)
4. the wetland is a significant regional component of the hydrological cycle (has an important hydrological storage, recharge or discharge function; or an hydrochemical function)

YES. Wetland UFI 7775 provides important resources for maintenance of the large numbers of Quenda in the area and possibly other fauna in summer drought (moist sandy soils due to a high watertable). These resources are not commonly available elsewhere in BFS 387 in summer.

Wetland Biodiversity: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland exhibits unaltered wetland vegetation and fauna

2. the wetland has a scarce vegetation association or faunal association
3. the wetland has a highly diverse wetland flora or fauna

NO. Although wetland UFI 7775 exhibits vegetation of the Pinjarra Plain Vegetation Complex but this vegetation is in partly degraded condition and does not include species rich flora.

Wetland Scientific value: A wetland may be classed as Conservation if it satisfies one or more of the following criteria

1. the wetland contains scientifically significant pollen records
2. the wetland is underlain by unusual wetland sediments (indicators of wetland history)
3. the wetland has unusual geomorphology (i.e., it is situated in an unusual geomorphic setting or contains unusual geomorphic features within it)

YES. Wetland UFI 7775 is underlain by wetland sediments of a Pinjarra Plain alluvial fan which are unusual on the SCP. It is also likely to be underlain by Muchea Limestone which is even more unusual and of high scientific value.

The criterion that was not satisfied above at the level of Conservation (i.e. wetland biodiversity) was then examined below at the Resource Enhancement level.

2. Resource Enhancement Wetlands Criteria

Wetland Bio diversity: A wetland may be classed as **Resource Enha ncement** if it satisfies the following criterion

1. the wetland exhibits some unaltered wetland vegetation and fauna which may be extended through re-vegetation programmes

YES. The understorey of wetland UFI 7775 will regenerate its biodiversity given protection from further disturbance and some weed control.

The criteria were all now satisfied so there was no need to examine the wetland at the level of Multiple Use. The scores in the categories examined were summarized (Table F3). This wetland met five criteria for CCW, one for REW and none for MUW. The unusual hydrology of this wetland, the sandy surface sediments and high water table in summer, and the closed canopy of Paperbark trees were the most important features of this wetland regionally and locally.

Table F3: Score sheet for the evaluation of part of wetland UFI 7775 on Lot 28 Brook Rd Wattle Grove by the method of V & C Semeniuk Research Group (1998)

Wetland Values	Criteria met at the level of CCW	Criteria met at the level of REW	Criteria met at the level of MUW
Wetland type	Yes		
Wetland processes	Yes		
Wetland habitats	Yes		
Wetland functions	Yes		
Biodiversity of wetland	No	Yes	
Scientific value of wetland	Yes	n/a	n/a
Total Score	Score 5	Score 1	Score 0

The management category is allocated to the wetland according to the column above that achieves the best score.

The Management Category allocated to the part of wetland UFI 7775 that occurs on Lot 28 Brook Rd by the method of V & C Semeniuk Research Group (1998) was thus **Conservation Category Wetland.**

B. Bulletin 686 (EPA, 1993) method of wetland evaluation for wetland UFI 7775

Bulletin 686 consists of a questionnaire that includes several parts that were answered for the evaluation of the part of the wetland UFI 7773 that occurs on Lot 28 Brook Rd Wattle Grove as below.

Part I: Presence of Rare Species

(If the wetland includes gazetted rare flora or fauna species then the wetland is automatically allocated to CCW).

NO. Wetland 7775 does not include Gazetted Rare or Priority Species:

Part II Natural Attributes

Part IIA: For permanent and seasonal wetlands with well defined boundaries.

i. Environmental geology classification. Wetlands in the Quindalup Dunes or in river/estuary floodplain receive Score= 5; other areas Score=1.

NO. The part of wetland that occurs on Lot 28 is not in these areas……..……**SCORE=1**

Part II Natural Attributes

ii. Adjacent wetlands. Wetlands that have no other wetlands within a 2km radius of them receive Score =3, others go to Question iii (below).

YES. There are other wetlands nearby to the part of wetland UFI 7775 that occurs on Lot 28. Go to Question iii.

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iii. Habitat diversity. If the composition and structure of the vegetation of the wetland under evaluation is significantly different to that found at other nearby wetlands, the wetland receives Score= 3; if not then Score =1.
YES. Other wetlands that occur on Lot 28 include a range of vegetation types but they are heath and scrub and not low Paperbark forest as is UFI 7775. ……..…….**SCORE= 3**

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iv. Drought refuge for birds. Major refuge Score=5; Minor refuge Score =2; No importance Score=0.
……..…….**SCORE= 0**

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v. Wetland size. Wetland area >100ha Score=5; 50-100ha Score =4; 25-50ha Score =3; 10-25ha Score =2; <10ha Score =1. The part of UFI 7775 on Lot 28 is <10ha …….**SCORE= 1**

---

vi. Habitat type. Habitat types scored in this question (up to a maximum Score = 15) include vegetation and landforms typical of lakes and sumplands such as fringing rushes and sedges, extensive in-lake beds of rushes and sedges, large paperbark trees, islands, flooded grassland, permanent or seasonal open water, extensive low thickets and samphires. The high conservation value vegetation of palusplains and damplands scores very badly on this part of the questionnaire because of this flaw in the design of this method of evaluation.
YES. Only the category of large paperbark trees (Score=1) and scattered sedges (Score=0.5) are applicable to UFI 7775….....S**CORE=1.5**

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vii. Emergent vegetation. 40-50% cover Score=5; 30-40% or 60-70% cover Score=4; 20-30% or 70-80% cover Score=3; 10-20% or 80-90% cover Score=2; <10% or >90% Score=1. These scores only have relevance for lakes and sumplands with open water habitats that are used by certain birds. UFI 7555 has 100% cover
.....**SCORE=1**

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viii. Adverse water quality e.g. nutrient blooms, oil slicks, botulism. In the last year: No incidents Score =5, 1 incident Score =2; 2incidents Score=1; 3 or more incidents Score=0……. **SCORE=5**

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ix. Drainage. This deal with drains into and/or out of the wetland that can alter water levels or water quality. Wetlands with drains directing water into or out of the wetland Score=0; if no drains Score =5.
YES. This part of UFI 7775 has drains adjacent to it but it is not clear how much effect these have on the hydrology of this wetland.....……**SCORE=0**

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x. Adjacent nutrient sources. (septic tanks within 100m, rubbish tips and landfill, lawns and /or grazed land fertilized regularly, livestock holding yards or feedlots). One source, Score=2; >one source Score=0.
YES. This part of UFI 7775 has one source nearby -a riding school/stables……..…….**SCORE=2**

---

xi. Area of wetland modified by clearing of vegetation, landfill, paving, cultivation, irrigation, grazing, weed invasion, mining etc. Wetlands with 0-10 % modified Score= 5; 11-20 % modified Score= 4; 21-30 % modified Score= 3; 31-40 % modified Score= 2; >40 % modified Score= 1.
UFI 7775 on Lot 28 has less than 30% that could be considered as modified as weeds cover <30%……..
SCORE=4

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xii. Reserve Area. **Ratio of wetland area to total reserve area.** <0.1 Score =5; 0.1-0.25, Score =4; 0.25- 0.5, Score =3; 0.5 -0.75, Score =2; <0.75 -1.0, Score =1.
UFI 7775 is small compared to total BFS 387 area and in comparison to the total area of Lot 28……..…… **SCORE= 5**

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xiii. Native vegetation buffer (% wetland perimeter with native vegetation buffer of 50m wide or more)
100-90% Score =10; 89-80% Score =8; 79-70% Score =6; 69-60% Score =4; 59-50% Score =2; <50% Score =1;
UFI 7775 has less more than 60% vegetation buffer along its perimeter of 50m wide or more than 20% that could considered as modified……..……. **SCORE=4**

TOTAL NATURAL ATTRIBUTES SCORE = 25.5

Part III: Human Use Questionnaire.
i. Aesthetics.
Little if any artificial noise. NO. Score=0
Understorey mostly intact. NO. Score=0
Few buildings evident from wetland. NO. Score=0
Steep ridge visible as part of scenery. NO. Score=0
Ridge accessible giving view of wetland. NO. Score=0
Wetland is a lake and open water easy to view. No. Score=0
Section of wetland where few people visit. Yes. Score=0
.....**TOTAL SCORE=0**

ii. Historical and archaeological features.
Number of historical archaeological features. NONE…….…… **SCORE=0**
iii. Security of wetland.
Current vesting/ownership of land = private ownership……..…..……...**SCORE=1**
iv. Protection groups. NONE…….**SCORE=0**
v. Passive recreation.
Not used for passive recreation…….…….. **SCORE=0**
vi. Active recreation.
Not used for active recreation……..……..…… **SCORE=0**
vii. Other human uses. None…….……**SCORE=0**
TOTAL HUMAN ATTRIBUTES SCORE =3

The Management Category allocated to the part of wetland UFI 7775 that occurs on Lot 28 Brook Rd, Wattle Grove by the method of EPA Bulletin 686 (1994) was thus transitional between REW and MUW

Part IV: Supplementary Questions. These questions concern the occurrence of rare, but ungazetted, flora and fauna species, the effect of wetlands on nearby land values, the frequency of human use of wetlands and the importance of the wetland to the owner. This section is usually only evaluated if the management category obtained by the uses of Parts I, II and III above results in a wetland management category that is transitional between two management zones on the EPA (1994) graph. This was the case with wetland UFI 7775.

Wetland UFI 7775 includes several species of regional conservation significance when they occur on the Pinjarra Plain (*Gahnia trifida, Hypocalymma angustifolium* Mud Habitats Variant. C.Tauss 1850, *Ficinia nodosa* and *Goodenia pulchella* subsp. Perth Coastal Plain M. Hislop pn).

The Management Category allocated to the part of wetland UFI 7775 that occurs on Lot 28 Brook Rd, Wattle Grove by the method of EPA Bulletin 686 (1994) was thus **Resource Enhancement Wetland.**

C. Wetland Vegetation Condition Assessment for wetland UFI 7775.

This vegetation of the wetland UFI 7775 on Lot 28 was in good condition (see vegetation description in Section 4 above). The relatively undisturbed area of the wetland as mapped in Figure 8 was in excess of 50%. The Management Category allocated to this wetland was thus **Conservation Category Wetland.**

D. Conclusion for wetland UFI 7775.

The part of wetland UFI 7775 that occurs in Lot 28 Brook Rd was evaluated by three methods (Table F4). This wetland was thus allotted to **Conservation Category Wetland.**

Table F4: Summary of wetland evaluation for UFI 7775 Lot 28 Brook Rd

Wetland Evaluation Method	Wetland Management Category
V& C Semeniuk Research Group (1998)	CCW
EPA Bulletin 686 (1994)	REW
Vegetation Condition	CCW

3. WETLAND UFI 13367 EVALUATION

A. V & C Semeniuk Research Group (1998) questionnaire for wetland evaluation applied to wetland UFI 13367

1. Conservation Category Wetlands Criteria

Wetland type (geomorphology): A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. it is an anthropogenically unaltered wetland type (i.e., river, creek, paluslope, palusplain, floodplain, lake, sumpland, dampland)
2. it is a scarce wetland type
3. it is a representative wetland type (i.e., representative of its consanguineous suite)
YES. The data obtained in the current survey show that wetland UFI 13367 is a palusplain, partly altered, but a scarce wetland (only 6% of the former extent of palusplains remain undeveloped on the SCP; Hill *et al*., 1996). This palusplain is not representative of the Keysbrook consanguineous suite of wetlands (*i.e.* the wetlands of alluvial fans on the Pinjarra Plain) as it is partly altered by the clearing of vegetation and the dumping of landfill or the remains of a former dwelling on Lot 36.

Wetland p rocesses: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland is subject to anthropogenically unaltered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes.)

2. the wetland exhibits unusual wetland processes
3. the wetland exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting)

NO. The clearing of the catchment area, the building of roads and other hard surfaces around this palusplain, the dredging and diversion of Yule Brook and the excavation of artificial drains along roads may be affecting the recharge and discharge of wetland UFI 13367. The sediments once deposited on the wetland through the regular flooding of Yule Brook and the spread of floodwaters over the alluvial plain (that includes Lots 32 and 36) has been altered.

Wetland habitats: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland is a habitat for rare & endangered fauna
2. the wetland is a habitat for rare & endangered flora
3. the wetland exhibits a high diversity of habitats

NO. Wetland UFI 13367 does not satisfy any of these criteria

Wetland functions: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland is necessary for maintenance of large faunal populations
2. the wetland is a refuge for resident fauna
3. the wetland is an important breeding, feeding or watering site for migratory populations (local and international)
4. the wetland is a significant regional component of the hydrological cycle (has an important hydrological storage, recharge or discharge function; or an hydrochemical function)

YES. Wetland UFI 13367 performs an important hydrological function as it is located high in the groundwater catchment of other wetlands in BFS 387. The groundwater flow through Wetland UFI 13367 contributes to the water and nutrient budgets of these other wetlands and the maintenance of the downstream biodiversity. This function is important regionally as few, if any, other undeveloped corridors along undisturbed alluvial fans exist from the Darling Range to the Canning River that are comparable to BFS 387 and Lot 36 is part of this alluvial fan system.---

Wetland Biodiversity: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland exhibits unaltered wetland vegetation and fauna
2. the wetland has a scarce vegetation association or faunal association
3. the wetland has a highly diverse wetland flora or fauna

NO. Wetland UFI 13367 does not satisfy any of these criteria

Wetland Scientific value: A wetland may be classed as Conservation if it satisfies one or more of the following criteria
1. the wetland contains scientifically significant pollen records
2. the wetland is underlain by unusual wetland sediments (indicators of wetland history)
3. the wetland has unusual geomorphology (i.e., it is situated in an unusual geomorphic setting or contains unusual geomorphic features within it)

NO. Wetland UFI 13367 does not satisfy any of these criteria

The criteria that were not satisfied above at the level of Conservation (i.e. wetland processes, habitats, biodiversity) were then examined below at the Resource Enhancement level.

2. Resource Enhancement Wetlands Criteria

Wetland processes: A wetland may be classed as Resource Enhancement if it satisfies the following criterion
1. The wetland is subject to anthropogenically altered wetland processes (i.e., recharge and discharge mechanisms, hydroperiod, sedimentary processes) but not to the degree that habitats cannot still be identified and rehabilitated

YES. Wetland UFI 13367 satisfies this criterion. There is a small amount of landfill on Lot 36 but the palusplain sediments are still more or less intact and so groundwater recharge and discharge still function in a similar way to that prior to disturbance. The processes can be enhanced by replanting vegetation and correcting drainage works, if the latter is assessed as affecting the site.

Wetland habitats: A wetland may be classed as **Resource Enhancement** if it satisfies the following criterion
the wetland habitats are disturbed but the wetland is a habitat for rare & endangered fauna or flora, or the wetland exhibits a high diversity of habitats and for these reasons should be re-habilitated (i.e., water quality addressed, water levels naturalised, re-vegetation of communities undertaken, and re-establishment of ecological links with surrounding areas via corridors and/or buffer zones)

Yes. Wetland UFI 13367 habitat is disturbed but is part of the area of occurrence of rare flora species nearby and could be restored to suitable habitat for these rare flora species to recruit into or to be replanted into. The sediments, water quality and water levels, are not altered sufficiently in Lot 36 that re-establishment of original flora and fauna communities is not possible. Lot 36 should be restored to strengthen the ecological link of BFS 387 between the Darling Range and the Canning River.

Wetland functions: A wetland may be classed as **Resource Enhancement** if it satisfies one or more of the following criteria

1. the wetland is necessary for maintenance of specific faunal populations
2. the wetland is a breeding, feeding or watering site for migratory faunal populations (local)
3. the wetland is a fauna refuge but is degraded and requires re-vegetation or improvement of water quality
4. the wetland is a significant local component of the hydrological cycle (has an hydrological storage, recharge or discharge function; or an hydrochemical function)
5. the wetland is a regionally important hydrological or ecological link in a system
6. portion of extended wetlands is vegetated and therefore functions as an ecological corridor

YES. Wetland UFI 13367 is a significant local component of the hydrological cycle (it has a hydrological storage, recharge and discharge function for groundwater that supplies down slope areas of BFS 387).

Wetland Bio diversity: A wetland may be classed as **Resource Enha ncement** if it satisfies the following criterion

1. the wetland exhibits some unaltered wetland vegetation and fauna which may be extended through re-vegetation programmes

NO. Wetland UFI 13367 does not satisfy this criterion.

The criterion that were not satisfied above at the level of Resource Enhancement (i.e. biodiversity) was then examined below at the Multiple Use level.

3. Multiple Use Wetlands Criteria

Biodiversity: A wetland may be classed as **Multiple Use** if it satisfies the following criterion

1. the wetland has minor biodiversity, but does have ecosystem diversity and landscape diversity.

YES. Wetland UFI 13367 satisfies this criterion.

The scores in the categories examined for Wetland UFI 13367 were summarized (Table F5). This wetland met one criterion for CCW, two for REW and one for MUW. Although the wetland biodiversity and habitats of Wetland UFI 13367 have been largely lost due to the clearing of native vegetation, the wetland has conservation value because it is a scarce wetland type (palusplain on the Pinjarra Plain) and it retains some of the wetland processes and functions that are important to areas of very high conservation significance in BFS 387 down slope from it.

Table F5: Score sheet for the evaluation of part of palusplain UFI 13367 on Lots 32 and 36 Brook rd Wattle Grove by the method of V & C Semeniuk Research Group (1998)

Wetland Values	Criteria met at the level of CCW	Criteria met at the level of REW	Criteria met at the level of MUW
Wetland type	Yes		
Wetland processes	No	Yes	
Wetland habitats	No	Yes	
Wetland functions	No	Yes	
Biodiversity of wetland	No	No	Yes
Scientific value of wetland	No	n/a	n/a
Total Score	Score 1	Score 3	Score 1

The management category is allocated to the wetland according to the column above that achieves the best score.

The Management Category allocated to the part of palusplain UFI 13367 that occurs on Lots 32 and 36 Brook Rd by the method of V & C Semeniuk Research Group (1998) was thus **Resource Enhancement Wetland.**

B. Bulletin 686 (EPA, 1993) method of wetland evaluation for wetland UFI 13367

Bulletin 686 consists of a questionnaire that includes several parts that were answered for the evaluation of the part of the wetland UFI 13367 that occurs on Lots 32 and 36 Brook Rd Wattle Grove as below.

Part I: Presence of Rare Species

(If the wetland includes gazetted rare flora or fauna species then the wetland is automatically allocated to CCW).

NO. Wetland UFI 13367 does not include any Gazetted Rare Species

---

Part II Natural Attributes

Part IIA: For permanent and seasonal wetlands with well defined boundaries.

Not applicable go to part IIB below.

Part IIB: Seasonal and episodic wetlands with poorly defined boundaries.

i. Environmental geology classification. Wetlands in the Quindalup Dunes or in river/estuary floodplain receive Score= 5; other areas Score=1.
NO. The part of wetland UFI 13367 that occurs on Lot 253 is not in these areas…….**SCORE=1**

Part II Natural Attributes
ii. Adjacent wetlands. Wetlands that have no other wetlands within a 2km radius of them receive Score =3, others go to Question iii (below).
YES. There are other wetlands nearby to the part of palusplain UFI 13367 that occurs on Lot 28. Go to Question iii.

---

iii. Habitat diversity. If the composition and structure of the vegetation of the wetland under evaluation is significantly different to that found at other nearby wetlands, the wetland receives Score= 3; if not then Score =1.
NO. Other wetlands nearby to part of wetland UFI 13367 have similar vegetation……..**SCORE= 1**

---

iv. Habitat type. Habitat types scored in this question (up to a maximum Score = 15) include vegetation and landforms typical of lakes and sumplands such as fringing rushes and sedges, extensive in-lake beds of rushes and sedges, large paperbark trees, islands, flooded grassland, permanent or seasonal open water, extensive low thickets and samphires. The high conservation value vegetation of palusplains and damplands scores very badly on this part of the questionnaire because of this flaw in the design of this method of evaluation.
YES. Only category of large paperbark trees & fringing woodland/heath are applicable to this wetland…..S**CORE= 2.0**

---

v. Drainage. This deal with drains into and/or out of the wetland that can alter water levels or water quality. Wetlands with drains directing water into or out of the wetland Score=0; if no drains Score =5.
NO. Wetland UFI 13367 has drains adjacent to it but it is not clear how much effect these have on the hydrology of this wetland.....……..**SCORE= 0**

---

vi. Area of wetland modified by clearing of vegetation, landfill, paving, cultivation, irrigation, grazing, weed invasion, mining etc. Wetlands with 0-10 % modified Score= 5; 11-20 % modified Score= 4; 21-30 % modified Score= 3; 31-40 % modified Score= 2; >40 % modified Score= 1.
Wetland UFI 13367 has >40% that could considered as modified……..…… **SCORE= 1**

---

vii. Wetland size. Wetland area >100ha Score=5; 50-100ha Score =4; 25-50ha Score =3; 10-25ha Score =2; <10ha Score =1.
NO. The part of wetland UFI 13367 on Lots 32 and 36 is less than 10ha…….……**SCORE= 1**

TOTAL NATURAL ATTRIBUTES SCORE = 6.0

Part III: Human Use Questionnaire.
i. Aesthetics.
Little if any artificial noise. NO. Score=0
Understorey mostly intact. NO. Score=0
Few buildings evident from wetland. NO. Score=0
Steep ridge visible as part of scenery. YES. Score=2
Ridge accessible giving view of wetland. NO. Score=0
Wetland is a lake and open water easy to view. No. Score=0
Section of wetland where few people visit. NO. Score=0
.....**TOTAL SCORE=2**
ii. Historical and archaeological features.
Number of historical archaeological features. NONE……..…… **SCORE=0**
iii. Security of wetland.
Current vesting/ownership of land = private ownership……..…..……...**SCORE=1**
iv. Protection groups. NONE…….**SCORE=0**
v. Passive recreation.
Not used for passive recreation……..…….. **SCORE=0**
vi. Active recreation.
Not used for active recreation……..…….. **SCORE=0**
vii. Other human uses. None…….……**SCORE=0**
TOTAL HUMAN ATTRIBUTES SCORE =3

The Management Category allocated to the part of wetland UFI 13367 that occurs on Lots 32 and 36 Brook Rd, Wattle Grove by the method of EPA Bulletin 686 (1994) was thus **Multiple Use Wetland.**

C. Wetland Vegetation Condition Assessment for wetland UFI 13367

This vegetation of the wetland UFI 13367 was degraded to completely degraded (see vegetation description in Section 4 above). The Management Category allocated to this wetland on this criterion was thus Multiple Use Wetland.

D. Conclusion for wetland UFI 13367

The part of wetland UFI 13367 that occurs in Lots 32 and 36 Brook Rd was evaluated by three methods (Table F6). UFI 13367 is a scarce wetland type (a palusplain of the Pinjarra Plain) and is therefore eligible for CCW status for this attribute. It retains some of the wetland processes and functions that are important to areas of very high conservation significance in BFS 387 down slope from it. The physical environment of the wetland is not sufficiently altered that the wetland habitats cannot be restored and replanted with much the same flora assemblages as adjacent wetlands. It can thus serve as an effective, fully-vegetated buffer zone for adjacent wetlands. This wetland, when appropriately revegetated and managed, can also provide badly needed additional habitat for a number of flora species of conservation significance that occur locally. For example, a rare species that would benefit greatly, if additional habitat was made available to it on Lot 36 within its previous natural range, is *Grevillea thelemanniana.* The latter species is currently totally confined to the wetlands of Kenwick and Wattle Grove and is threatened with a further contraction of its range due to industrial development locally. Wetland UFI 13367 is also part of a Regional Greenway between the Canning River and the Darling Range (Alan Tingay and Associates, 1998; Bush Forever, 2000; Del Marco et al.,2004)).

Wetland UFI 13367 should be replanted with native vegetation to restore additional ecological functions as a buffer zone for other wetlands of BFS 387 and as part of the Regional Greenway. This wetland was thus allocated the management category of **Resource Enhancement Wetland.** It satisfies all of the wetland criteria at the level of either CCW or REW except biodiversity and scientific value.

Table F6: Summary of wetland evaluation for UFI 13367 in Lots 32 and 36 Brook Rd, Wattle Grove

Wetland Evaluation Method	Wetland Management Category
V& C Semeniuk Research Group (1998)	REW
EPA Bulletin 686 (1994)	MUW
Vegetation Condition	MUW

Appendix 7
Bushfire Management Plan

Bushfire Management Plan

655 Welshpool Rd East and 31 Brook Road, Wattle Grove BMP

Prepared for
Evangelos Litis Nominees Pty Ltd

1 March 2018







DOCUMENT TRACKING

Item	Detail
Project Name	655 Welshpool Rd East and 31 Brook Road, Wattle Grove BMP
Project Number	17PER-8345
Project Manager	Daniel Panickar
Prepared by	Sarah Muller, James Leonard
Reviewed by	Daniel Panickar (BPAD37802-L2)
Approved by	Daniel Panickar (BPAD37802-L2)
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Template 29/9/2015

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1 Introduction

1.1 Proposal details

Eco Logical Australia (ELA) was commissioned by Evangelos Litis Nominees, to prepare a Bushfire Management Plan (BMP) to support a scheme amendment being prepared for 655 Welshpool Rd East and 31 Brook Road, Wattle Grove (hereafter referred to as the subject site; **Figure 1**).

The subject site is within a designated bushfire prone area as per the Western Australia State Map of Bush Fire Prone Areas (DFES 2017; **Figure 2**), which triggers bushfire planning requirements under State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7; WAPC 2015) and reporting to accompany submission of the subdivision application in accordance with the associated Guidelines for Planning in Bushfire Prone Areas v 1.3 (the Guidelines; WAPC 2017).

This assessment has been prepared by ELA Bushfire Consultants Sarah Muller and James Leonard with quality assurance undertaken by Senior Bushfire Consultant, Daniel Panickar (FPAA BPAD Level 2 Certified Practitioner No. BPAD37802-L2).

1.2 Purpose and application of the plan

The primary purpose of this BMP is to act as a technical supporting document to inform planning assessment.

This BMP is also designed to provide guidance on how to plan for and manage the bushfire risk to the subject site through implementation of a range of bushfire management measures in accordance with the Guidelines.

1.3 Environmental considerations

The subject site has been predominately cleared of native vegetation with isolated paddock trees remaining. Removal of these trees will be facilitated through subsequent planning approval and is unlikely to pose constraint to development. There is no requirement for any environmental approvals relating to native vegetation clearing for this development to proceed.

No revegetation is proposed as part of the development.

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Figure 1: Site Overview

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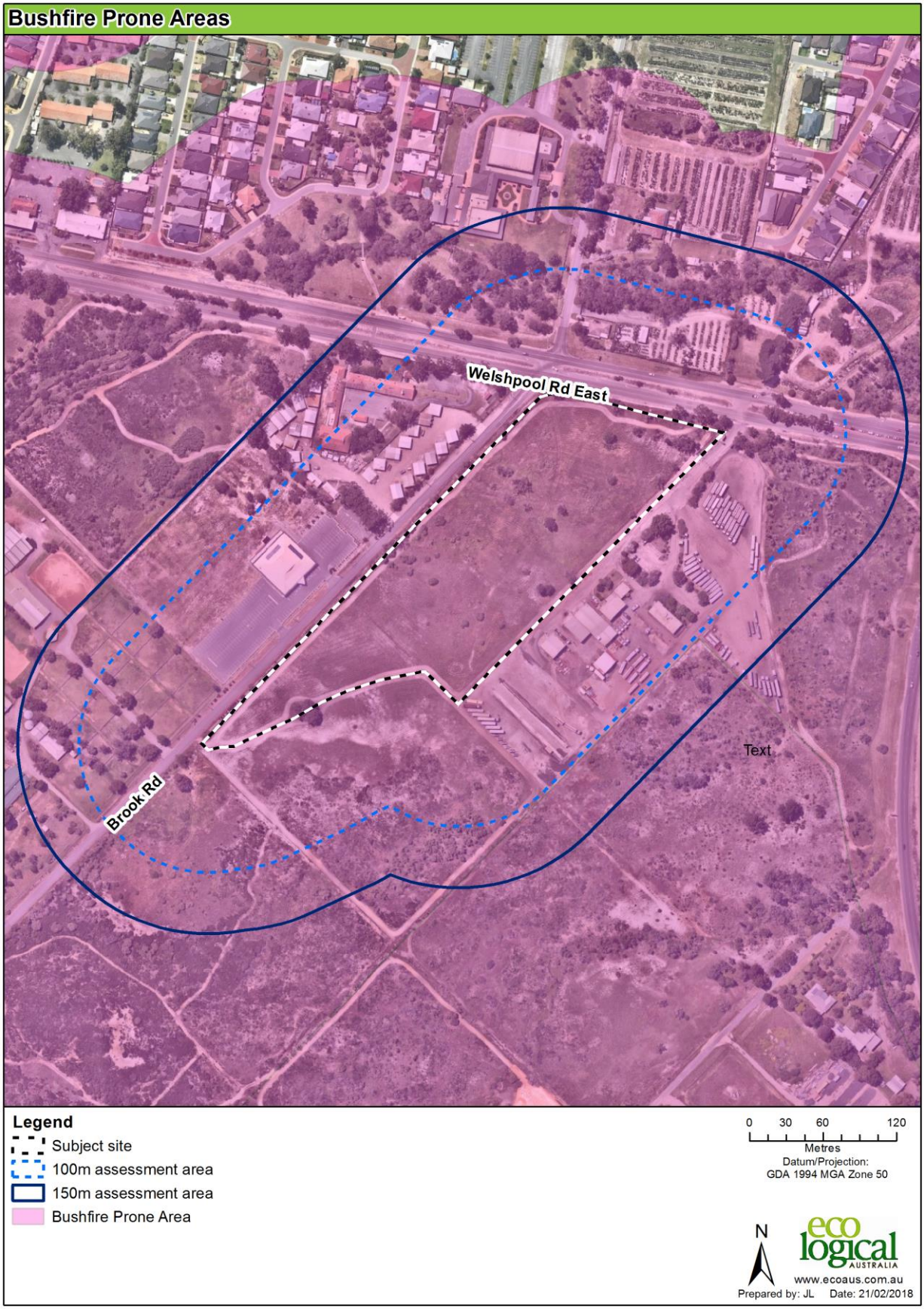

Figure 2: Bushfire Prone Areas

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2 Bushfire assessment results

2.1 Bushfire assessment inputs

The following section is a consideration of spatial bushfire risk and has been used to inform the bushfire assessment in this report.

2.1.1 General

The subject site is located in the City of Kalamunda, and is bound by:

- Welshpool Rd East to the north;
- Industrial land and native/introduced vegetation to the east;
- Native/introduced vegetation to the south; and
- Brook Rd to the west.

Visual assessment of the surrounding vegetation within the assessment area did not identify any recent fire scars and fire history was not able to be determined. Accumulation of vegetative matter over time, combined with the moderate to high risk of ignition associated with high levels of public access and proximity to urban areas would potentially facilitate a bushfire occurrence in this area.

2.1.2 Vegetation classification

Vegetation within the subject site and surrounding 150 m (the assessment area) was assessed in accordance with the Guidelines and AS 3959-2009 *Construction of Buildings in Bushfire Prone Areas* (SA 2009) with regard given to the Visual guide for bushfire risk assessment in Western Australia (DoP 2016). The site inspection was undertaken on 5 January 2018.

The following vegetation classes and exclusions were identified within the assessment area as depicted in **Figure 3** and listed below:

- Class A forest;
- Class B woodland;
- Class C shrubland;
- Class G grassland; and
- Exclusions as per clause 2.2.3.2 (e) and (f) (i.e. non-vegetated areas and low-threat vegetation).

Photographs relating to each vegetation type are included in **Appendix A**.

Table 1: Bushfire Hazard Level (BHL) Assessment

Plot and Vegetation classification	Effective slope	Bushfire Hazard Level
Plot 1 - Excluded as per clause 2.2.3.2 (e) and (f) of AS3959-2009	Upslope/flat land	N/A
Plot 2 – Class G grassland		Moderate
Plot 3 – Class C shrubland		Moderate
Plot 4 – Class B woodland		Extreme
Plot 5 – Class B woodland		Extreme
Plot 6 – Class A forest		Extreme

The Bushfire Hazard Level (BHL) assessment addresses this topic further in **Section 2.2**.

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2.1.3 Topography and slope under vegetation

Effective slope under vegetation was assessed for a distance of 150 m from the subject site in accordance with the Guidelines and AS 3959-2009. Slope under classified vegetation in all directions from the subject site was assessed as upslope/flat land (**Figure 3**).

The BHL assessment addresses this topic further in **Section 2.2**.

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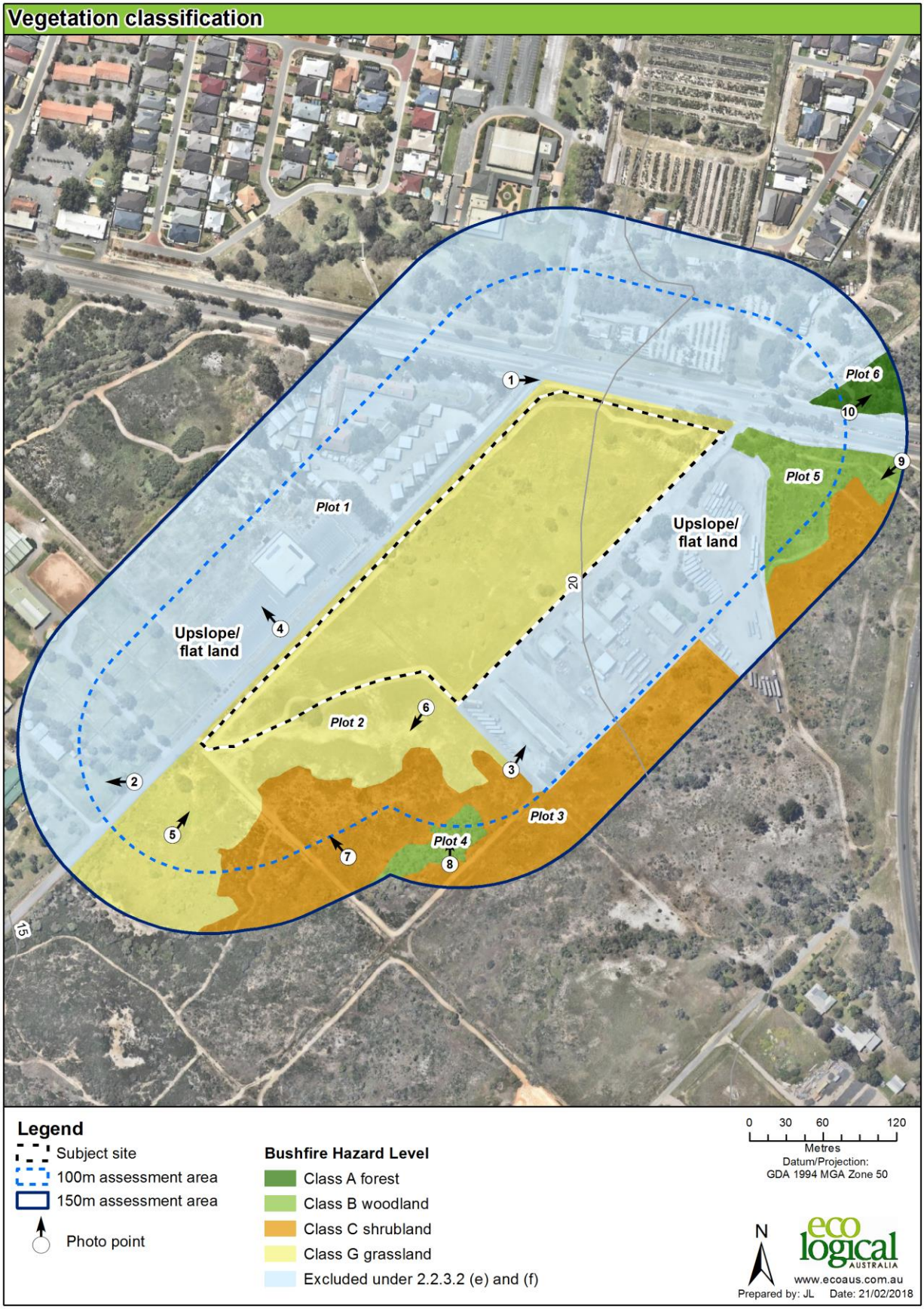

Figure 3: Vegetation classification

2.2 Bushfire assessment outputs

A BHL assessment has been undertaken in accordance with SPP 3.7, the Guidelines, AS 3959-2009 and the bushfire assessment inputs in **Section 2.1**.

2.2.1 Bushfire Hazard Level (BHL) assessment

All land located within 100 m of the classified vegetation depicted in **Figure 3**is considered bushfire prone and is subject to a BHL assessment in accordance with AS 3959-2009.

Bushfire hazard levels have been assessed for the subject site in accordance with methodology contained within the Guidelines for the proposed development and incorporates the following factors:

- Vegetation class; and
- Slope under classified vegetation.

A summary of results is provided in **Table 1** and **Figure 4**.

As the subject site is proposed to be cleared for development, a post-development BHL assessment is provided in **Figure 5**.

2.3 Identification of issues arising from the BHL assessment

The on-site vegetation extent is proposed to be cleared to enable development of a significant urban built footprint and various easements. Therefore, for the purposes of strategic level planning, ELA does not consider the current on-site vegetation extent to be a bushfire hazard issue post-development, since these hazards can be managed through a staged clearing process, adequate separation of future built assets from classified vegetation, and ongoing fuel management that can be undertaken in and around individual development stages.

On the basis of the above information, ELA considers that the bushfire hazards within and adjacent to the subject site and the associated bushfire risk is readily manageable through standard management responses and compliance with acceptable solutions outlined in the Guidelines and AS 3959-2009. These management measures will need to be factored into subdivision and/or development design as early as possible to ensure a suitable, compliant and effective bushfire management outcome is achieved to ensure protection of future life and property assets.

Demonstration of compliance with the relevant requirements of SPP 3.7, the Guidelines and AS 3959-2009 at future planning stages will also depend on the developer's ability to coordinate the timing and staging of clearing and development works within the subject site with those developments proposed on adjacent landholdings in the aim of avoiding bushfire impacts from temporary retained vegetation.

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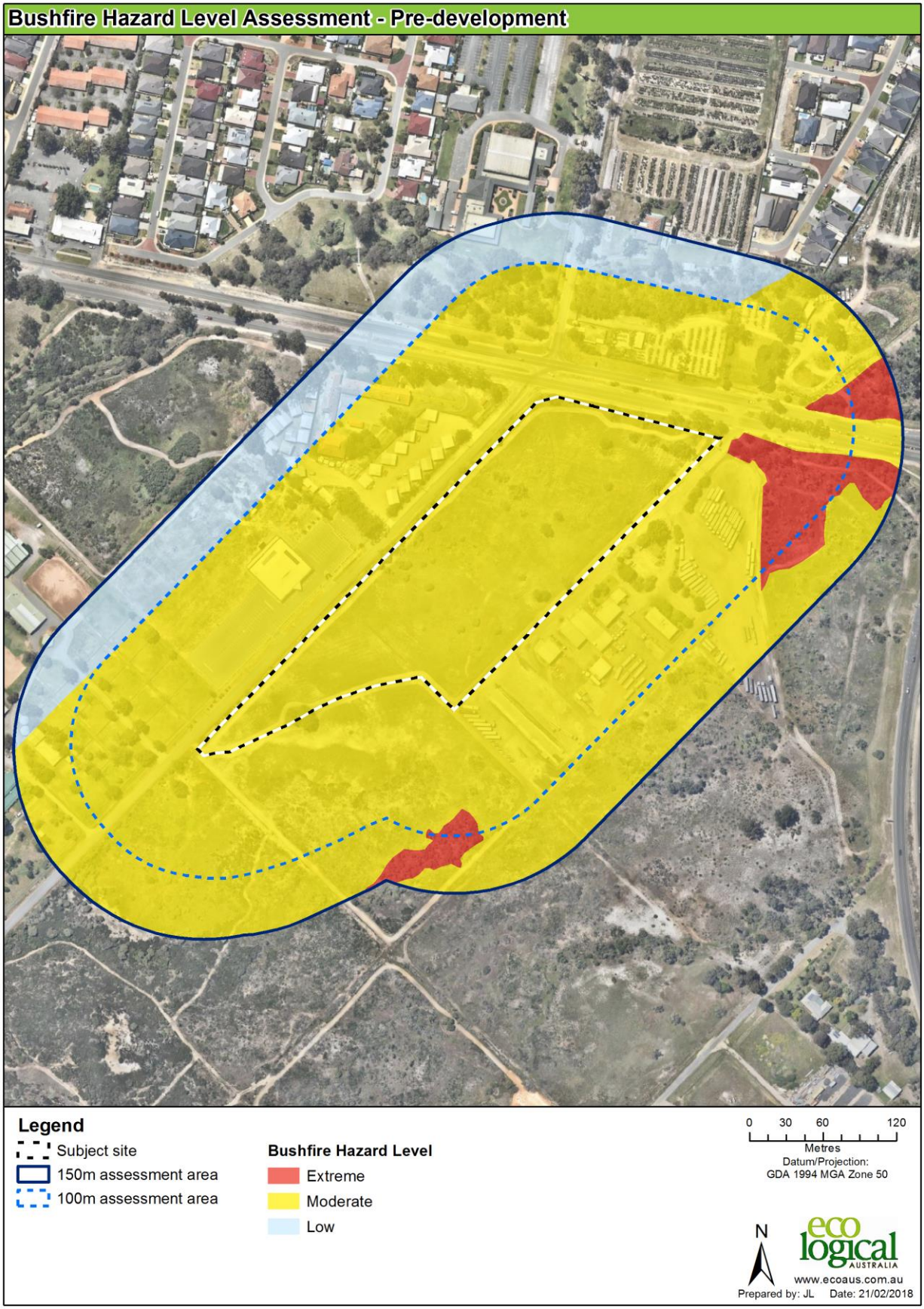

Figure 4: Bushfire Hazard Level (BHL) assessment

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3 Assessment against the Bushfire Protection Criteria

3.1 Compliance

The proposed scheme amendment is required to comply with policy measures 6.2 and 6.3 of SPP 3.7 and the Guidelines. Implementation of this BMP is expected to meet objectives 5.1-5.4 of SPP 3.7.

In response to the above requirements of SPP 3.7 and the Guidelines, bushfire management measures, as outlined, have been devised for the proposed development in accordance with Guideline acceptable solutions to meet compliance with bushfire protection criteria.

The 'acceptable solutions assessment' is provided below in **Table 2** to assess the proposed bushfire management measures against each bushfire protection criteria in accordance with the Guidelines and demonstrate that the measures proposed meet the intent of each element of the bushfire protection criteria. **Figure 5** depicts bushfire management strategies where necessary.

Table 2: Summary of solutions used to achieve bushfire performance criteria

Bushfire Performance Criteria	AS	PS	N/A	Comment
Element 1: Location A1.1 Development location	☒	☐	☐	Post-development, the subject site will be situated in areas subject to BHLs of moderate or low (refer to **Figure 5**). The proposed development is considered to be compliant with A1.1.
Element 2: Siting and design of development A2.1 Asset Protection Zone (APZ)	☒	☐	☐	APZs can be accommodated between all future buildings and classified vegetation This will be addressed in future BMPs. The proposed development is considered to be compliant with A2.1.

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Bushfire Performance Criteria	AS	PS	N/A	Comment
Element 3: Vehicular access A3.1 Two access routes	☒	☐	☐	There are more than two access routes to/from the subject site associated with the existing road network (**Figure 5**). The final development design will not interfere with this access network. The proposed development is considered to be compliant with A3.1.
Element 3: Vehicular access A3.2 Public road	☐	☐	☒	No public roads are proposed to be constructed as part of the development.
Element 3: Vehicular access A3.3 Cul-de-sac	☐	☐	☒	No cul-de-sacs are proposed as part of the development.
Element 3: Vehicular access A3.4 Battle-axe	☐	☐	☒	No battle axe lots are proposed.
Element 3: Vehicular access A3.5 Private Driveway longer than 50 m	☐	☐	☒	No private driveways longer than 50 m are proposed.
Element 3: Vehicular access A3.6 Emergency Access way	☐	☐	☒	No emergency access ways are required or proposed.
Element 3: Vehicular access A3.7 Fire-service access routes	☐	☐	☒	No fire service access routes are required or proposed.
Element 3: Vehicular access A3.8 Firebreak width	☐	☐	☒	None of the proposed lots is greater than 0.5 hectares and therefore firebreaks are not required.
Element 4: Water A4.1 Reticulated areas	☒	☐	☐	The subject site has a reticulated water supply that will be extended to all proposed lots. The proposed development is considered to be compliant with A4.1. A4.2 and A4.3 are not applicable to this proposed development. .

3.2 Additional management strategies

Revised BMPs will be prepared during subsequent planning applications for the subject site. Additional risk management is likely to include the maintenance of the prescribed APZ in line with future BMPs and the City of Kalamunda's firebreak notice.

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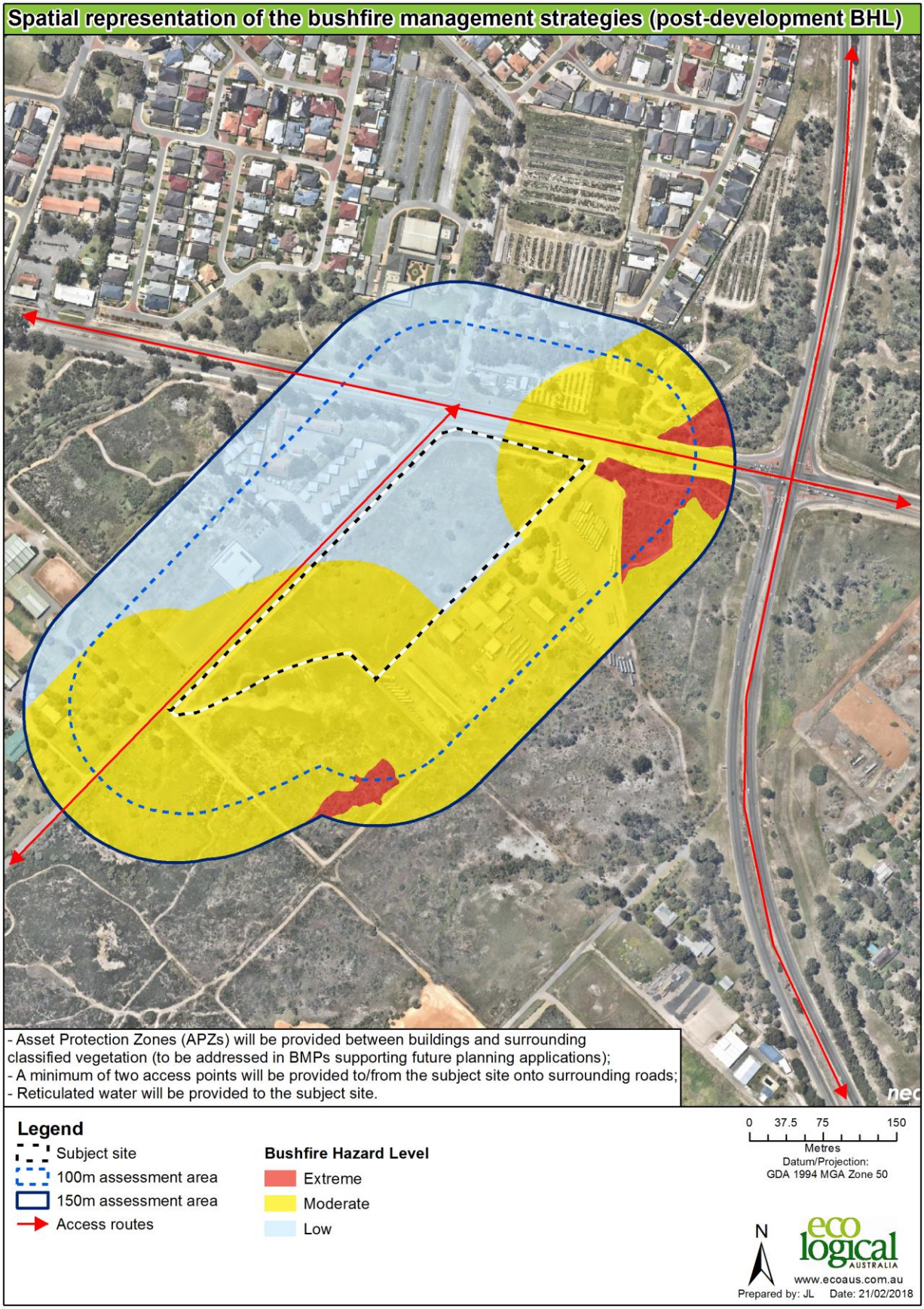

Figure 5: Spatial representation of the bushfire management strategies

4 Implementation and enforcement

Implementation of the BMP applies to the developer, the City of Kalamunda, and future landowners to ensure bushfire management measures are adopted and implemented on an ongoing basis.

The developer will be required to submit updated BMPs to support future Structure Plans, subdivision applications, and/or development applications in accordance with SPP 3.7. The BMPs will need to ensure that the intent of the Bushfire Protection Criteria in the Guidelines (i.e. Location, Siting and design of development, Vehicular Access, and Water supply) can be met.

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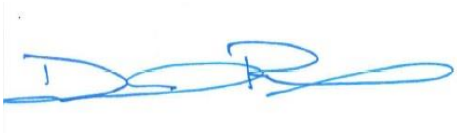
Conclusion

In the author's professional opinion, the bushfire protection requirements listed in this assessment provide an adequate standard of bushfire protection for the proposed development. As such, the proposed development is consistent with the aim and objectives of SPP 3.7 and associated guidelines and is recommended for approval.



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Western Australian Planning Commission (WAPC). 2017. *Guidelines for Planning in Bushfire Prone Areas Version 1.3 (including appendices).* WAPC, Perth.

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Appendix A Plates

Plot	Photo ID	Photo and vegetation class
1	1	 Excluded – clause 2.2.3.2 (e) & (f): Cleared road and maintained verges
1	2	 Excluded – clause 2.2.3.2 (e) & (f): Cleared road and maintained verges/lawn

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Plot	Photo ID	Photo and vegetation class
1	3	 Excluded – clause 2.2.3.2 (e) & (f): Industrial development
1	4	 Excluded – clause 2.2.3.2 (e) & (f): Car park area

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Plot	Photo ID	Photo and vegetation class
2	5	 Class G grassland
2	6	 Class G grassland

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Plot	Photo ID	Photo and vegetation class
3	7	 Class C shrubland
4	8	 Class B woodland

Plot	Photo ID	Photo and vegetation class
5	9	 Class B woodland
6	10	 Class A forest

Appendix B Standards for Asset Protection Zones

The following standards have been extracted from the *Guidelines for Planning in Bushfire Prone Areas v 1.2* (WAPC 2017).

Every habitable building is to be surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the following requirements:

a. Width: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a fire does not exceed 29kW/m² (BAL 29) in all circumstances.

b. Location: the APZ should be contained solely within the boundaries of the lot on which a building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity (see explanatory notes).

c. Management: the APZ is managed in accordance with the requirements of '*Standards for Asset Protection Zones*' (below):

- Fences: within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used
- Objects: within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors
- Fine Fuel load: combustible dead vegetation matter less than 6 millimetres in thickness reduced to and maintained at an average of two tonnes per hectare
- Trees (> 5 metres in height): trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy (**Figure 6**).

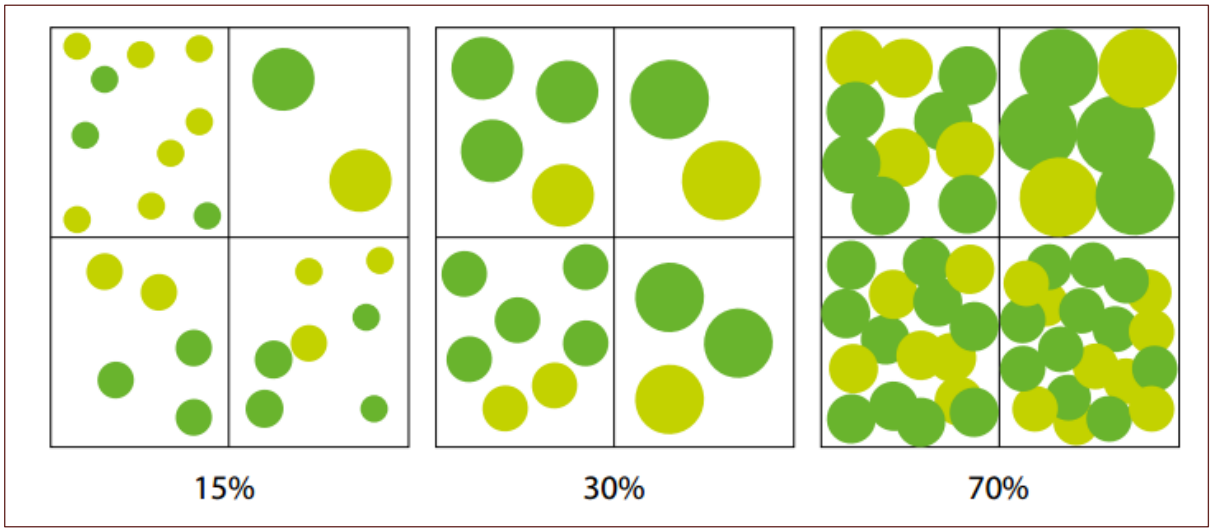

Figure 6: Illustrated tree canopy cover projection (WAPC 2017)

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- **Shrubs (0.5 metres to 5 metres in height):** should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated as trees
- **Ground covers (<0.5 metres in height):** can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 metres of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs
- **Grass:** should be managed to maintain a height of 100 millimetres or less.

Additional notes

The Asset Protection Zone (APZ) is an area surrounding a building that is managed to reduce the bushfire hazard to an acceptable level. Hazard separation in the form of using subdivision design elements or excluded and low threat vegetation adjacent to the lot may be used to reduce the dimensions of the APZ within the lot.

The APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity. The APZ may include public roads, waterways, footpaths, buildings, rocky outcrops, golf courses, maintained parkland as well as cultivated gardens in an urban context, but does not include grassland or vegetation on a neighbouring rural lot, farmland, wetland reserves and unmanaged public reserves.

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Appendix C Vehicular access technical requirements (WAPC 2017)

Technical requirements	Public road	Cul-de-sac	Private driveway	Emergency access way	Fire service access route
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal distance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	N/A	4.5	4.5	4.5
Maximum grade <50 m	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius	8.5	8.5	8.5	8.5	8.5

* Refer to E3.2 Public roads: Trafficable surface

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ecological AUSTRALIA

bsi. ISO 14001 Environmental Management

bsi. AS/NZS 4801:2001 Occupational Health and Safety Management

bsi. ISO 9001 Quality Management

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F 02 9542 5622

COFFS HARBOUR
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F 02 6651 6890

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Level 1, Bishop's See
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F 02 9542 5622

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Newcastle NSW 2300
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F 02 9542 5622

ARMIDALE
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Armidale NSW 2350
T 02 8081 2685
F 02 9542 5622

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 9542 5622

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Brisbane QLD 4000
T 07 3503 7192

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Huskisson NSW 2540
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F 02 9542 5622

NAROOMA
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Narooma NSW 2546
T 02 4302 1266
F 02 9542 5622

MUDGEE
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79 Market Street
Mudgee NSW 2850
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F 02 6372 9230

GOSFORD
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ADELAIDE
2, 70 Pirie Street
Adelaide SA 5000
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Appendix 8
Engineering Servicing Report

McDowall Affleck
CONSULTING ENGINEERS | PROJECT MANAGERS
Responsive. Reliable. Results.

ENGINEERING SERVICING REPORT

FOR

LOT 36 (655) WELSHPOOL ROAD EAST AND LOT 810 (31) BROOK ROAD, WATTLE GROVE

REVISION 2

Prepared by

McDOWALL AFFLECK PTY LTD

Consulting Engineers / Project Managers

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3.0	GEOTECHNICAL INFORMATION	3
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5.0	WASTE WATER RETICULATION	4
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9.0	NATURAL GAS SUPPLY	5
10.0	CONCLUSION	5

APPENDIX A – WATER CORPORATION DBYD INFORMATION – WATER RETICULATION

APPENDIX B - WATER CORPORATION INFORMATION – WASTE WATER RETICULATION (SEWER)

APPENDIX C - WESTERN POWER MAPS

APPENDIX D - TELECOMMUNICATIONS MAPS

APPENDIX E – ATCO GAS MAPS

1.0 INTRODUCTION

McDowall Affleck Pty Ltd has been commissioned by Evangelos Litis Nominees Pty Ltd to prepare an Engineering Servicing Report for the proposed development of Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove into a Commercial Development, to accommodate a mix of commercial and light industrial uses including retail, fast food shop, factories and warehouses with vehicle parking facilities.



The site is approximately 14km south-east of the Perth Central Business District and is currently zoned as Industrial Development under the City of Kalamunda Local Planning Scheme No. 3. The site is bounded by Brook Road to the north west, Welshpool Road to the north east, Lot 341 Welshpool Road to the south east and bush forever area to the south.

This report is based on the findings from a desktop study of available information from records and discussion with relevant statutory authorities.

2.0 EXISTING FEATURES

The site has two road frontages, Brook Road to the north west and Welshpool Road to the north east.

The intersection of Brook Road and Welshpool Road east is a three-way junction and controlled by giveway sign and line making.

The site is generally cleared with sparse trees through the site.

3.0 GEOTECHNICAL INFORMATION

We have interrogated the Geological Survey Maps of Perth and noted that the site is described as “SAND OVER CLAY”

“white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin over sandy clay to clayey sand of the Guildford Formation”

It is recommended a geotechnical investigation be completed over the site to better understand the site classification.

4.0 STORMWATER DRAINAGE

The site falls within the Maddington Kenwick Strategic Employment Area Precinct 3 as per the City of Kalamunda’s District Water Management Strategy. Based on our investigation, the site is sand over clay with a perched groundwater table.

In accordance with the LWMS, the 100 year ARI storm event will be required to be stored onsite with predevelopment flows onto Brook Road. A proposed drainage basin/swale is located on the western portion of the site as per the proposed light industrial development plan.

5.0 WASTE WATER RETICULATION

The Water Corporation ESInet system indicates there is no nearby existing sewer main that is adequate to support the development.

The Water Corporation long term planning for the area indicates that the site will be serviced from the existing sewer main along Bickley Road, west of Roe Highway (other side of Roe Highway) approximately 2.7km to the west of the site via a DN150 sewer main. There are no current plans by the Water Corporation to construct the proposed reticulated sewer main to enable the site to be serviced by reticulated sewer.

The Water Corporation has indicated that a private pump station may be constructed onsite to service the development or alternatively an onsite effluent system can be used in accordance with the Government Sewerage policy.

Refer to Appendix A for DBYD information, Wattle Grove long term Conceptual Plan by Water Corporation and the response from Water Corporation.

6.0 WATER SUPPLY

The Water Corporation DBYD information shows an existing 150CI water main along Welshpool Road East fronting the site and an existing 200P-12 along Brook Road on the other side of the road reserve. The Water Corporation have confirmed that, there is adequate network capacity for our proposed commercial development. In addition, there is no water upgrade required for a 20 L/s for firefighting purposes.

Therefore, the site can ultimately be serviced with reticulated water.

Refer to Appendix B for DBYD information and the response from Water Corporation.

7.0 POWER SUPPLY

Upon our request, APD Engineering has provided a high level review of the power requirements for the commercial development.

Power:

- The existing lot is not serviced by Western Power at this stage.
- Based on an initial assessment, a minimum of a 1MVA site supply will be required to service Stage 1, however, this is likely to increase once further information on the use of the Showroom/Warehouse and detailed electrical equipment details are received.
- The minimum load requirement for Stages 2 and 3 is estimated to be a total of approximately 700kVA, again, this is likely to increase once further information on the use of the Factory/Warehouse Units and detailed electrical equipment details are received.
- Based on organic load growth in the area capacity does not appear to be constrained for the duration of the 10 year forecast. However, discrete loads may impact available capacity as applications are received by Western Power.
- If the development is to be undertaken as a strata development, it is recommended that a substation site with an allowance for two transformers be created near the boundary of Stage 1 and 2 on Brook Road. This will allow for the development to be serviced from a more central location. A single 1MVA transformer and HV switchgear can be installed in Stage 1 with a second transformer to be installed once a supply upgrade is required.
- If the development is to be undertaken as a strata development an additional consideration may involve connecting directly to the HV network, which is typically offered for loads exceeding 1.5MVA. This allows for flexibility when future load increases are required as the site is not limited by the size of standard Western Power transformers and the layout of the HV network can be modified without direct WP input. However, by connecting to the Western Power high voltage network the customer is required to purchase, maintain & operate their own HV network. Additional technical documentation is required prior to energisation by means of a 'HV submission'.

- Alternatively, if each stage is to be developed as a separate Green Title lot, based on the minimum load requirements, a new transformer will be required for each stage which will be serviced from a new HV switchgear installed under Stage 1.

8.0 COMMUNICATIONS

Upon our request, APD Engineering has provided a high level review of the telecommunications requirements for the commercial development.

Telecommunications:

- As per the Federal Government's TIND (Telecommunications In New Developments) policy, the Developer is now responsible for the cost of delivering communications infrastructure in new developments (i.e. new pit & pipe and cables & equipment).
- DBYD plans indicate Telstra Pit and Pipe network running along Brook Road and Welshpool East Road with the existing lot being serviced by a 5-Pit on Brook Road.
- NBN Fibre to the Node (FTTN) infrastructure is currently planned to be made available for this development by October-December 2018.
- Since this area is going to be serviced by FTTN technology, it is likely that NBN will be made available through Telstra's Pit and Pipe network.
- NBN will require each building within the development to be serviced by a single NBN point of connection.
- New pits will be required to cut into the existing network and to extend the network to each building.
- For the Showroom/Warehouse in Stage 1 and the Factory/Warehouse Units in Stages 2 and 3, the pit and pipe network will be extended to a communications room/cabinet within each building. With this arrangement, NBN cable will be installed until the communications room/cabinet and the developer's contractor will be required to service each proposed tenancy from the communications room/cabinet through internal reticulation.

9.0 NATURAL GAS SUPPLY

The DBYD information shows and existing 155PVC gas main along Welshpool Road East at the corner of Brook road and Welshpool Road East fronting the site.

Therefore, the site can ultimately be serviced with natural gas.

Refer to Appendix E for DBYD information

10.0 CONCLUSION

The site is ultimately serviced with reticulated water, reticulated gas, power and communications to service the proposed commercial development.

Closure

We trust this is as you require. If you have any questions, please call me on 9274 6444.

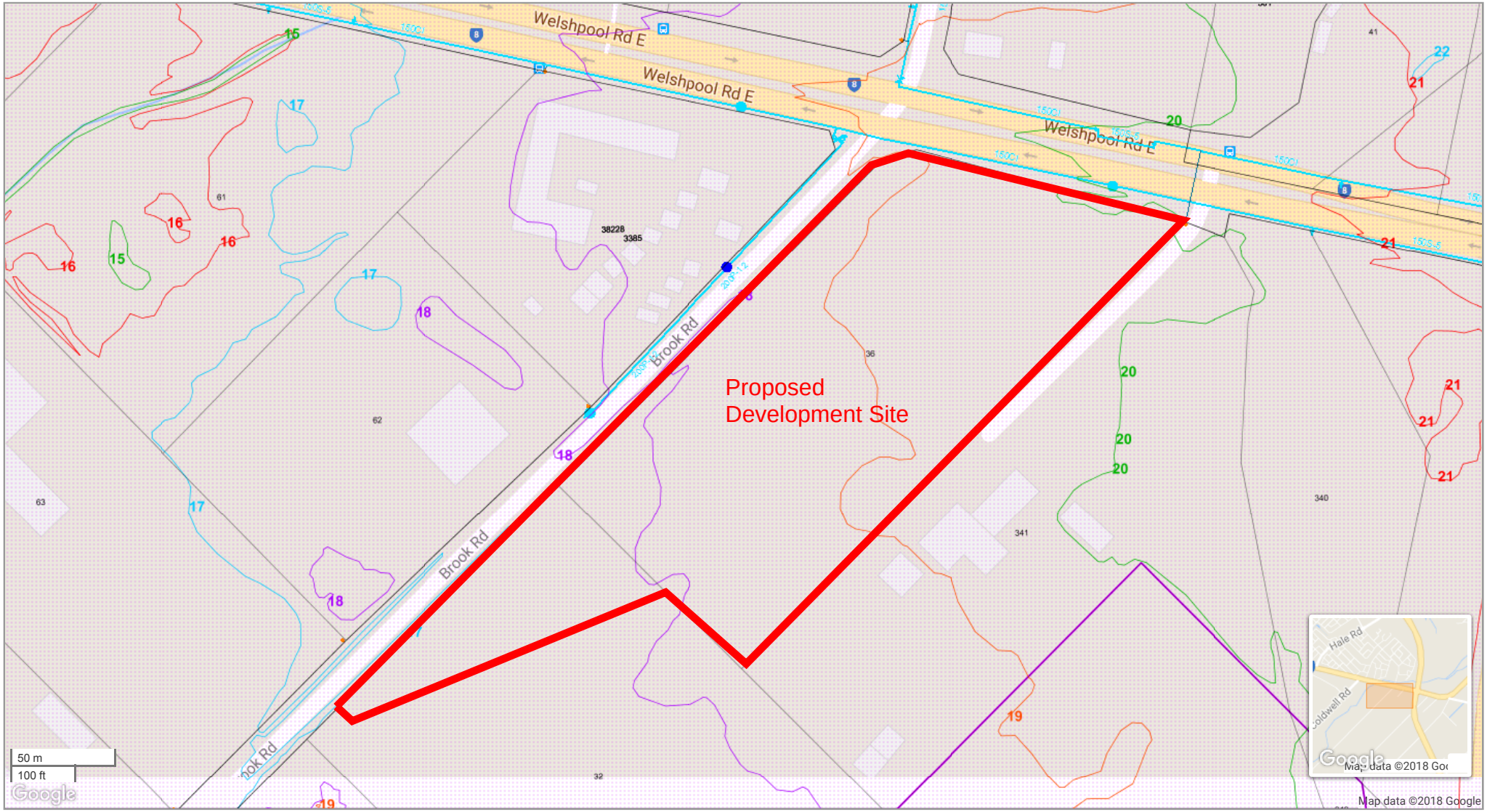
Yours faithfully



Vince Tran
6th March 2018
vtran@mapl.net.au
www.mcdowallaffleck.com.au

APPENDIX A – WATER CORPORATION DBYD INFORMATION – WATER RETICULATION

Water



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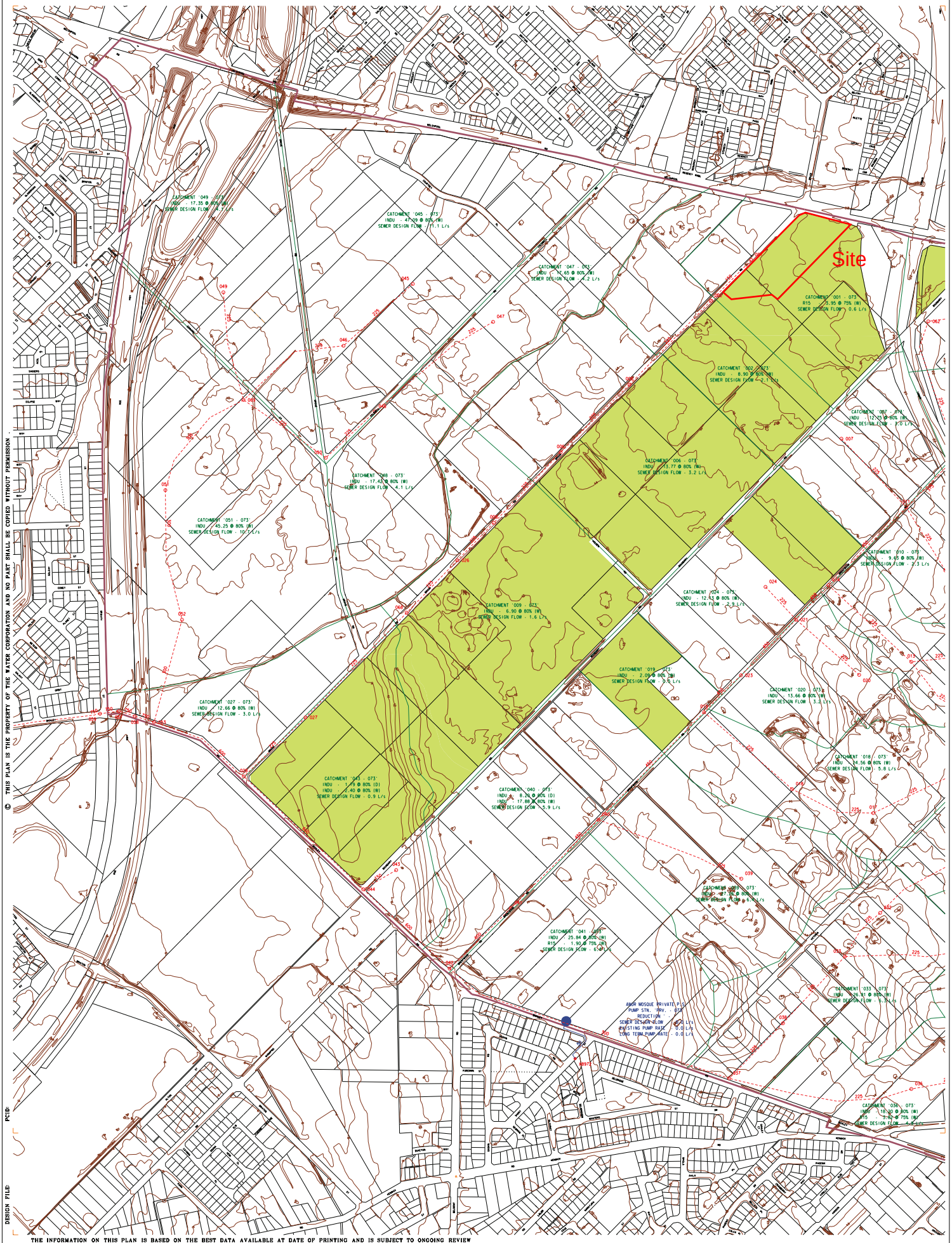
APPENDIX B - WATER CORPORATION INFORMATION – WASTE WATER RETICULATION (SEWER)



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DESIGN FILE:

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LEGEND

- EXISTING PUMPING STATION
- EXISTING PRESSURE MAIN
- EXISTING GRAVITY SEWER
- PROPOSED PUMPING STATION
- PROPOSED PRESSURE MAIN
- PROPOSED GRAVITY SEWER
- PARKS AND PUBLIC OPEN SPACE
- EXISTING SEWERED AREAS
- SEWERED BY PRIVATE PS
- NODE CATCHMENT
- PS AND SEWER CATCHMENTS
- SEWER DISTRICT CATCHMENT
- WWTP CATCHMENT

NOTATION

SEWER DISTRICT NUMBER
CATCHMENT NODE
CATCHMENT '7001 - 121'
R15 - 108.4 @75% (W)
GROSS AREA (ha)
'R' CODE ZONING
x OF LAND DEVELOPMENT
(W) - WET CONDITIONS
(D) - DRY CONDITIONS
SEWER DESIGN FLOW - 1.5 x AVERAGE DAILY FLOW RATE

SHEET INDEX



AQUA NO.

AQUA VERSION

WATER CORPORATION

ISSUED WITH THE AUTHORITY OF THE MANAGER INFRASTRUCTURE PLANNING BRANCH
629 NEWCASTLE STREET, LEEDERVILLE 6007
WESTERN AUSTRALIA.
TELEPHONE (08) 9420 2420, FAX (08) 9420 3179

WASTEWATER SCHEME PLANNING SERIES

WATTLE GROVE - SD073
CONCEPTUAL PLANNING
LONG TERM SCHEME: SHEET 1 OF 2

PLANNING BY	COMPILED BY	ACCEPTED BY
R. APPOLONI	R. APPOLONI	T. ZHENG
SCALE: 1:5,000	FULL REVIEW: SEPTEMBER 2010	FILE NO.: JT1 2010 07521 V01 A1

Vincent Tran

From: Janaka Rajakaruna
Sent: Thursday, 15 February 2018 3:22 PM
To: Vincent Tran
Subject: FW: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

FYI

Kind Regards,

| Janaka Rajakaruna | Senior Civil Engineer | McDowall Affleck Pty Ltd | ABN: 23 009 033 345 |

| T: +61 8 9274 6444 | F: +61 8 9250 3433 | www.mcdowallaffleck.com.au |

From: Rob Pettersson [mailto:Rob.Pettersson@watercorporation.com.au]
Sent: Thursday, 15 February 2018 12:24 PM
To: Janaka Rajakaruna
Subject: FW: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

Hi Janaka

We have completed the water analysis for the development proposal and determined there is adequate network capacity for normal commercial services. In addition there is no water upgrade required for a 20 L/s fireflow scenario.

Rob Pettersson
Client Consultant
Water Corporation
Perth
T: (08) 9420 3970 | **F:** (08) 9420 3193

From: Rob Pettersson
Sent: Wednesday, 14 February 2018 1:43 PM
To: 'Janaka Rajakaruna'
Subject: RE: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

Hi Janaka,

With respect to sewerage, a gravity service to the North is not available to this lot, Likewise, major infrastructure (if indeed justified) would be require to service this development in line with our planning regime.
Therefore, a private system appears to be the only solution, however this would require a considerably long pressure main.

Water service upgrades along Welshpool Road appear to be necessary in establish an acceptable services to this development – I'm waiting for further clarification on this issue and will advise!

Rob Pettersson
Client Consultant
Water Corporation
Perth
T: (08) 9420 3970 | **F:** (08) 9420 3193

From: Rob Pettersson
Sent: Wednesday, 14 February 2018 9:51 AM
To: 'Janaka Rajakaruna'
Subject: RE: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

Hi Janaka,

Thanks for the reminder – I'll follow-up today!

Rob Pettersson
Client Consultant
Water Corporation
Perth
T: (08) 9420 3970 | **F:** (08) 9420 3193

From: Janaka Rajakaruna [mailto:jrajakaruna@mapl.net.au]
Sent: Wednesday, 14 February 2018 9:25 AM
To: Rob Pettersson
Cc: Vincent Tran
Subject: RE: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

Good Morning Rob

Did you receive any comments form the planning yet ?

Kind Regards,

| **Janaka Rajakaruna** | **Senior Civil Engineer** | **McDowall Affleck Pty Ltd** | **ABN: 23 009 033 345** |

| **T: +61 8 9274 6444** | **F: +61 8 9250 3433** | **www.mcdowallaffleck.com.au** |

From: Vincent Tran
Sent: Thursday, 8 February 2018 11:06 AM
To: Rob Pettersson <Rob.Pettersson@watercorporation.com.au>
Cc: Janaka Rajakaruna <jrajakaruna@mapl.net.au>
Subject: RE: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

Thanks Rob, look forward to your response.

| **Vincent Tran** | **Senior Civil Engineer** | **McDowall Affleck Pty Ltd** | **ABN: 23 009 033 345** |

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From: Rob Pettersson [mailto:Rob.Pettersson@watercorporation.com.au]
Sent: Thursday, 8 February 2018 10:56 AM

To: Vincent Tran <vtran@mapl.net.au>
Subject: RE: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

Hi Vincent,

I have asked our Planning Group to make comment on network capacities and upgrades in respect to this development proposal.
They may require further details!

I would expect a response sometime next week.

Rob Pettersson
Client Consultant
Water Corporation
Perth
T: (08) 9420 3970 | **F:** (08) 9420 3193

From: Vincent Tran [mailto:vtran@mapl.net.au]
Sent: Wednesday, 7 February 2018 2:40 PM
To: Rob Pettersson
Cc: Janaka Rajakaruna
Subject: 15574-RE: WELSHPOOL RD EAST DEVELOPMENT

Hi Rob,

Thank you for sending through the information, we have reviewed the sewer planning and there doesn't seem to be anything nearby for us to connect to, nearest connection point is along Regency Ramble, however we will need to cross the Yule Brook, other connection point is to the northwest on the other side of Roe Highway.

Are there any plans for a pump station or developments nearby that would bring the sewer near our site?

Also, as we are proposing a large amount of commercial, would there be any water main upgrades?

Thanks
Vince

| Vincent Tran | Senior Civil Engineer | McDowall Affleck Pty Ltd | ABN: 23 009 033 345 |

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From: Rob Pettersson [mailto:Rob.Pettersson@watercorporation.com.au]
Sent: Wednesday, 7 February 2018 1:54 PM

To: Janaka Rajakaruna <jrajakaruna@mapl.net.au>
Subject: WELSHPOOL RD EAST DEVELOPMENT

Hi Janaka,

Planning sheet as requested!

Rob Pettersson
Client Consultant
Assets Planning Group
Water Corporation

T: (08) 9420 3970 | **F:** (08) 9420 3193
629 Newcastle Street, Leederville, WA 6007
PO Box 100, Leederville, WA 6902
www.watercorporation.com.au
land.servicing@watercorporation.com.au

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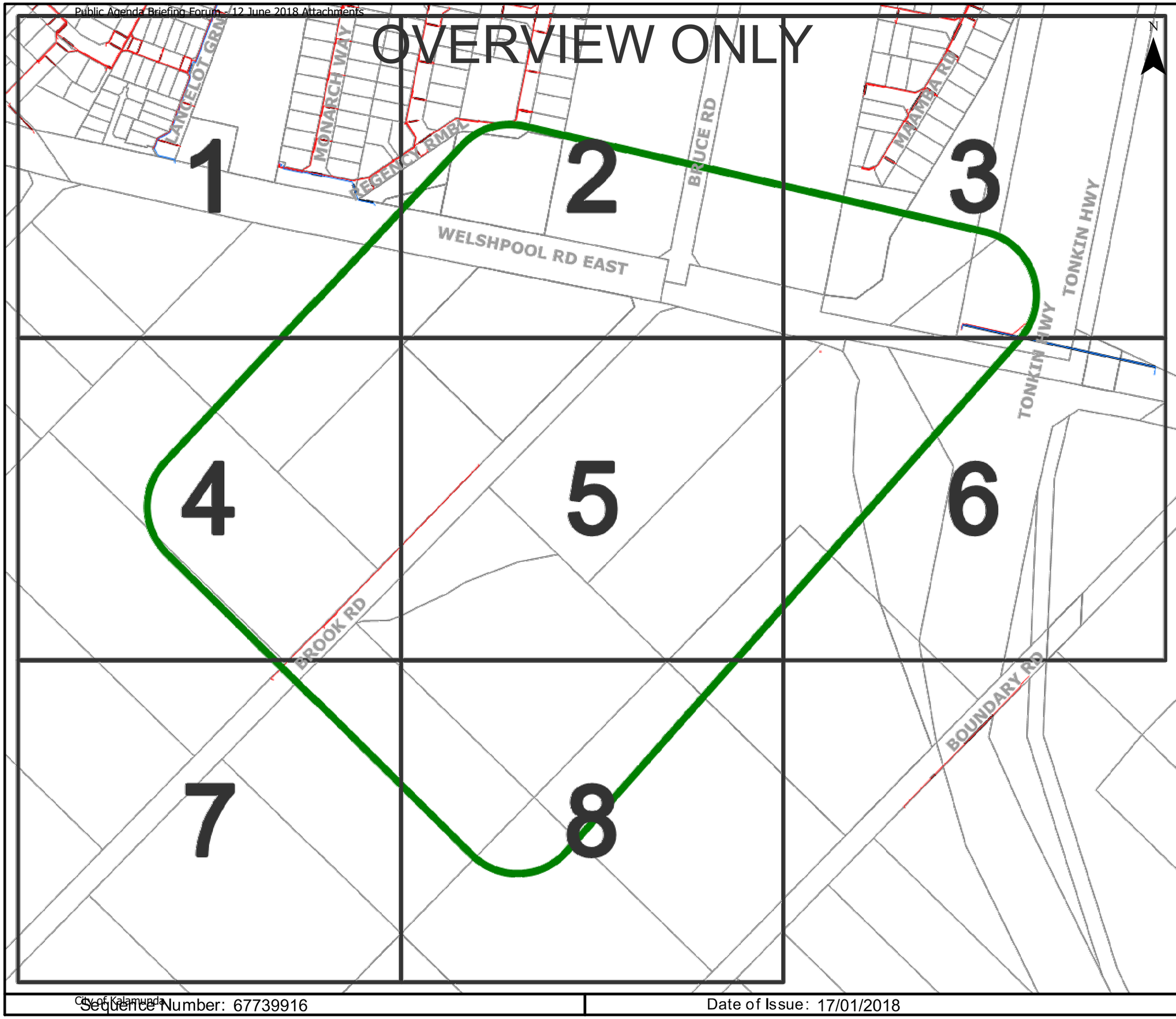
APPENDIX C - WESTERN POWER MAPS

OVERVIEW ONLY



UNDERGROUND LEGEND

Structures

- Pillar
- Metal Pole
- Transformer Site
- UG Crossing *
- Ring Main Unit
- LV Distribution Frame

Distribution Cables

- High Voltage Cable (1kV - 33kV)
- Low Voltage Cable (< 1kV)
- Street Light Circuit (< 1kV)
- Street Light Pilot (< 1kV)
- Earth Wire

Cable Pole Terminations

- HV Termination
- LV Termination

Proposed Construction Assets

- Design Area *
- High Voltage Underground Cable
- Low Voltage Underground Cable
- Metal Pole
- HV Termination
- LV Termination
- Pillar
- Transformer site

State Underground Power Project

- CURRENT Work Area *
- COMPLETED Area *

Feature

- Area of Interest

*** Please refer to coversheet**

Privately owned cables NOT SHOWN (including house services)

This map is INDICATIVE ONLY. Hand exposure via pothole method is MANDATORY.

Telephone Support: 1300 769 345
Mon to Fri - 08:00 to 16:30

Information valid for 30 days from date of issue

A4	Scale : 1:4612

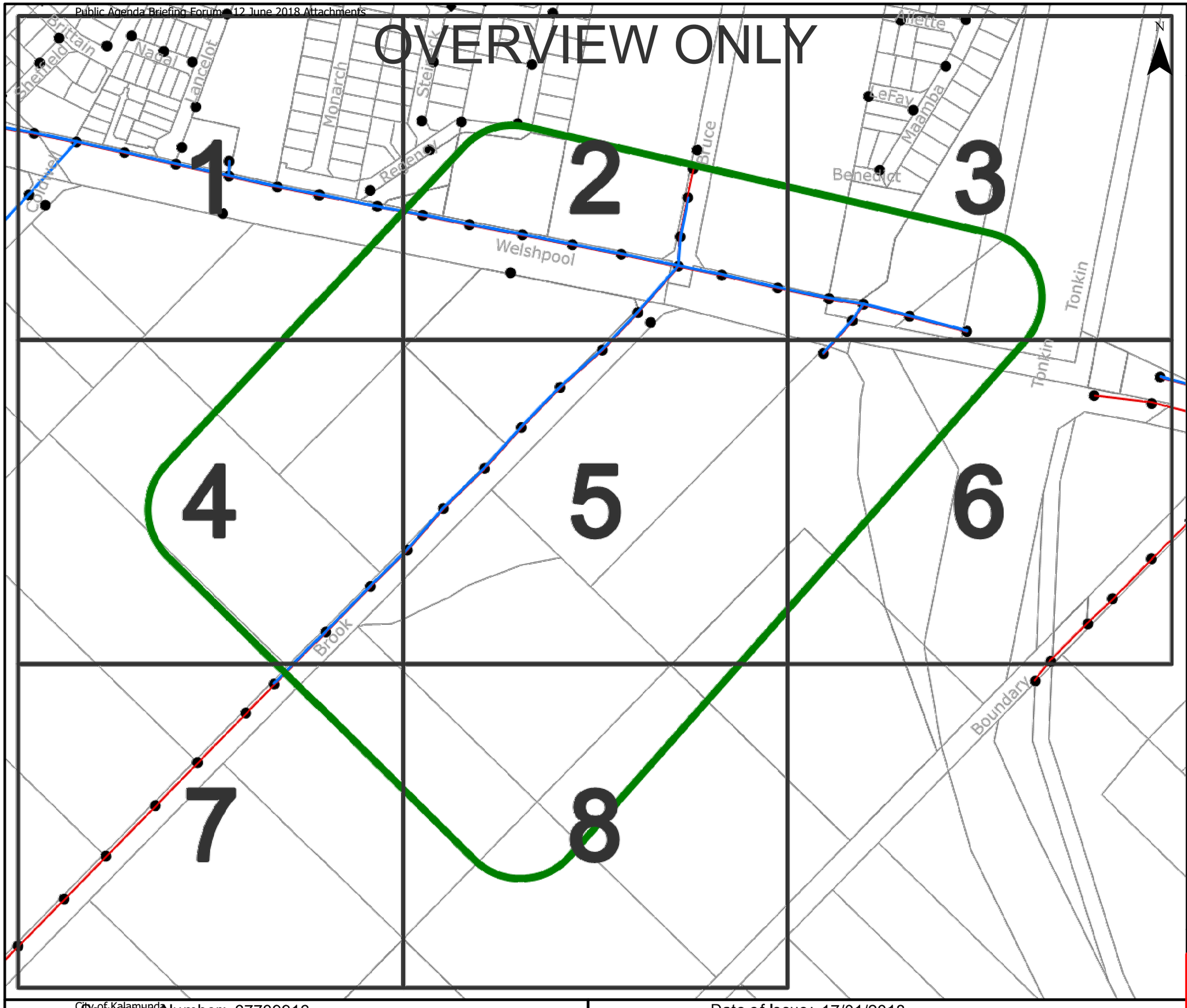
WARNING! Look out for overhead power lines

City of Kalamunda

Sequence Number: 67739916

Date of Issue: 17/01/2018

OVERVIEW ONLY



Attachment 10.1.4.1

westernpower

OVERHEAD LEGEND

Structures

- Power Pole
- Transmission Poles

Transmission Overhead Powerline

- Transmission (33kV - 330kV)

Distribution Overhead Powerline

- High Voltage (1kV - 33kV)
- Low Voltage (< 1kV)

Proposed Construction Assets

- Design Area *
- High Voltage Overhead Powerline
- Low Voltage Overhead Powerline
- Power Pole

Communications Assets

- Overhead Pilot Cable

Feature

- Area of Interest

*** Please refer to coversheet**

Privately owned cables NOT SHOWN (including house services)

This map is INDICATIVE ONLY. Check that you have enough clearance from the DANGER ZONES near overhead powerlines.

Telephone Support: 1300 769 345
Mon to Fri - 08:00 to 16:30

Information valid for 30 days from date of issue

A4	Scale : 1:4612

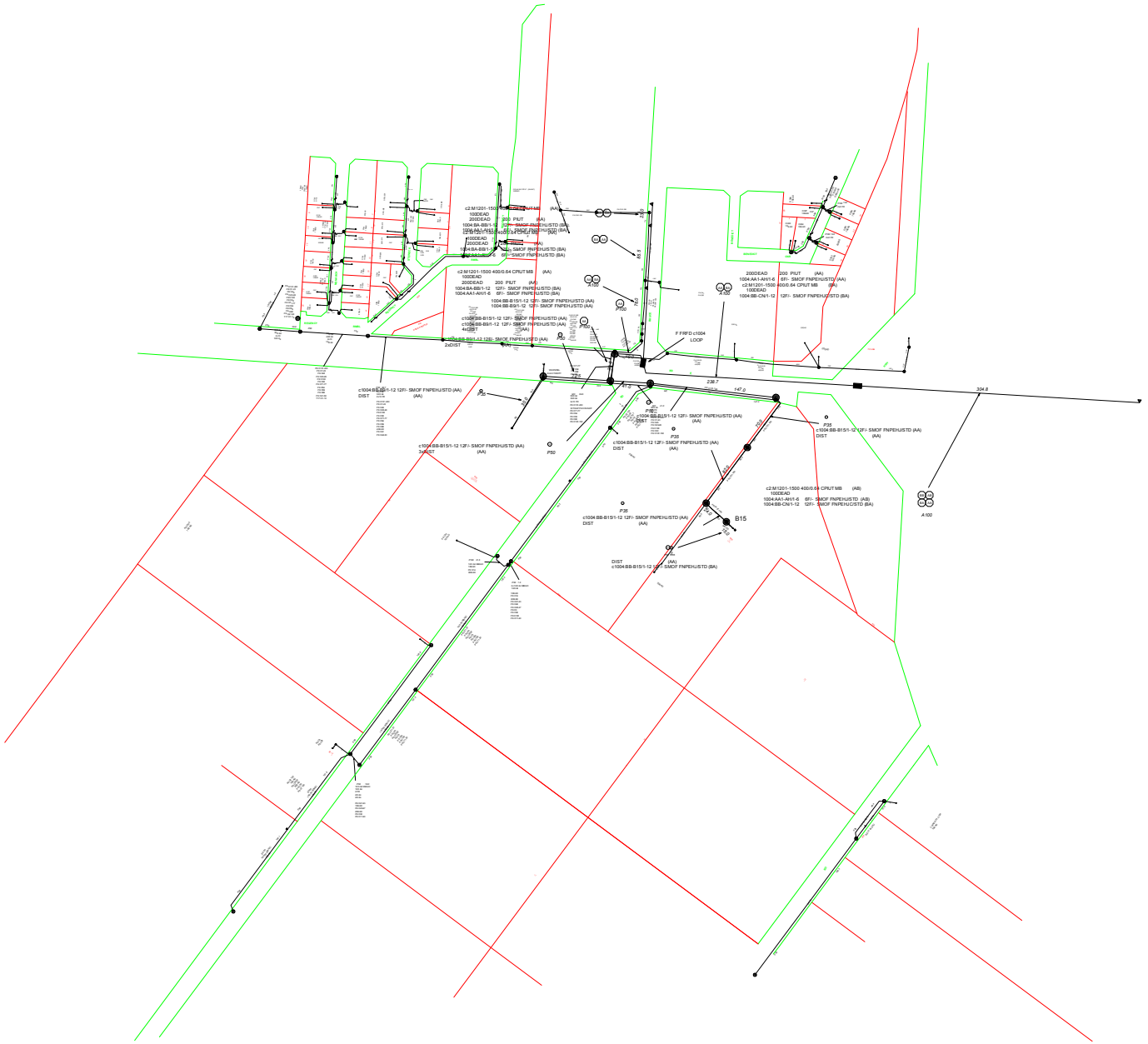
WARNING! Look out for overhead power lines

City of Kalamunda

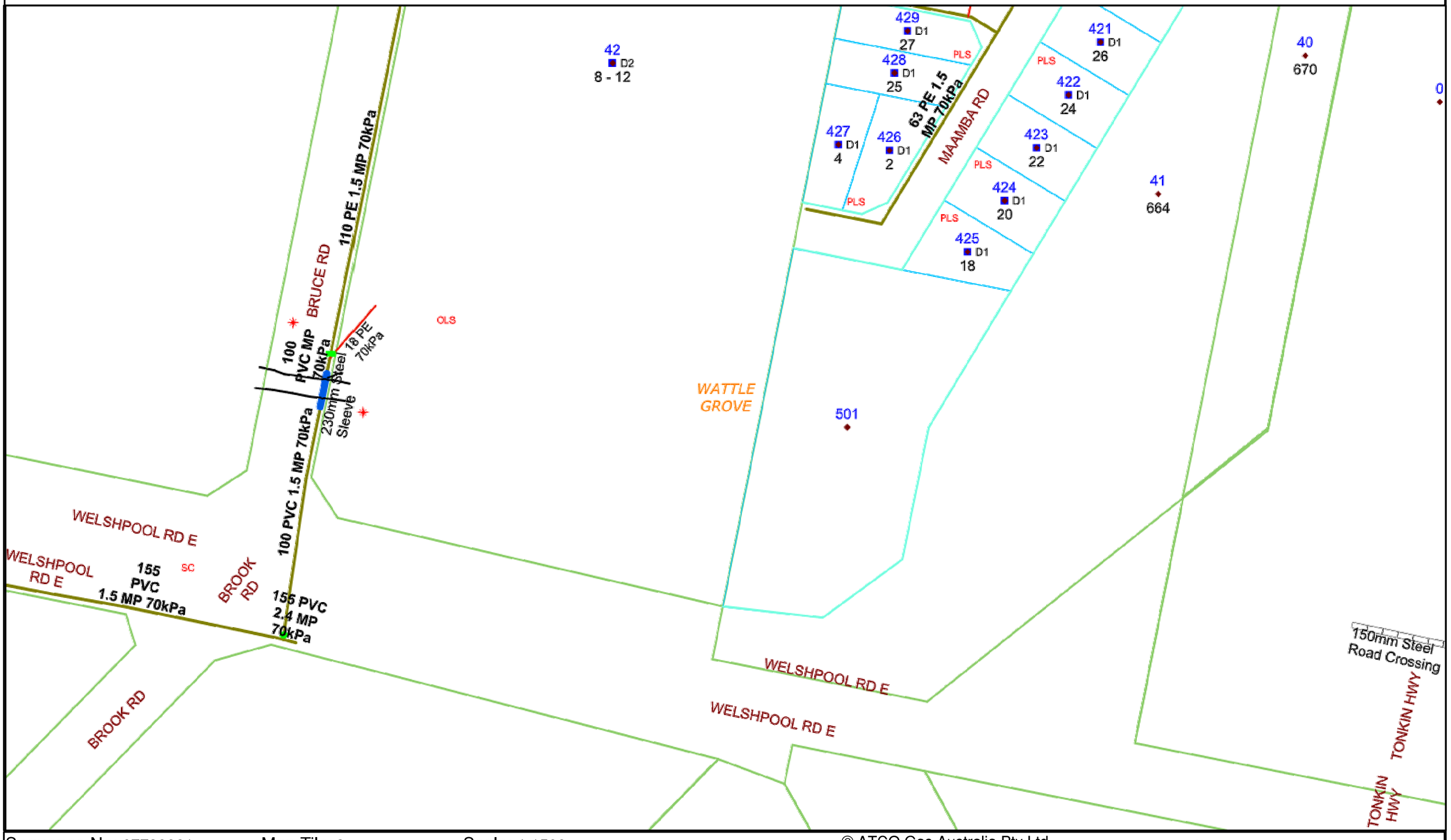
Sequence Number: 67739916

Date of Issue: 17/01/2018

APPENDIX D - TELECOMMUNICATIONS MAPS



APPENDIX E – ATCO GAS MAIN MAP



Sequence No: 67739921 Map Tile: 2 Scale: 1:1500

Job No: 13542933 Date: 17/01/2018 Location: Brook Road, Wattle Grove 6107

© ATCO Gas Australia Pty Ltd
ABN 90 089 531 975

N W E S

ATCO Gas AUSTRALIA

Please read all **warnings**, conditions and information on the attached "Underground Asset Details" information sheet. This plan is issued subject to that information and those conditions and **warnings** (including, but not limited to, the "NO HOT WORKS" warning). Plans are current for only **30 days** from date of request, indicative only and not warranted to be accurate. It is your responsibility to carefully locate underground assets and follow safe work practises and procedures (eg pot-holing). ATCO Gas Australia will seek compensation for damage caused to assets.

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LOCAL PLANNING SCHEME NO. 3

Amendment No. 98

city of kalamunda

Planning and Development Act 2005 (as amended)

RESOLUTION TO ADOPT AMENDMENT TO LOCAL PLANNING SCHEME

CITY OF KALAMUNDA LOCAL PLANNING SCHEME NO. 3

AMENDMENT NO. 98

RESOLVED that the local government, in pursuant to section 75 of the *Planning and Development Act 2005,* of amend the above Local Planning Scheme by:

1. Rezoning Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove from 'Industrial Development' to 'Light Industry', by modifying the Local Planning Scheme No. 3 map in accordance with the attached map.

2. Modifying the boundary of Special Control Area 4 to exclude Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove.

3. Inserting the following new sub-clause 6.1.1(k):

   "*(k) Brook Road Light Industrial Precinct, for which subdivision and development shall be in accordance with clause 6.9 shown on the Scheme map as SCA7"*

4. Amend the scheme map to include a new Special Control Area 7 boundary around Lot 36 (655) Welshpool Road East and Lot 810 (31) Brook Road, Wattle Grove.

5. Inserting the following new Special Control Area as Clause 6.9

   "6.9 BROOK ROAD LIGHT INDUSTRIAL PRECINCT

   6.9.1 Subdivision and/or development proposals within the Special Control Area shall be supported by:

   i. A BAL assessment or Contour Map, prepared in accordance with the Guidelines for Planning in Bushfire Prone Areas (as amended), demonstrating how any bushfire hazards identified can be appropriately managed within the context of the proposal to the satisfaction of the City of Kalamunda.
   ii. A Local Water Management Strategy, prepare in accordance with Better Urban Water Management on the advice of the City of Kalamunda, to the satisfaction of the Department of Water.
   iii. Local Development Plan approved by the City of Kalamunda under Part 6 of the Deemed Provisions for development of land directly fronting Welshpool Road East.
   iv. Design guidelines adopted as a Local Planning Policy by the local government under part 2 of the deemed provisions for development of land on Lots directly fronting Welshpool Road East.

6.9.2 Notwithstanding Table 1, the permissibility of the following use classes within the 'Light Industry' zone within the Special Control Area is to be in accordance with the designation listed below for the purpose of clause 4.3:

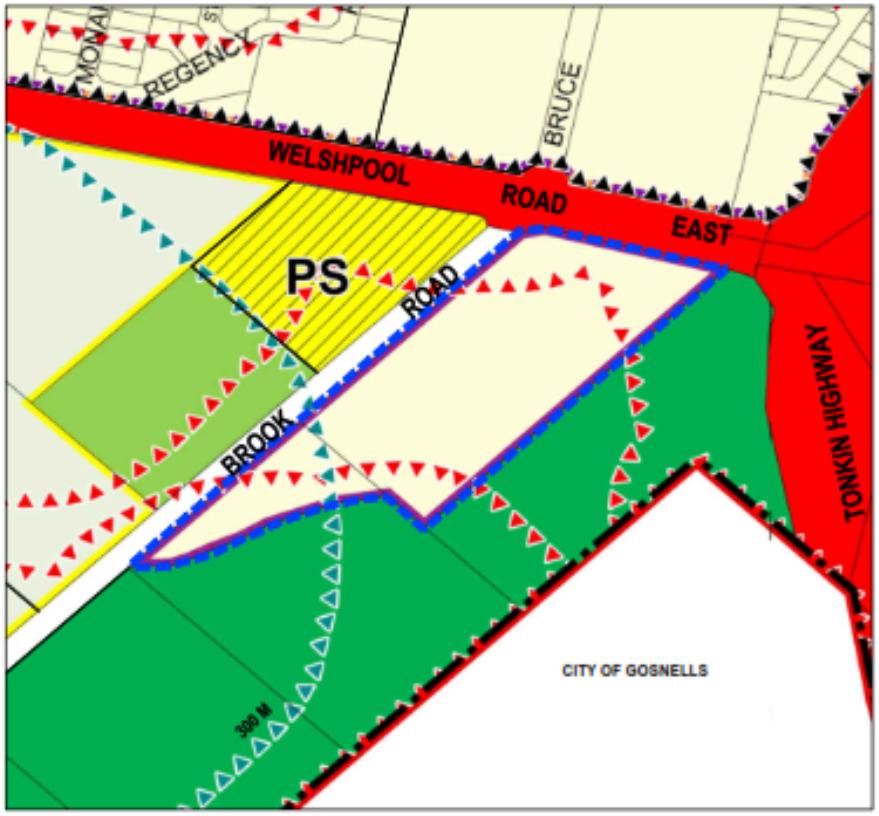
- Motor Vehicle Wrecking – 'X' use
- Resource Recovery Centre – 'X' use
- Salvage Yard – 'X' use
- Storage – 'X' use

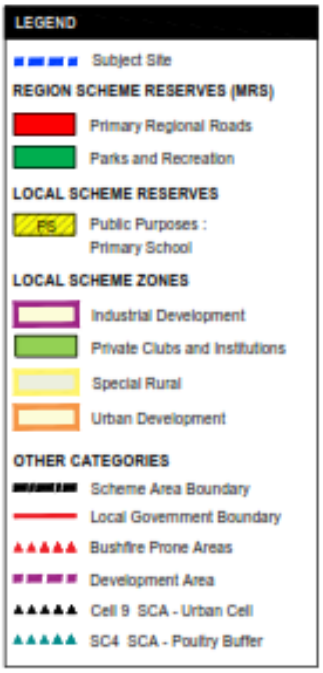
The Amendment is standard under the provisions of the *Planning and Development (Local Planning Schemes) Regulations 2015* for the following reason(s)

a) The Amendment is consistent with the objectives identified in the Scheme for the Light Industry zone.
b) The Amendment is consistent with the City of Kalamunda Local Planning Strategy.
c) The Amendment is consistent with the MRS zoning that applies to the site and the applicable strategic planning framework.
d) The Amendment is considered to have a minimal impact upon the land within the City of Kalamunda, particularly through the provision of a proposed Local Planning Policy to guide subsequent assessment of development applications.
e) The Amendment will not result in any significant environmental, social, economic or governance impacts within the surrounding local area.

Dated this _____ day of _____ 20_____

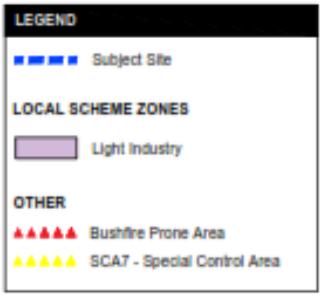
_____
CHIEF EXECUTIVE OFFICER





EXISTING ZONING





PROPOSED ZONING

PLANNING SOLUTIONS | PS

SCALE 1: 5,000 @ A4
DATE 19 March 2018
FILE 02 180319 5328 Zoning Map.dwg
REVISION 4DR/3Rev/19.03.2018
3OW2Rev/11.01.2018
2OW1Rev/08.01.2018

SCHEME AMENDMENT MAP - CITY OF KALAMUNDA
LOCAL PLANNING SCHEME NO.3
LOT 36 (655) WELSHPOOL ROAD EAST AND LOT 810 (31) BROOK ROAD
WATTLE GROVE, WESTERN AUSTRALIA

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Proposed Initiation of Scheme Amendment 79 to Local Planning Scheme No. 3 – Consulting Rooms in the Residential Zone
Existing and Proposed Excerpt of Zoning Table

Existing Zoning Table Excerpt

Use Classes	District Centre	Commercial	Mixed Use	Residential	Residential Bushland	Light Industry	General Industry	Service Station	Private Clubs & Inst.	Special Rural	Rural Composite	Rural Agriculture	Rural Landscape Interest	Rural Conservation	Industrial Development
Consulting Rooms	P	P	P	**X**	X	D	D	X	P	X	X	X	X	X	X

Proposed Zoning Table Excerpt

Use Classes	District Centre	Commercial	Mixed Use	Residential	Residential Bushland	Light Industry	General Industry	Service Station	Private Clubs & Inst.	Special Rural	Rural Composite	Rural Agriculture	Rural Landscape Interest	Rural Conservation	Industrial Development
Consulting Rooms	P	P	P	**A**	X	D	D	X	P	X	X	X	X	X	X

LOCAL PLANNING SCHEME NO. 3

Amendment No. 81

shire of kalamunda

Planning and Development Act 2005 (as amended)

RESOLUTION TO ADOPT AMENDMENT TO LOCAL PLANNING SCHEME

CITY OF KALAMUNDA LOCAL PLANNING SCHEME NO. 3

AMENDMENT NO. 81

RESOLVED that the local government, in pursuant to section 75 of the *Planning and Development Act 2005,* of amend the above Local Planning Scheme by:

1 Modifying Table 1 (Zoning Table) of the Local Planning Scheme No. 3 to modify the use of 'Consulting Rooms' in the Residential zone, as follows:

Use Classes	**District Centre**	**Commercial**	**Mixed Use**	**Residential**	**Residential Bushland**	**Light Industry**	**General Industry**	**Service Station**	**Private Clubs & Inst.**	**Special Rural**	**Rural Composite**	**Rural Agriculture**	**Rural Landscape Interest**	**Rural Conservation**	**Industrial Development**
Consulting Rooms	P	P	P	**A**	X	D	D	X	P	X	X	X	X	X	X

The Amendment is standard under the provisions of the *Planning and Development (Local Planning Schemes) Regulations 2015* for the following reason(s)

a) The Amendment is consistent with the objectives identified in the Scheme for the Residential zone.
b) The Amendment is consistent with the City of Kalamunda Local Planning Strategy.
c) The Amendment is consistent with the MRS zoning that applies to the site, and the applicable strategic planning framework.
d) The Amendment is considered to have a minimal impact upon the land within the City of Kalamunda, particularly through the provision of a proposed Local Planning Policy to guide subsequent assessment of development applications.

e) The Amendment will not result in any significant environmental, social, economic or governance impacts within the surrounding local area.

Dated this _____ day of _____ 20_____

_____
CHIEF EXECUTIVE OFFICER

LOCAL PLANNING SCHEME NO. 3

Amendment No. 81

COUNCIL ADOPTION FOR ADVERTISING

Adopted for advertising by resolution of the Council of the City of Kalamunda at the Ordinary Council Meeting of the Council held on the 29 September 2015.

.....
CITY MAYOR

.....
CHIEF EXECUTIVE OFFICER

COUNCIL RECOMMENDED/SUBMITTED FOR APPROVAL

Supported for submission to the Minister for Planning for approval by resolution of the City of Kalamunda at the Ordinary Meeting of the Council held on the 26 June 2018 and the Common Seal of the City of Kalamunda was hereunto affixed by the authority of a resolution of the Council in the presence of:

.....
CITY MAYOR

.....
CHIEF EXECUTIVE OFFICER

WAPC RECOMMENDED/SUBMITTED FOR APPROVAL

.....
DELEGATED UNDER S.16 OF
THE *PLANNING AND DEVELOPMENT ACT 2005*

DATE.....

APPROVAL GRANTED

.....
MINISTER FOR PLANNING
S.87 OF THE *PLANNING AND DEVELOPMENT ACT 2005*

DATE.....

Summary of Submissions
Amendment No. 81 to Local Planning Scheme No. 3 – Amending the Permissibility of Consulting Rooms in the Residential Zone

Submitter No.	Nature of Submission	Response/ Recommended Modifications
Submission 1	Do not object. This property was originally flagged for an increase in zoning but has since been removed from the rezoning area. We fully support the amendment, provided each application is assessed on its merits, and consulting rooms are encouraged in appropriate locations on major arterial roads such as Kalamunda Road.	Noted.
Submission 2	Do not object. I am a Private Psychologist who has just moved back from Esperance to High Wycombe. I believe there is a need to provide consultancy rooms in this shire for specialists as I am finding it difficult to find somewhere suitable to rent or buy that already exists. Often consultancy rooms are low impact in terms of traffic and noise, especially if situated on a main road. They bring vibrancy, jobs and access to professionals, that otherwise locals need to travel too (out of the shire)	Noted.
Submission 3	Object. I am sure it would be difficult to find a single resident who would want to have consulting rooms approved by council next door. What with up to 10 or 12 car parks, people coming and going all day this use is not appropriate for a residential zone. I cannot believe that the council approved this for advertisement on 14 September 2015 and it is only now being advertised? Knowing that if you live on a residential lot in Kalamunda you can wake up one day to find consulting rooms have been approved next door will certainly make you think twice about living here. It should remain an X or a prohibited use for land zoned residential.	The City of Kalamunda is in the process of preparing a Local Planning Policy to guide the assessment of 'Consulting Rooms' within the Residential zone. The intent of the Local Planning Policy is to ensure the operation of 'Consulting Rooms' in residential areas does not affect or impinge on the prevailing amenity and character of the local area. Nonetheless, proposed to be considered a 'A' use within the Residential zone, any proposals seeking approval for a 'Consulting Room'

Summary of Submissions
Amendment No. 81 to Local Planning Scheme No. 3 – Amending the Permissibility of Consulting Rooms in the Residential Zone

Submitter No.	Nature of Submission	Response/ Recommended Modifications
		within the Residential zone will need to be advertised in accordance with the City of Kalamunda Local Planning Policy regarding public notification of planning proposals, thereby providing adjoining landowners the ability to have their concerns addressed through the development approval process.
DFES	No objection.	Noted.
Department of Aboriginal Affairs	No objection.	Noted.
MAIN ROADS WESTERN AUSTRALIA	No objection.	Noted.

Attachment 2
Applicant's Amendment Report

ALTUS PLANNING & APPEALS

27 April 2017

Chief Executive Officer
Shire of Kalamunda
PO Box 42
KALAMUNDA WA 6926

Dear Sir/Madam,

PROPOSED AMENDMENT TO THE SHIRE OF KALAMUNDA LOCAL PLANNING SCHEME NO. 3 – LOT 601 (NO. 782) WELSHPOOL ROAD EAST, WATTLE GROVE

Please find enclosed planning justification and associated attachments detailing a request for a proposed amendment to the Shire of Kalamunda Local Planning Scheme No. 3. Specifically, the proposal seeks the inclusion of an additional use of 'Reception Centre' to the land located at Lot 601 (No. 782) Welshpool Road East, Wattle Grove that is currently zoned 'Rural Composite'.

Please feel free to contact this office if you have any questions or require any further information regarding this application.

Yours faithfully,

JOE ALGERI
Director

PROPOSED AMENDMENT TO SHIRE OF KALAMUNDA LOCAL PLANNING SCHEME NO. 3 – ADDITIONAL USE

Lot 601 (No. 782) Welshpool Road East, Wattle Grove



Prepared by

ALTUS PLANNING & APPEALS

April 2017

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Prepared for: Rothwood Homestays

Prepared by: Altus Planning & Appeals
68 Canning Highway
SOUTH PERTH WA 6151

Phone: (08) 9470 9447
contact@altusplan.com.au
www.altusplan.com.au

Document Version Control				
Version	**Date**	**Description**	**Author**	**Review**
1	27/04/2017	Initial	BL	JA
2	27/04/2017	Client review	BL	JA

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2.3 Staff 3
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4.0 Conclusion 9

1.0 Background

1.1 Purpose

The following report has been prepared by Altus Planning & Appeals on behalf of Rothwood Homestays ('the Applicant') as the relevant background and planning justification for an amendment to the Shire of Kalamunda ('the Shire') Local Planning Scheme No. 3 ('LPS3').

The purpose of this scheme amendment is to allow for the additional use of 'Reception Centre' ('the proposed amendment' or 'proposal') at Lot 601 (No. 782) Welshpool Road East, Wattle Grove ('the subject land' or 'the site').

Please also find enclosed the following documents:

- Certificate of Title;
- Letter of Landowner Consent;
- Site Plan, scaled to 1:1,000 at A3; and
- Bushfire Management Plan.

1.2 Site Description

The subject land measures approximately 2.0057 hectares and is situated on the north-western side of Welshpool Road East, in the section bound by Crystal Brook Road to the south and Lewis Road to the north-east. The land currently exists with a single residential dwelling that was originally constructed circa 1927 (and subsequently renovated and extended), an adjoining ancillary dwelling or 'granny flat', a swimming pool and a number of outbuildings, all of which are located in the north-western half of the property. It was formerly run as an equestrian centre.

The land is bound to the north/north-west by the Hartfield Country Club, and similar semi-rural properties to the north-east and south/south-west, both of which have been re-subdivided. On the south-eastern boundary is Welshpool Road East; the subject land has direct access onto Welshpool Road East and in fact, the existing crossover and driveway is directly opposite a break in the median strip, allowing for vehicular access and egress in both directions.

In terms of the immediate surrounding locality, there is a distinct change in the character of Welshpool Road East at its intersection with Tonkin Highway with land west of the intersection generally being more industrial or residential whilst east of the intersection is more rural in nature. Furthermore, a variety of uses are currently being conducted along this particular section of Welshpool Road East and include a concrete crushing centre, scrap yard, dog kennels, veterinary centre, tree removalists, and garden centres. There are also a number of undeveloped lots.

Aerial imagery with cadastral overlay of the subject land and immediate surrounding locality is provided at Figure 1 overleaf, with site photos provided at **Attachment 1**.



Figure 1: Aerial with cadastral overlay of subject land and surrounding locality (Source: Landgate Map Viewer 2017)

2.0 Proposal

On 20 August 2015, the Shire granted the Applicant with planning approval to operate a 'Bed and Breakfast' at the subject land for a maximum of six (6) guests, in addition to any persons currently residing at the property.

The proposed scheme amendment would allow for the Applicant to consolidate and diversify the use of the land, better utilising the well-established and manicured garden areas by way of an additional use over the subject land for the purposes of 'Reception Centre'.

More specifically, the proposed amendment would essentially add an incidental use to complement the existing operations with the more specific parameters as outlined below.

2.1 Frequency & Hours of Operation

It is proposed that the 'Reception Centre' would have the ability to operate seven (7) days per week, on an as needs basis, however it is intended that the use would be seasonal (i.e. during the warmer, dryer months of spring and autumn) and that there would be approximately 15 events per year. At all other times, the site would continue to operate as the approved 'Bed and Breakfast'.

Furthermore, it is proposed that all events will have a cut-off time of 11:00pm, except on Sundays when the cut-off time will be 9:00pm.

2.2 Patrons

It is proposed that the 'Reception Centre' would cater for small to medium-sized garden weddings. Furthermore, it is anticipated that the majority of events would attract approximately 50 guests with provision for the maximum number of guests to be capped at 100.

2.3 Staff

It is proposed that the 'Reception Centre' will be purely 'BYO' and will continue to be maintained and run by the caretakers of the existing 'Bed and Breakfast' who will be on hand to assist and tend to matters such as directing traffic to parking areas, enforcing cut-off times, etc.

3.0 Planning Considerations

3.1 Metropolitan Region Scheme

The subject land is zoned 'Rural' pursuant to the Metropolitan Region Scheme ('MRS').

3.2 Shire of Kalamunda Local Planning Scheme No. 3

The subject land is zoned 'Rural Composite' pursuant to the Scheme Map of LPS3 and is also partly contained within the Shire's designated 'Bushfire Prone Area'. An extract of the Scheme Map is provided at Figure 2 overleaf.

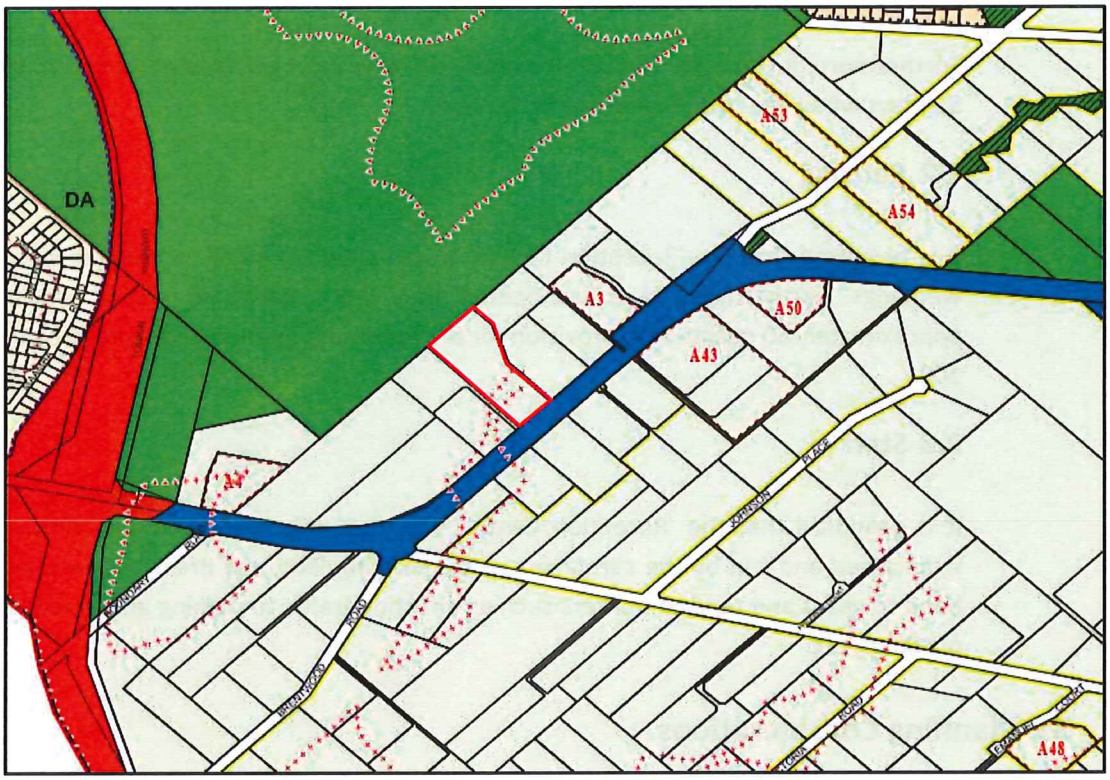


Figure 2: Extract of LPS3 Scheme Map (Source: Department of Planning 2017)

As mentioned, the current approved use for the subject land is 'Bed and Breakfast' which is defined within Scheme 1 of LPS3 as follows:

> ***"bed and breakfast"*** *means a dwelling, used by a resident of the dwelling, to provide accommodation for persons away from their normal place of residence on a commercial basis and includes the provision of breakfast, but does not include a lodging house;*

Whilst the proposed use of 'Reception Centre' is provided with the following definition:

> ***"reception centre"*** *means premises used for functions on formal or ceremonial occasions but not for unhosted use for general entertainment purposes;*

Pursuant to Table 1 – Zoning Table of LPS3, the current approved use of 'Bed and Breakfast' is a 'D' (discretionary) use within the 'Rural Composite' zone and the proposed use of 'Reception Centre' is an 'X' (not permitted) use.

Notwithstanding the above, clause 4.5 of LPS3 provides that:

> *"Despite anything contained in the Zoning Table, the land specified in Schedule 2 may be used for the specific use or uses that are listed in addition to any uses permissible in the zone in which the land is situated subject to the conditions set out in Schedule 2 with respect to that land.*

Note: An additional use is a land use that is permitted on a specific portion of land in addition to the uses already permissible in that zone that applies to the land."

Accordingly, the purpose of the amendment is to include 'Reception Centre' as an additional use on the subject land.

In accordance with clause 4.2.2 of LPS3, the objectives for the 'Rural Composite' zone are stated as follows:

"To provide for small semi-rural lots that can accommodate a limited range of rural and low scale commercial land uses in a manner that will not adversely affect the landscape and environmental qualities of the land and are appropriate to the area."

Having regard to the above, we submit that the proposed amendment is of a scale that will not adversely affect the landscape and environmental qualities of the area, particularly given the variety of uses being conducted in the surrounding area. If anything, the proposed amendment would serve as an incentive for the existing well maintained and aesthetically pleasing garden areas onsite to be maintained.

Clause 5.13 outlines the general development requirements for the 'Rural Composite' zone and states that:

"In this zone it is recognised that there is a mix of semi-rural and commercial land uses which the local government seeks to maintain as a balance in a rural setting. Commercial land uses within the zone will only be considered for approval when it has been demonstrated that the use is appropriate to the area and that the commercial activity will not have a detrimental impact on the surrounding area."

Clause 5.13.1 outlines provisions relating to the subdivision of land which are not relevant in this instance. Clause 5.13.2 outlines provisions relating to land use and development which are addressed below.

(i) The minimum setback for structures or buildings from lot boundaries in this zone shall be as per Table 2, unless otherwise approved by the local government.

Not applicable; no new structures or buildings are proposed as part of the proposed amendment.

(ii) With the exception of boundary or other fencing that complies with Local Laws or Policy adopted by the local government, no boundary or other fence shall be erected in a Rural Composite zone without the approval of the local government having first been obtained. In making its decision on applications for approval to erect a fence, the local government shall take into consideration the aesthetic impact of the fence on the environment of the Rural Composite zone.

Not applicable; no new fencing is proposed as part of the proposed amendment.

(iii) The use of fibre cement sheeting, wooden pickets and metal sheeting as fencing material is not permitted, unless specifically approved by the local government.

Not applicable; again, no new fencing is proposed as part of the proposed amendment.

(iv) In order to conserve the environment, trees shall be retained unless their removal is approved by the local government.

No further development is proposed as part of this amendment and therefore no trees are proposed to be removed.

(v) In order to enhance the rural amenity of the land, in areas deficient of tree cover, it may be required as a condition of any planning approval or building permit issued in these areas, the owner to plant and maintain such trees and/or groups of trees as specified by the local government.

It is considered that the existing development and tree cover already makes a positive contribution to the rural amenity of the locality, perhaps even more so than the immediate surrounding properties.

(vi) The clearing of natural vegetation will be permitted only in accordance with clause 5.18 'Tree and Vegetation Preservation' of the Scheme.

Again, no clearing of vegetation is proposed as part of this amendment.

(vii) The keeping of animals in the Zone is subject to the specific written approval of the local government and will be assessed on an investigation of each property. Approval will be given where the land is capable of supporting the number of animals applied for having regard to the specific land management practices proposed to be implemented by the applicant. The keeping of animals will be in accordance with the provisions of clause 5.17 'Rural Pursuit' of the Scheme.

Not applicable; whilst some horses are currently being kept on-site, there is no association to the proposed amendment.

(viii) Commercial development proposals will only be considered in accordance with clause 5.14 'Commercial Zones' of the Scheme. In addition, the following development requirements will apply:

(a) the maximum amount of net lettable area (NLA) is 300m2;

(b) A separate landscaping plan will be required for any commercial proposal. Extensive landscaping will be required to screen:

- *parking areas from the road and from adjoining properties.*
- *non-residential buildings from adjoining properties;*

(c) the use of land outside any building for the display, sale or storage of materials, goods or equipment, will require the prior approval of the local government; and

(d) planning approval will be required for all signs located on land.

The proposed amendment is to simply formalise an incidental use which complements the current approved use of 'Bed and Breakfast' and no further commercial development by way of built form is proposed. It is proposed that the parking area will be located on the north-eastern side of the existing driveway and the Applicant has indicated a willingness to provide landscaping screening through the development stage to ensure there are no adverse impacts on the adjoining property.

Additionally, it is noted that the existing dwelling is listed within the Shire's Municipal Heritage Inventory 2015 as Place No: 183 – Formerly Taylor's Home and is contained within Management Category No. D as being of 'Little' significance (refer to **Attachment 2**). Whilst the Applicant has some reservation about the nature of this heritage listing, one of the advantages of the proposed amendment is that the dwelling would potentially be exposed to a broader section of the public.

In terms of parking requirements, Table 3 outlines the following in relation to a 'Reception Centre':

> *"1 bay for every 4 persons to be accommodated, or 1 bay for every 5 square metres of dining area, whichever is the greater."*

Accordingly, based on a maximum attendance of 100 persons, the 'Reception Centre' (which would be subject to a development application) would require 25 parking bays. The enclosed concept plan illustrates that such a requirement is achievable on the subject land and can be further refined, if necessary, as part of the development stage.

As mentioned, the subject land is also contained within the Shire's 'Bushfire Prone Areas' Special Control Area ('SCA') and clause 6.7 of LPS3 outlines provisions for the SCA. Notwithstanding that these provisions relate to applications for planning approval (not scheme amendments) and make reference to the former versions of the application State Planning Policy and associated Planning for Bush Fire Protection Guidelines, a Bushfire Management Plan ('BMP') has been prepared to accompany this submission and is addressed further in the following section.

3.3 State Planning Policy 3.7: Planning in Bushfire Prone Areas

In accordance with the Map of Bush Fire Prone Areas on the Department of Fire and Emergency Services ('DFES') website, the subject land is partly located within a State designated bushfire prone area (refer to Figure 3).



Figure 3: Extract of Map of Bush Fire Prone Areas (Source: DFES 2016)

Accordingly and as previously mentioned, a BMP has been prepared by Smith Consulting to support the proposed amendment in accordance with the requirements of State Planning Policy 3.7: Planning in Bushfire Prone Areas ('SPP3.7') and the associated Guidelines for Planning in Bushfire Prone Areas (Version 1.1). A copy of the BMP is appended to this submission.

The BMP outlines that whilst the land is situated within a designated bushfire prone area, the assessed bushfire risk is considered manageable subject to the bushfire risk management measures contained within.

Specifically, the proposed use has been deemed to have addressed all applicable legislation, policy, standards and guidelines including the four elements of the Bushfire Protection Criteria of location, siting and design, vehicular access and firefighting water supply.

4.0 Conclusion

The proposed scheme amendment is to allow the additional use of 'Reception Centre' to be granted for the 'Rural Composite' zoned land located at Lot 601 (No. 782) Welshpool Road East, Wattle Grove. The subject land currently has approval for a 'Bed and Breakfast' which was granted in 2015.

It is submitted that the subject land would be an ideal location for and could suitably accommodate a Reception Centre given the size and layout of the land as well as its direct (and full) access to Welshpool Road East. Furthermore, the nature, scale and frequency of the events are such that it will not have any adverse impacts on the surrounding area and in fact, the amendment would provide an incentive for the landowner to maintain his well-manicured and established garden setting, as well as the heritage listed dwelling, all of which is considered to have a positive impact on the amenity of the locality.

For the reasons outlined within this report, it is our view that such an amendment on the subject land is consistent with the objectives and requirements of the Shire's LPS3, and that it will not prejudice any future planning pursuits of the land or the general locality, nor will it have a detrimental impact on the surrounding area.

It is noted that should this amendment be initiated and approved the land will still be subject to a development application that addresses the specific parameters of a particular proposal for the Shire's consideration.

It is submitted that the proposal is minor in nature and complements the existing use of the land without any detrimental impact on the amenity of the locality.

I trust this information is to your satisfaction, we otherwise look forward to your favourable determination.

Altus Planning & Appeals

Attachment 1



Photo 1: Entrance to subject land from Welshpool Road East



Photo 2: Caretaker's dwelling



Photo 3: 'Bed and Breakfast' (B&B) dwelling and swimming pool



Photo 4: Garden area and shed immediately to the north-west of the B&B



Photo 5: View towards the rear garden area where wedding ceremonies are likely to be conducted



Photo 6: South-eastern view from the property boundary (adjacent to Hartfield Country Club) back towards the B&B and associated garden areas



Photo 7: Existing guest parking area



Photo 8: View toward Welshpool Road East of the existing driveway and proposed parking area (LHS)

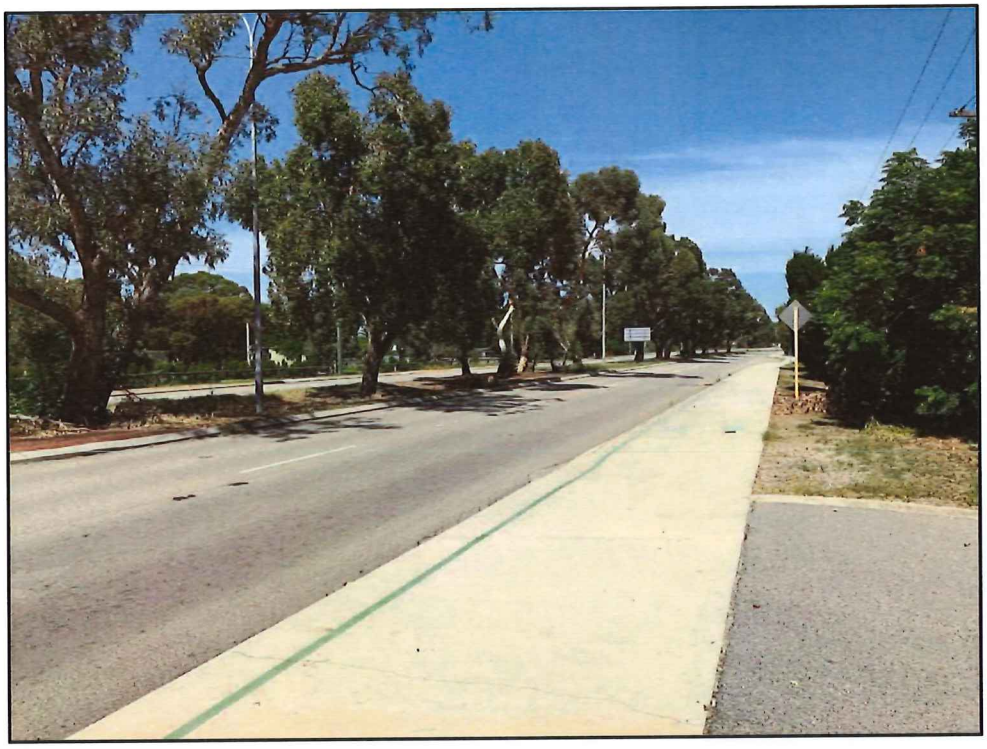


Photo 9: South-western view along Welshpool Road East from the site's existing crossover

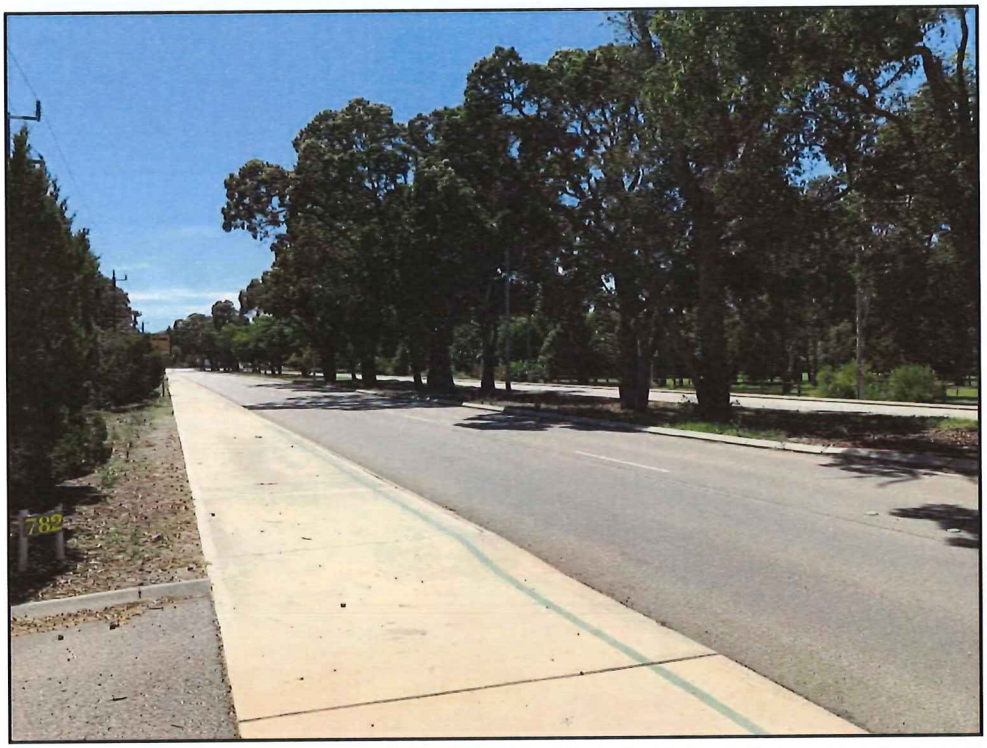


Photo 10: North-eastern view along Welshpool Road East from the site's existing crossover

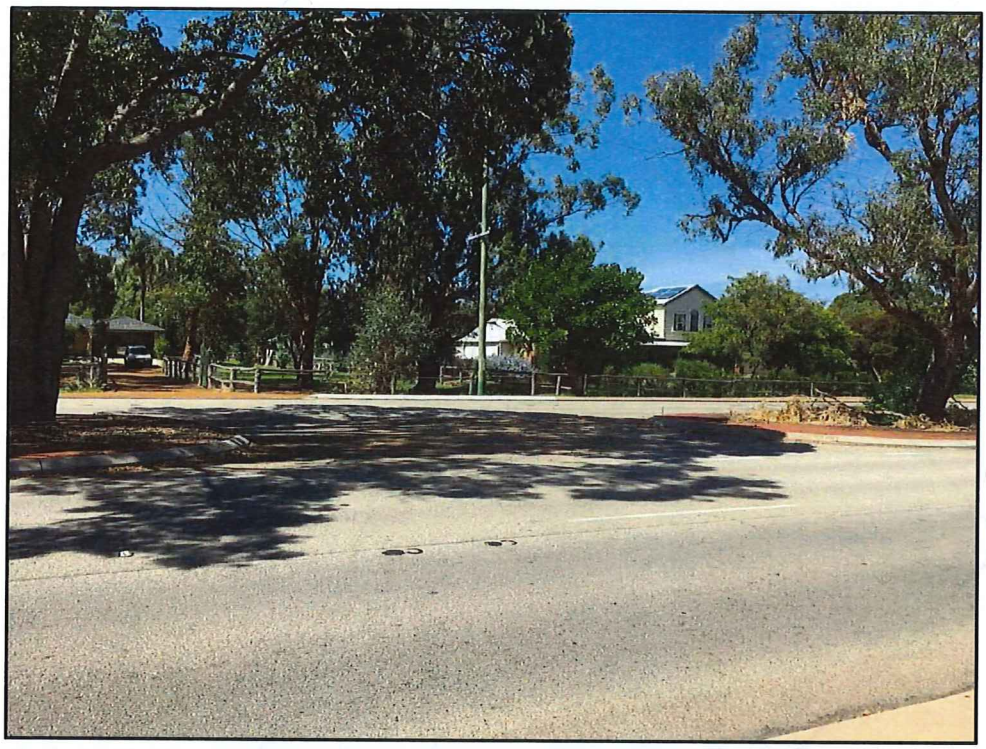
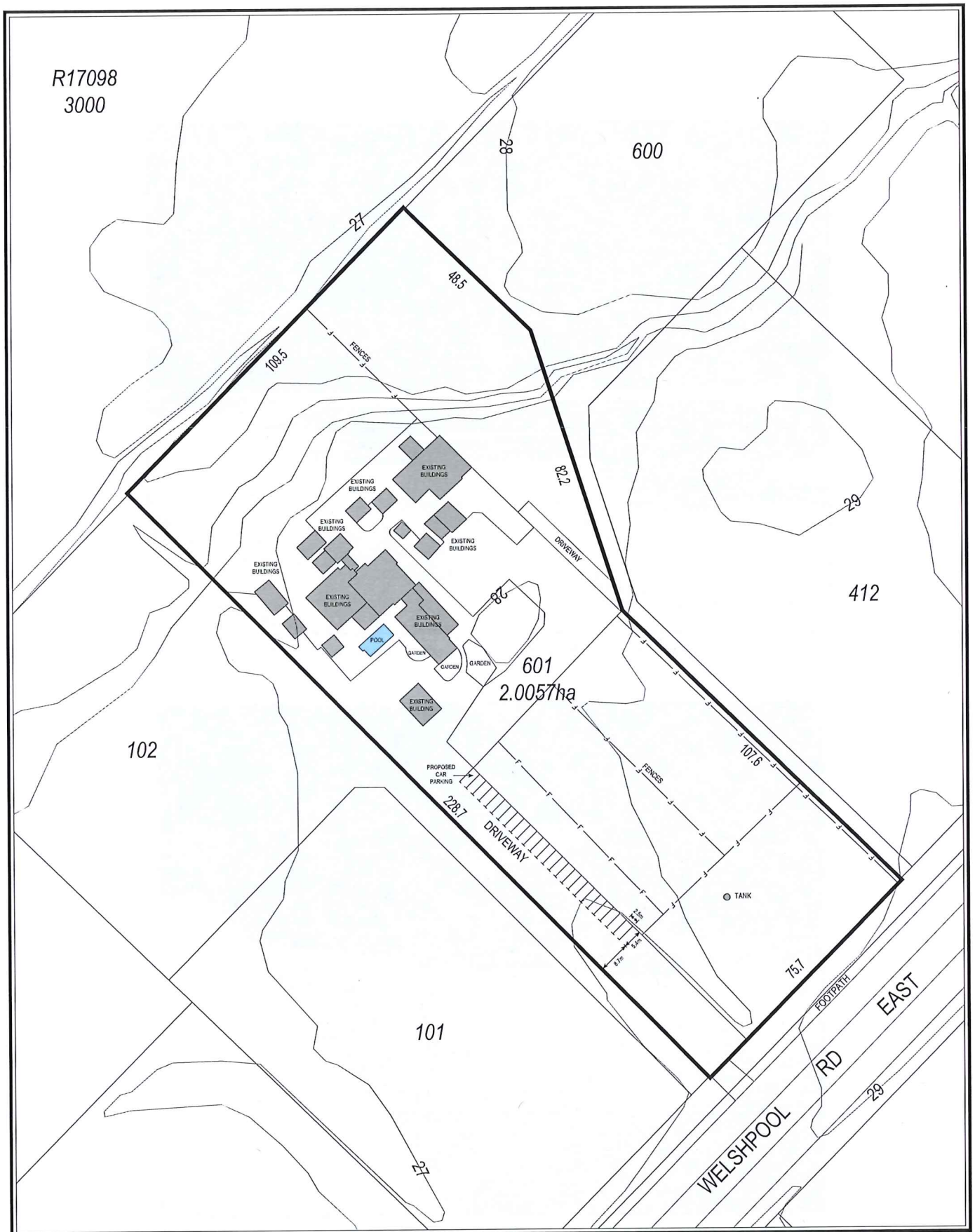


Photo 11: Break in the Welshpool Road East median strip, directly opposite the site's existing crossover



Photo 12: View of the existing crossover servicing the subject land and adjoining property



0 10 20 30 40m
SCALE 1:1000
ORIGINAL PLAN SIZE: A3

Base Mapping Prepared By Landgate	DATE: 13.03.2017	REV 1

NORTH

ALTUS PLANNING & APPEALS

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LEGEND:
Subject Land.....

NOTE: Areas and dimensions are subject to survey.

DISCLAIMER: This plan has been prepared under instruction of the client, Altus Planning & Appeals bears no responsibility for any inaccuracies or errors.

SITE PLAN

LOT 601 (No. 782) WELSHPOOL ROAD EAST
WATTLE GROVE
Shire of Kalamunda

WESTERN AUSTRALIA

REGISTER NUMBER	
601/DP53453	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1 (NDI)	24/1/2008

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 2681 FOLIO 281

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 601 ON DEPOSITED PLAN 53453

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

KEVIN ERNEST BENNETT OF 782 WELSHPOOL ROAD EAST, WATTLE GROVE

(T M263230) REGISTERED 6/5/2013

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. EASEMENT BURDEN CREATED UNDER SECTION 27A OF T. P. & D. ACT - SEE DEPOSITED PLAN 53453 - AS CREATED ON DIAGRAM 83603.
2. *J402479 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. AS TO PORTION DELINEATED "A" ON DEPOSITED PLAN 53453 ONLY. LODGED 25/8/2005.
3. *M263231 MORTGAGE TO COMMONWEALTH BANK OF AUSTRALIA REGISTERED 6/5/2013.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP53453
PREVIOUS TITLE:	1505-576, 2599-368
PROPERTY STREET ADDRESS:	782 WELSHPOOL RD EAST, WATTLE GROVE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF KALAMUNDA

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING M263231.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Wed Mar 8 09:21:29 2017 JOB 53332386

Landgate
www.landgate.wa.gov.au

8 March 2017

Chief Executive Officer
Shire of Kalamunda
PO Box 42
KALAMUNDA WA 6926

Attention: Planning Administration

Dear Sir/Madam,

RE – CONSENT OF LANDOWNER/S

I refer to the enclosed application to initiate an amendment to the Shire of Kalamunda's Local Planning Scheme No. 3 as it relates to the land located at Lot 601 (No. 782) Welshpool Road East, Wattle Grove, more fully described as Lot 601 on Deposited Plan 53453 contained within Certificate of Title Volume 2681 Folio 281 (**"the Application"**).

This application has been made by Altus Planning & Appeals in the capacity of planning consultant to the landowner.

The following person is recorded as the owner of the land:

1. Kevin Ernest Bennett

I, the abovementioned person, hereby consent to the Application being made in relation to the land described above. Furthermore, I have appointed Altus Planning & Appeals to act for me as my authorised representative.

Signature

Kevin Ernest Bennett

TRANSPORT IMPACT STATEMENT

PROPOSED AMENDMENT TO SHIRE OF KALAMUNDA LOCAL PLANNING SCHEME NO. 3 – ADDITIONAL USE

Lot 601 (No. 782) Welshpool Road East, Wattle Grove

Prepared by

ALTUS PLANNING & APPEALS

June 2017

Disclaimer

This report has been prepared by Altus Planning & Appeals solely for the benefit and use of the client.

This document may not be reproduced or copied in whole or part without the express written consent of Altus Planning & Appeals and the client.

Prepared for: Rothwood Homestays

Prepared by: Altus Planning & Appeals
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SOUTH PERTH WA 6151

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Version	**Date**	**Description**	**Author**	**Review**
1	19/06/17	Initial	BL	JA

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1.0 Background

1.1 Purpose

The following Transport Impact Statement has been prepared by Altus Planning & Appeals on behalf of Rothwood Homestays ('the Applicant') to support the proposed amendment to the Shire of Kalamunda ('the Shire') Local Planning Scheme No. 3 ('LPS3'). Specifically, the purpose of the scheme amendment request is to allow for the additional use of 'Reception Centre' ('the proposed amendment' or 'proposal') at Lot 601 (No. 782) Welshpool Road East, Wattle Grove ('the subject land' or 'the site').

The scheme amendment request was lodged with the Shire on 27 April 2017 and is currently under assessment (Shire reference: IE-199863). The purpose of this Transport Impact Statement is to provide a non-technical statement of the transport aspects of the proposal in accordance with the Western Australian Planning Commission's ('WAPC') Transport Impact Assessment Guidelines (Revised August 2016) ('TIA Guidelines').

1.2 Site Description

The subject land is zoned 'Rural Composite' pursuant to the Scheme Map of LPS3, it measures approximately 2.0057 hectares and is situated on the north-western side of Welshpool Road East, in the section bound by Crystal Brook Road to the south and Lewis Road to the north-east. The land currently exists with a single residential dwelling, an adjoining ancillary dwelling or 'granny flat', a swimming pool and a number of outbuildings, all of which are located in the north-western half of the property.

The land is bound to the north/north-west by the Hartfield Country Club, and similar semi-rural properties to the north-east and south/south-west, both of which have been re-subdivided. On the south-eastern boundary is Welshpool Road East; the subject land has direct access onto Welshpool Road East and in fact, the existing crossover and driveway is directly opposite a break in the median strip, allowing for vehicular access and egress in both directions.

In terms of the immediate surrounding locality, a variety of uses are currently being conducted along this particular section of Welshpool Road East and include a concrete crushing centre, scrap yard, dog kennels, veterinary centre, tree removalists, and garden centres. There are also a number of undeveloped lots.

Aerial imagery with cadastral overlay of the subject land and immediate surrounding locality is provided at Figure 1 overleaf.



Figure 1: Aerial with cadastral overlay of subject land and surrounding locality (Source: Landgate Map Viewer 2017)

2.0 Western Australian Planning Commission Transport Impact Assessment Guidelines

The WAPC's TIA Guidelines have been prepared to assist with the assessment of transport planning implications for land use development proposals. The TIA Guidelines identify which type of development proposals require supporting transport information, the level of information that is required, and the format in which it is to be presented.

Table 1 of the TIA Guidelines outlines the level of assessment required based on the size and nature of various land use categories (refer to Figure 2 overleaf).

LAND USE	MODERATE IMPACT	HIGH IMPACT
	Transport Impact Statement required	Transport Impact Assessment required
	10 – 100 vehicle trips in the peak hour	> 100 vehicle trips in the peak hour
Residential	10–100 dwellings	>100 dwellings
Schools	10–100 students	>100 students
Entertainment venues, restaurants, etc.	100–1000 persons (seats) OR 200–2000 m² gross floor area	>1000 persons (seats) OR >2000 m² gross floor area
Fast food restaurants	50–500 m² gross floor area	>500 m² gross floor area
Food retail /Shopping centres with a significant food retail content	100–1000 m² gross floor area	>1000 m² gross floor area
Non-food retail	250–2500 m² gross floor area	>2500 m² gross floor area
Offices	500–5000 m² gross floor area	>5000 m² gross floor area
Service Station	1–7 refuelling positions	>7 refuelling positions
Industrial/Warehouse	1000–10,000 m² gross floor area	>10,000 m² gross floor area
Other Uses	Discuss with approving authority	Discuss with approving authority

Figure 2: Level of TIA required by land use and size (Source: WAPC TIA Guidelines 2016)

The proposed amendment seeks to introduce a 'Reception Centre' at the subject land which would fall within the 'Entertainment Venue' land use category and due to the proposed cap of 100 patrons, is considered to be of 'Moderate Impact' in accordance with the abovementioned table. Accordingly, a Transport Impact Statement is required.

In accordance with Part B, Section 1 of the TIA Guidelines (Volume 4), the purpose of a Transport Impact Statement is to provide the approving authority with support information to confirm that the transport aspect of the proposal has been adequately considered and that the proposal will not have an adverse transport impact on the surrounding area. It is expected that it will mostly contain non-technical information and will not require input from a specialist transport planner and/or engineer.

Furthermore, Section 3 outlines the area that is to be covered by the Transport Impact Statement, including:

- the proposed development site;
- all roads fronting the site, for the extent of the site frontage plus 100 metres beyond the site;
- pedestrian routes to the nearest bus stops (for all bus routes passing within 400 metres of the site);
- pedestrian routes to nearest train station(s) (if within 800 metres);
- pedestrian/cycle routes to any major attractors within 400 metres, (five-minute walk) of the site, for example, for a small residential development attractors could be a corner shop, the primary school and the nearby park; and

- the area(s) likely to be affected by the site specific issue(s).

Section 5 outlines the required content of the Transport Impact Statement and the remainder of this report will be structured similarly to cover all aspects identified under the TIA Guidelines.

3.0 Transport Impact Statement

3.1 Proposed Development

The proposal seeks to amend the Shire's LPS3 to allow for an additional use of 'Reception Centre' at the subject land which currently has approval to operate as a 'Bed and Breakfast' for a maximum of six (6) guests in addition to any persons residing at the property.

More specifically, the proposed scheme amendment would allow for the Applicant to consolidate and diversify the use of the land, better utilising the well-established and manicured garden areas for the purposes of 'Reception Centre', catering for a maximum of 100 persons. It would essentially add an incidental use to complement to the existing operations.

Whilst the 'Reception Centre' would be subject to a development application upon gazettal of the Scheme Amendment, the concept/site plan contained at **Attachment 1** illustrates that the Shire's requirement to provide 25 parking bays can be accommodated along the existing driveway.

3.2 Vehicle Access and Parking

Vehicle access to the subject land and the proposed Reception Centre is obtained via the existing 15m wide crossover which is shared with Lot 101 (No. 774) Welshpool Road East, the adjoining property to the south-west. The crossover is directly opposite the break in the median strip on Welshpool Road East, providing access and egress in both directions.

Extending from the crossover to the developed (north-western) portion of the land is a 14.1m wide gravel access leg. It is proposed that along the fence line of the driveway, 25 x 90 degree car parking bays can be accommodated, each measuring 2.5m x 5.4m, whilst still providing an 8.7m wide aisle/thoroughfare along the south-western boundary of the land (refer to **Attachment 1**).

3.3 Provision of Service Vehicles

The amount of service/delivery vehicle traffic for the proposal is considered minimal. All necessary chairs and tables are permanently stored on-site and therefore do not amount to any additional traffic accessing the site. On the day of the event, only one (1) service vehicle is ordinarily anticipated for a pop-up style food van or other catering van, depending on the

client's arrangement. Other set-up services such as a florist would deliver the day prior and pick up a day after the event.

In all, it is anticipated that each event will attract 3-4 deliveries, primarily by commercial vans/utes, with access gained via the existing driveway. These vehicles are able to drive the length of the driveway to the rear garden area and utilise the turnaround area that exists between the pool and the southernmost outbuilding.

3.4 Hours of Operation

It is proposed that the 'Reception Centre' would have the ability to operate seven (7) days per week, on an as needs basis, however it is intended that the use would be seasonal (i.e. during the warmer, dryer months of spring and autumn) and that there would be approximately 15 events per year. At all other times, the site would continue to operate as the approved 'Bed and Breakfast'.

Furthermore, it is proposed that all events will have a cut-off time of 11:00pm, except on Sundays when the cut-off time will be 9:00pm.

3.5 Daily Traffic Volumes and Vehicle Types

Welshpool Road East is classified as an 'Other Regional Road' pursuant to the Metropolitan Region Scheme ('MRS'). Furthermore, in accordance with Main Roads Western Australia's ('MRWA') Road Information Mapping System, Welshpool Road East is classified as a 'Distributor A' road east of the Tonkin Highway intersection.

According to MRWA's Traffic Map, Welshpool Road East (east of Tonkin Highway) averaged 16,299 vehicles per day ('VPD') across Monday to Sunday in 2013/14, with approximately 9.0% (or 1,597) being heavy vehicles.

MRWA's 'Road Hierarchy for Western Australia – Road Types and Criteria' document outlines different road classifications and characteristics. It is identified that the predominant purpose of a 'District Distributor A' road is to cater for high capacity traffic movements between industrial, commercial and residential areas, and that the indicative traffic volume for a 'District Distributor A' road is above 8,000 VPD. Catering for approximately 15 event days per year and with a cap of 100 persons per event, it is considered that Welshpool Road East can sufficiently accommodate the proposal.

3.6 Traffic Management on the Frontage Streets

East of its intersection with Tonkin Highway, Welshpool Road East is a dual carriageway 'District Distributor A' road with a posted speed limit of 80km/h. Its eastbound and westbound lanes separated by a median strip and as previously mentioned, directly opposite

the subject land's crossover is a break in the median strip which allows access and egress movements in both directions.

A shared path with a width of approximately 3m exists along the north-western side of Welshpool Road East, being the same side as the subject land.

Similar to the subject land, the surrounding properties have direct vehicular access onto Welshpool Road East but due to the existence of the median strip, not all can achieve access and egress movements in both directions.

3.7 Public Transport Access

Bus Stop No: 13683 exists approximately 132m to the south-west of the subject land and Bus Stop No: 13684 exists approximately 264m to the north-east (refer to Figure 3 below). These bus stops can be accessed from the subject land utilising the shared path along the north-western side of Welshpool Road East.

Bus Stop No: 13694 exists approximately 165m to the north-east of the subject land (refer to Figure 3 below). Pedestrian access to and from the subject land would require crossing Welshpool Road East (utilising the median strip) however it is noted that there are no designated crossing points.

These bus stops provide services travelling between the Kalamunda Bus Station and the Elizabeth Quay Bus Station.



Figure 3: Nearby bus stops (Source: Department of Planning's PlanWA 2017)

The closest train station to the subject land is Kenwick Station which is approximately 4.5km to the south-west, as the crow flies.

3.8 Pedestrian Access

As previously mentioned, a shared (pedestrian and cycle path) exists along the north-western side of Welshpool Road East, providing safe and convenient access from the aforementioned bus stops. Given the nature of the proposed use and its siting amongst a variety of rural and industrial-type land uses, it is considered that there are no other major attractors for pedestrians to access within 400m of the subject land.

3.9 Cycle Access

Similarly, the shared path on the north-western side of Welshpool Road East provides safe and convenient cycle access to and from the subject land for any patrons/visitors choosing to cycle.

3.10 Site Specific Issues

It is submitted that the subject land would be an ideal location for and could suitably accommodate a Reception Centre given the size and layout of the land as well as its direct (and full) access to Welshpool Road East and its accessibility by public transport. Furthermore, the nature, scale and frequency of the events are such that it will not have any adverse impacts on the surrounding area, particularly by way of traffic.

3.11 Safety Issues

Having regard to matters such as the subject land's direct and full access onto Welshpool Road East, the capacity of the road, the existence of a shared footpath running adjacent to the subject land, the proximity of public transport, and the nature, scale and frequency of the proposed use, it is considered that there are no immediate safety issues surrounding this development.

4.0 Conclusion

For all of the reasons outlined within this Transport Impact Statement, it is our view that the subject land is, and will continue to be, easily and safely accessible by the patrons/visitors via private cars and other non-car modes such as public transport. Furthermore, due to the nature, scale and frequency of the proposed Reception Centre, it is considered that the subject land is capable of accommodating such a use and that it will not have any significant impact on the traffic volumes or traffic management of Welshpool Road East.

I trust this information is to your satisfaction and we otherwise look forward to your favourable determination.

Altus Planning & Appeals

ML
Traffic Engineers

A1815283W Sight Line Assessment 782 Welshpool Road East, Wattle Grove

10 April 2018

City of Kalamunda
PO Box 42
Kalamunda WA 6926

Dear Sir / Madam,

Sight Line Assessment – Proposed Wedding Venue, 782 Welshpool Road, Wattle Grove

We have been commissioned to undertake an assessment of the sight lines at the access for a proposed wedding venue at 782 Welshpool Road East, Wattle Grove.

The subject site, Rothwood Homestays, currently operates as bed and breakfast with the intension of extending the business to provide a venue for wedding ceremony and receptions. The functions will cater for a maximum of 100 people, with the majority of the events occurring on the weekends and a lesser amount on Friday.

The subject sight is located adjacent to a median divided dual carriageway, with a wide (9m) median break for right turning movements.

In order to determine whether the driveway configuration with the median break is acceptable for the expected increase in the turning traffic volume, a number of safety and site conditions need to be considered:

- Sight distance, to and from the access point
- Traffic generation of the subject site
- Traffic volumes on Welshpool Road East
- Road layout and turning facilities
- Crashes within 200m radius of subject site

IBM Building, Level 3, 1060 Hay Street, West Perth WA 6005

Telephone: 08 6467 7558 ***Facsimile: 1300 739 523***
perth@mltraffic.com.au *www.mltraffic.com.au*



Figure 1: Subject Site Location, Rothwood Homestays

ML
Traffic Engineers

1. Sight Lines

According to Austroads Guide to Road Design, Part 4A: Unsignalised and Signalised Intersections, the sight distances required at an intersection in an 80km/h speed environment with a reaction time of 2.5 seconds are:

- Stopping Sight Distance: 181m
- Approach Sight Distance: 114m
- Minimum Gap Sight Distance:
  - 111m crossing two lanes one direction (right turn from site to median)
  - 89m right turn against one direction (right turn from median)
  - 111m left turn

1.1 Between the Driver Exiting the Property and Northbound Vehicles on Welshpool Road East (A)

The available sight distance looking south from the access point as measured 5m from the kerb line is approximately 190m, exceeding the 181m stopping sight distance requirement.

The approach sight distance from northbound travelling vehicles to the subject site entrance exceeds the 114m requirement. The minimum gap sight distance for exiting vehicles intending to turn right of 111m is also exceeded.

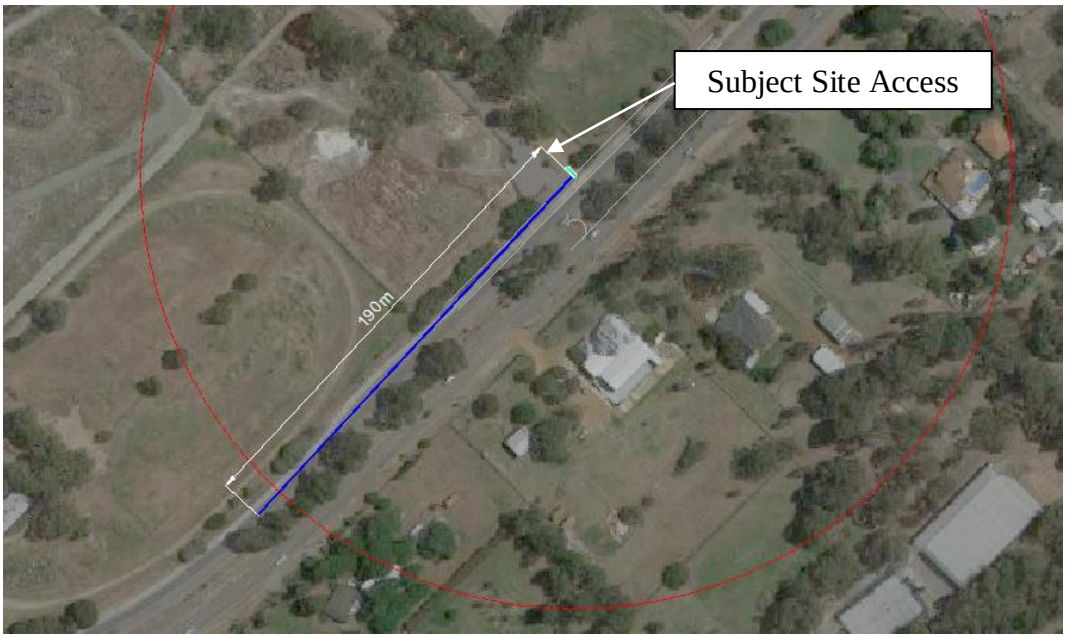

Figure 2: Sight Lines from Access looking South

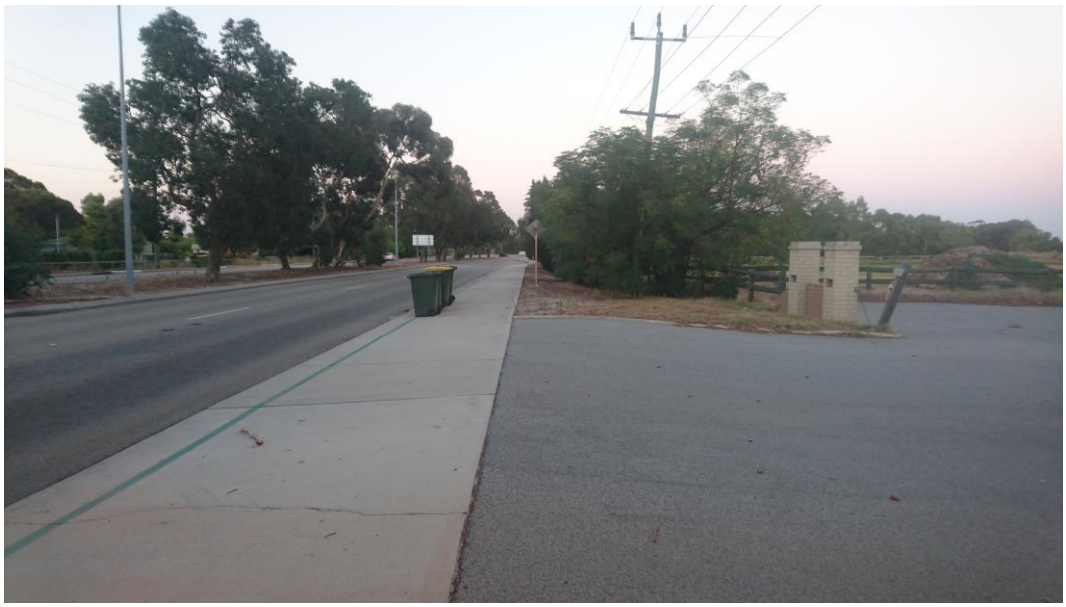

Figure 3: Visibility from Access looking South

1.2 Between the Driver Exiting the Property and Northbound Vehicles on Welshpool Road East (B)

A driver exiting the subject site is able to manoeuvre into the median break prior to entering the southbound traffic flow. The maximum angle in which a vehicle can be assessed against a right turn movement is 110 degrees, in accordance with Figure 3.5 of Austroads Part 4A.

Sight lines from the median break are restricted due to the presence of two large trees located on the northern side of the median break. As such, a waiting vehicle is required to 'creep' out toward the live lane. Without entering the live lane, the driver has a sight distance of approximately 120m. See Figures 3 and 4.

The approach sight distance of 114m is exceeded, as is the minimum gap sight distance of 89m.



Figure 3: Sight Lines from Median Break looking North

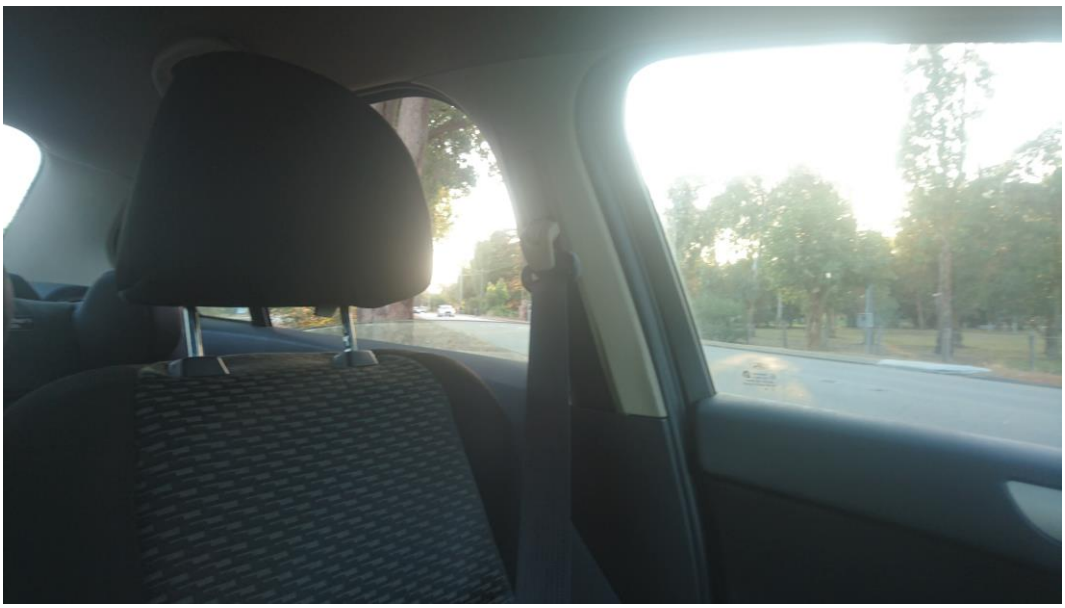

Figure 4: Visibility from Access looking North form within Vehicle



Figure 5: Median Break Tree Sight Line Obstruction

1.3 Visibility to the Median Break Southbound

The median break is able to be seen from a southbound vehicle from approximately 340m north of the location. In saying this, the continuity of the median island and tree line either side of the break does make the refuge area somewhat indistinguishable on approach from the north.

2. Traffic Generation

Western Australian Planning Commission's Transport Assessment Guidelines for Developments specifies rates for traffic generation for different land uses, however there is no rate specified for a wedding venue or function centre.

The RTA Guide to Traffic Generating Developments also does not provide a rate appropriate for the intended use. As such, a traffic generation rate will be determined based on the intended maximum number of guests and applicable car parking rate requirements of the City's Local Planning Scheme.

For the purposes of this report, the following traffic generation rates are assumed:

- A rate of 1 vehicle trips for every 4 guests, in the arrival peak period. This equates to 25 vehicle trips for events catering for 100 people. This rate is based on the car parking requirements for Civic Use, Community Purpose and Reception Area, as described in Table 3 – Parking Requirements of the City of Kalamunda Local Planning Scheme 3.

- The assumed generation is 25 vehicle trips in the arrival peak hour. With a 90% inbound and 10% outbound split, this equates to 22 inbound trips and 3 outbound trips in the arrival peak hour for a particular event. Due to the nature of the events held, people departing the subject site will be more spread out over an extended period and not compacted to within a 'peak' hour.
- The majority of traffic accessing the site will be doing so from the southern direction. For the purposes of this report it is considered that at least 80% of those attending the site will be travelling from the south, equating to 18 northbound (left turn) travelling vehicles and 4 southbound (right turn) travelling vehicles.

3. Traffic Volumes on Welshpool Road East

Traffic volumes on Welshpool Road East are assessible from the Main Roads website. The survey location closest to the development is located approximately 580m south of the subject site, near the intersection with Tonkin Highway. The traffic volume data available is for the year 2015/16 and indicates that peak hour traffic volumes on the weekend are:

- Eastbound: 595 vehicles per hour between 10am and 11am
- Westbound: 675 vehicles per hour between 4pm and 5pm

4. Turning Facilities

Austroads Guide to Road Design Part 4A discusses the requirement of right and left turning traffic facilities. The warrants for the facilities relate to the volume of traffic on the Major Road (Welshpool Road East) and the Minor Road (the subject site).

The warrant for turning facilities on the major road with a design speed less than 100km/h can be seen in Figure 6. The value of Q_M Major Road Traffic Volume is determined to be that of the closest through lane to the turning move. The traffic volumes available from Main Roads are not separated by lane and only by direction, therefore it is assumed that each lane will carry 50% of the total peak volume:

- Eastbound: 298 in each lane
- Westbound 338 in each lane

The left turn volume in the peak arrival time is 18 cars. The peak through traffic volume on Welshpool Road East in the westbound direction, although may not directly coincide with the arrival time of an event but the worst-case scenario, is 298 vehicles.

The right turn volume in the peak arrival time is 4 cars. The peak through traffic volume on Welshpool Road East in the eastbound direction, although may not directly coincide with the arrival time of an event but the worst-case scenario, is 338 vehicles.

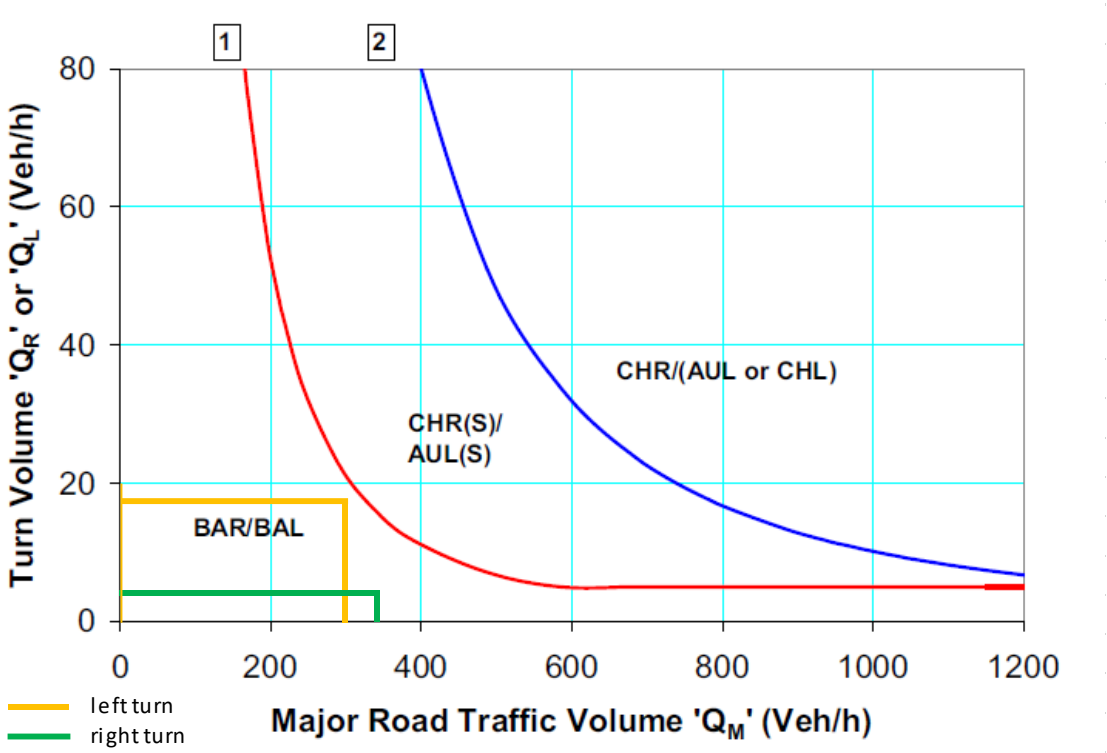

Figure 6: Turning Facility Warrant with Major Road Speed Less Than 100km/h

The subject site with a maximum attendance of 100 people will warrant only a basic left and right turn treatment, such as is already apparent on site.

With both directions being dual carriageway, there is opportunity for vehicles travelling behind a turning vehicle to manoeuvre to the adjaent lane given adequate advanced warning/indication of the intensions of the driver ahead.

5. Crash Analysis

Crash statistics are available from Main Road's Crash Analysis Reporting System for the section of road between Crystal Brook Road and Lewis Road, a section of approximately 800m, for the five years 2013 - 2017. Of the 41 crashes reported, 20 occurred at an intersection and have been excluded from the analysis. The following determinations have been made in relation to the remaining 21 crashes:

- 11 crashes involved vehicles travelling in the same direction, with 10 of those rear end type crashes.

- 5 crashes involved a right turn versus through movement, not at an intersection
- 6 crashes occurred on Friday or on the weekend
- 15 crashes were in travelling in the northbound direction, of which 6 were rear end type crashes. The remaining 3 rear end type crashes were travelling southbound, with 1 rear end crash in an unspecified direction.

The proposed development will not exacerbate the crash risk significantly along this section of road.

6. Recommendations

To improve the visibility of the subject site and the associated access and median break, consideration should be given to:

- Installation of advertising signage at the site entry for northbound traffic. This is to be in accordance with Conditions for Advertising Within State Road Reserves – Business Signs, including but not limited to the sign being static and not illuminated, less than 4m^2 and outside of the clear zone.
- Installation of a Tourist Signage including an Intersection Direction Sign MR-VID and Advanced Direction Series MR-VAD, namely for the southbound direction to give advanced warning to those attending the site of the approaching right turn.
- Installation of advanced warning in the form of either Median Opening MR-WDRW or Vehicles Entering MR-WDO-7(A-C) signage.
- Consideration should be given to sign placement to ensure it meets Main Road's requirements, and to avoid sign clutter.
- Regarding the median break, it is recommended that the kerb on approach and the paved areas either side of the opening be painted white to improve the delineation of the median opening.

If you have any questions regarding the contents of this report, please do not hesitate to ring me on 0406 473 681, or email me at shayes@mltraffic.com.au.

Yours sincerely,



Sonja Hayes
Senior Traffic Engineer

Attachment 4
Bushfire Management Plan Report

SMITH CONSULTING
Bushfire Consultants

BUSHFIRE MANAGEMENT PLAN

Lot 601 (No 782) Welshpool Road East, Wattle Grove
Shire of Kalamunda

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

Prepared by Ralph Smith
SMITH CONSULTING
BPAD27541
smith.consulting@bigpond.com
0458 292 280
Site visited 5 April 2017; Report completed 21 April 2017

Bushfire management plan/Statement addressing the Bushfire Protection Criteria coversheet

Site address: Lots 601 (No 782) Welshpool Road East, Wattle Grove

Site visit: Yes ☑ No ☐

Date of site visit (if applicable): Day 5 Month April Year 2017

Report author: Ralph Smith

WA BPAD accreditation level (please circle):

Not accredited ☐ Level 1 BAL assessor ☐ Level 2 practitioner ☑ Level 3 practitioner ☐

If accredited please provide the following.

BPAD accreditation number: 27541 Accreditation expiry: Month August Year 2017

Bushfire management plan version number: 1

Bushfire management plan date: Day 11 Month April Year 2017

Client/business name: Altus Planning & Appeals

	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?		✓
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the bushfire protection criteria elements)?		✓

Is the proposal any of the following (see SPP 3.7 for definitions)?	Yes	No
Unavoidable development (in BAL-40 or BAL-FZ)		✓
Strategic planning proposal (including rezoning applications)		✓
Minor development (in BAL-40 or BAL-FZ)		✓
High risk land-use		✓
Vulnerable land-use		✓

None of the above ☐

Note: Only if one (or more) of the above answers in the tables is yes should the decision maker (e.g. local government or the WAPC) refer the proposal to DFES for comment.

Why has it been given one of the above listed classifications (E.g. Considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author  Date 21/04/2017

NOTE

This Bushfire Management Plan has been developed by Smith Consulting for the exclusive use of the client, Altus Planning & Appeals.

The plan has been compiled using the standard methodologies required by Western Australian government departments and agencies. It is based on the following:

- *State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7)*, December 2015
- *Guidelines for Planning in Bushfire Prone Areas*, March 2017
- *Australian Standard 3959 – Construction of buildings in bushfire-prone areas (incorporating amendments 1, 2 and 3)*, March 2009
- Standard fuel load field data collection methods and conversion to a fuel load applicable for the appropriate fire spread models.

The techniques described in the above publications have been applied in the appropriate areas and circumstances for the development of this document.

Where there was no public access the interpretation is based on photographic and satellite imagery, and a laser distance meter was used to measure distances and effective slope.

It is recommended that this Bushfire Management Plan be revised every five years to ensure that it remains relevant and in-line with current requirements. This will optimise protection. It is proposed that the property owners undertake the review.

DISCLAIMER

This Bushfire Management Plan has been prepared in good faith. It is derived from sources believed to be reliable and accurate at the time of publication. Nevertheless, this plan is distributed on the terms and understanding that the author is not responsible for results of any actions taken based on information in this publication or for any error or omission from this publication.

Smith Consulting has exercised due and customary care in the preparation of this Bushfire Management Plan and has not, unless specifically stated, independently verified information provided by others.

Any recommendations, opinions or findings stated in this report are based on circumstances and facts as they existed at the time Smith Consulting performed the work. Any changes in such circumstances and facts upon which this document is based may adversely affect any recommendations, opinions or findings contained in this plan.

DOCUMENT STATUS

Version	Comment	Reviewer	Review Date
1	Original version	RDS	13 April 2017

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1. Introduction

This Bushfire Management Plan (BMP) is provided to provide guidance for the planning and management of the potential bushfire threat on the proposed change of land use on Lot 601 (No 782) Welshpool Road East, Wattle Grove. The Bushfire Management Plan is a supporting document for the proposed change of land use to permit weddings and associated functions.

The development site is adjacent to a Bush Forever site, but not any Aboriginal Heritage sites. A portion of the development site has been designated by the Fire and Emergency Services Commissioner as a bushfire prone area. The BMP is prepared as a condition of development at the request of the Western Australian Planning Commission (WAPC). It should also be noted that the Department of Fire and Emergency Services (DFES) advise that it is an unreasonable expectation that a fire appliance will be available to protect every home during a bushfire emergency. It is therefore critical that all new residential buildings are constructed to an appropriate standard and the surrounding vegetation appropriately managed.

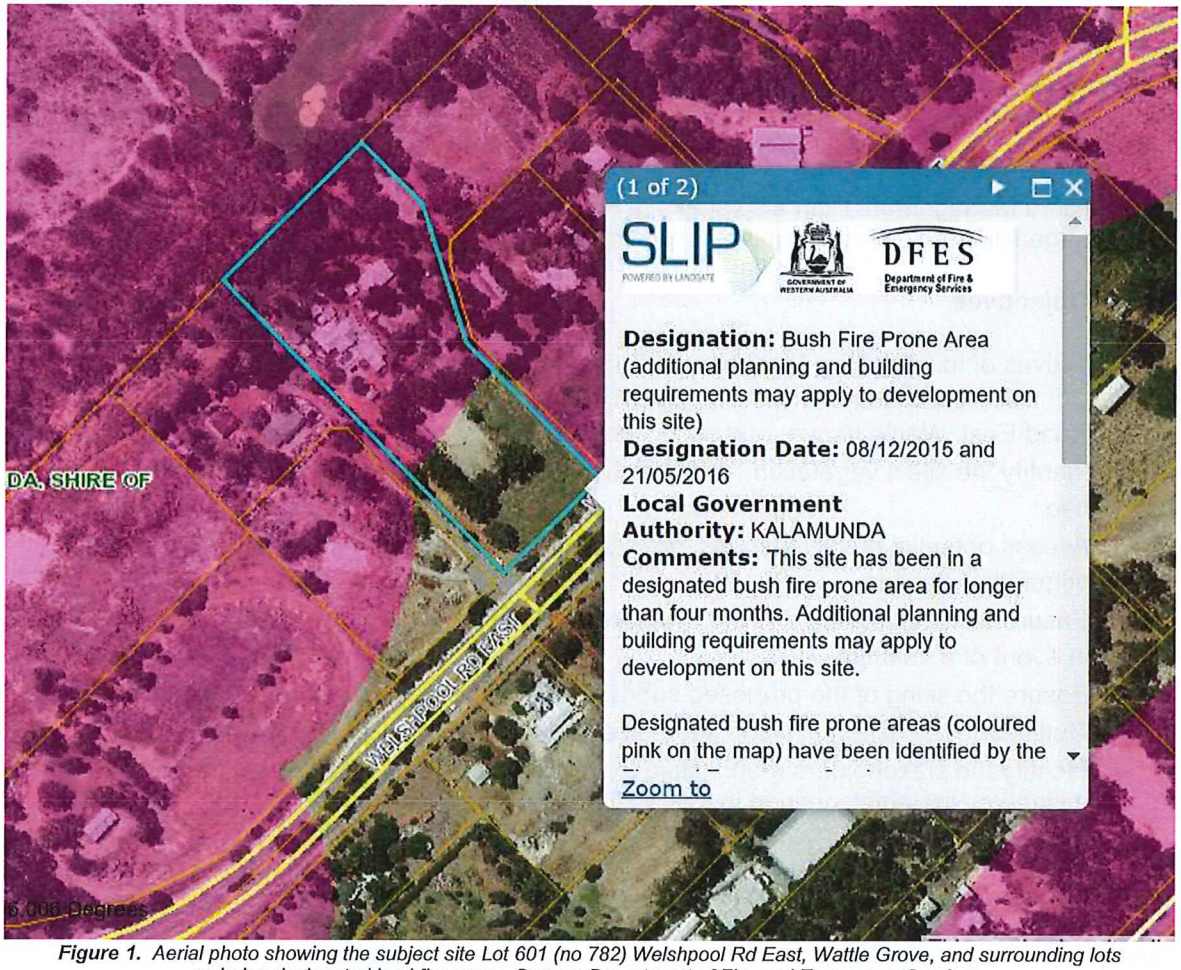


Figure 1. Aerial photo showing the subject site Lot 601 (no 782) Welshpool Rd East, Wattle Grove, and surrounding lots as being designated bushfire prone. Source: Department of Fire and Emergency Services.

2. Aim

It is generally recognised that bushfires are an inevitable threat in the spring, summer and autumn months in the south-west of Western Australia.

The aim of this Bushfire Management Plan when implemented is to reduce occurrence of, and minimise the potential impact of bushfires onto buildings and vegetation located within the subject site, thereby reducing the threat to life, property and the environment.

This plan will document the minimum fire prevention requirements for the site.

3. Objectives

3.1 Purpose

The purpose of this Bushfire Management Plan is to address the fire protection risks within the subject site, Lot 601 (No 782) Welshpool Road East, Wattle Grove. Implementation of the Bushfire Management Plan will reduce the threat to the landowners, residents, visitors and firefighters in the event of a bushfire within or near the site. It achieves this by presenting the minimum requirements to be implemented.

The Bushfire Management Plan also seeks to ensure that the landowners, residents and relevant agencies are aware of their responsibilities.

3.2 Objectives

The objectives of this Bushfire Management Plan are achievable and measurable:

- Consider the change of land use proposal for the existing Lot 601 (No 782) Welshpool Road East, Wattle Grove, and associated vehicular access
- Identify the site's vegetation, and surrounding vegetation, topography and proposed land use
- Assess potential bushfire issues, hazards and the proximity of the site to predominant vegetation classes
- Ensure water is available to the development to enable property and life to be defended in event of a bushfire
- Ensure the siting of the proposed subdivision minimises the level of bushfire impact
- Outline the bushfire mitigation strategies for the site
- Identify the stakeholders responsible for undertaking and implementing the bushfire mitigation strategies defined in this Bushfire Management Plan.

4. Legislation and Policy Considerations

The Western Australian Planning Commission and the Shire of Kalamunda require the preparation of a Bushfire Management Plan for the proposed change of land use as part of the proposed scheme amendment to the Shire of Kalamunda's Plan. This document has been prepared to satisfy that requirement.

All relevant provisions of applicable planning legislation and policies have been considered in the preparation of this Bushfire Management Plan. These include:

- Bush Fires Act (1954)
- State Planning Policy 3.7 (2015)
- Guidelines for Planning in Bushfire Prone Areas (2017)
- Visual guide for bushfire risk assessment in Western Australia (2016)
- Local planning scheme requirements (bush fire related)
- Local planning policy requirements (bush fire related)
- Fire Control Notice requirements
- Relevant approvals

5. Description of the Area (Current Status)

5.1 General

Lot 601 (No 782) Welshpool Road East, Wattle Grove, is located within the Shire of Kalamunda. The subject site has been designated in part by the Fire and Emergency Services as bushfire prone.

The land has been extensively cleared and has reticulated grass (for managed horse feed and management) through the south-east side of the lot (nearest Welshpool Road East) and cultivated gardens and lawns through the area around the current dwellings and sheds. The neighbouring property to the north provide a potential bushland bushfire threat. To the west, south and east is land that has been developed for housing, associated infrastructure and semi-rural activities. To the south-west a portion of the neighbouring property has been cleared of most vegetation with unmanaged grassland remaining.

There are no environmentally significant features on the lot being developed. There is a municipal heritage listing being Category D – Formerly Taylor's House which is on the first home developed on the site.

5.2 Climate

The scheme area of the Shire of Kalamunda has a Mediterranean climate with four seasons: cool, wet winters (June-August) followed by a mild spring (September-November), and hot, dry summers (December-February) leading into autumn (March-May). Rainfall usually occurs in autumn through to spring. This rainfall facilitates substantial vegetation growth during the winter and spring months, which dries in summer and continues through autumn.

The maximum temperatures occur during summer when the bushfire fuels are at their driest. As the summer progresses the grass fuels cure and become available as bushfire fuel. Grass fuels are a diminishing bushfire risk as they start to break down, post being 100% cured. This is in stark contrast to the natural environment where forest, woodland or shrubland with a scrub multi-tiered understorey become a greater bushfire risk late in summer and early autumn, until the winter rains break. The bulk of the bushfire fuel in this assessed location, which includes up to 100 metres from the development site is grassland to the west and north and banksia to the east.

5.3 Topography

Lot 601 (No 782) Welshpool Road East, Wattle Grove is basically flat. The potential bushfire threat is the vegetation, (forest) associated with neighbouring properties to the north-west and the unmanaged grassland to the south-west.

5.4 Bushfire fuels

Historically, Lot 601 (No 782) Welshpool Rd East, Wattle Grove (and the surrounding lots), were part of a modified vegetation area that was partially cleared. To the north-west is forest vegetation which is a Bush Forever Site (Crown Reserve R17098) that is 136 ha and was recently subject to a bushfire. To the west, south and east is land that has been developed for housing, associated infrastructure and semi-rural activities. Properties within the general area have been subdivided.

The predominant vegetation type, as described in the *Australian Standard 3959 – Construction of buildings in bushfire-prone areas (AS 3959)*, on Lot 601 (No 782) Welshpool Road East, Wattle Grove, is cleared land that is fully reticulated. The very scattered overstorey in the area is mixed introduced tree species and reticulated grassland surface fuels.



Figure 2. *Photographs showing the vegetation immediately to the east of Lot 601 (No 782) Welshpool Road East, Wattle Grove.*



Figure 3. *Photographs showing the vegetation north of Lot 601 (No 782) Welshpool Road East, Wattle Grove.*

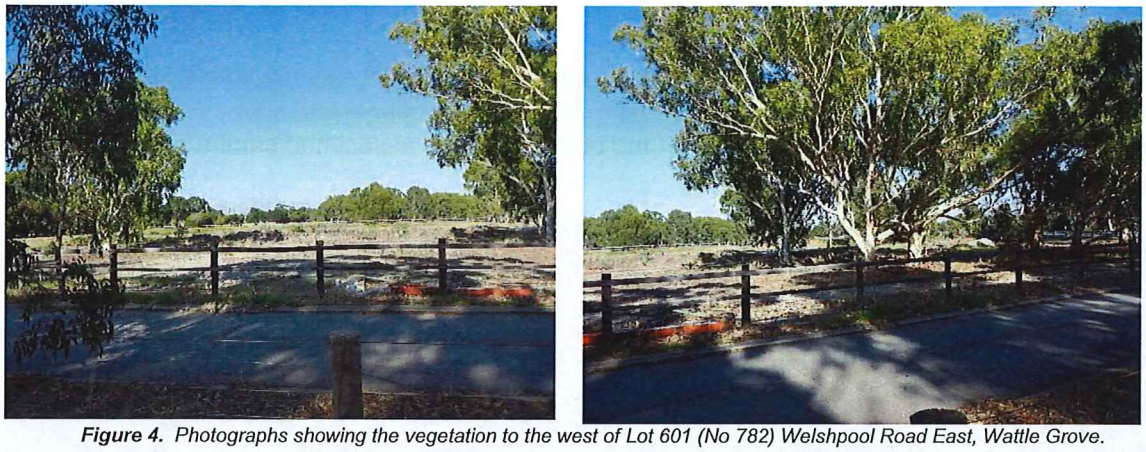


Figure 4. *Photographs showing the vegetation to the west of Lot 601 (No 782) Welshpool Road East, Wattle Grove.*

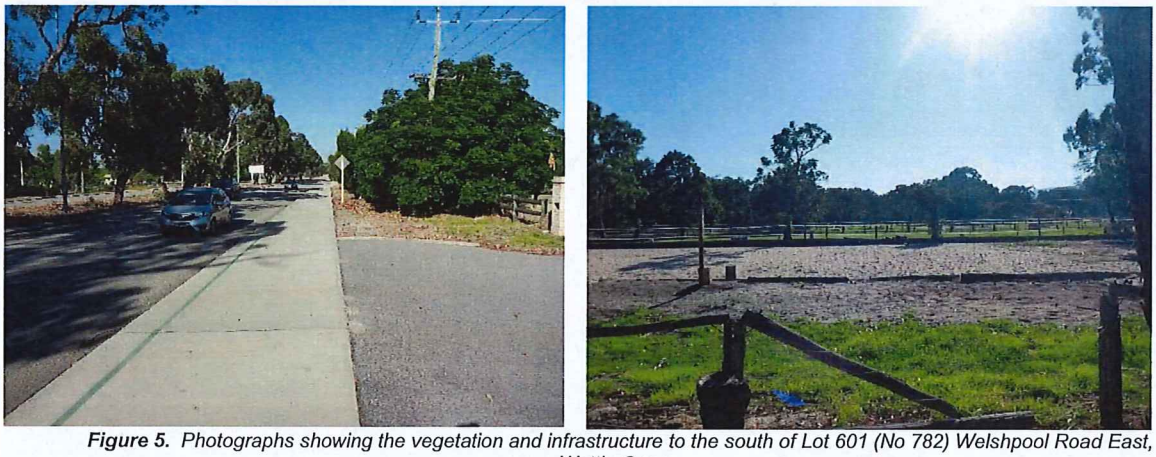


Figure 5. *Photographs showing the vegetation and infrastructure to the south of Lot 601 (No 782) Welshpool Road East, Wattle Grove.*

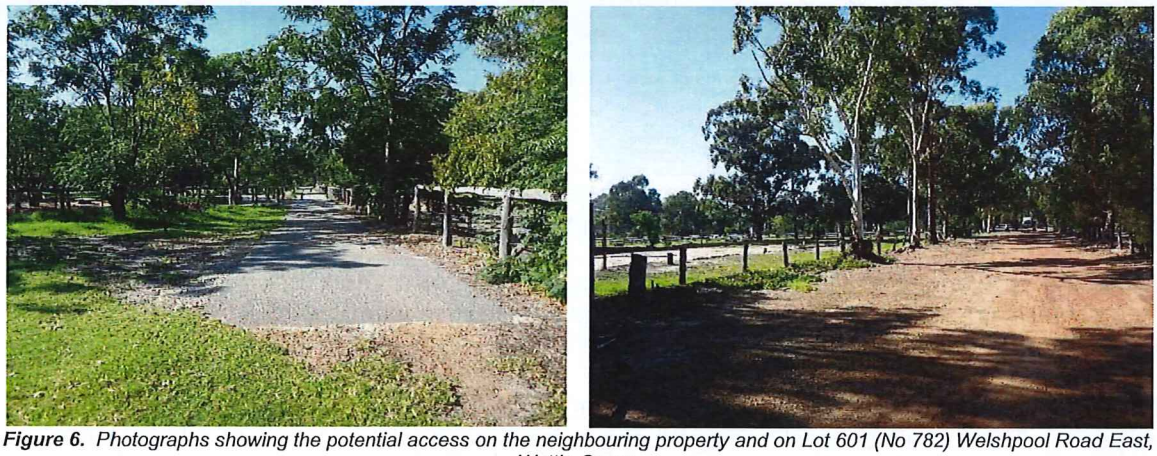


Figure 6. *Photographs showing the potential access on the neighbouring property and on Lot 601 (No 782) Welshpool Road East, Wattle Grove.*

5.5 Land use

The general land use adjacent to Lot 601 (No 782) Welshpool Rd East, Wattle Grove, is land that has been subdivided into smaller special rural lots (many single lots have been subdivided into two lots since the initial subdivision of the estate) and the associated semi-rural infrastructure.



Figure 7. *Aerial photograph showing Lot 601 (No 782) Welshpool Road East, Wattle Grove, and surrounding land use. Source: Shire of Kalamunda Online Mapping System.*

5.6 Assets

The subject site is ready for the proposed change of use with all buildings and gardens developed and in place. There is ample parking available onsite for guests.

Within the local area, the assets include all the built structures on neighbouring properties, and the animals within the paddocks, windbreaks and the grass (pasture) within those areas. The local assets are changing and becoming a more 'standard' semi-urban development.

There are no environmentally significant features on the lot where the change of land use is proposed. There is a municipal heritage listing being Category D – Formerly Taylor's House which is on the first home developed on the site.

5.7 Access

General access to the development site is currently via the main road being Welshpool Road East, which is a major bitumen road. Alternative access is the bitumen driveway that runs

between the boundaries of the subject land and the neighbouring property to the north-east. The distance between the two driveways is 75 metres. This provides multiple ingress/egress routes for individual properties in the area. It also facilitates emergency services access.

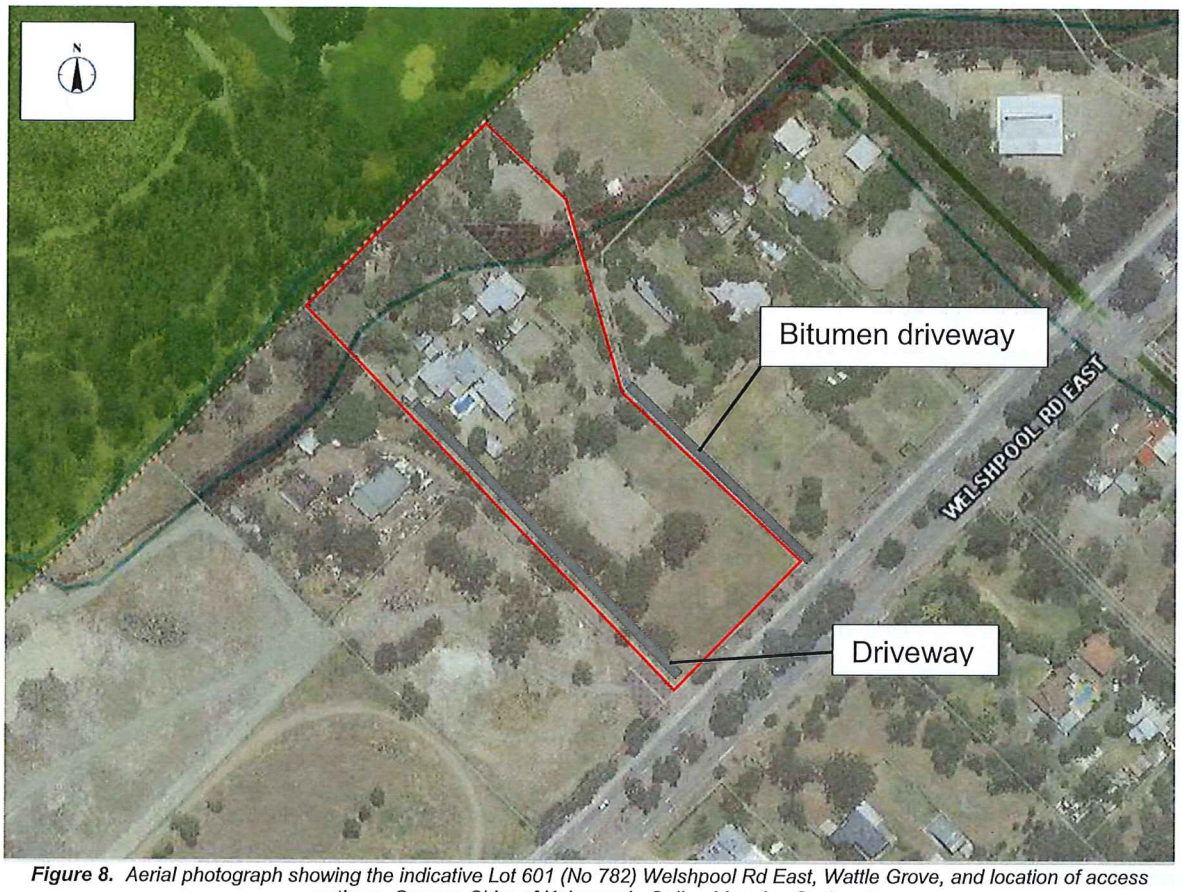


Figure 8. *Aerial photograph showing the indicative Lot 601 (No 782) Welshpool Rd East, Wattle Grove, and location of access options. Source: Shire of Kalamunda Online Mapping System.*

5.8 Water supply

Reticulated mains water supply is available to the lot. There are also two ground water bores that are used to reticulate the grass and gardens. There is a fire hydrant on Welshpool Road East opposite the lot.

6. Bushfire

6.1 Bushfire hazard level

The bushfire hazard assessment for this site is moderate and has a bushfire attack level of BAL–12.5 when considered against the requirements in *Guidelines for Planning in Bushfire Prone Areas* (2017), AS 3959 and the Building Code of Australia (BCA). This determination is based on the observation of the predominant vegetation type on the lot and adjacent assessable lands and aligning that to the published criteria.

All vegetation within 100 metres of the lot boundaries or building have been considered in accordance with the Western Australian Government criteria. AS 3959 only requires consideration of 50 metres between the vegetation and the lot boundary or building for grassland.

For AS 3959 to be applicable requires the formal declaration of the site to be bushfire prone. This site is declared as bushfire prone.

6.2 Bushfire Attack Level (BAL) Assessment

6.2.1 Potential Bushfire Impacts

The potential bushfire impacts to the built structures on the site from the identified vegetation plots are identified below.

Plot	Vegetation Classification	Effective Slope	Separation (m)	BAL
1	Exclusion 2.2.3.2 (e) and (f)	Not applicable	Not applicable	BAL–LOW
2	Class A – Forest	Flat	58m	BAL–12.5
3	Class G – Grassland	Flat	68m	BAL–LOW
4	Class G – Grassland	Flat	56m	BAL–LOW

6.2.2 Determination of Bushfire Attack Level (BAL)

The vegetation on the proposed land use change site will continue to be managed to the standard required in AS 3959 for 'low threat' vegetation and the State Government's asset protection zone.

The determined Bushfire Attack Level (highest BAL) on the building nearest to the vegetation has been determined in accordance with clause 2.2.6 of AS 3959 using the above analysis.

There is no intention to construct any new buildings on the site.

The determined Bushfire Attack Level (BAL) for the site is **BAL-12.5**.

6.2.4 Assessment area with the current vegetation classified

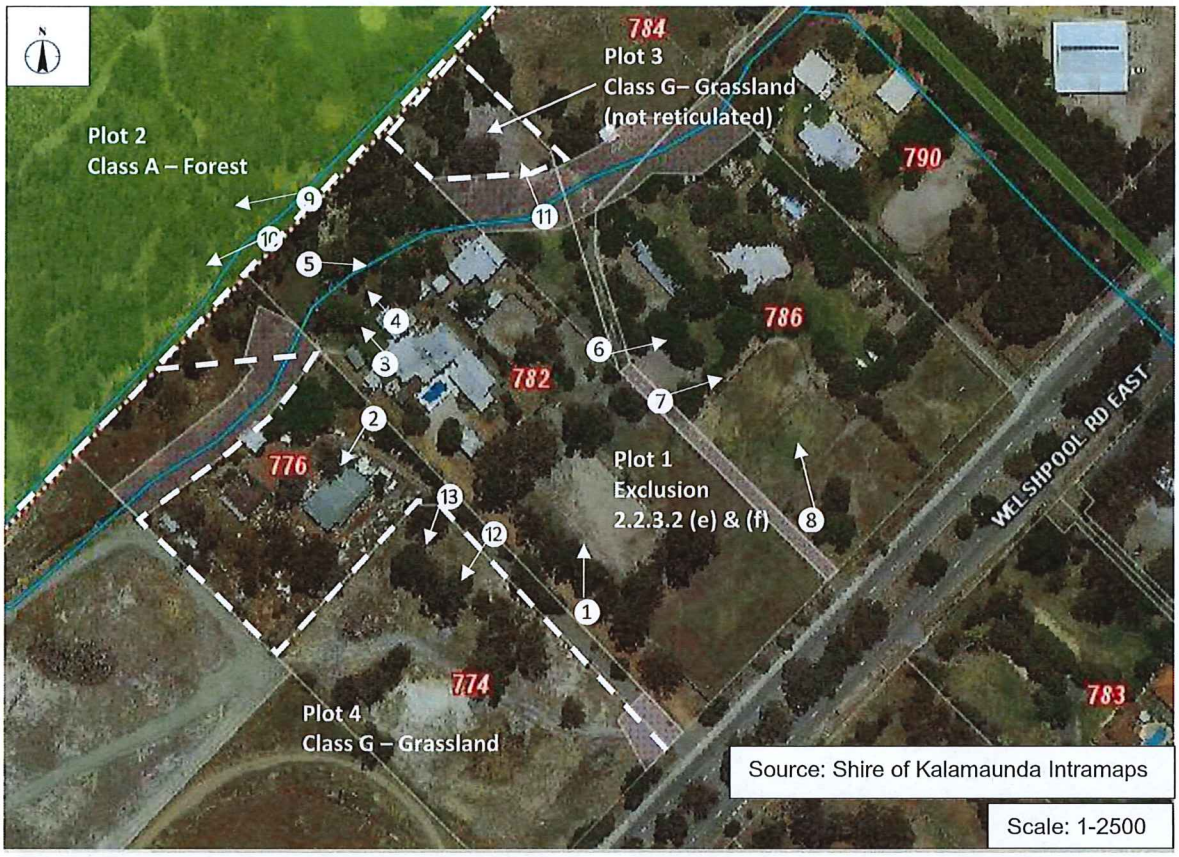


Figure 9. *Plan showing assessment area with AS 3959 vegetation classification and photo points and direction.*



Figure 10. *Aerial photo showing assessment area to 100 metres.*

6.2.5 Photos showing vegetation classification to a distance of 100 metres from the assessment site on Lot 601 (No 782) Welshpool Rd East, Wattle Grove

Plot 1
Exclusion 2.2.2.3 (e) and (f)

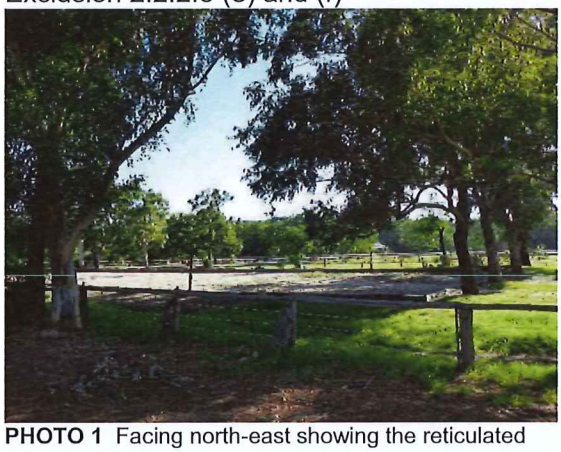


PHOTO 1 Facing north-east showing the reticulated horse paddock.



PHOTO 2 Facing south-west looking at the neighbouring garden.

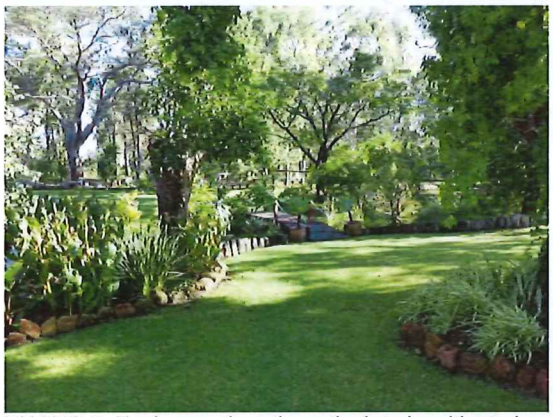


PHOTO 3 Facing north at the reticulated, cultivated garden near the houses on the lot.

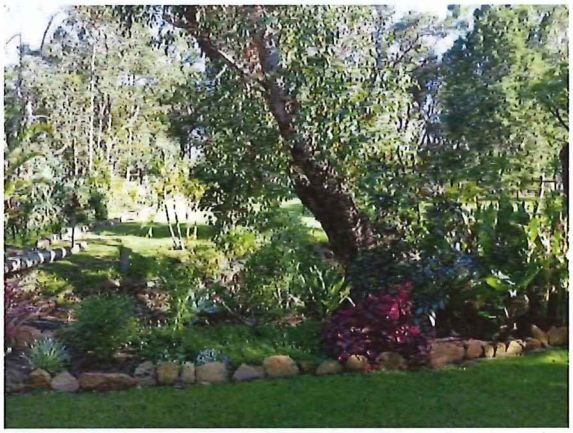


PHOTO 4 Showing the cultivated and reticulated garden near the houses and sheds on the lot.



PHOTO 5 Facing north at the reticulated, cultivated garden near the houses on the lot.



PHOTO 6 Showing the cultivated and reticulated grass on the neighbouring property.

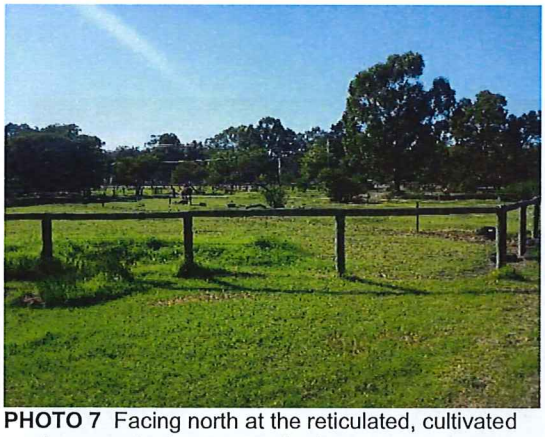


PHOTO 7 Facing north at the reticulated, cultivated garden near the houses on the lot.



PHOTO 8 Showing the cultivated and reticulated garden near the houses and sheds on the neighbouring property.

Plot 2
Class A – Forest



PHOTO 9 Showing the forest north of the site.



PHOTO 10 Showing the forest vegetation.

Plot 3
Class G – Grassland



PHOTO 11 Showing the unmanaged grassland behind the reticulated grass surface fuel.

Plot 4
Glass G – Grassland



PHOTO 12 Facing west showing the grassland on the neighbouring property.



PHOTO 13 Showing the grassland on the neighbouring property.

7. Bushfire Mitigation Strategies

This Bushfire Management Plan is developed to provide guidance for the planning and management of the potential bushfire threat on the proposed change of land use on Lot 601 (No 782) Welshpool Rd East, Wattle Grove. The Bushfire Management Plan (BMP) is a supporting document for the proposed scheme amendment to the Shire of Kalamunda's Local Planning Scheme No. 3. In accordance with the State Government's requirements, the BMP considers the bushfire threat after the BMP has been implemented.

This Bushfire Management Plan adopts an acceptable solution and performance-based system of control for each bushfire hazard management issue. The approach is consistent with Appendix 4 of *Guidelines for Planning in Bushfire Prone Areas* (2017).

7.1 Bushfire protection performance criteria and acceptable solutions

Element 1: Location

Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk to bushfire to facilitate the protection of people, property and infrastructure.

Performance principle

The intent may be achieved where:

P1

The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is, or will, upon completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For minor or unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the Department of Fire and Emergency Services and the decision-maker.

COMPLIANT

The change of land use is located in an area where the bushfire hazard level is moderate, and the bushfire attack level is assessed as BAL–12.5 on the buildings on the lot. The area surrounding the building is established, reticulated, cultivated garden and grassland under a tree overstorey.

The change of land use is to provide a temporary land use activity, of only limited hours of use per session, where visitors will be mobile.

Element 2: Siting and Design of Development

Intent: To ensure that the siting and design of development minimises the level of bushfire impact.

Performance principle

The intent may be achieved where:

P2
The siting and design of the proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of the bushfire threat that applies to the site. It minimises the bushfire risk to people, property and infrastructure, including compliance with *AS 3959* if appropriate.

COMPLIANT
The proposed change of land use is located in an area that will remain as semi-rural area. The Western Australian government has declared only a portion of the site as bushfire prone and the buildings (which are currently on the site) have been BAL rated as BAL–12.5 because of the vegetation type and separation distance from the vegetation. There is no intention to construct new buildings, but rather to utilise the site as it is in regard to structures.

The buildings have an extensive APZ, which is surrounded by a well-managed garden and lawns currently reticulated, which will be maintained post development.

The horse paddocks on the lot are reticulated and maintained in a 'low threat' status as described in AS 3959 sections 2.2.3.2. (f).

The driveway is all weather access and is estimated to be 131 metres long and is 13 metres wide. The required turn around area is currently in place (parking area) and is adjacent to the houses (and within 50 metres of the dwellings as required in the Guideines) and the turn-around does allow a 3.4 fire appliance to turn around safely and meet the minimum of 17.5m kerb to kerb.

The internal firebreaks will continue to be maintained in accordance with the Shire of Kalamunda fire break notice.

Element 3: Vehicular access
Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.

Performance principle
The intent may be achieved where:

P3
The internal layout, design and construction of public and private vehicular access and egress in the development allow emergency and other vehicles to move through it easily and safely at all times.

COMPLIANT
There are two 4x2 alternative access driveways to facilitate movement onto Welshpool Road East, which provides two alternative routes east and west. These are located on the north side of the southern boundary of the lot and the north side of the northern boundary. These are shown on figure 8 (page 10) of this BMP.

The second or alternative access is the bitumen driveway that runs between the boundaries of the subject land and the neighbouring property to the north-east. The distance between the two driveways is 75 metres. This provides multiple ingress/egress routes for individual properties in the area. It also facilitates emergency services access.

Element 4: Water
Intent: To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.

Performance principle
The intent may be achieved where:

P4
The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for fire-fighting purposes.

COMPLIANT The site is serviced by reticulated scheme water. There is also a fire hydrant on Welshpool Road East immediately opposite the site that provides secure fire-fighting water.

8. Implementing the Bushfire Management Plan

8.1 Property owner's responsibilities

To maintain the reduced level of risk and threat of fire, the owners/occupiers of lots created by this proposal will be responsible for undertaking, complying and implementing measures protecting their own assets from the threat and risk of bushfire.

The owner/occupier shall be responsible for:

- Where specified, maintaining firebreaks on their property clear of flammable material by the dates shown on the Shire of Kalamunda's *Fire Break Notice and Bushfire Information*. This is a statutory requirement. A copy is available from the Shire of Kalamunda website.
- The APZ will be established prior to construction and maintained after dwelling construction to comply with the APZ requirements
- Maintaining in good order and condition all fencing and gates
- Ensuring that any new domestic dwellings to be built on the property are designed and constructed in full compliance with the requirements of the Shire of Kalamunda and as detailed in *Australian Standard 3959 – Construction of buildings in bushfire-prone areas*
- Implementing and maintaining bushfire fuels as specified in the Bushfire Management Plan and in accordance with the Shire of Kalamunda requirements
- Reviewing and implementing hazard reduction, when required, as required by the Shire of Kalamunda
- Installing and maintaining crossovers and driveways as required by the Shire of Kalamunda

8.2 Shire of Kalamunda responsibilities

The responsibility for compliance with the law rests with individual property owners and occupiers. The following conditions are not intended to transfer some of the responsibilities to the Shire of Kalamunda. The Shire of Kalamunda has statutory control and responsibility for ensuring that community fire safety is maintained.

The Shire of Kalamunda shall be responsible for:

- Providing timely advice on standards and methods to achieve community fire protection to owners/occupiers of land
- Administering development controls in accordance with the local planning scheme, with due regard for *State Planning Policy 3.7 – Planning in Bushfire Prone Areas* and other policies and publications outlined in these guidelines
- Seeking compliance with Bushfire Management Plans, including issuing the annual issuing of Firebreak Notices under section 33 of the *Bush Fires Act 1954*

9. Revising the Bushfire Management Plan

It is recommended that this Bushfire Management Plan be revised every five years to ensure that it is current and in-line with contemporary requirements to optimise protection. It is proposed that the property owners undertake the review.

10. References

Australian Government Bureau of Meteorology climate reports, summaries and maps. Retrieved 17 January 2017 from http://www.bom.gov.au/climate/averages/tables/cw_009225.shtml

Shire of Kalamunda, (2016). *Fire Break Notice2016/17*. Retrieved 31 March 2017 from https://www.wanneroo.wa.gov.au/our- services/emergency services/Documents/Firebreaks.pdf

Department of Fire and Emergency Services (DFES), (2016). *Map of Bushfire Prone Areas 2016*. Retrieved 31 March 2017 2017 from http://www.dfes.wa.gov.au/regulationandcompliance/bushfireproneareas/Pages/default.aspx

Standards Australia. (2009). *Australian Standard 3959 – Construction of buildings in bushfire-prone areas (incorporating amendment numbers 1, 2 and 3)*. Standards Australia, Sydney, NSW.

Western Australian Planning Commission. (2015). *State Planning Policy 3.7 – Planning in Bushfire Prone Areas*. Western Australian Planning Commission, Perth, WA. Retrieved 14 January 2015 from http://www.planning.wa.gov.au/dop_pub_pdf/SPP_3.7_Planning_in_Bushfire_Prone_Areas.pdf

Western Australian Planning Commission. (2017). *Guidelines for Planning in Bushfire Prone Areas*. Western Australian Planning Commission, Perth, WA. Retrieved 14 January 2015 from http://www.planning.wa.gov.au/dop_pub_pdf/SPP_3.7_Planning_in_Bushfire_Prone_Areas.pdf

Department of **Planning, Lands and Heritage**

GOVERNMENT OF WESTERN AUSTRALIA

Your ref:
Our ref: 808-2-24-3
Enquiries: Peter Ajo (Ph: 6551 9111)

City of Kalamunda
PO Box 42
KALAMUNDA WA 6926

13 February 2018

Attention: Ross Jutras-Minett

Dear Ross,

Re: Lot 601 Welshpool Road East, Wattle Grove

I refer to an email received from the Department of Transport dated 7 February 2018 regarding the above application. In accordance with the Western Australian Planning Commission's (WAPC) Instrument of Delegation dated 30 May 2017, the following comments are provided with respect to this proposal which seeks approval for an amendment to the City of Kalamunda Local Planning Scheme No. 3 – Additional Use (Reception Centre).

Land Requirements

Lot 601 abuts Welshpool Road East, which is classified as an Other Regional Road (ORR) in the Metropolitan Region Scheme (MRS), also reserved as a Category 2 Road per Plan Number SP 694/4. Lot 601 is not affected by the ORR reservation for Welshpool Road East, per the attached WAPC Land Requirement Plan Number (LRP) 1.0821.

Access

The subject lot currently accommodates a single vehicular access from Welshpool Road East and no changes are proposed to this arrangement. This is in accordance with the Commission's Regional Roads (Vehicular Access) Policy D.C. 5.1, which seeks to minimise the number of new crossovers onto regional roads.

Recommendation

The Transport Impact Statement prepared by Altus Planning and Appeals dated June 2017 states that there is an existing break in the median strip and therefore full vehicular movements will be provided at this location. The Department recommends that the City consider the installation of a right turning pocket within the median for reasons of safety and efficiency in order to separate turning vehicles from those travelling along Welshpool Road East and avoid rear end collisions for right turning vehicles.

Conclusion

The Department of Planning, Lands and Heritage has no objection to the proposal on regional transport planning grounds subject to the above recommendation.

Yours sincerely

Simon Luscombe
Principal Planning Officer
Strategy and Engagement



Land Requirement Plan No. 1.0821

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Planning, Lands and Heritage**

Your ref:
Our ref: 808-2-24-3
Enquiries: Peter Ajo (Ph: 6551 9111)

City of Kalamunda
PO Box 42
KALAMUNDA WA 6926

30 April 2018

Attention: Ross Jutras-Minett

Dear Ross,

Re: Lot 601 Welshpool Road East, Wattle Grove

I refer to your email dated 17 April 2018 regarding the above application. In accordance with the Western Australian Planning Commission's (WAPC) Instrument of Delegation dated 30 May 2017, the following comments are provided. This proposal seeks approval for an amendment (No. 95) to the City of Kalamunda Local Planning Scheme No. 3 – Additional Use (Reception Centre).

Please note that the Department previously provided comments on 20 February 2018 regarding this application, recommending the installation of a right turning pocket within the median for Welshpool Road East.

Land Requirements

Lot 601 abuts Welshpool Road East, which is classified as an Other Regional Road (ORR) in the Metropolitan Region Scheme (MRS), also reserved as a Category 2 Road per Plan Number SP 694/4. Lot 601 is not affected by the ORR reservation for Welshpool Road East, per the attached WAPC Land Requirement Plan Number 1.0821.

Access

The subject lot currently accommodates a single vehicular access point from Welshpool Road East and no changes are proposed to this arrangement. This is in accordance with the Commission's Regional Roads (Vehicular Access) Policy D.C. 5.1, which seeks to minimise the number of new crossovers onto regional roads.

Sight Line Assessment

The above report, prepared by ML Traffic Engineers dated April 2018 includes a traffic assessment in response to safety concerns, particularly for right turning movements. A safety audit including: sight distances, crash data, existing road layout and turning facilities have been assessed, and the Department is satisfied with the findings and supports the recommendations within section 6 of the report.

Recommendation

The Department of Planning, Lands and Heritage has no objection to the proposal on regional transport planning grounds subject to the above recommendations.

Yours sincerely

Simon Luscombe
Principal Planning Officer
Strategy and Engagement



Land Requirement Plan No. 1.0821

mainroads WESTERN AUSTRALIA

Enquiries: Nicole Coaker on 9265 5380
Our Ref: 17/9720 (D18#90785)
Your Ref:

6 February 2018

Chief Executive Officer
City of Kalamunda
PO Box 42
KALAMUNDA WA 6926

Via email: ross.jutras-minett@kalamunda.wa.gov.au

ATTENTION: ROSS JUTRAS-MINETT

Dear Sir/Madam,

REQUEST FOR COMMENT, PROPOSED SCHEME AMENDMENT NO. 95 – ADDITIONAL USE (RECEPTION CENTRE) – LOT 782 WELSHPOOL ROAD EAST, WATTLE GROVE

I refer to your correspondence dated 15 December 2017, seeking comments on the proposed amendment No.95 to Kalamunda Local Planning Scheme No.3. The proposal to rezone Lot 601 (782) Welshpool Road East, Wattle Grove for an additional use of (Reception Centre).

Main Roads has now had the opportunity to review the documentation and attached Plans. Welshpool Road East is a designated blue road "Other Regional Road" within the Metropolitan Regional Scheme (MRS), under the control of Department of Planning, Lands and Heritage. Main Roads generally do not provide comment on these roads (with the exception of a few). As this Scheme Amendment is not adjacent to any roads under Main Roads control, Main Roads has no comment or objection to the proposal.

Please ensure the proposal has been referred to the Department of Planning Lands and Heritage – Infrastructure and Land Use Co-ordination (ILUC) Branch for review and comment on the traffic and access implications including signage.

If you require any further information please contact Nicole Coaker on (08) 9323 6370 or via email nicole.coaker@mainroads.wa.gov.au. In reply please quote file reference number: 17/9720 (D18#90785).

Yours faithfully

Justin McKirdy
MANAGER STATUTORY ROAD PLANNING

Main Roads Western Australia
Don Aitken Centre, Waterloo Crescent, East Perth WA 6004
PO Box 6202, East Perth WA 6892

mainroads.wa.gov.au
enquiries@mainroads.wa.gov.au
138 138

Government of Western Australia
Department of Fire & Emergency Services

DFES
Department of Fire & Emergency Services

Our Ref: D02517
Your Ref: PG-LPS-003/097

Shire of Kalamunda
2 Railway Road
KALAMUNDA WA 6076
Ross.jutras-minett@kalamunda.wa.gov.au

Dear Ross

PROPOSED SCHEME AMENDMENT NO 97 TO LOCAL PLANNING SCHEME NO 3 – LOT 601 (782) WELSHPOOL ROAD EAST, WATTLE GROVE

I refer to a letter received by the Department of Fire and Emergency Services (DFES) dated 11 July 2107, regarding the above scheme amendment, and the Bushfire Management Plan (BMP), revision 1, dated 13 April 2017 prepared by Smith Consulting.

DFES provide the following comments with regard to *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) and the *Guidelines for Planning in Bushfire Prone Areas* (Guidelines).

Assessment

1. Policy measure 6.3 c) Compliance with the Bushfire Protection Criteria

Element	Assessment	Action
Location	**A1.1 – Comment** The BAL assessment states that the potential bushfire impacts to the built structures on the site are BAL-12.5 or below. This is sufficient for demonstrating compliance to this element.	However further assessment will be required at subsequent planning stages (development approval) to ensure no new structures are located in BAL-40 or BAL-FZ.

Recommendation – supported compliant application

DFES advises that the BMP has adequately identified issues arising from the bushfire risk assessment and considered how compliance with the bushfire protection criteria can be achieved for the scheme amendment.

Should you require further information, please contact me on telephone number 9482 1761.

Yours sincerely

Sandeep Shankar
LAND USE PLANNING OFFICER

27 September 2017

DFES Advisory Services | 20 Southport Street, West Leederville WA 6007
Tel (08) 9482 1764 | Fax (08) 9395 9384 | advice@dfes.wa.gov.au | www.dfes.wa.gov.au

City of Kalamunda

Local Planning Scheme No. 3

Amendment No. 95

Inclusion of an additional use of 'Reception Centre' to the land located at Lot 601 (No. 782) Welshpool Road East, Wattle Grove

FORM 2A

Planning and Development Act 2005

RESOLUTION TO ADOPT AMENDMENT TO LOCAL PLANNING SCHEME

City of Kalamunda Local Planning Scheme No. 3
Amendment No. 95

Resolved that the Local Government pursuant to section 75 of the *Planning and Development Act* 2005, amend the above Local Planning Scheme by:

1. Inserting the following new Additional Use in Schedule 2 – Additional Uses:

NO.	DESCRIPTION OF LAND	ADDITIONAL USE	CONDITIONS
A 57	782 WELSHPOOL ROAD EAST, WATTLE GROVE Lot 601	Reception Centre	a) The use is not permitted unless planning approval is granted by the Local Government. b) The applicant / land owner shall provide and implement a Bushfire Management Plan. c) The applicant / land owner shall provide and implement a traffic Management Plan.

2. Amending the Scheme Map accordingly.

The amendment is standard under the provisions of the *Planning and Development (Local Planning Schemes) Regulations* 2015 for the following reason(s):

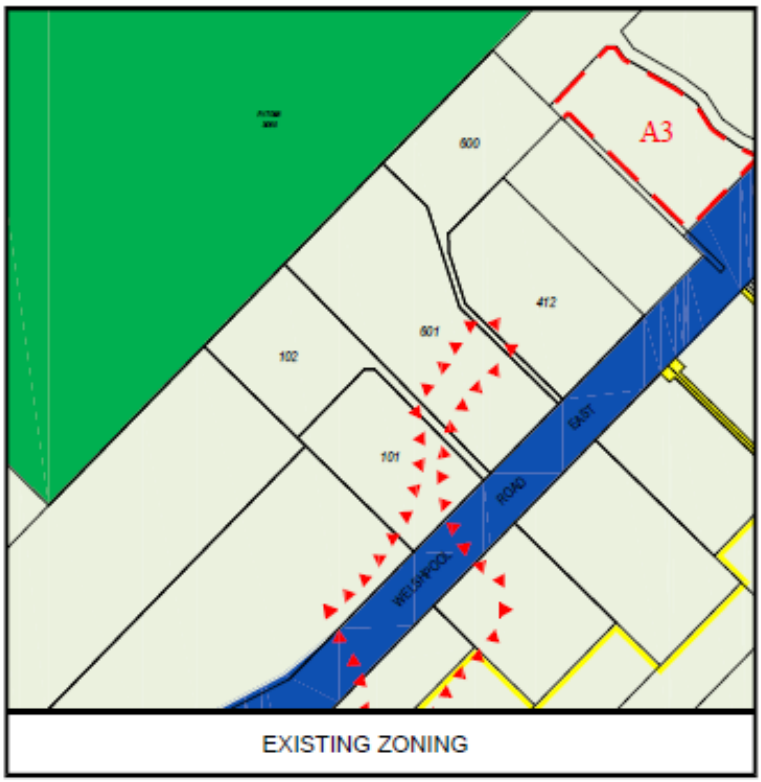
1. The amendment would have minimal impact on land in the Scheme area that is not the subject of the amendment;
2. The amendment is not considered to result in significant environmental, social, economic or governance impacts on land in the Scheme area; and
3. The amendment is not considered to meet the definition of a ‘complex’ or ‘basic’ amendment under the Regulations.

Dated this _____ day of _____ 20___

_____
(Chief Executive Officer)

CITY OF KALAMUNDA
LOCAL PLANNING SCHEME No. 3

Planning and Development Act 2005



EXISTING ZONING

LEGEND

REGION SCHEME RESERVES (MRS)

PARKS AND RECREATION

OTHER REGIONAL ROADS

LOCAL SCHEME ZONES

RURAL COMPOSITE

SPECIAL RURAL

OTHER
(see scheme text for additional information)

A1 ADDITIONAL USES

BUSHFIRE PRONE AREAS



SCHEME (AMENDMENT) MAP

N
SCALE: 1:5000
DATE: 09.05.2018

Amendment No. 95

Local Planning Scheme No.3 Amendment 95

Submissions Summary Table

Agency	Response	Officer Comments
Department of Planning Lands and Heritage	**No Objection** The City received advice on the 13th February 2018 *"The Department recommends that the City consider the installation of a right turning pocket within the median for reasons for safety and efficiency in order to separate turning vehicles from those travelling along Welshpool Road East and avoid rear end collisions for right turning vehicles."* Upon receipt of the Sightlines Report dated the 10th April 2018 the City referred this additional information back to the DPLH who provided a reply to the City on the 30th April 2018 *"The above report, prepared by ML Traffic Engineers dated April 2018 includes a traffic assessment in response to safety concerns, particularly right turning movements. A safety audit including: Sight distances, crash data, existing road layout and turning facilities have been assessed, and the Department is satisfied with the findings and*	**Noted.** A Traffic Management Plan condition required to be implemented will be maintained in the scheme amendment document, this will capture the requirements of the sightline assessment provided by ML Traffic Engineers of April 2018.

	supports the recommendations within Section 6 of the report." The DPLH has stated that it has no objection to the proposal on regional transporting planning grounds subject to the recommendations of the Sightlines Report by ML Traffic Engineers.	
Department of Transport	**No Objection** The City received comments from the DoT on the 14th February 2018 which stated the following: *The DoT has no objection to this proposal, as it unlikely to cause significant impact on Welshpool Rd East.* *However, due to the extent of vegetation in the central median, a visibility assessment is recommended for access and egress movements from the venue.* Further to this and the DPLH comments the question of sightlines and safety was put back to the applicant to prepare further information. They submitted a sightlines report from their traffic engineers which was then referred back to DoT to revisit their comments and provide revised advice to the City.	A Traffic Management Plan condition required to be implemented will be maintained in the scheme amendment document, this will capture the requirements of the sightline assessment provided by ML Traffic Engineers of April 2018.

	The City received comments from the DoT on the 30th April 2018 which followed referral of the Sightlines Assessment Report from ML Traffic Engineers being forwarded to them for additional comment. *'Generally, it would be Main Roads WA's role to provide assistance with respect to warrants for intersection upgrade requirements.* *However, I will provide the following comments:* *Personally, I would suggest that the modelling criteria used are pretty optimistic (100pax guests generating only 25 vehicle trips during the generator's peak hour is lower than I would expect).* *However, there may be arguments for its occasional use not representing sufficient need for channelization; at the discretion of the Shire.* *Based on my professional experience, I think that the sightline assessment is adequate for the purpose.'*	
Main Roads WA	**No Objection** *Main Roads has now had the opportunity to review the documentation and attached plans. Welshpool Road East is a designated*	**Noted.**

	blue road "Other Regional Road" within the Metropolitan Region Scheme (MRS), under the control of the Department of Planning, Lands and Heritage. Main Roads do not provide comment on these roads (within the exception of a few). At this Scheme Amendment is not adjacent to any roads under Main Roads control, Main Roads has no comment or objection to the proposal."	
Department of Health	**No Objection** **Water Supply and Wastewater Disposal** The amendment is to condition that any developments are required to connect to Scheme water and reticulated sewerage (if available) as required by the Government Sewerage Policy – Perth Metropolitan Region. Should reticulated sewerage not be available then approval is required for any on-site waste water treatment process with such proposals being in accordance with DoH publications which may be reference and downloaded from the Departments website. **Food Act Requirements** The reception centre is to comply with the provisions of the Food Act 2008 and related code, regulations and guidelines. Details can be downloaded from the Department's website.	The requirements for connection to reticulated water can be a condition of a subsequent development application which will be required for the land use once the Scheme is amended. The applicant will be required to review the provisions for effluent disposal and this will be required at development application stage.

	Health (Miscellaneous Provisions) Act Requirements. All public access areas (reception centre etc.) to comply with the provisions of the Health (Miscellaneous Provisions) Act 1911 in particular Part IV- Public Buildings, related regulations and guidelines. Sufficient sanitary facilities are to be provided for the maximum number of patrons.	
Department of Biodiversity, Conservation and Attractions	**No Comments**	**Noted.**
Department of Environment and Water	The Department of Water and Environmental Regulation has assessed the above application as a proposal of no interest and as such has no comments to provide.	**Noted.**
Department of Mines, Industry Regulation and Safety	**No Objection**	**Noted.**
Department of Planning Lands and Heritage (Aboriginal Heritage Directorate)	The amendment of the scheme for additional use does not necessitate approvals under the Aboriginal Heritage Act (AHA) 1972 but any proposed developments on that land may require submission of a Section 18 Notice under the AHA. Before the submission of such a Notice, the AHD recommends proponents consult with the South West Aboriginal Land and Sea Council (SWALSC) and knowledge Holder Mr Noel Morich to assist in determining what the proposal's possible impacts may be on heritage place ID 36929 (Yule Brook Mandoorm)	The City acknowledges the advice provided by the Aboriginal Heritage Directorate) and notes that the Section 18 notice runs as a separate legislative process in which the applicant will need to consider separately to the Scheme Amendment Process. The applicant is advised to contact the South West Aboriginal Land and Sea Council (SWALSC) and knowledge Holder Mr Noel Morich to assist in determining what the proposal's possible impacts may be on heritage place ID 36929 (Yule Brook Mandoorm)

	The AHD recommends that proponents refer to the State's Aboriginal Heritage Due Diligence Guidelines (Guidelines) which can be found on the DPLH website.	
Department of Fire and Emergency Services (DFES)	*In accordance with SPP 3.7 the Bushfire Management Plan (BMP) was referred to the Department of Fire and Emergency Services (DFES) as the proposed land use is classified as a vulnerable land use. A response was provided on the 27th September 2017 and forms part of Attachment 4 to this report. DFES advise that the Bushfire Management Plan (BMP) has adequately identified issues arising from the bushfire risk assessment and considered how compliance with the bushfire protection criteria can be achieved for the scheme amendment. It is anticipated that any proposed bushfire management requirements are to be addressed as a condition of the additional use approval and would apply to any subsequent application to commence development. DFES advise that further assessment will be required at subsequent stages (development approval) to ensure that no new structures are located in the BAL-40 of BAL-FZ risk areas.*	It is noted that the application complies with the requirements of the SPP 3.7 State Planning Policy 3.7 Planning in Bushfire Prone Areas and the Guidelines for Planning in Bushfire Prone Areas (Guidelines) It is noted that additional assessment will be required at development application stage to ensure that any new structures are located in an area on-site with acceptable bushfire risk (BAL 40 or BAL FZ being areas of exclusion)

GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

S48A Referrals

Title: City of Kalamunda Local Planning Scheme 3 Amendment 95

Location: Lot 601 (782) Welshpool Road East, Wattle Grove

Description: The City of Kalamunda proposes to include the additional use of 'Reception Centre' at Lot 601 (782) Welshpool Road East, Wattle Grove

Ref ID: CMS17344

Date Received: 14/3/2018 **Date Sufficient Information Received:** 14/3/2018

Responsible Authority: City of Kalamunda

Contact: Ross Jutras-Minett

Preliminary Environmental Factors: Nil

Potential Significant Effects: Nil

Management: Nil

Determination: Referral Examined, Preliminary Investigations and Inquiries Conducted. Scheme Amendment Not to be Assessed Under Part IV of EP Act. No Advice Given. (Not Appealable)

The EPA has carried out some investigations and inquiries before deciding not to assess this scheme. In deciding not to formally assess schemes, the EPA has determined that no further assessment is required by the EPA.

This Determination is not appealable.

Chairman's Initials:

Date: 29/3/18









Proposed Amendment to Local Planning Scheme No. 3 – Use Class Permissibility in the District Centre and Commercial Zones
Justification for Proposed Changes to Table 1 of the Scheme

	District Centre		Commercial		Residential		Justification
	Existing	Proposed	Existing	Proposed	Existing	Proposed	
Aged/Dependant Dwellings	D		D				
Aged Residential Care	D	**A**	D	**A**			It is considered that an aged residential care development should be subject to public advertising prior to a determination being made.
Agriculture – extensive	X		X				
Agriculture – intensive	X		X				
Amusement Parlour	P	**D**	P	**D**			Entertainment based uses could potential result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land.
Ancillary Dwelling	D	**X**	D	**X**			Ancillary dwellings are associated with single house development, which typically and suitably occurs in a residential environment rather than a commercial centre. Accordingly, it is not complementary with the objectives of the District Centre zone.
Animal Establishment	X		X				
Animal Husbandry – intensive	X		X				
Art Gallery	P	**D**	P	**D**			Entertainment based uses could potential result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land.

Bed and Breakfast	D		D				
Betting Agency	P	**D**	P	**D**			Entertainment based uses could potential result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land.
Bulky Goods Showroom	P	**D**	P	**D**			Bulky Goods Showroom land uses are generally suited to car based commercial and light industrial areas. Each application should be assessed on a case-by-case basis.
Caravan Park	X		X				
Caretakers Dwelling	P	**D**	P	**D**			A caretakers dwelling should be subject to planning approval and assessment in a district centre context to determine the appropriateness of the use having regard to the nature of the commercial operation occurring on the site.
Car Park	P	**D**	P	**D**			A car park land use that is not incidental of a predominant commercial use should be subject to planning control, so that the design and location of the use is full considered.
Chalets – short term accommodation	X		X				
Child Care Premises	P	**D**	P	**D**			While Child Care Premises are encouraged in a District Centre environment, applications should be required to determine the appropriateness of the location.
Cinema/Theatre	P	**D**	P	**D**			Entertainment based uses could potential result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land.
Civic Use	D	**P**	D	**P**			This use class would be deemed 'public works' in a majority of cases and exempt from the requirement from obtaining planning approval on zoned land.

Club Premises	P	**D**	P	**D**			Private club based uses could potential result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land.
Commercial Vehicle Parking	X		X				
Community Purpose	P	**D**	P	**D**			Community based uses could potential result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land.
Consulting Rooms	P		P				
Convenience Store	D		D				
Corrective Institution	X		X				
Educational Establishment	D		D				
Family Day Care	P	**D**	P	**D**			Family Day Care uses are generally associated with an occupant of a dwelling caring for a maximum of seven (7) children. Given that this use would likely be associated with grouped or multiple dwellings, which are generally in more confined living environments, it is considered that discretion should be applied when determining the appropriateness of the use.
Fast Food Outlet	P	**D**	P	**D**			Fast Food Outlets should be subject to development approval, particularly where drive through services are proposed. Given the broad nature of this use class, the dynamics of a fast food outlet can vary significantly from use to use.
Fuel Depot	X		X				
Funeral Parlour	D		D				

Garden Centre	P	**D**	P	**D**			Given the broad nature of a Garden Centre use class, uses can vary significantly and should be subject to a discretionary decision.
Grouped Dwelling	D	D	D	D			This should be kept as a discretionary use, however consideration should be given to allowing grouped dwellings to occur only in a mixed use context.
Health/Fitness Centre	P	**D**	P	**D**			Given the broad nature of a Health/Fitness Centre use class, uses can vary significantly and in the interest of protecting amenity for residential occupants within and adjacent to District Centre and Commercial zoned land, it should be subject to a discretionary decision.
Home Business	P	**D**	P	**D**			Home Business uses are operated by an occupant of a dwelling. Given that this use would likely be associated with grouped or multiple dwellings, which are generally in more confined living environments, it is considered that discretion should be applied when determining the appropriateness of the use.
Home Occupation	P	**D**	P	**D**	P	**D**	Home Occupation uses are operated by an occupant of a dwelling. Given that this use would likely be associated with grouped or multiple dwellings, which are generally in more confined living environments, it is considered that discretion should be applied when determining the appropriateness of the use. This amendment also seeks to correct an error in Table 1 relating to the Home Occupation use in a Residential Zone, by changing it from a 'P' (permitted) use to a 'D' (Discretionary) use. This is consistent with the approach taken by other local governments and will ensure that an appropriate level of development control is applied to home occupation proposals. The City will also investigate the preparation of a local planning policy for home occupations

							to provide a transparent and consistent decision making framework for these types of proposals.
Home Office	Nil.	**P**	Nil.	**P**			By definition, a Home Office does not entail any externalities, and should not be subject to the requirement to obtain development approval.
Home Store	P	**D**	P	**D**			Future occupants of grouped/multiple dwellings may wish to incorporate a home store, this should be assessed on case by case basis.
Hospital	D	**A**	D	**A**			Given the significance of a Hospital use/development, it should be subject to public advertising prior to a determination being made.
Hotel	D	**A**	D	**A**			It is considered that a hotel development should be subject to public advertising prior to a determination being made.
Industry	X		X				
Industry – Cottage	D		D				
Industry – Extractive	X		X				
Industry – General	X		X				
Industry - Light	X		X				
Industry – Mining	X		X				
Industry – Rural	X		X				
Industry – Service	D	**X**	D	**X**			Service Industry is a use that is appropriately located in an industrial area.
Lodging House	A		A				

Logistics Centre	X		X				
Lunch Bar	P		P				
Market	A		A				
Medical Centre	P		P				
Motel	A		A				
Motor Vehicle, Boat or Caravan Sales	P	**X**	P	**D**			Motor Vehicle, Boat or Caravan Sales is a use that may be appropriate in a Commercial zone, however not within the District Centre environment. These uses are more appropriately located in an industrial area.
Motor Vehicle Repairs	P	**X**	P	**X**			Motor Vehicle Repairs is a use that is appropriately located in an industrial area.
Motor Vehicle Wash	D		D				
Motor Vehicle Wrecking	X		X				
Multiple Dwelling	D		D				
Museum	A		A				
Night Club	A		A				
Office	P		P				
Park Home Park	X		X				
Place of Worship	D	**A**	D	**A**			Places of Worship could potential result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land. Given the level of public interest involved in the consideration of Place of Worship uses, it is considered that advertising should be undertaken prior to determination.

Public Utility	P		P				
Reception Centre	P	**A**	P	**A**			Reception Centre uses can involve large numbers of occupants for short periods and can potentially result in undue impacts on the amenity of residential occupants within and adjacent to District Centre and Commercial zoned land. Given the level of public interest involved in the consideration of Reception Centre uses, it is considered that advertising should be undertaken prior to determination.
Recreation – Private	D		D				
Research and Technology Premises	X		X				
Resource Recovery Centre	X		X				
Restaurant/Café	P		P				
Restricted Premises	X		X				
Rural Pursuit/Hobby Farm	X		X				
Salvage Yard	X		X				
Service Station	P	**A**	P	**A**			The design and operation of a Service Station is not usually conducive in a District Centre and is more suited to a ribbon patterned commercial area (along busy roads), however depending on the location and design of the proposal, there should be the potential to consider an application within these zones. It is considered appropriate to advertise a proposal prior to a determination being made.
Shop	P		P				
Single Bedroom Dwelling	D	**X**	D	**X**			A single bedroom dwelling is not appropriate as it would not result in the highest and best use of land in a District Centre and Commercial environment.

Single House	D	**X**	D	**X**			A single house is not appropriate as it would not result in the highest and best use of land in a District Centre and Commercial environment.
Small Bar	Nil.	**P**	Nil.	**P**			It is considered that Small Bar should be introduced as a land use in the Scheme and encouraged within the District Centre and Commercial zones.
Tavern	D	**A**	D	**A**			Given the nature of a Tavern land use can include amenity impacts and is usually a use that attracts significant public interest, it should be subject to public advertising.
Telecommunications Infrastructure	D		D				
Trade Display	D	**X**	D	**X**			Trade Display is a use that is appropriately located in an industrial area.
Transport Depot	X		X				
Veterinary Centre	P	**D**	P	**D**			A Veterinary Centre should be a discretionary use in a District Centre and Commercial zone given the likely amenity impacts resulting from animals under care which stay overnight.
Warehouse/Storage	D	**X**	D	**X**			Warehouse is a use that is appropriately located in an industrial area.
Winery	X		X				

Summary of Submissions
Amendment No. 96 to Local Planning Scheme No. 3 – Modifying the Use Class Permissibility in the District Centre, Commercial and Residential Zones

Submitter No.	Nature of Submission	Response/ Recommended Modifications
Submission 1	**Objection** This submission relates to the proposed changes to Table 1 of LPS3 and does not concern the insertion of a definition for a 'small bar' land use. The inclusion of a 'small bar' land use and its associated permissibility proposed thorough the Amendment is supported. We do not, however, support the proposed changes to the permissibility of land uses within the District Centre Zone outlined above. The Amendment proposed to modify the use permissibility in Table , so as to require landowners to obtain planning approval, which would have otherwise not required approval as a result of the *Planning and Development (Local Planning Schemes) Regulations 2015* (the Regulations) coming into force. The Amendment appears to respond to the relevant exemptions under the Regulations through modifying the permissibility of uses in Table 1 of LPS3 to provide the City with greater control over development taking place within the District Centre Zone. This is considered to be contrary to the purpose and intent of the Regulations as the proposed Table 1 changes simply appear to be requiring landowners to seek planning approval from the City by modifying those land uses currently notes as being permitted ('P') uses to discretionary ('D') uses, therefore not allowing clause 61 of the Regulations to be triggered and thus requiring a landowner to seek planning approval. The City does consider this in its report to Council requesting the initiation of the Amendment and states the following: *'In August 2015, the Planning and Development (Local Planning Schemes) Regulations 2015 introduced deemed provisions that exempted development from requiring planning approval that is classified as 'P' (permitted) and:* *i) the development has no works component; or* *ii) development approval is not required for the works component of the development.*	Noted. In a District Centre and Commercial zoned environment, it is important to facilitate the types of uses that are desirable, however this should be balanced with an appropriate level of development control. The introduction of the deemed provisions in August 2015, removed the City's discretion through development control whereby a proposal complied with Clause 61(2)(b). This created several concerns for the City of Kalamunda, namely the ability to control the provision of parking for a change of use application. For example a change of use from one permitted use to another (eg. Office to Restaurant) without any external works would potentially result in greater parking demand, however not require a development application. This means that the City would be unable to require the provision of necessary additional parking or cash in lieu of parking, and would be unable to refuse an application that does not provide appropriate car parking. In summary, the proposed amendment will modify Table 1 to bring it into line

Summary of Submissions
Amendment No. 96 to Local Planning Scheme No. 3 – Modifying the Use Class Permissibility in the District Centre, Commercial and Residential Zones

Submitter No.	Nature of Submission	Response/ Recommended Modifications
	This means that where a site changes use, and the new use is classified as 'P' (permitted), and no works are proposed, it will not require planning approval unless there are external modifications to the building. In a District Centre and Commercial zoned environment, it is important to facilitate the types of uses that are desirable, however this should be balanced with an appropriate level of development control. *This amendment proposes to reclassify the permissibility of some uses to ensure that a development application is required prior to the commencement of the use, and that appropriate development standards and processed are applied through the development application process'.* The City Officer's report to request the Council initiate the Amendment outlined that Council's Strategic Service Delivery Review in 2017 set out to investigate exemptions in the Forrestfield District Centre with a particular view of facilitating desirable land uses (Shop, Office, Small Bar, Restaurants and Consulting Room), though it noted that all of these uses were already 'P' (permitted) land uses. Despite this, the remaining land uses and their permissibility were also reviewed but contrary to the objective of the 2017 Delivery Review, this has appeared to result in making the approval process more onerous, complicated and time consuming, by reducing the exceptions and increasing the process timeframes. The City's recommendation to Council contradicts the intent of the Regulations to expedite basic land use changes across all local governments areas within the Western Australia for appropriate uses. It should be noted that where there is a works component or additional parking then an application is required in any event and will trigger the need for the City to consider an application for planning approval.	with contemporary planning objectives and community expectations.

Summary of Submissions
Amendment No. 96 to Local Planning Scheme No. 3 – Modifying the Use Class Permissibility in the District Centre, Commercial and Residential Zones

<table>
<tr><th>Submitter No.</th><th>Nature of Submission</th><th>Response/ Recommended Modifications</th></tr>
<tr><td></td><td>
The District Centre zone is the highest order commercial zone within the Scheme and its objectives are:

To promote, facilitate and strengthen the District Centres as the major foci of activity, particularly for shopping, business, professional, civic, cultural, environment facilities and related employment opportunities.
Provide for medical and other health related services.
Allow for the establishment of uses which would co-exist with the District Centre's activities whilst recognising a limited level of residential activities in the District Centre.
Achieve safety and efficiency in traffic and pedestrian circulation.
Ensure that the scale, size, design and location of buildings are compatible with the existing development in the District Centre.

The proposed Amendment appears to be in conflict with the stated objectives for the District Centre Zone which is clearly meant to be the focus of activity for a wide variety of commercial uses. It is not considered orderly or proper planning for the permissibility of uses to be made more restrictive and onerous given the clearly stated objective.

With regard to particular uses the following comments are made:
<table>
<tr><th></th><th colspan="2">District Centre</th><th></th></tr>
<tr><th>Land Use</th><th>Existing</th><th>Proposed</th><th>Comments</th></tr>
<tr><td>Aged Residential Care</td><td>D</td><td>A</td><td>There are typically no amenity impacts associated with the use to warrant advertising. The City can always advertise the development aspect anyway under Claude 9.4.2 Such uses should be encouraged in District Centres where there is typically high access to public transport and amenities.</td></tr>
</table>
</td><td></td></tr>
</table>

Summary of Submissions
Amendment No. 96 to Local Planning Scheme No. 3 – Modifying the Use Class Permissibility in the District Centre, Commercial and Residential Zones

Submitter No.	Nature of Submission				Response/ Recommended Modifications
	Amusement Parlour	P	D	District Centre is the most appropriate zone for such a use.	
	Ancillary Dwelling	D	X	No objection	
	Art Gallery	P	D	There are no amenity impacts with an Art Gallery. The objective of the zone is to encourage cultural use.	
	Betting Agency	P	D	District Centre is the most appropriate zone for such a use	
	Bulky Goods Showroom	P	D	This should be left to the market to determine as more intensive areas attract more rent.	
	Caretakers Dwelling	P	D	No objection	
	Car Park	P	D	District Centre is the most appropriate zone for such a use.	
	Child Care Premises	P	D	Such use should be encouraged in District Centres where there is typically high access to public transport and amenities and opportunities for shared vehicle trips.	
	Cinema/Theatre	P	D	The objective of the zone is to encourage entertainment uses.	
	Civic use	D	P	The objective of the zone is to encourage cultural uses.	
	Club premises	P	D	No objection	
	Community Purpose	P	D	The objective of the zone is to encourage cultural uses.	
	Family Day Care	P	D	No objection	
	Fast Food Outlet	P	D	The objective of the zone is to encourage entertainment uses.	
	Garden Centre	P	D	No objection	

Summary of Submissions
Amendment No. 96 to Local Planning Scheme No. 3 – Modifying the Use Class Permissibility in the District Centre, Commercial and Residential Zones

Submitter No.	Nature of Submission				Response/ Recommended Modifications
	Health/Fitness Centre	P	D	Such uses should be encouraged in District Centres, supporting extended hours of activity.	
	Home Business	P	D	No objection	
	Home Occupation	P	D	There are no amenity impacts associated with a Home Occupation use and it should be permitted	
	Home Office	NIL	D	No objection	
	Home Store	P	D	No objection	
	Hospital	D	A	No objection	
	Motor Vehicle Repairs	P	X	Such as use should be a 'D' use to ensure amenity impacts are addressed. Such facilities should be encouraged given the higher level of public transport.	
	Place of Worship	D	A	No objection	
	Reception Centre	P	A	No objection	
	Service Station	P	A	No objection	
	Single Bedroom Dwelling	D	X	Housing diversity should be encouraged in the zone, this proposed amendment goes against the fundamental principles of creating Activity Centres and Mixed Use Precincts.	
	Single House	D	X	No objection	
	Small Bar	Nil	P	No objection	
	Tavern	D	A	No objection	
	Trade Display	D	X	This should be an A use to allow for temporary uses of vacant areas.	
	Veterinary Centre	P	D	No objection	
	Warehouse/Storage	D	X	This should be an A use for temporary use of vacant tenancies.	

Summary of Submissions
Amendment No. 96 to Local Planning Scheme No. 3 – Modifying the Use Class Permissibility in the District Centre, Commercial and Residential Zones

Submitter No.	Nature of Submission	Response/ Recommended Modifications
	Whilst we are supportive of the land use permissibility changes proposed to occur to some of those existing uses already require planning approval of the City, the proposed blanket wide changes to the permissibility of those uses currently permitted within the District Centre Zone is not supported as it directly conflicts with the objective of the Zone. In this respect, the existing planning framework already allows the City to control certain types of development which are considered to necessitate the need for further controls. The City's response to the introduction of the Regulations and the associated exemptions it provides to certain development through this Amendment is not considered reasonable, and is in fact contrary to the intent of the Regulations to streamline development control and certain development across all local governments within Western Australia. It is respectfully requested that the City reconsider the proposed changes to the existing permitted uses within the District Centre Zone and allow for these uses to remain permitted, being exempt from the need to require approval where they are consistent with the City's planning framework and require no works component as allowed for under the Regulations.	
Submission 2	**No objections** to the proposal.	Noted.
Submission 3	**Non-objection** The changes are mainly a dilution in town-planning terms from Permitted uses to Discretionary and Advertising. We appreciate this is a precautionary approach by the City as its accords with determinations by the Western Australian Planning Commission. Therefore, whilst some of the changes are considered a weakening for proponents/landowners they are not significant enough to affect valuations ect. and arguing against them would not bring about any change. However, the changes to a more discretionary basis make for more work by consultants and a longer time frame to achieve an outcome.	Noted.

Summary of Submissions
Amendment No. 96 to Local Planning Scheme No. 3 – Modifying the Use Class Permissibility in the District Centre, Commercial and Residential Zones

Submitter No.	Nature of Submission	Response/ Recommended Modifications
	On that basis, we submit the changes as per the amendment.	
Submission 4	I am very much in favour for the Scheme amendment No. 96 in the city of Kalamunda. I feel that Kalamunda is severely lacking in this type of venue and that is would bring more visitors to our lovely area. Some people may argue that is would bring more unruly behaviour, I do not believe this will be true with the responsible serving of alcohol and I very much hope this measure passes.	Noted.
DEPARTMENT OF PLANNING, LANDS AND HERITAGE (HERITAGE)	No objection	Noted.
DEPARTMENT OF WATER	No objection	Noted.
DEPARTMENT OF HEALTH	No objection	Noted.
MAIN ROADS WESTERN AUSTRALIA	No objection	Noted.

LOCAL PLANNING SCHEME NO. 3

Amendment No. 96

shire of kalamunda

Planning and Development Act 2005 (as amended)

RESOLUTION TO ADOPT AMENDMENT TO LOCAL PLANNING SCHEME

CITY OF KALAMUNDA LOCAL PLANNING SCHEME NO. 3

AMENDMENT NO. 96

RESOLVED that the local government, in pursuant to section 75 of the *Planning and Development Act 2005,* of amend the above Local Planning Scheme by:

1 Amending Table 1 (Zoning Table) of the Local Planning Scheme No. 3, by deleting the existing use permissibility classifications and substituting it with the following in the District Centre, Commercial and Residential zones:

Use Classes	**District Centre**	**Commercial**	**Mixed Use**	**Residential**	**Residential Bushland**	**Light Industry**	**General Industry**	**Service Station**	**Private Clubs & Inst.**	**Special Rural**	**Rural Composite**	**Rural Agriculture**	**Rural Landscape Interest**	**Rural Conservation**	**Industrial Development**
Aged/Dependant Dwellings	D	D													
Aged Residential Care	**A**	**A**													
Agriculture – extensive	X	X													
Agriculture – intensive	X	X													
Amusement Parlour	**D**	**D**													
Ancillary Dwelling	**X**	**X**													
Animal Establishment	X	X													
Animal Husbandry – intensive	X	X													
Art Gallery	**D**	**D**													
Bed and Breakfast	D	D													
Betting Agency	**D**	**D**													
Bulky Goods Showroom	**D**	**D**													
Caravan Park	X	X													

Caretakers Dwelling	**D**	**D**													
Car Park	**D**	**D**													
Chalet – Short Term Accommodation	X	X													
Child Care Premises	**D**	**D**													
Cinema/Theatre	**D**	**D**													
Civic Use	**P**	**P**													
Club Premises	**D**	**D**													
Commercial Vehicle Parking	X	X													
Community Purpose	**D**	**D**													
Consulting Rooms	P	P													
Convenience Store	D	D													
Corrective Institution	X	X													
Educational Establishment	D	D													
Family Day Care	**D**	**D**													
Fast Food Outlet	**D**	**D**													
Fuel Depot	X	X													
Funeral Parlour	D	D													
Garden Centre	**D**	**D**													
Grouped Dwelling	D	D													
Health/Fitness Centre	**D**	**D**													
Home Business	**D**	**D**													
Home Occupation	**D**	**D**		**D**											
Home Office	P	P													
Home Store	**D**	**D**													
Hospital	**A**	**A**													
Hotel	**A**	**A**													
Industry	X	X													
Industry – Cottage	D	D													
Industry – Extractive	X	X													
Industry - General	X	X													
Industry - Light	X	X													
Industry – Mining	X	X													

Industry – Rural	X	X													
Industry – Service	**X**	**X**													
Lodging House	A	A													
Logistics Centre	X	X													
Lunch Bar	P	P													
Market	A	A													
Medical Centre	P	P													
Motel	A	A													
Motor Vehicle, Boat or Caravan Sales	**X**	**D**													
Motor Vehicle Repairs	**X**	**X**													
Motor Vehicle Wash	D	D													
Motor Vehicle Wrecking	X	X													
Museum	A	A													
Multiple Dwelling	D	D													
Night Club	A	A													
Office	P	P													
Park Home Park	X	X													
Place of Worship	**A**	**A**													
Public Utility	P	P													
Reception Centre	**A**	**A**													
Recreation – Private	D	D													
Research and Technology Premises	X	X													
Resource Recovery Centre	X	X													
Restaurant/Café	P	P													
Restricted Premises	X	X													
Rural Pursuit/Hobby Farm	X	X													
Salvage Yard	X	X													
Service Station	**A**	**A**													
Shop	P	P													
Single Bedroom Dwelling	**X**	**X**													
Single House	**X**	**X**													

Small Bar	**P**	**P**	**A**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Tavern	A	A													
Telecommunications Infrastructure	D	D													
Trade Display	**X**	**X**													
Transport Depot	X	X													
Veterinary Centre	**D**	**D**													
Warehouse/Storage	**X**	**X**													
Winery	X	X													

2 Inserting a new definition for Small Bar under the 'Land Use Terms Used in the Scheme' in accordance with the Model Provision definition under the *Planning and Development (Local Planning Schemes) Regulations 2015,* as follows

"*Small bar means premises the subject of a small bar license granted under the Liquor Control Act 1988.*"

The Amendment is standard under the provisions of the *Planning and Development (Local Planning Schemes) Regulations 2015* for the following reason(s):

a) The amendment is consistent with the objectives identified in the Scheme for the applicable zones.
b) The amendment is consistent with the City of Kalamunda Local Planning Strategy.
c) The amendment is consistent with the MRS zoning that applies to the site, and the applicable strategic planning framework.
d) The amendment is considered to have a minimal impact upon the land within the City of Kalamunda.
e) The amendment will not result in any significant environmental, social, economic or governance impacts within the surrounding local area.

Dated this _____ day of _____ 20_____

_____
CHIEF EXECUTIVE OFFICER

LOCAL PLANNING SCHEME NO. 3

Amendment No. 96

COUNCIL ADOPTION FOR ADVERTISING

Adopted for advertising by resolution of the Council of the City of Kalamunda at the Ordinary Council Meeting of the Council held on the 26 September 2017.

.....
CITY MAYOR

.....
CHIEF EXECUTIVE OFFICER

COUNCIL RECOMMENDED/SUBMITTED FOR APPROVAL

Supported for submission to the Minister for Planning for approval by resolution of the City of Kalamunda at the Ordinary Meeting of the Council held on the 26 June 2018 and the Common Seal of the City of Kalamunda was hereunto affixed by the authority of a resolution of the Council in the presence of:

.....
CITY MAYOR

.....
CHIEF EXECUTIVE OFFICER

WAPC RECOMMENDED/SUBMITTED FOR APPROVAL

.....
DELEGATED UNDER S.16 OF
THE *PLANNING AND DEVELOPMENT ACT 2005*

DATE.....

APPROVAL GRANTED

.....
MINISTER FOR PLANNING
S.87 OF THE *PLANNING AND DEVELOPMENT ACT 2005*

DATE.....

Bicycle Plan 2017
Summary







DRAFT







city of kalamunda

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1 INTRODUCTION

1.1 VISION AND OBJECTIVES

Our vision is:

"Connected Communities, Valuing Nature and Creating our Future Together"

One of the key aspects of the vision story is for the City to be "easily accessible to and from Perth City, and around the City" – this Bicycle Plan supports this vision by setting out a clear way forward for investment in the active transport network.

The goals of this Bicycle Plan are:

> To improve the safety of the cycling environment by providing better cycling paths, shared paths, and road treatments, after considering crash history and community feedback on cycling safety.

> To provide more paths and road spaces that are suited to the design needs of cyclists, and accommodate the different types of cycling users such as shared path users, commuters, recreational cyclists, and competitive cyclists. This includes consideration of shorter and longer travel distances, path geometry, travel routes, convenience, and connectivity.

> To increase the use of public transport, by providing more cycling options for people to use public transport, providing better end of trip facilities, and improving connections to the cycling network.

> To improve cycling access to the Forrestfield Train Station and the use of the public transport system associated with the train station.

> To promote and educate in cycling, and thus improve cycling participation for the flow-on effects such as improvements in health and social values, economic development and tourism.

> To provide the research and strategy that will enable planning for cycling works and applying for funding for cycling infrastructure and programs.

1.2 POLICY CONTEXT

The Bicycle Plan was formulated to support and integrate with the objectives of national, state and local government policies.

2 THE BENEFITS OF CYCLING



Cycling can be undertaken for commuting, recreational and casual purposes, and has been acknowledged to provide benefits to the individual and the wider community including:

> Social Benefits such as encouraging regular exercise and social interactions, increasing mobility for those unable to drive and increasing safety for all road users.

> Personal Economic Benefits such as decreasing the cost of transport, lessening the need for multiple family cars and reducing personal health care costs.

> Commercial Economic Benefits such as happier, healthier and more productive staff, reducing pressure on parking facilities and new potential customers.

> Environmental Benefits such as improvements to air quality, reductions in greenhouse gas emissions and increasing green spaces as a result of fewer car trips.

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3 COMMUNITY CONSULTATION

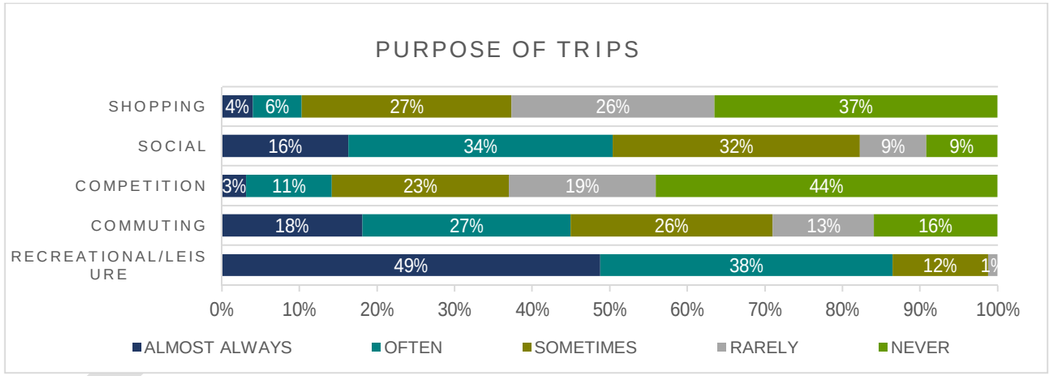
Community consultation was a critical component of developing this Bicycle Plan. Community Consultation was undertaken to guide the Bicycle Plan so that it could meet the needs of existing cyclists and encourage a greater uptake of cycling.

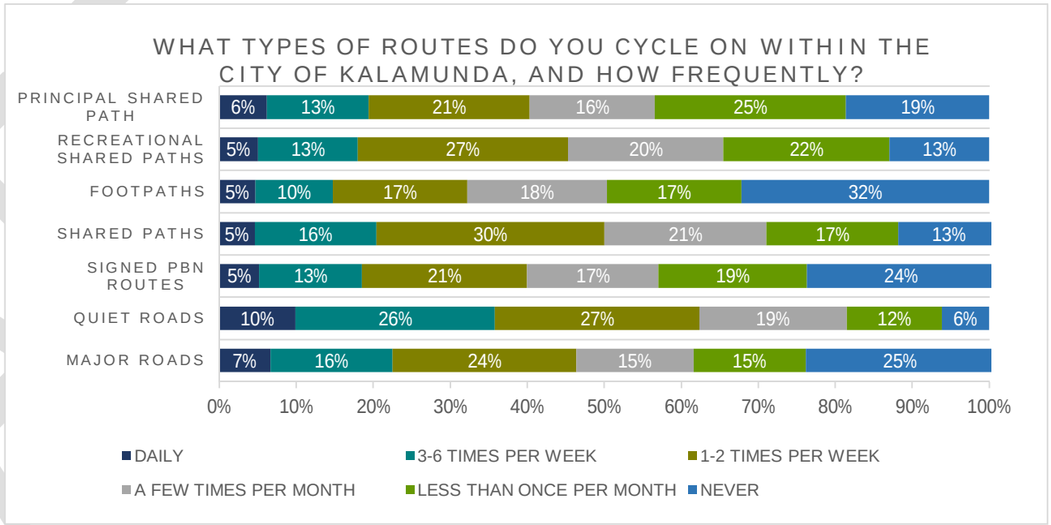
An open public consultation process was undertaken during March and April 2017. This process consisted of a survey questionnaire, which was available both in hard copy and on the City of Kalamunda's website. Over 200 responses were received, 64% of which were from residents of the Hills portion of the City. Over 20% of the responses were from non-residents of the City, indicating strong interest from cyclists who visit the City from other parts of Perth.

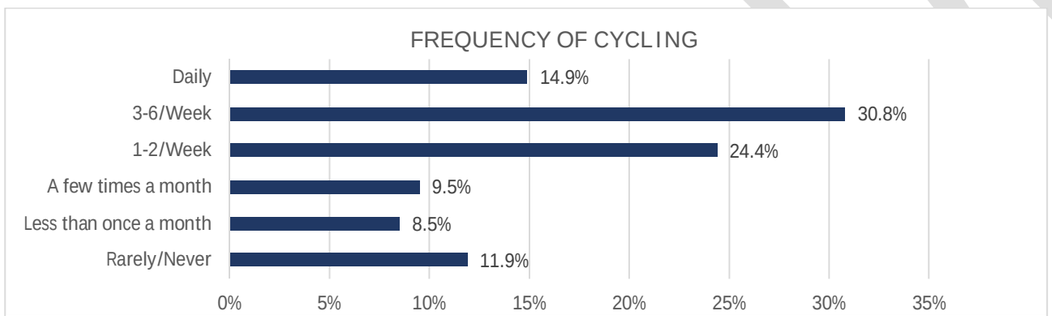
The survey results show that quiet roads are the most used route type in the City, with 63% of respondents riding through them at least 1-2 times a week. Shared paths are the second most used cycling infrastructure in the City. The number of respondents using Principal Shared Paths (PSP) at least weekly was 40%. Note that within the City only a short section of PSP currently exists, between Tonkin Highway and Berkshire Road. This indicates that there is a demand for additional high quality infrastructure within the City.

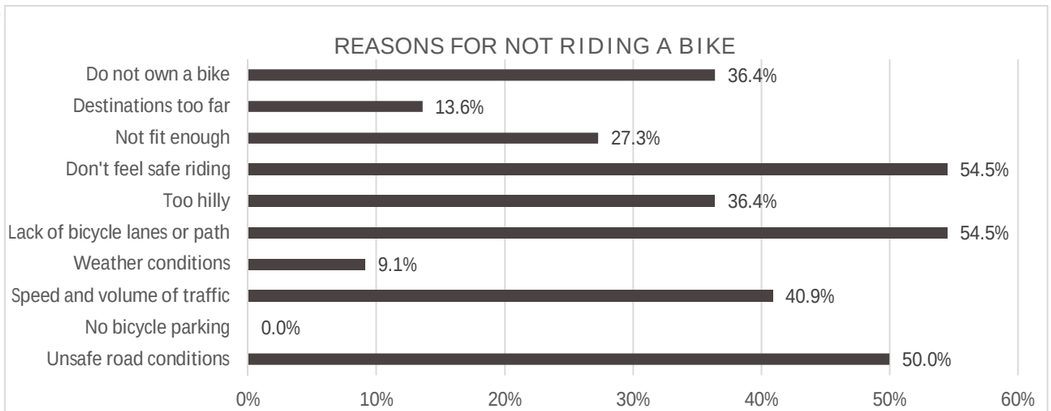
For the respondents of the survey, weekends were the most popular time to ride. Forty percent claimed to 'almost always' ride through the City on the weekends. Sixty percent of respondents stated that they stopped within the City during their ride to buy food and/or drinks. The majority of respondents stop at shops and cafes around the Kalamunda Town Centre. For people who did not stop, better and safer bike parking was an improvement they would most like to see around the City, especially at the Kalamunda Town Centre.

Respondents who rarely cycle were asked to nominate the main reasons for not currently riding. The main reasons respondents listed for not riding a bike were "don't feel safe riding", "unsafe road conditions", "speed and volume of traffic" and "lack of bicycle lanes or path." These results indicate a definite need for the City to invest in dedicated on-road cycling facilities to create a safer cycling environment.









4 ENCOURAGEMENT AND EDUCATION

Constructing new infrastructure is crucial to the promotion of cycling in the City of Kalamunda. It is also important to encourage the use of new infrastructure with education programs that encourage behaviour change.

4.1 Behaviour Change Approach

There are many ways to encourage behaviour change and the methods proposed for the City of Kalamunda are:

> Raise awareness of cycling by including information regarding cycling related activities on the City's website, newsletter and social media;

> Ensure that tools and resources, for example route maps, road rules, safety, and cycling etiquette are easily accessible, either electronically or in print form;

> Provide cycling education courses and conduct educational rides to encourage inexperienced riders to ride more often;

> Ensure that the infrastructure and supporting facilities are well maintained, safe, legible and convenient so that the new rider has a positive initial experience;

> Provide positive reinforcement for existing bike riders to encourage them to keep riding, for example by participating in the Super Tuesday annual bike count event and Bike Week.

4.2 Bicycle Library

One of the major reasons that residents do not cycle is that they do not own a bicycle. Purchasing a bicycle is a significant investment for many people and one which is unlikely to be made without some confidence that it will be frequently used.

To overcome this barrier, a "Bicycle Library" scheme can be introduced, where residents are permitted to borrow the bicycles for a few hours at no cost, with longer ride attracting a small fee. Non-residents with suitable identification are also able to use the scheme.

This scheme has been successfully implemented in the City of Vincent, with bicycles booked out most weekends and many weekdays. The cargo bike allows households without a car to do shopping that would otherwise be difficult on a regular bicycle.

The City should investigate the feasibility of a Bicycle Library scheme, based at the Kalamunda, Forrestfield and High Wycombe libraries. The scheme could be started with the opening of sections of Secondary Routes and Local Routes, for example the Hills Spine and the Foothills Spine. The scheme could also be tied to the opening of Forrestfield Station as a way to encourage residents to ride to the station.

4.3 Targeted Education Program

Driver education, when targeted properly, can be an effective tool in encouraging better road user behaviour. It is recommended that the City collaborate with the Eastern Metropolitan Regional Council, WestCycle, Main Roads Western Australia, and the Road Safety Commission to implement a Driver and Cyclist Education Program.

4.4 Schools Program

School aged children are a critical component for sustainable transport as they are the next generation of cyclists. The early exposure of children to cycling as an enjoyable way to spend their leisure time and to get to/from school has been proven to contribute significantly to children continuing to cycle into adulthood.

The opportunities for encouraging school aged children to ride bicycles include:

> Cycling to and from school as the majority of children live within five kilometres of their school which is a comfortable cycling distance;

> Receiving cycling lessons at school, covering the basics of riding a bicycle and safety on and around the roads;

> Participating in organised cycling sports, either at school or on weekends, ranging from simple leisurely rides to road riding and mountain biking, and

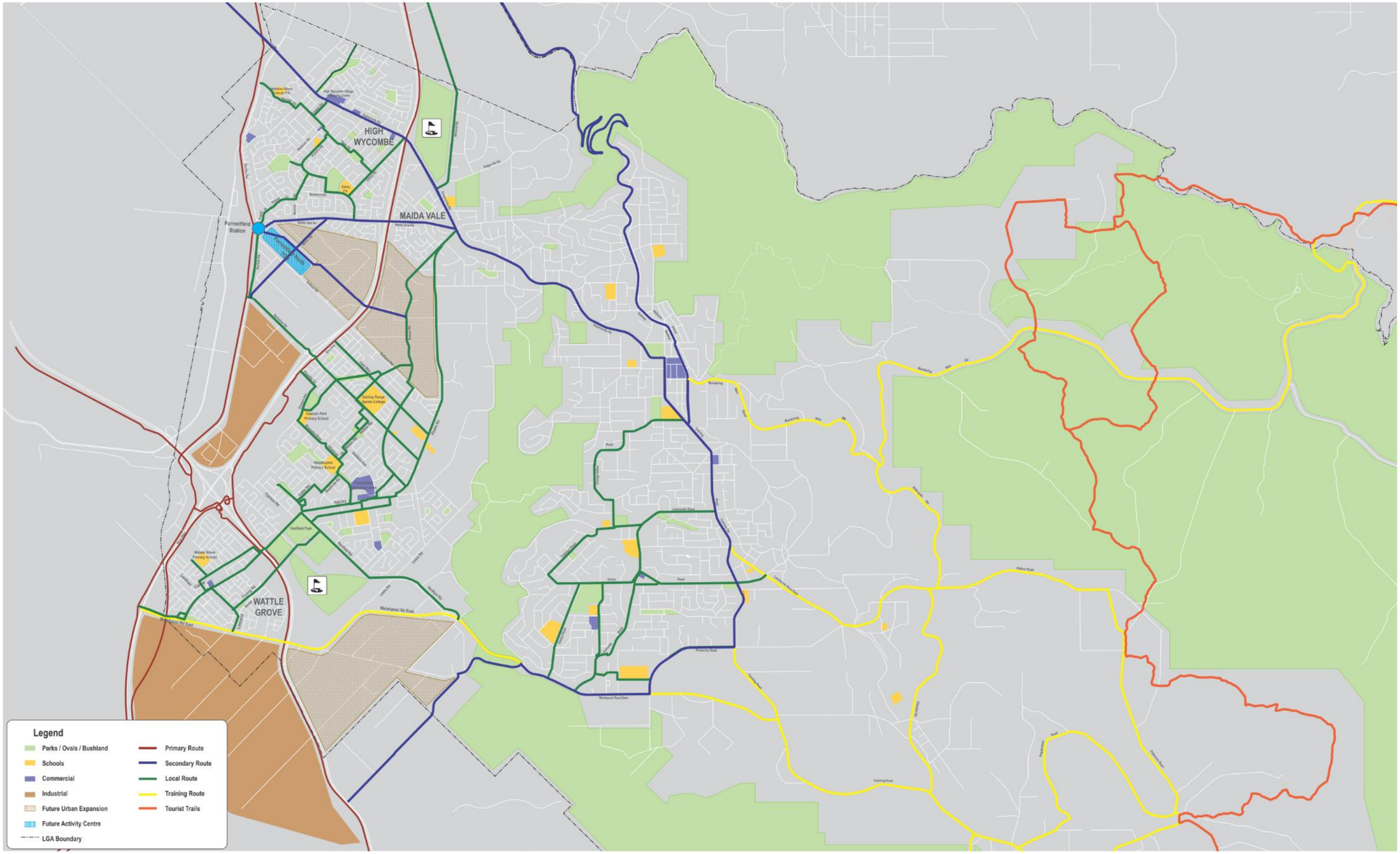
> Participating in the 'Your Move' Program (yourmove.org.au), where schools can earn points by sharing stories regarding active transport. Points can be redeemed for items and services such as bicycle racks and bicycle education sessions.

The City, in conjunction with State Government agencies and community groups, could undertake programs to encourage school students to take up cycling. These initiatives should be continued at least once every two years, with different schemes targeting different age groups. A key focus should be children in the range of ten to fourteen years old, who are reaching the age where they may want to cycle to school and are permitted by their parents (or accompanied by their parents).

A separate school program to target kindergarten and primary school students (in the five to nine year old range) can also be provided. The goal is to instil a good travel behaviour early in the student's life, with the hope that they would continue through to adulthood.



ULTIMATE CYCLING NETWORK



CITY OF KALAMUNDA - ULTIMATE CYCLING NETWORK (ROUTE HIERARCHY)

5 ULTIMATE CYCLING NETWORK

The Ultimate Cycling Network has been developed in alignment with the Route Hierarchy used by the Department of Transport as part of its *Transport Plan @ 3.5 Million Cycling Network:*

> Primary Routes are the high quality regional routes such as the existing and proposed Principal Shared Paths (PSPs) along Roe Highway, Tonkin Highway and railway corridors, which are also the backbone of the cycling network in Perth Metropolitan Area. These paths provide high-quality direct cycling connections completely separated from road traffic.

> Secondary Routes provide safe and direction connections between Primary Routes and major trip generators such as shopping centres, industrial areas or major health, education, sporting and civic facilities.

> Local Routes provide safe cycling conditions in local (predominantly residential) areas, collecting cycling traffic from local roads within suburbs and distribute it to the primary and secondary networks.

> Training Routes provide training or sports cyclists with designated routes in which to undertake long distance rides in on-road environments. These are normally located on rural or semi-rural roads but can also include the major access roads to these areas where these roads do not form part of Primary, Secondary or Local Routes.

5.1 PRIMARY ROUTES

Roe Highway

The Roe Highway PSP currently extends 21 kilometres from the Kwinana Freeway and terminates at Berkshire Road, with grade separation at intersecting roads. It is understood that the Roe Highway / Kalamunda Road intersection will have grade separation in the near future. This project presents an important opportunity for the completion of further sections of the Roe Highway PSP. It is recommended that the City of Kalamunda advocate and work with the State Government to ensure that the PSP extension is included as part of the grade separation including:

> Grade-separation of the PSP under Kalamunda Road,

> Extension of the PSP from Berkshire Road to Kalamunda Road, including an underpass at Maida Vale Road, and

> Extension of the PSP north from Kalamunda Road to the Brinsmead Road area, subject to a suitable connection being available to Midland Road.

Freight Railway/Dundas Road Corridor

The main freight railway runs north-south along the western edge of the City, parallel to Abernethy and Dundas Roads and passing the new Forrestfield Station. The area surrounding the Forrestfield Station is being planned as a Transit Oriented Development (TOD), with medium to high density residential and mixed use developments. There will be a significant increase in the residential population near Dundas Road and therefore it is critical that there is a safe, convenient cycling link to the Tonkin Highway PSP and the major employment centres at Welshpool, Kewdale and the Airport.

Given the significance of this link, the recommended improvement for this route is a PSP which would eventually link Midland and Forrestfield.

As part of the State Government's METRONET plan, a passenger railway line is identified as linking the new Forrestfield Station with the Thornlie spur and a future extension to Cockburn Central. The timing of this project is not known, however it is desirable that plans for a PSP along this rail corridor be included in any planning and design.

Tonkin Highway

The Tonkin Highway PSP will be a significant connection for the southern edge of the City, connecting Wattle Grove with the wider network and the significant employment areas in Maddington and Gosnells. The priorities for extension are as follows:

1. PSP along the southern side of Tonkin Highway from Roe Highway to Hale Road (parallel to Hardey East Road),
2. PSP along the southern side of Tonkin Highway connecting to the Coyong Road and Maamba Road shared paths in Wattle Grove,
3. Connection across Tonkin Highway between Coyong Road and Maamba Road and Hartfield Park,
4. Extension of PSP from Hale Road to Welshpool Road East, and
5. Extension of PSP from Welshpool Road East to Kelvin Road and beyond.

TONKIN HIGHWAY PRIMARY ROUTE



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5.2 SECONDARY ROUTES

Hills Spine (Midland – Kalamunda - Lesmurdie)

The key component of the cycling network for the hills portion of the City of Kalamunda is a north-south spine linking Midland, Kalamunda and Lesmurdie. The route includes the following elements:

> Two-way bicycle access via Zig Zag Scenic Drive. Several options were investigated, and Option A is the preferred option for Zig Zag Scenic Drive as it provides the best outcomes in terms of safety and is relatively simple to implement compared to other options,

> Safe Active Street treatment between the top of Zig Zag Scenic Drive and Hill Street,

> Upgrade of the Kalamunda Railway Heritage Trail to a high quality shared path from Hill Street to Elizabeth Street,

> Multiple options for the link through Kalamunda Town Centre between Elizabeth Street and the southern end of Railway Road,

> Protected cycle lanes along Railway Road from Mead Street to Canning Road,

> Buffered cycle lanes along Canning Road from Railway Road to Pomeroy Road, and

> Existing shared path on Pomeroy Road to connect to Lesmurdie State High School.

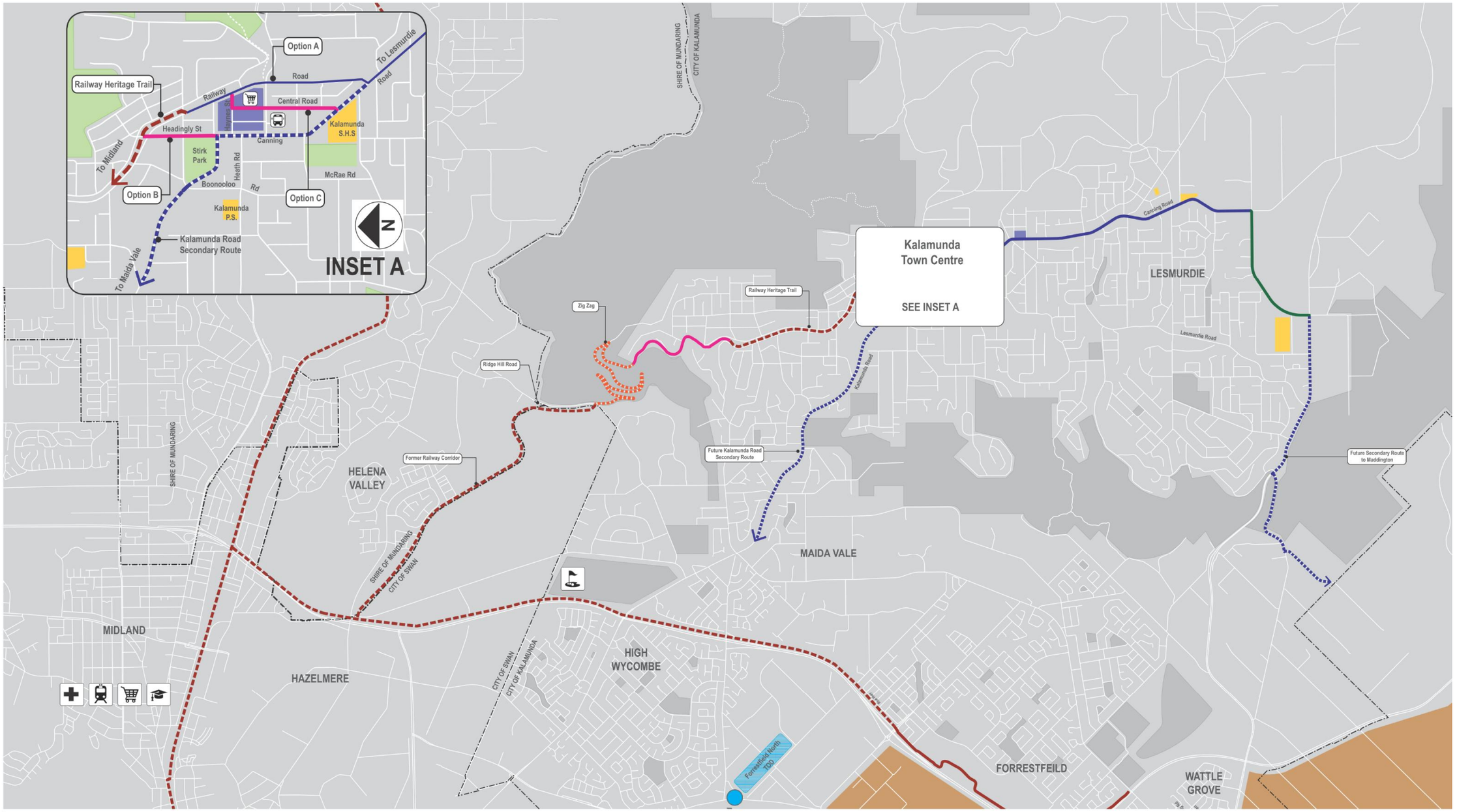
ZIG ZAG SCENIC DRIVE TREATMENT OPTIONS

	Treatment Option	Order of Cost
A	Close Zig Zag Scenic Drive to motorised traffic and permit two-way pedestrian and cyclist traffic	Low
B	Permit two-way cycling traffic on existing pavement with one-way uphill motorised traffic	Low
C	Widen carriageway to permit one-way uphill traffic flow and two-way cycling in a ‘Safe Active Street’ type environment	High
D	Widen carriageway to permit one-way downhill traffic flow and two-way cycling in a ‘Safe Active Street’ type environment	High
E	Timed closure – night-time access for motorised traffic (e.g. from 5PM to 10PM)	Medium
F	Timed closure – weekday access for motorised traffic	Medium

It is noted that separate, detailed community engagement will be necessary to review the Zig Zag Scenic Drive treatment options



HILLS SPINE SECONDARY ROUTE



CITY OF KALAMUNDA - HILLS SPINE SECONDARY ROUTE (Midland - Kalamunda - Lesmurdie)

9

Kalamunda Road

Kalamunda Road, along with Maida Vale Road, forms a Secondary Route between Kalamunda Town Centre and Forrestfield Station and the development of the station presents a significant opportunity for encouraging commuter cycling in the hills.

The recommended strategy for the Kalamunda Road Secondary Route is outlined below:

> Implement 2.0 metre wide buffered bicycle lanes from Canning Road to Hawtin Road generally using the existing carriageway with minor widening where required,

> Install 1.5 metre wide sealed shoulders between Hawtin Road and Roe Highway,

> Maintain the existing sealed shoulders between Roe Highway and Fernan Road, and include 1.5 metre wide sealed shoulders in the future upgrade between Fernan Road and Abernethy Road, and

> Maintain a continuous 2.5 metre wide shared path between Hawtin Road and Abernethy Road.

Buffered bicycle lanes have a painted buffer strip and are recommended so that the large cycling groups can make use of these lanes while riding two-abreast and/or overtaking.

KALAMUNDA SECONDARY ROUTE



Forrestfield Station Connections

The Forrestfield Station Transit Oriented Development (TOD) presents a significant opportunity to encourage greater uptake of cycling in the foothills area. The area surrounding the station is a largely undeveloped or lightly developed area, with few cycling facilities. There is a significant opportunity to provide high-quality cycling facilities from the beginning, encouraging new residents to adopt sustainable travel behaviours from the start rather than trying to change behaviours later.

The routes proposed to serve the Forrestfield Station are:

> Maida Vale Road Secondary Route – the primary connection from the areas east of Roe Highway to the train station, and the strategic connection to Kalamunda and the hills part of the City.

> New Forrestfield Station TOD Connector Road Secondary Route – Connecting Forrestfield Station through Forrestfield North and over Roe Highway (indicatively via a bridge) to Maida Vale

> High Wycombe Local Route – connection to the nearest existing residential area to the station.

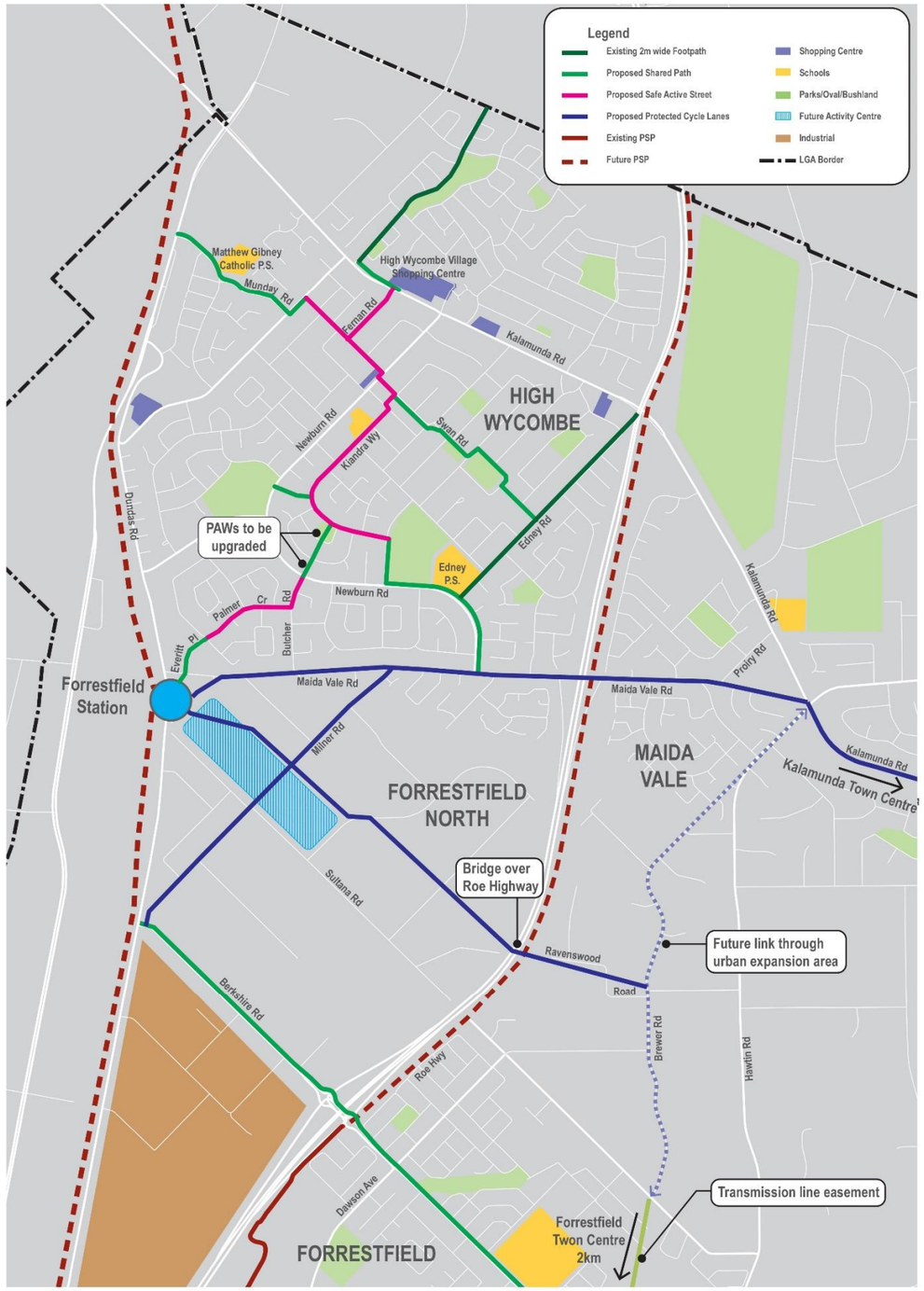
> Berkshire Road Local Route – a short-term connection to Forrestfield residential area pending completion of the Sultana Road bridge over Roe Highway.

Lesmurdie to Maddington

In the future (beyond the life of this Bicycle Plan), the Hills Spine Secondary Route can be further developed to connect to Maddington, via Welshpool Road East, Crystal Brook Road and Kelvin Road. This would provide an entry to the hills area from the southern part of the metropolitan area and facilitate commuting to the growing employment centres in Maddington and Gosnells.

In the meantime, any upgrades to these roads should provide for the future Secondary Route, for example through the provision of sealed shoulders on Kelvin Road.

FORRESTFIELD STATION CONNECTIONS



5.3 LOCAL ROUTES

Foothills Spine

This route has been developed to serve local demand through the suburbs of Wattle Grove and Forrestfield, as well as commuters from these suburbs accessing the wider cycling network. A future extension through the Maida Vale South urban expansion area is also proposed to provide a continuous link through to Maida Vale and the Kalamunda Road Secondary Route.

The overall route concept is shown the following figure. The key elements of the route are:

> A new shared path along the northern side of Welshpool Road East from Roe Highway to Hale Road;

> An upgrade to the existing shared path along Hale Road;

> Two cycling routes, west and east, through Wattle Grove;

- The western route consists of a shared path parallel to The Promenade, serving Wattle Grove Primary School, then rejoining Hale Road at Tonkin Highway;
- The eastern route utilises the existing shared path through public open space parallel to Kalari Drive and Coyong Road, then continues via a new crossing of Tonkin Highway into Hartfield Park;
- Both routes combine at the intersection of Hartfield Road and Sussex Road.

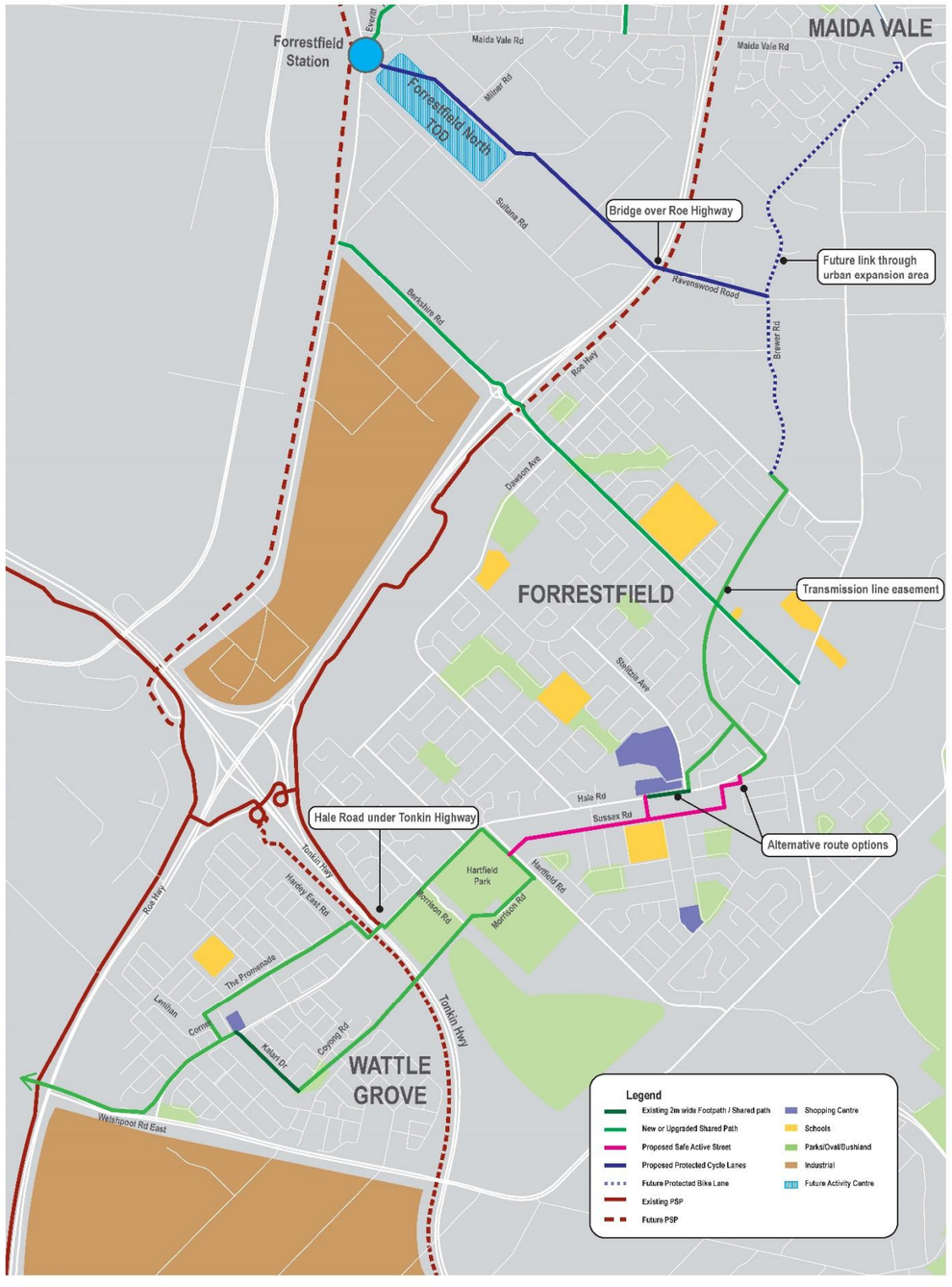
> A Safe Active Street through Sussex Road;

> A shared path along the transmission line easement from Hale Road to Sultana Road East. Two route options are proposed to link the Sussex Road Safe Active Street to this shared path;

- Option 1 to continue the Sussex Road Safe Active Street to Coburg Street and Holmes Road to near Mallow Way, where the route would transition into a shared path and cross Hale Road into the transmission line easement;
- Option 2 to continue the Safe Active Street through Hanover Road, then run along a shared path along Hale Road to Strelitzia Avenue. At Strelitzia Avenue the existing signalised intersection would facilitate crossing Hale Road, and the route would run as a shared path from Strelitzia Avenue along Woodlupine Brook to the transmission line easement; and

> North of Sultana Road East, the route will continue along Brewer Road until Kalamunda Road. At Ravenswood Road, the route branches into the future Forrestfield Station TOD Connector Road.

FOOTHILLS SPINE WATTLE GROVE TO FORRESTFIELD



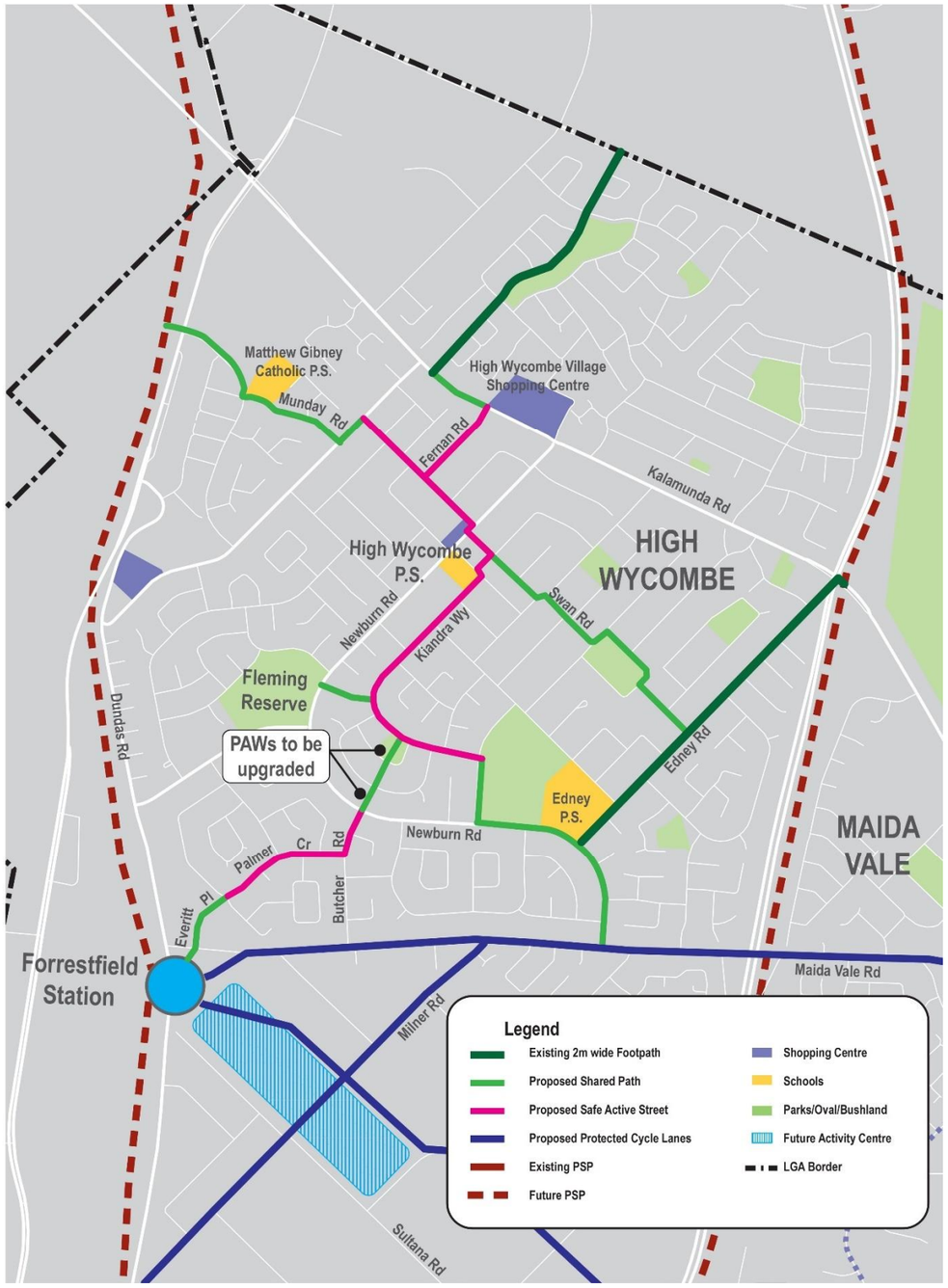
High Wycombe Local Route

The High Wycombe Local Route has been developed to link Forrestfield Station with its closest residential catchment, as well as serve the three primary schools located in the suburb. With the focus on school students and local commuters travelling short distances to the train station, the selected infrastructure types reflect low-speed mixed traffic cycling environments and/or path-based links. Cyclists that are more confident may elect to use the existing sealed shoulders on Newburn Road in preference to the Safe Active Streets.

The highest priority section of this route is from Forrestfield Station to Kiandra Way, as this would serve the station's main residential catchment from opening day. Given its importance to the station, the City should seek State Government funding support for this first stage of the route.



HIGH WYCOMBE LOCAL ROUTE



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Lesmurdie Local Routes

The hilly terrain and irregular road network in the Lesmurdie area makes it difficult to identify and develop high-quality cycling links. The number of schools in this area justify the provision of shared paths to facilitate students riding to school and the more important of these links have been identified as Local Routes:

> Lesmurdie Road

This is the main north-south spine through Lesmurdie, serving Lesmurdie Senior High School, St Brigid's College and Falls Roads Primary School. There is a continuous shared path from Canning Road to Rootes Road but only narrow footpaths continuing to Welshpool Road East. In the medium to long term at least one of these paths will need widening to a shared path standard to provide a function connection to Welshpool Road East.

> Kalamunda – Falls Road – Lesmurdie

This route follows Cotherstone Road, Betti Road, Orange Valley Road, Burma Road, Trafalgar Road, part of Grove Road and Gladys Road, connecting the western residential areas of Kalamunda and Lesmurdie with schools and shops.

> Grove Road

This east-west link connects the Gladys Road, Lesmurdie Road and Canning Road routes as well as serving three schools.

Forrestfield to Lesmurdie Local Route

Following an extensive review of route options up and down the escarpment, a future Local Route has been nominated from Forrestfield to Lesmurdie via Hartfield Road and Welshpool Road East. This route is intended to provide a local commuter and utility cyclist connection between the hills and the foothills, as well as connecting to the wider cycling network via the Tonkin Highway PSP.

Indicatively, the route would consist of:

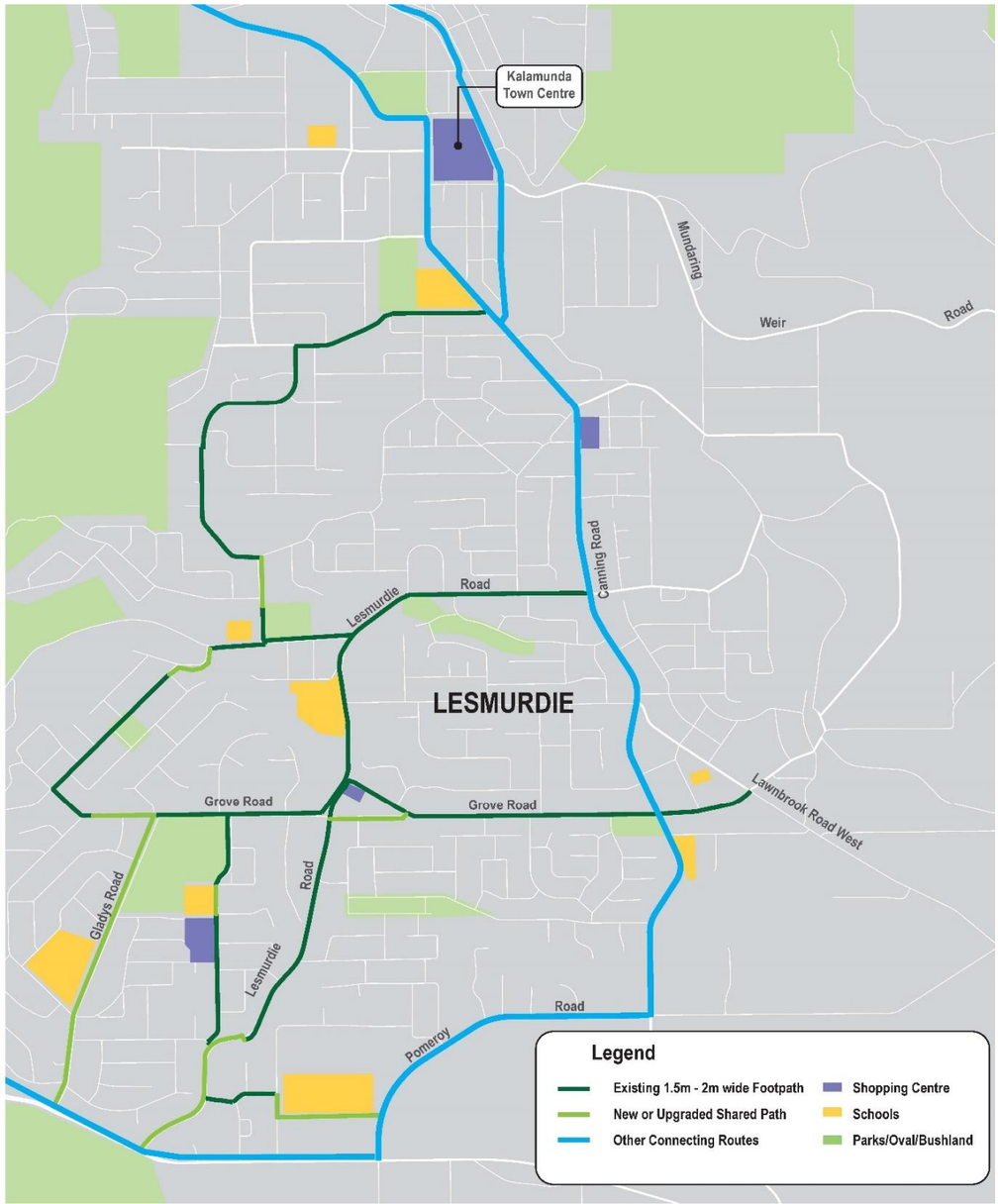
> A high-quality shared path along the southern verge of Hartfield Road from Morrison Road to Lewis Road;

> Improvements to the on-road environment along Hartfield Road from Lewis Road to Welshpool Road East with the potential for a shared path in the long term; and

> A shared path along the northern side of Welshpool Road East, from Hartfield Road to Lesmurdie Road. This section will be a long term project involving significant earthworks component.

A number of existing walking and management trails within Mundy Regional Park were reviewed as possible alternatives to constructing a shared path on Welshpool Road East. Each trail that was reviewed was constrained by very steep grades, however it was noted that could be the potential to develop a 'zig zag' type alignment to ease the grades. It is recommended that the City consult with the Department of Biodiversity, Conservation and Attractions to understand their stance towards providing a shared path type facility through the park.

LESMURDIE LOCAL ROUTES



5.4 SAFE ACTIVE STREETS

Safe Active Streets are cycle routes on quiet local streets, where speeds have been reduced to 30 km/h to allow people in cars and on bikes to share the street safely. With lower traffic speeds, streets are also much safer for pedestrians and children, and additional tree planting and landscaping make them more attractive places to walk or ride.

Along the routes, bicycle symbols and surface colours are used to mark out Safe Active Streets and suggest where bicycles should ride. Various measures may be used to slow traffic, discourage through-travel by cars and improve bike flow, including:

> Single lane slow points, where approaching vehicles must give way to any car or bike already at or passing through the slow point, such as the City has in Agincourt Drive,

> Raised platforms at intersections, and

> Narrowing carriageway widths by introducing on-street parking and garden beds.

Forrestfield Safe Active Streets

> *Sussex Road* forms part of the Wattle Grove to Forrestfield (Foothills Spine) Local Route.

> *Hibiscus Drive and Pavetta Crescent* form part of a connection from Forrestfield Town Centre to the Roe Highway PSP near Berkshire Road, utilising existing Public Open Space corridors and an existing shared path on Dawson Avenue.

> *Peach Tree Way, Cedar Way and Bauhinia Road* form a connection from Hartfield Park and Cypress Road through to Woodlupine Primary School.

> *Hibiscus Drive, Mallee Way and Akebia Way* form a connection between Woodlupine Primary School and Berkshire Road, utilising the existing school crossing on Strelitzia Avenue.

> *Ilex Way* as part of continuous route between Dawson Park Primary School and Brewer Road. The Safe Active Street would link to shared paths through Public Open Space at each end of Ilex Way.

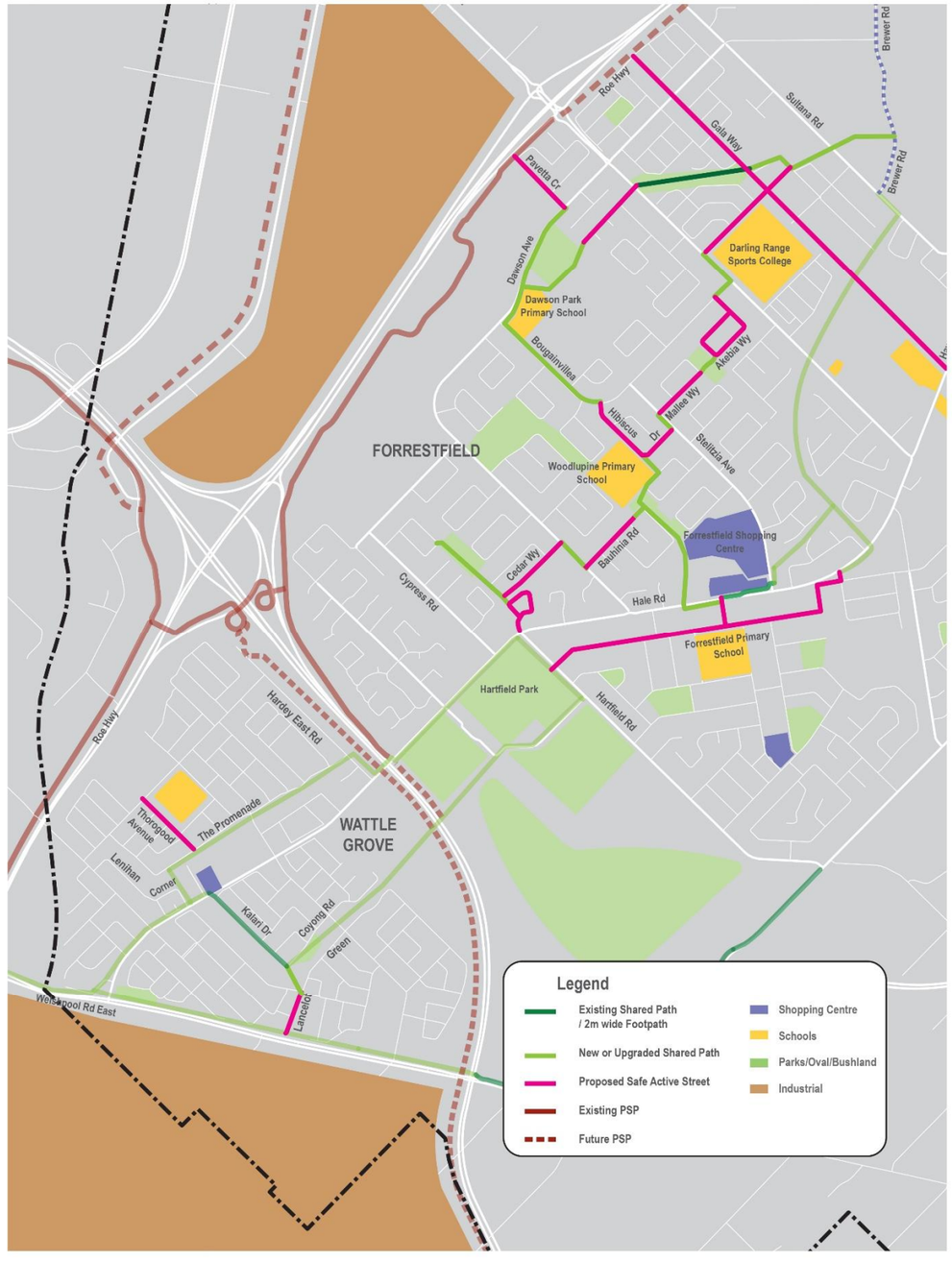
> *Gala Way,* once completed, would form a continuous link for the residential area between Sultana and Berkshire Roads that stretch from Roe Highway to Hawtin Road. The Safe Active Street can link into the transmission line as well as the future Roe Highway PSP extension.

Wattle Grove Safe Active Streets

> *Thorogood Avenue* would form a key active transport corridor accessing Wattle Grove Primary School, linking into the extensive existing and proposed shared path networks through the open space corridors. Combined with these shared paths, parents would be able to ride with their children to the school from most parts of Wattle Grove with minimal interaction with traffic.

> *Lancelot Green* would form a link between the main Public Open Space corridor and the future signalised intersection of Welshpool Road East / Coldwell Road.

FORRESTFIELD AND WATTLE GROVE SAFE ACTIVE STREETS



Kalamunda Safe Active Streets

Opportunities for Safe Active Streets in the hills are limited due to the hilly terrain and impermeable road network. Potential Safe Active Streets locations include:

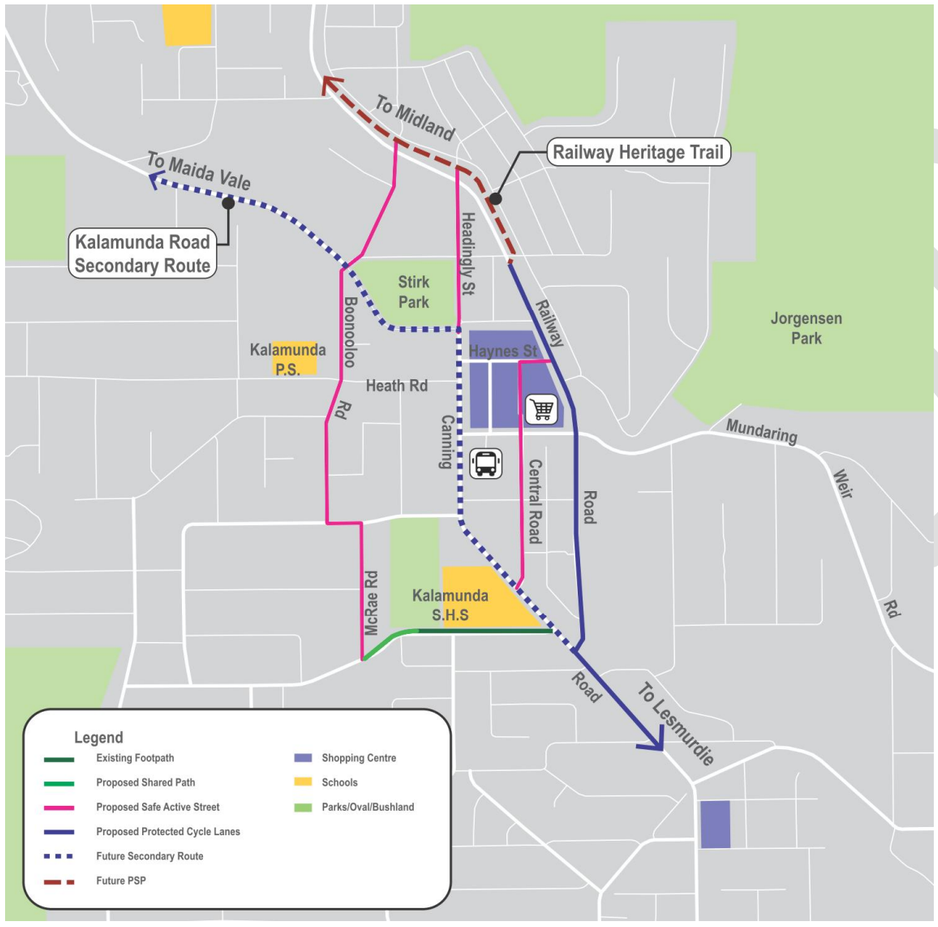
> *Williams Street / Lascelles Parade* – this section from Hill Street to the top of the Zig Zag Scenic Drive forms part of the Midland – Kalamunda – Lesmurdie Secondary Route.

> *Headingly Street* – a potential route option for the Midland – Kalamunda – Lesmurdie Secondary Route, connecting the Railway Heritage Trail to the proposed Canning Road protected bicycle lanes.

> *Central Road / Central Mall* – a potential route option for the Midland – Kalamunda – Lesmurdie Secondary Route, providing a link between the Railway Heritage Trail, Kalamunda State High School, and Canning Road corridor. Careful design would be required for the section through the mall.

> *Lindsay Street / Boonooloo Road / McRae Road* – this north-south link would connect the Midland – Kalamunda – Lesmurdie Secondary Route with Kalamunda Primary School and Kalamunda State High School, linking to the residential area west of the town centre. A preliminary review of this route indicates that the grades may be too steep, however further investigation is warranted.

KALAMUNDA SAFE ACTIVE STREETS



5.5 OTHER SHARED PATHS

In addition to the nominated Secondary Routes, Local Routes and Safe Active Streets there are many other missing links in the City's shared path network. While these missing links may not form part of major continuous cycling routes they can be the difference between encouraging a parent to ride to school with their child or taking up cycling as part of a more active lifestyle.

A review of missing links within the City has been undertaken and the sections listed below have been identified for future shared path funding.

Suburb	Street	From	To
Bickley	First Ave	Nairn Rd	Lawnbrook Rd E
Gooseberry Hill	Ledger Rd	Huntley St	Aboyne Rd
Kalamunda	Burma Rd	Connor Rd	Orange Valley Rd
Lesmurdie	Albert Rd	Reid Rd	Arthur Rd
Lesmurdie	Gladys Rd	Welshpool Rd E	Grove Rd
Lesmurdie	Grove Rd	George Rd	Chislehurst Rd
Lesmurdie	Lesmurdie Rd	Welshpool Rd E	Rootes Rd
Lesmurdie	Reid Rd	Albert Rd	Pomeroy Rd
Lesmurdie	Sanderson Rd	Wiloughby Rd	Gilroy Rd
Lesmurdie	Trafalgar Road - Kimbarlee Way	Waterloo Cres	Falls Road

5.6 TRAINING ROUTES

The recommended strategy for the training routes is to manage the conflicts between cyclists and motorised traffic, mainly through signage and other behavioural strategies, while also implementing some infrastructure improvements. The projects provide benefits to both cyclists and other road users: Drivers will be able to more easily overtake in a safe manner, reducing delays and frustrations and correspondingly improving safety for riders.

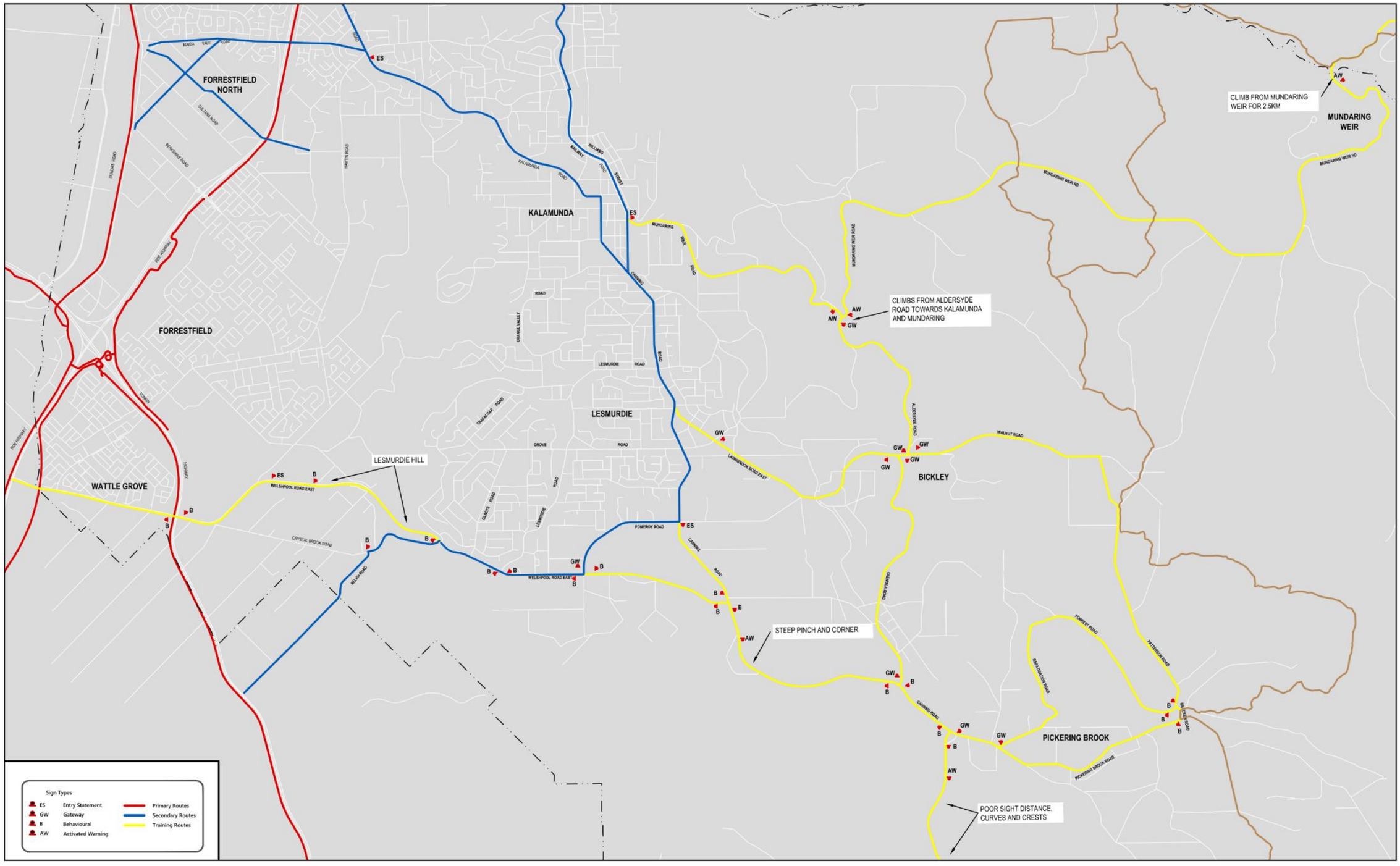
> Welshpool Road East – Install additional signage to warn drivers of cyclists, improve the safety at Lesmurdie Road intersection, widening of the road in selected sections from Lesmurdie Road to Canning Road to allow drivers overtake cyclists along this section.

> Canning Road (south of Pomeroy Road) – in the long term Canning Road should be widened to provide 2m wide sealed shoulders. In the short to medium term targeted widening at selected sections is recommended to reduce conflict between cyclist and drivers. A Road Safety Audit should be undertaken to inform identify the level of risk, assist the City to seek external funding and identify targeted staged improvements.

> Mundaring Weir Road – recondition of road pavement edges to allow cyclist to keep as far left as possible and identify sections where widening can be achieved. A Road Safety Audit should be undertaken to inform identify the level of risk, assist the City to seek external funding and identify targeted staged improvements.

> Signage and Behavioural Strategies – develop a signage strategy that focuses on informing road users to expect to see cyclists, particularly on the popular training routes, and encourage safe and courteous behaviour from all road users.

PRELIMINARY TRAINING ROUTE SIGNAGE AND BEHAVOURAL STRATEGY



6 ACTION PLAN

Category	No.	Action
Infrastructure	1	Upgrade and expand cycling network as per the Schedule of Works.
Maintenance	2	Regularly maintain roads and path to ensure facilities are in A good condition.
	3	Regularly prune vegetation to ensure that facilities are accessible.
Advocacy	4	Advocate for funding of major projects from the State Government (for example Forrestfield Airport Link, Principal Shared Paths).
	5	Participate in the planning and design of major projects (such as the Roe Highway Principal Shared Path) and ensure connections to the local neighbourhoods are included in the scope.
	6	Assign resource time to implement advocacy actions.
Behaviour Change and Awareness	7	Raise awareness of cycling by including information regarding cycling related activities through the City of Kalamunda's media.
	8	Make cycling related information such as route maps, road rules, safety, and cycling etiquette easily accessible.
	9	Communicate new cycling infrastructure concepts (such as Safe Active Streets) to the community.
	10	Promote the completion of new cycling infrastructure or routes through community and cycling events.
	11	Provide cycling education courses and lead rides to encourage inexperienced cyclists to cycle more often.
	12	Participate in the Super Tuesday annual bike count event and Bike Week to promote cycling and positive reinforcement to existing cyclists.
	13	Investigate the feasibility of a bicycle library scheme, possibly located at libraries at Kalamunda, Forrestfield, and High Wycombe.
	14	Provide driver education for City staff to encourage better road use behaviour, including sharing the road with cyclists.
	15	Collaborate with the Eastern Metropolitan Regional Council, WestCycle, Main Roads WA and the Road Safety Commission to implement a Driver and Cyclist Education Program.
	16	Assign resource time (for example a Sustainable Travel Officer) to implement the Behaviour Change and Awareness actions.
School Programs	17	Conduct programs, such as cycling lessons and sport events, at schools within the City to encourage cycling uptake.
	18	Encourage schools to participate in the 'Your Move' program provided by the Department of Transport (yourmove.org.au).
Cycling Tourism	19	Commission a detailed investigation into the opportunities and benefits of promoting cycling tourism in the City and develop an Action Plan.
	20	Establish a funding stream to assist businesses in becoming 'Bicycle Friendly Businesses' for example by part-funding additional bicycle parking.
End of trip facilities	21	Conduct an audit of existing end of trip facilities to identify and create/update an inventory and map of end of trip facilities within the City. Provide an updated inventory to the Department of Transport for inclusion in the Comprehensive Bike Maps.
	22	Provide suitable end of trip facilities in public places such as parks and libraries that are managed by the City.
	23	Update the Local Planning Scheme to include requirements for end of trip facilities for new developments and create a new bicycle parking policy.

DRAFT

7 SCHEDULE OF WORKS

HIGH PRIORITY (0 - 5 YEARS)

Item	Route	Description	Start	End	Cost Estimate
80a	Roe Highway	PSP Completion Part of Roe Highway/Kalamunda Road Upgrade	Berkshire Road	Kalamunda Road	$2,260,000
81a	Tonkin Highway	PSP Extension on the Southern Side (including link to Hartfield Park)	Roe Highway	Welshpool Road East	$1,430,000
82a	Freight Railway / Dundas Road	Dundas Road PSP	Tonkin Highway	Forrestfield Station	$2,580,000
82b	Freight Railway / Dundas Road	Dundas Road PSP	Forrestfield Station	Wittenoom Road	$730,000
1a	Hills Spine	Zig Zag Option A	Ridge Hill Road	Ocean View Parade	$35,000
1d	Hills Spine	Kalamunda Town Centre Section Options Study	Canning Road	Elizabeth Street	$50,000
2c	Kalamunda Road	Sealed Shoulder	Fernan Road	Abernethy Road	$560,000
3d	Forrestfield Station Connection	Milner Road Protected Cycle Lanes	Maida Vale Road	Dundas Road	$620,000
20a	Foothills Spine	Welshpool Road East Shared Path (including to connection from Puddy lane to Hale Road)	Roe Highway (City Boundary)	Puddy Lane	$130,000
20b	Foothills Spine	Puddy Lane Shared Path	Welshpool Road East Shared Path	Hale Road	$170,000
20c	Foothills Spine	Hale Road Shared Path Extension	Extensa Road	Puddy Lane	$50,000
20d	Foothills Spine	Hale Road Existing Shared Path Upgrade (Western Side)	Extensa Road	Lenihan Corner	$320,000
21d	High Wycombe Local Route	Public Access Way Upgrades (through McLarty Way, and Walker Crescent)	Kiandra Way	Newburn Road	$95,000
21e	High Wycombe Local Route	Butcher Road & Palmer Crescent Safe Active Street	Newburn Road	Palmer Crescent	$390,000
21f	High Wycombe Local Route	Everitt Place Shared Path	Palmer Crescent	Maida Vale Road	$85,000
22a	Berkshire & Dundas Road	Berkshire Road (West of Roe Highway) Shared Path Upgrade	Roe Highway	Dundas Road	$460,000
22c	Berkshire & Dundas Road	Dundas Road Shared Path	Berkshire Road	Forrestfield Station	$360,000
44	Forrestfield (Gala Way)	Gala Way Safe Active Street	Fruit Tree Crescent	Hawtin Road	$50,000
61a	Canning Road	Road Safety Audit	-	-	$25,000
61b	Canning Road	Targeted Shoulder Widening Stage 1	Pickering Brook Road	City Boundary	$450,000
63	Welshpool Road East	Lesmurdie Road Intersection Safety Improvement	-	-	$40,000
64a	Mundaring Weir Road	Road Safety Audit	-	-	$15,000
64b	Mundaring Weir Road	Targeted Shoulder Widening Stage 1	Railway Road	City Boundary	$450,000
65	City of Kalamunda	Safe Passing Law Review	-	-	$10,000
		TOTAL COST ESTIMATE (0-5 Years)			$11,365,000
		CITY FUNDED			$2,710,000

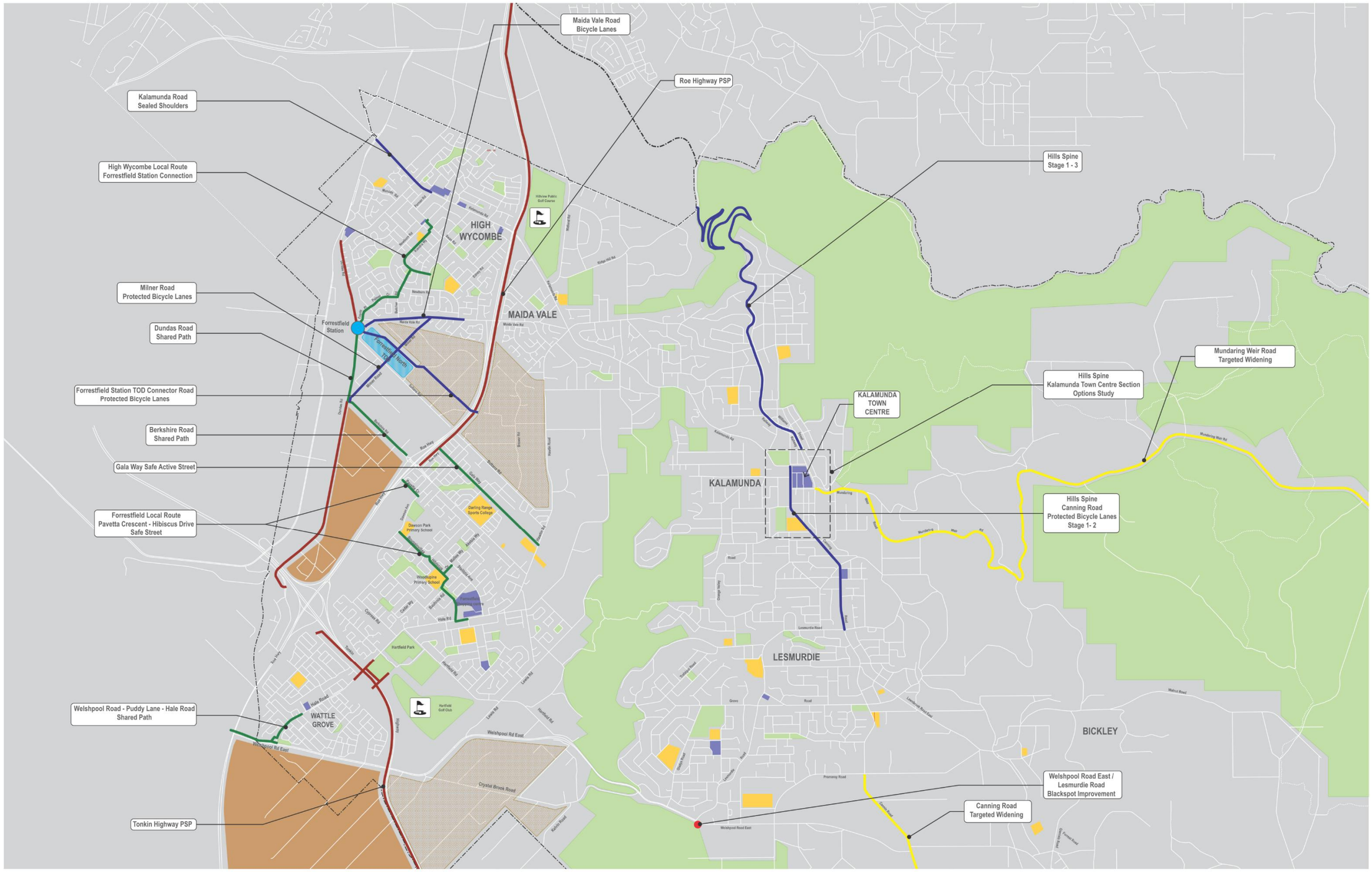
MODERATE PRIORITY (5 – 10 YEARS)

Item	Route	Description	Start	End	Cost Estimate
80b	Roe Highway	Roe Highway PSP Completion	Kalamunda Road	Brinsmead Road	$660,000
81b	Tonkin Highway	PSP Completion	Welshpool Road East	Kelvin Road	$1,310,000
1b	Hills Spine	Lascelles Parade / William Street Safe Active Street	Zig Zag Scenic Drive	Hill Street	$640,000
1c	Hills Spine	Kalamunda Railway Heritage Trail Sealed Path	Hill Street	Elizabeth Street	$300,000
1e	Hills Spine	Canning Road Buffered Bike Lanes Stage 1	Kalamunda Road	Railway Road	$760,000
1f	Hills Spine	Canning Road Buffered Bike Lanes Stage 2	Railway Road	Lesmurdie Road	$1,200,000
3a	Forrestfield Station Connection	Maida Vale Road Protected Cycle Lanes Stage 1	Forrestfield Station	Priory Road	$1,090,000
3b	Forrestfield Station Connection	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 1	Forrestfield Station	Roe Highway	$1,460,000
21c	High Wycombe Local Route	Kiandra Way Safe Active Street	Western Avenue	Norling Road	$660,000
41a	Forrestfield (Hibiscus Drive)	Hale Road Shared Path	Hannover Street	Hibiscus Drive	$430,000
41b	Forrestfield (Hibiscus Drive)	Hibiscus Drive SAS	Bougainvillea Avenue	Strelitzia Avenue	$330,000
41c	Forrestfield (Hibiscus Drive)	Bougainvillea Avenue Shared Path	Hibiscus Drive	Dawson Avenue	$240,000
41e	Forrestfield (Hibiscus Drive)	Pavetta Crescent SAS	Dawson Avenue	Roe Highway	$200,000
61c	Canning Road	Targeted Shoulder Widening Stage 2	Pomeroy Road	Pickering Brook Road	$500,000
64c	Mundaring Weir Road	Targeted Shoulder Widening Stage 2	Railway Road	City Boundary	$500,000
		TOTAL COST ESTIMATE (5-10 Years)			$10,280,000
		CITY FUNDED			$2,620,000

REMAINING PROJECTS BEYOND 10 YEARS

TOTAL COST ESTIMATE	$ 27,795,000
CITY FUNDED	$ 19,213,000

THE LOCATION OF 0-10 YEAR INFRASTRUCTURE



CITY OF KALAMUNDA - BICYCLE PLAN
PRIORITY PROJECTS

city of kalamunda

City of Kalamunda

Bicycle Plan 2017 Technical Report



Prepared for
City of Kalamunda

13 April 2018

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4	13 April 2018	Training Routes Update	Sam Laybutt	Ray Cook

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Executive Summary

Vision

Our vision is:

"Connected Communities, Valuing Nature and Creating our Future Together"

One of the key aspects of the vision story is for the City to be "easily accessible to and from Perth City, and around the City" – this Bike Plan supports this vision by setting out a clear way forward for investment in the active transport network.

Strategic Opportunities

This Bicycle Plan has been developed to integrate and maximise strategic opportunities including:

> Forrestfield Airport Link

> Forrestfield North Transit Oriented Development (TOD)

> Roe Highway PSP

> Tonkin Highway PSP

> Connections to Midland

> Cycle Tourism

> Safe Active Streets Program

Consultation

Key stakeholders as well as the wider community have been consulted as part of the development of the Bicycle Plan, with over 200 responses to the survey and over 30 attendees across two public workshops. The community expressed a strong preference for safer cycling routes with greater separation from motor vehicles, particularly on major roads, increasing the connectivity of the network and increased maintenance of existing facilities.

Ultimate Network Plan

The Ultimate Network Plan has been developed in accordance with the route hierarchy developed by the Department of Transport, aligning the City's network with the strategic planning undertaken for the *Perth & Peel @ 3.5 Million Transport Plan*.

Primary Routes

The function of Primary Routes is to provide safe, prioritised and uninterrupted facilities, which form the spine of a cycle network. They are conducive to medium and long distance commuting, recreational and tourism trips. Within the City of Kalamunda, Primary Routes generally take the form of Principal Shared Paths (PSP) – e.g. Roe Highway, Tonkin Highway and a future PSP along the Dundas Road/Freight Railway corridor.

Secondary Routes

Secondary Routes are intended to provide safe and direct connections, typically between Primary routes and major trip generators such as shopping centres, industrial areas or major health, education, sporting and civic facilities.

The proposed Secondary Routes in this Bicycle Plan are:

> **Hills Spine** – linking Midland with Kalamunda and Lesmurdie via the Zig Zag Scenic Drive and Canning Road

> **Kalamunda Road** – the primary connection between the Hills and Foothills portions of the City

> **Forrestfield Station Connections** – including Maida Vale Road, TOD Connector Road and Milner Road

> **Lesmurdie to Maddington** – a future route to serve the south western part of the City

Local Routes

Local Routes provide safe cycling conditions in local (predominantly residential) areas, collecting cycling traffic from local roads within suburbs and distributing it to the Primary and Strategic Networks. Local Routes can take a number of forms including Safe Active Streets, quiet suburban streets and shared paths.

The proposed Local Routes in this Bicycle Plan are:

> **Foothills Spine** – a link serving Wattle Grove, Forrestfield and Maida Vale Central with connections to the Primary Route network.

> **High Wycombe Local Route** – a link connecting Forrestfield Station with its closest residential catchment

> **Berkshire and Dundas Roads** – a link between Forrestfield and Forrestfield Station

> **Hale / Hawtin Roads** – a link between Wattle Grove, Forrestfield and Maida Vale, primarily for confident commuter and recreational cyclists

> **Midland Road** – a link between Maida Vale and Midland, primarily for confident commuter and recreational cyclists

> **Lesmurdie Local Route**s – a collection of links serving the numerous schools and neighbourhood shopping precincts within Lesmurdie

> **Forrestfield to Lesmurdie** – a future local connection between the Hills and Foothills.

Safe Active Streets

The development of Safe Active Streets has been specifically considered as part of this Bicycle Plan, with potential locations identified in High Wycombe, Forrestfield, Wattle Grove and Kalamunda.

Training Routes

The function of Training Routes is to provide training or sports cyclists with designated routes in which to undertake long distance rides in on-road environments. Training routes are mainly located in the rural and semi-rural portions of the City, including links such as Canning Road (south), Pickering Brook Road, Aldersyde Road and Mundaring Weir Road. Welshpool Road East is also included as a Training Route as it is the primary connection for training cyclists between the Hills and the Foothills.

Specific recommendations for Training Routes include:

> Undertake formal Road Safety Audits of Mundaring Weir Road and Cannig Road (Pomeroy Road to City Boundary) to identify the level of risk associated with conflicts between cyclists and other vehicles, including particular locations of concern.

> Targeted widening of Welshpool Road East, Mundaring Weir Road and Canning Road to provide more frequent, safer overtaking opportunities for motorists.

> Safety improvements to the Welshpool Road East / Lesmurdie Road intersection which has the highest number of bicycle crashes in the City

> A signage strategy to inform road users of the likelihood of encountering cyclists and encouraging safe driving and riding behaviour.

> Review of 1m Safe Passing Law and identify areas of concern within the City (primarily on training routes)

Infrastructure Implementation

A prioritised Schedule of Works for a budget of $500,000 per annum has been developed and is outlined in the table below.

No.	Routes	Description	Start	End	Cost Estimate
0-5 Years					
80a	**Roe Highway**	PSP Completion Part of Roe Highway/Kalamunda Road Upgrade	Berkshire Road	Kalamunda Road	$2,260,000
81a	**Tonkin Highway**	PSP Extension on the Southern Side (including link to Hartfield Park)	Roe Highway	Welshpool Road East	$1,430,000
82a	**Freight Railway / Dundas Road**	Dundas Road PSP	Tonkin Highway	Forrestfield Station	$2,580,000
82b	**Freight Railway / Dundas Road**	Dundas Road PSP	Forrestfield Station	Wittenoom Road	$730,000
1a	**Hills Spine**	Zig Zag Option A	Ridge Hill Road	Ocean View Parade	$35,000
1d	**Hills Spine**	Kalamunda Town Centre Section Options Study	Canning Road	Elizabeth Street	$50,000
2c	**Kalamunda Road**	Sealed Shoulder	Fernan Road	Abernethy Road	$560,000
3d	**Forrestfield Station Connection**	Milner Road Protected Cycle Lanes	Maida Vale Road	Dundas Road	$620,000
20a	**Foothills Spine**	Welshpool Road East Shared Path (including to connection from Puddy lane to Hale Road)	Roe Highway (City Boundary)	Puddy Lane	$130,000
20b	**Foothills Spine**	Puddy Lane Shared Path	Welshpool Road East Shared Path	Hale Road	$170,000
20c	**Foothills Spine**	Hale Road Shared Path Extension	Extensa Road	Puddy Lane	$50,000
20d	**Foothills Spine**	Hale Road Existing Shared Path Upgrade (Western Side)	Extensa Road	Lenihan Corner	$320,000
21d	**High Wycombe Local Route**	Public Access Way Upgrades (through McLarty Way, and Walker Crescent)	Kiandra Way	Newburn Road	$95,000
21e	**High Wycombe Local Route**	Butcher Road & Palmer Crescent Safe Active Street	Newburn Road	Palmer Crescent	$390,000
21f	**High Wycombe Local Route**	Everitt Place Shared Path	Palmer Crescent	Maida Vale Road	$85,000
22a	**Berkshire & Dundas Road**	Berkshire Road (West of Roe Highway) Shared Path Upgrade	Roe Highway	Dundas Road	$460,000
22c	**Berkshire & Dundas Road**	Dundas Road Shared Path	Berkshire Road	Forrestfield Station	$360,000
44	**Forrestfield (Gala Way)**	Gala Way Safe Active Street	Fruit Tree Crescent	Hawtin Road	$50,000
61a	**Canning Road**	Road Safety Audit	-	-	$25,000
61b	**Canning Road**	Targeted Shoulder Widening Stage 1	Pickering Brook Road	City Boundary	$450,000

No.	Routes	Description	Start	End	Cost Estimate
63	**Welshpool Road East**	Lesmurdie Road Intersection Safety Improvement	-	-	$40,000
64a	**Mundaring Weir Road**	Road Safety Audit	-	-	$15,000
64b	**Mundaring Weir Road**	Targeted Shoulder Widening Stage 1	Railway Road	City Boundary	$450,000
65	**Training Routes**	Safe Passing Law Review	-	-	$10,000
			TOTAL COST ESTIMATE (0-5 Years)		$11,365,000
			CITY FUNDED		$2,710,000
		5-10 Years			
80b	**Roe Highway**	Roe Highway PSP Completion	Kalamunda Road	Brinsmead Road	$660,000
81b	**Tonkin Highway**	PSP Completion	Welshpool Road East	Kelvin Road	$1,310,000
1b	**Hills Spine**	Lascelles Parade / William Street Safe Active Street	Zig Zag Scenic Drive	Hill Street	$640,000
1c	**Hills Spine**	Kalamunda Railway Heritage Trail Sealed Path	Hill Street	Elizabeth Street	$300,000
1e	**Hills Spine**	Canning Road Buffered Bike Lanes Stage 1	Kalamunda Road	Railway Road	$760,000
1f	**Hills Spine**	Canning Road Buffered Bike Lanes Stage 2	Railway Road	Lesmurdie Road	$1,200,000
3a	**Forrestfield Station Connection**	Maida Vale Road Protected Cycle Lanes Stage 1	Forrestfield Station	Priory Road	$1,090,000
3b	**Forrestfield Station Connection**	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 1	Forrestfield Station	Roe Highway	$1,460,000
21c	**High Wycombe Local Route**	Kiandra Way Safe Active Street	Western Avenue	Norling Road	$660,000
41a	**Forrestfield (Hibiscus Drive)**	Hale Road Shared Path	Hannover Street	Hibiscus Drive	$430,000
41b	**Forrestfield (Hibiscus Drive)**	Hibiscus Drive SAS	Bougainvillea Avenue	Strelitzia Avenue	$330,000
41c	**Forrestfield (Hibiscus Drive)**	Bougainvillea Avenue Shared Path	Hibiscus Drive	Dawson Avenue	$240,000
41e	**Forrestfield (Hibiscus Drive)**	Pavetta Crescent SAS	Dawson Avenue	Roe Highway	$200,000
61c	**Canning Road**	Targeted Shoulder Widening Stage 2	Pomeroy Road	Pickering Brook Road	$500,000
64c	**Mundaring Weir Road**	Targeted Shoulder Widening Stage 2	Railway Road	City Boundary	$500,000
			TOTAL COST ESTIMATE (5-10 Years)		$10,280,000
			CITY FUNDED		$2,620,000

Action Plan

A comprehensive Action Plan has been developed to document the numerous recommendations made within the report.

Category	No.	Action
Infrastructure	1	Upgrade and expand cycling network as per the Schedule of Works (refer to **Section 8**)
Maintenance	2	Regularly maintain roads and path to ensure facilities are in good condition.
	3	Regularly prune vegetation to ensure that facilities are accessible
Advocacy	4	Advocate the State Government agencies or elected members for funding of major projects (e.g. Forrestfield Airport Link, PSPs)
	5	Participate in the planning and design process of major projects (e.g. Roe Highway PSP) and ensure connections to local neighbourhood are included within the scope
	6	Assign resource time to implement advocacy actions
Behaviour Change and Awareness	7	Raise awareness of cycling by including information regarding cycling related activities on the City's website, newsletter, and social media
	8	Make cycling related information such as route maps, road rules, safety, and cycling etiquette easily accessible, either electronically or in print form.
	9	Communicate new cycling infrastructure concepts (e.g. Safe Active Street) to residents through easily accessible means.
	10	Promote the completion of new cycling infrastructure or routes through related community or cycling events.
	11	Provide cycling education courses and lead rides to encourage inexperience riders to ride more often
	12	Participate in Super Tuesday annual bike count event and Bike Week to promote cycling and provide positive reinforcement to existing bike riders.
	13	Investigate the feasibility of a bicycle library scheme, potentially in libraries at Kalamunda, Forrestfield, and High Wycombe.
	14	Provide drivers education for City staff to encourage better road use behaviour, including sharing the road with cyclists.
	15	Collaborate with WestCycle to lobby MRWA and the Road Safety Commission to implement a Targeted Driver Education Program.
	16	Assign resource time (e.g. TravelSmart officer) to implement the Behaviour Change and Awareness actions.
School Programs	17	Conduct programs, such as cycling lessons and sport events, at schools within the City to encourage cycling uptake
	18	Encourage schools to participate in Your Move program.
Cycling Tourism	19	Commission a detailed investigation into the opportunities and benefits of promoting cycling tourism in the City and develop an Action Plan
	20	Establish a funding stream to assist businesses in becoming 'Bicycle Friendly Businesses' – e.g. by part-funding additional bicycle parking
End-of-trip (EoT) facilities	21	Conduct an audit of existing EoT facilities to identify and create/update an inventory and map of EoT facilities within the City. Provide updated inventory to DoT for inclusion in the Comprehensive Bike Maps.
	22	Provide suitable EoT facilities at public lands (parks, library) that are managed by the City
	23	Update the Local Planning Scheme to include requirements for EoT facilities for new developments or create a new bicycle parking policy

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1 Introduction and Background

1.1 Vision

Our vision is:

"Connected Communities, Valuing Nature and Creating our Future Together"

One of the key aspects of the vision story is for the City to be "easily accessible to and from Perth City, and around the City" – this Bike Plan supports this vision by setting out a clear way forward for investment in the active transport network.

This Bicycle Plan will assist the City to achieve the transport aspect of the above vision, particularly with regard to bike paths, by setting the direction for investment in cycling infrastructure over the next 10-20 years, informing Council's forward works and budgeting processes.

1.2 Objectives

This Bicycle Plan was developed to assist the City through the following objectives:

> To improve the safety of the cycling environment by providing better cycling paths, shared paths, and road treatments, after considering crash history and community feedback on cycling safety.

> To provide more paths and road spaces that are suited to the design needs of cyclists, and that accommodate the different types of cycling users such as shared path users, commuters, recreational cyclists, and competitive cyclists. This includes consideration of shorter and longer travel distances, path geometry, travel routes, convenience, and connectivity.

> To increase the use of public transport, by providing more cycling options for people to use public transport, providing better end of trip facilities, and improving connections to the cycling network.

> To improve cycling access to the Forrestfield Train Station and the use of the public transport system associated with the train station.

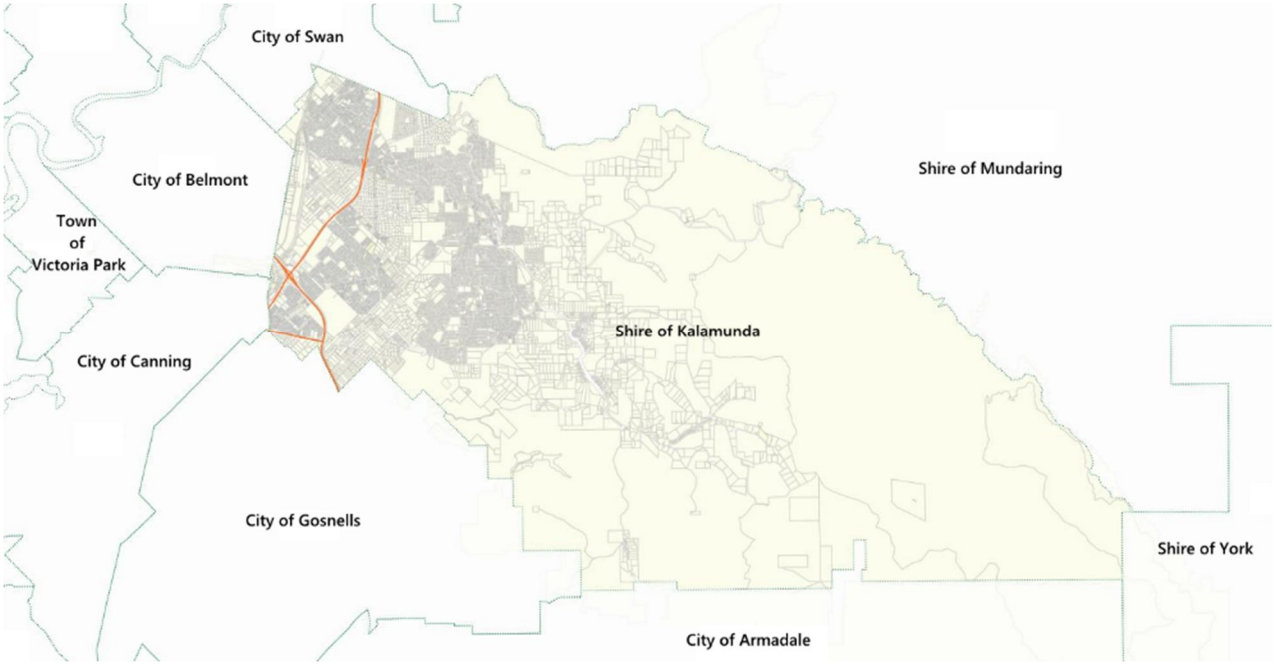
> To promote and educate in cycling, and thus improve cycling participation for the flow-on effects such as improvements in health and social values, and economic development and tourism.

> To provide the research and strategy that will enable planning for cycling works and applying for funding for cycling infrastructure and programs.

1.3 Study Area

The City of Kalamunda LGA is located in the Perth Metropolitan Region in Western Australia, approximately 20km east from the Central Business District (CBD) of Perth, as shown in **Figure 1-1.** The LGA covers an area of approximately 324km² with the population concentrated in the north-western third of the City. The eastern and south-eastern portions of the City are largely undeveloped forest area. The City of Kalamunda borders City of Swan to the north-east, Shire of Mundaring to the north, Shire of York to the east, City of Armadale to the south, City of Gosnells to the southwest, and the Cities of Canning and Belmont to the west.

Figure 1-1 City of Kalamunda – Location



Source: City of Kalamunda

1.4 Demography and Mode Share

The Estimated Residential Population (ERP) for the City in 2016 was 60,830 people. The population has increased to this ERP from 51,500 in a ten-year period which is a growth of over 18%. In terms of service age groups, the majority of the population (21%) are “parents and homebuilders”, and the region has seen larger numbers of “empty nesters and retirees” (aged 60-69) settling there over the period between 2006-2011.

In terms of cycling this demography represents different opportunities; parents and homebuilders are in a position to raise awareness of cycling as a viable transport mode to younger generations while the empty nesters and retirees are perhaps more interested in cycling as a form of low-impact exercise as part of a healthy lifestyle.

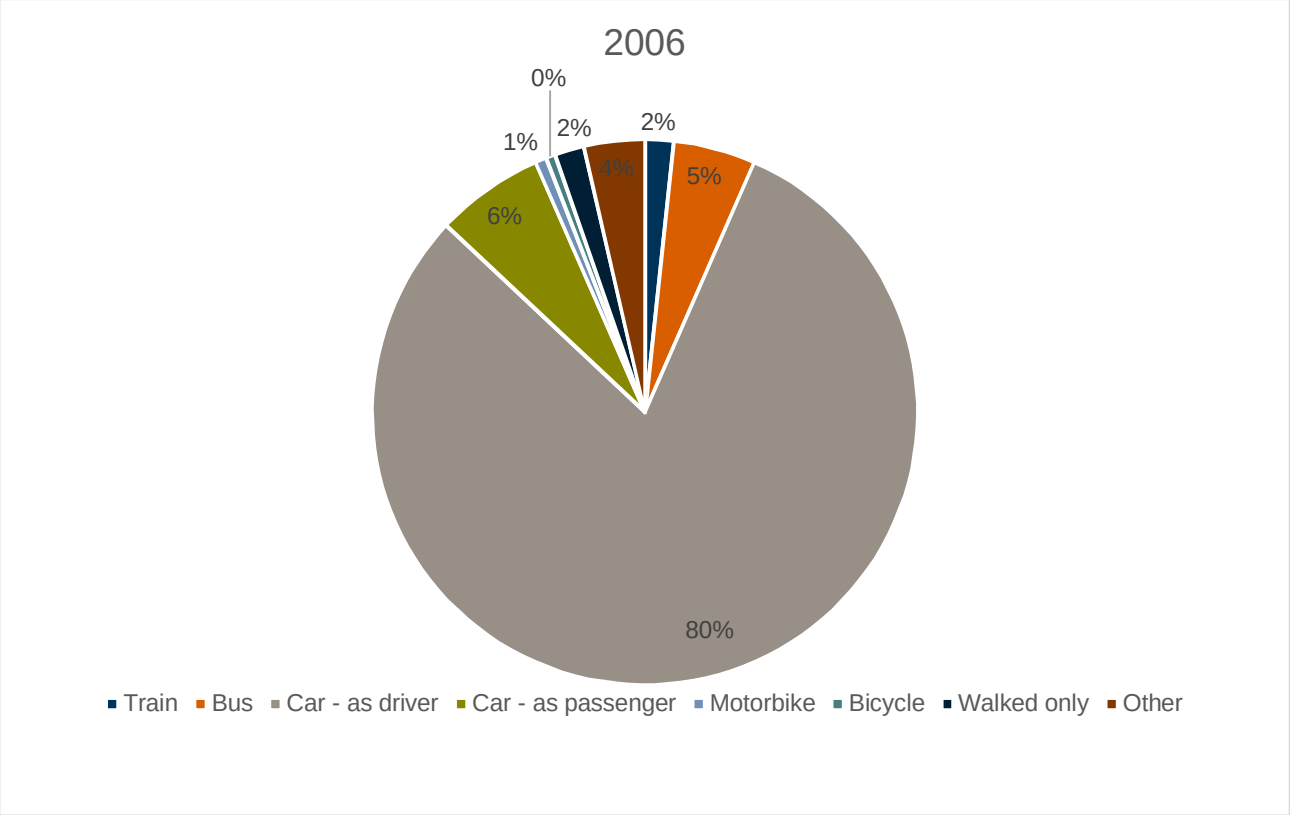
Cycling is a relatively underutilised form of transportation in the City (as shown in **Figure 1-2** and **Figure 1-3**) with 0.5% of residents travelling to work by bicycle. This is lower than the average 1.1% bicycle mode share for Greater Perth. Other than slight increases in car as driver and bus modes, all other modes have retained the same mode share between 2006 and 2011.

While there are currently no established mode share for the City, it is stated in numerous policy documents that active modes such as cycling should be encouraged with the aim of increasing mode share (see **section 1.5** and **Appendix A**).

There is therefore significant scope to build upon this level of cycling in the City, particularly in the foothills suburbs of Forrestfield, Wattle Grove, and High Wycombe, due to recent and future expansion of the Roe Highway Principal Shared Path (PSP) and the opportunity presented by the new Forrestfield Train Station and Transit Oriented Development (TOD).

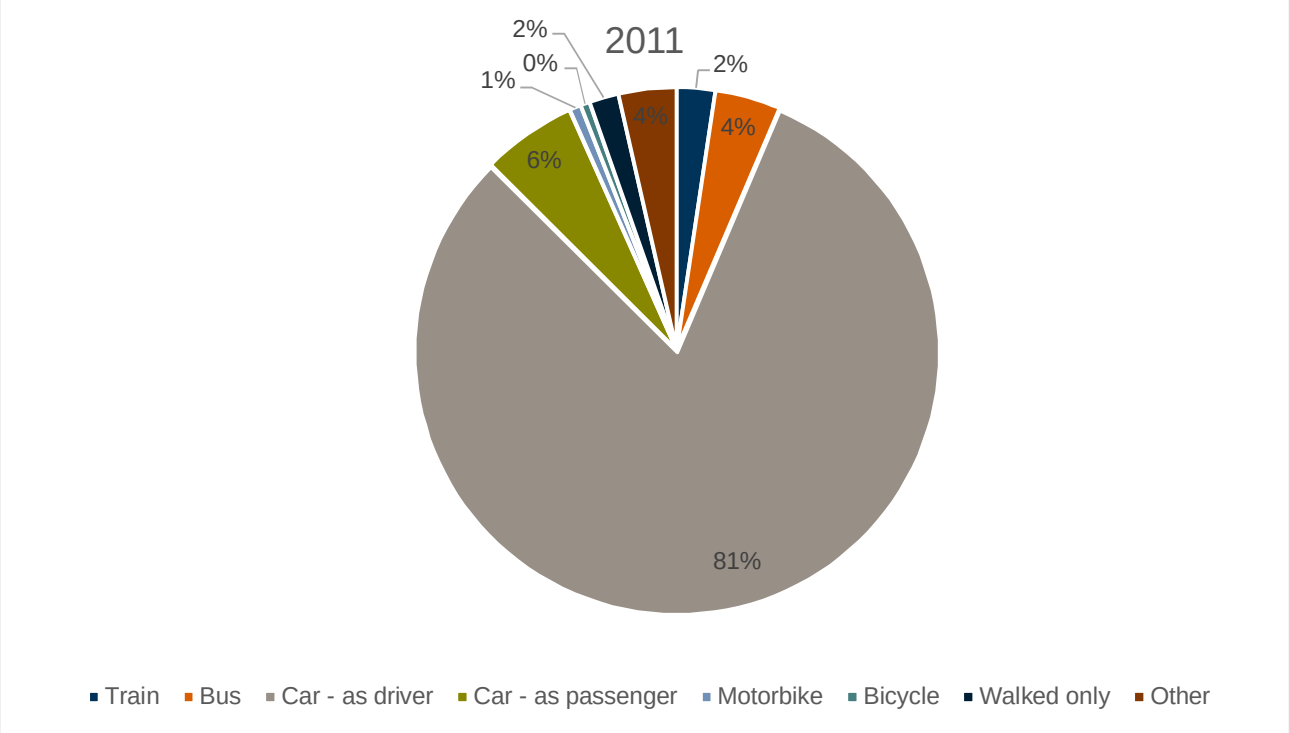
In the hills, there are opportunities for the City to capitalise on its status as the premium destination for training riders and mountain bikers by improving safety and amenity for these types of riders, and encouraging corresponding greater economic benefits to the City.

Figure 1-2 Method of travel to work 2006



Source: Australian Bureau of Statistics, Census of Population and Housing 2006 and 2011. Compiled and presented by .id, the population experts.

Figure 1-3 Method of travel to work 2011



Source: Australian Bureau of Statistics, Census of Population and Housing 2006 and 2011. Compiled and presented by .id, the population experts.

1.5 Policy Context

As part of the Bicycle Plan, Cardno reviewed existing local, state, and federal policies related to cycling in order to formulate a plan that is consistent with initiatives and directions set out by these policies. **Table 1-1** shows the relevant policies and planning documents that Cardno reviewed. **Appendix A** provides detail on each of the policies with relation to cycling.

Table 1-1 Policies Relevant to the Bicycle Plan

Policy	Federal	State	Local
National Urban Policy: Our Cities, Our Future (2011)	✓		
Moving Australia 2030 (2013)	✓		
National Cycling Strategy (2010)	✓		
Walking, Riding and Access to Public Transport (2013)	✓		
Western Australian Bicycle Network (WABN) Plan 2014-2031		✓	
Perth Metropolitan Transport Strategy 1995-2029		✓	
WAPC Development Control Policy 1.5 – Bicycle Planning (1998)		✓	
Bike Ahead: Bicycle Strategy for the 21st Century		✓	
Liveable Neighbourhoods (2009)		✓	
Main Roads WA Policy for Cycling Infrastructure (2000)		✓	
Activity Centres for Perth and Peel		✓	
Our Bike Path 2014-2020		✓	
Perth and Peel Transport Plan for 3.5 Million People and Beyond		✓	
Transport Plan @ 3.5 Million Cycle Network (2016)		✓	
Perth and Peel Mountain Bike Master Plan (2016)		✓	
Kalamunda Local Planning Scheme No. 3			✓
Kalamunda Advancing: Strategic Community Plan to 2023			✓
Shire of Kalamunda Bike Plan (2009)			✓
EMRC Regional Cycle Network Masterplan (2011) & Report Card (2016)			✓
Zig Zag Community Action Plan (2012/13)			✓
Shire of Kalamunda Health and Wellbeing Plan (2013-16)			✓
Perth Hills Trail Master Plan (2013)			✓
Perth Hills Trail Loop Concept Design Report (2016)			✓
Forrestfield North District Structure Plan (2016)			✓
North-East Sub-regional Planning Framework: Towards Perth and Peel @3.5 Million (2016)			✓
2016 Community Scorecard			✓

The key messages contained within these policy documents highlight the need for:

> Safety

> Integrated land use and transport planning for new developments and renewal of existing centres

> Comprehensive and convenient cycle networks for all cyclists

> Connectivity

> Sustainable infrastructure and high quality facilities

> The promotion of cycling and associated benefits

> Supporting policy and funding opportunities

> A reduction in the reliance on private car trips.

1.6 Strategic Opportunities

There are a number of major infrastructure projects being developed which present strategic opportunities for significantly increasing the accessibility, attractiveness and uptake of cycling within the City.

1.6.1 Forrestfield Airport Link

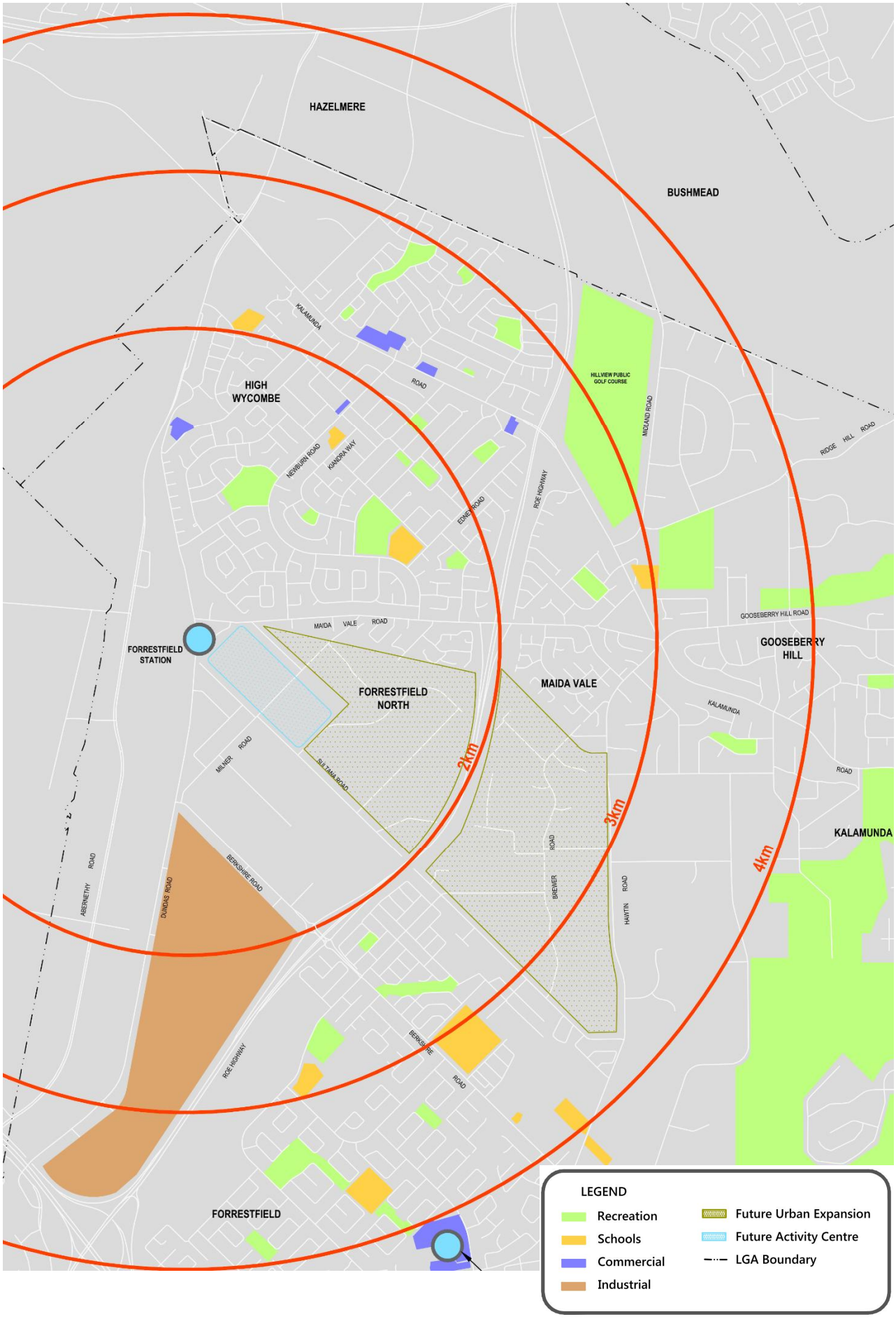
The Forrestfield Airport Link (FAL) is a new passenger railway line currently under construction and due to open in 2020. It will revolutionise commuter transport in the foothills, providing a fast, high-capacity public transport connection to the Airport and a 20min journey from Forrestfield to Perth CBD (compared to 45min by car currently).

Forrestfield Station is planned to include parking for 2500 vehicles and an extensive bus interchange. For cyclists, up to 180 bicycle parking bays will be provided from opening, along with multiple safe cycling routes approaching the station forecourt.

One of the most difficult aspects of encouraging greater uptake of cycling is creating an incentive for people with long-seated habitual travel patterns to try something new and different. FAL presents a significant incentive of travel time savings which would encourage mode shift and, with that change, comes the opportunity to encourage commuters to ride to the station rather than drive.

As shown in **Figure 1-4**, presently the main residential area within 2-3km of Forrestfield Station is High Wycombe. A safe cycling link to and through High Wycombe from the Forrestfield Station is a critical opportunity to encourage cycling to the station from opening day and in the first few years. A substantial portion of Forrestfield is also located within 4km of the Train Station. If a suitable safe and convenient link is provided (e.g. Berkshire or Sultana Roads), this could generate additional demand for cycling to the station.

Figure 1-4 Forrestfield Station Catchment



1.6.2 Forrestfield North Development

The Forrestfield North District Structure Plan is being developed to capitalise on the development of FAL, and the opportunities it brings to the surrounding area. This meant moving away from the industrial land uses, previously proposed, and focusing on urban uses more suitable for a train station precinct. The new focus resulted in planning for the delivery of high density residential, a new activity centre and a commercially focused Transit Oriented Development (TOD) precinct based around the new train station.

Key elements of the Forrestfield North District Structure Plan include:

> **Mixed Use Transit Oriented Development**

- A highly accessible area via all transport modes. Land uses will provide opportunities for active and recreational requirements as well as retail, entertainment and food and beverage needs of residents, visitors and employees.

> **Activity Centre**

- A new main street connecting to Forrestfield Station, which will be highly accessible to all transport modes, providing a node for the provision of community facilities for a growing population. This will be located adjacent to Forrestfield Train Station.

> **High and medium density residential precincts**

- A new permeable street and pedestrian/cycle network will provide convenient access to the train station and activity centre for all modes of transport. These precincts will be located generally between Maida Vale Road and Sultana Road West.

> **Light Industrial Precinct**

- This area will include large industrial and commercial buildings. Design guidelines will support access to business by all modes and connect to the new train station. New buildings will be expected to provide quality end of trip facilities for active commuters. This area will generally be located south of Sultana Road.

> **New road connections** including cycle lanes and shared paths, e.g. Berkshire Road, Milner Road and Sultana Road.

A copy of the District Structure Plan map is included at **Appendix B**.

Development of the residential precincts within the Forrestfield North precinct will bring a significant number of new residents within easy cycling distance of the Forrestfield Train Station, as well as local shops, cafes and employment. With the significant new and upgraded roads required to support the new land uses, there is a strategic opportunity to provide high-quality cycling facilities from the start to encourage active transport before commuting patterns become habitual.

1.6.3 Roe Highway PSP

As part of the Gateway WA project, over 21km of Principal Shared Path (PSP) was constructed along Tonkin, Leach and Roe Highways near the Airport. Further extensions of the Roe Highway PSP from Tonkin Highway to Berkshire Road (2016) and Orrong Road (2017) have brought foothills residents within comfortable cycling distance of many workplaces in Kewdale, Welshpool and the Airport Commercial Centre. Longer distance commuters also now have much safer and more convenient access to Perth CBD, Canning Vale and Jandakot Airport.

Following the 2017 election, the grade-separation of Roe Highway and Kalamunda Road intersection was announced as a priority. This project is likely to include the construction of a further section of the Roe Highway PSP that, when complete, would serve as a north-south cycling spine for the foothills suburbs, an area with very poor cycling access.

1.6.4 Tonkin Highway PSP completion

Main Roads Western Australia (MRWA) is planning to upgrade Tonkin Highway between Hale Road and Welshpool Road East to freeway standard with Tonkin Highway passing over Hale Road and an interchange Welshpool Road East. This project will significantly improve convenience and safety for pedestrians and

cyclists crossing Tonkin Highway at both these intersections, completing missing links in the path network. The opportunity also exists for a further pedestrian and cyclist connection from Wattle Grove (east) to Hartfield Park, providing access directly to the foothills most important recreational facility without any interaction with motorised traffic.

Beyond Welshpool Road East, further upgrades to Tonkin Highway should also include a PSP, which will facilitate connections from the foothills to employment centres at Maddington-Kenwick, Gosnells and Forestdale. Completing such a long section of PSP will also increase the accessibility of Kalamunda for recreational / training riders from the southern suburbs of Perth.

1.6.5 Connections to Midland

Midland is the closest major Activity Centre to the City and is located within 5km of the City boundary. Cycle access is poor, with no dedicated facilities and cyclists required to mix with heavy traffic through Hazelmere or with high-speed traffic on the shoulders of Roe Highway or Bushmead Road.

The City of Swan is currently designing and constructing an extension of Lloyd Street, Midland, from Clayton Street to Great Eastern Highway, connecting directly into Abernethy Road. This road extension has the potential to provide a safe cycling route connecting Midland directly with High Wycombe.

1.6.6 Cycle Tourism

Cycling Tourism is a growing market in Australia and one that is yet to be fully capitalised up on in Western Australia. Research and market analysis has shown that cycle tourists often spend significantly more than the average tourist, delivering significant benefits to the local economy.

Kalamunda is already home to world-class mountain biking facilities which already attract visitors from all over the state and country. The Munda Biddi Trail, the long distance touring route from Mundaring to Albany, passes through the City as well. The Darling Range provides relatively rare opportunities for sweeping city views – e.g. at Zig Zag.

This Bicycle Plan presents the opportunity to effectively plan to overcome one of the key barriers to encouraging greater cycle tourism in the City, which is the condition of the cycling network and the lack of clearly defined, high-quality touring routes.

1.6.7 Safe Active Streets

The Safe Active Street program has successfully completed several pilot trials in Western Australia, with the first three projects completed in Bayswater, Belmont and Vincent in 2016 and 2017. With State Government support and funding, the program is continuing with planning and design underway for Safe Active Streets in other Local Government Areas including Bassendean, Kalgoorlie, Melville, and Victoria Park.

While this type of infrastructure has strong State Government support there is an opportunity for the City to also benefit from the funding to implement Safe Active Streets at suitable locations within the City.

2 Benefits of Cycling

Cycling can be undertaken for commuting, recreational and casual purposes. Given the many benefits of cycling activities, there is considerable potential to increase the uptake of active transport modes as a viable choice for commuting, particularly in the foothills with the opening of Forrestfield Station. Uptake of recreational cycling and cycling tourism in general also have the potential to grow, particularly when considering the extent of local and regional trail networks, and natural heritage.

The benefits of cycling to both the individual and the wider community include:

> ***Social Benefits***

- Riding to work, school, or college, or taking your bike on short neighbourhood trips, is a convenient and practical way to incorporate regular exercise into your busy day
- A safe cycling trip is a healthy lifestyle choice that improves aerobic fitness and reduces stress levels
- A cyclist has many chances for social interaction during their trip
- Many opportunities to passively survey the street, increasing neighbourhood security.
- Improves the liveability and vibrancy of an area
- For people that do not have a driver's licence or vehicle (for example children and seniors) cycling provides a means of independent transport. This is extremely important to maintain social connectivity especially if there is a lack of public transport in the area.
- The more people cycle, the safer cycling becomes (safety in numbers) and also has the effect of a general slowing down of traffic, which improves overall road safety.

> ***Personal Economic Benefits***

- A bicycle trip is a low cost alternative to driving a car
- Having access to a bike reduces the need for a second family car, savings from which can be diverted to other aspects of the household budget
- Financial returns in dollar terms are nearly twice the costs incurred because people who cycle more will spend less on travel costs and gains in health and fitness will result in savings on health services[1]

> ***Commercial Economic Benefits***

- Cycling tourism provides a new demographic and increased business opportunities
- Benefits to businesses of cycling, both as a utility and leisure mode, as well as the benefit of running a business in an area which is conducive to cycling[2]
- Businesses with staff who cycle are potentially more likely to have healthier, happier and more productive employees
- Business are better able to attract and retain staff where on-site cycling facilities are of a high quality, and within easy access by bike; and reduces exclusion of potential employees to jobs who do not have access to a car (Rajé & Saffrey, 2016)
- Bikes have a much lower impact on road surfaces due to wear and tear, and contribute to a longer lifecycle of road infrastructure
- The demand for parking decreases and land can be redeveloped for more community-focused purposes, such as parks and public spaces which accommodate the needs of people rather than motor vehicles.

[1] *Source: RAC (2012) The Economic Cycle: A Business Case for Investment in Cycling in Western Australia*
[2] *Source: Rajé, F. & Saffrey, A. (2016) The Value of Cycling, Department for Transport, London UK*

> ***Environmental Benefits***

- Reduced consumption of petrol and dependency on fossil fuels
- A reduction of vehicles on the road results in less congestion
- Fewer car trips (and less congestion) result in fewer greenhouse gases being emitted
- Local air quality is better and this has a beneficial impact on health
- Noise levels are reduced
- The “heat island” effect (where impermeable roads and surfaces contribute to a heating of the temperature in urban areas) may reduce if larger numbers of people choose active modes, as some surfaced areas are returned to a greener or vegetated state (e.g. tree planting as part of Safe Active Streets treatment).
- Roads take up space and accelerate urban sprawl. Less driving results in less demand for roads. Cycling and walking both benefit from a more compact urban design, which also reduces urban sprawl and allows the City to retain more of its bushland into the future.

3 Consultation

3.1 Methodology

Community and stakeholder consultation was a major component of the Bicycle Plan, allowing cycling organisations and members of the public to provide input to the design and implementation of the final plan.

A wide range of consultative methods were utilised to enable visitors, residents and other stakeholders to voice their concerns, put forward ideas and provide information on their personal experiences of cycling throughout the City.

> **Public Surveys** – Public consultation was conducted by distributing online and hard copy surveys for members of the public to provide detail on the purpose of their cycling trips, as well as the frequency of their journeys. An open-ended section was included to:
  - Allow participants to state what they enjoy about cycling in the City;
  - Determine in which locations they experienced discomfort or avoided; and
  - Encourage participants to suggest ways in which the network could be improved

> **Stakeholder Consultation –** A number of key stakeholders were consulted as part of the Bicycle Plan, including the City's officers, neighbouring local government councils, state government agencies, WestCycle, and local sports clubs.

  Consulting with neighbouring local government was important in formulating this Bicycle Plan as the City shares borders with multiple councils and knowledge of other council's plans and priorities is important in order to establish a connected strategic network between and through neighbouring Local Government areas.

  State government agencies were also engaged to ensure that the proposed infrastructure within this bike plan is consistent with the existing State planning and policy.

3.2 Community Consultation

Community consultation was a critical component of developing this Bicycle Plan. The feedback received from the community and stakeholders informed the Project Team's understanding of the key issues for existing and potential cyclists within the City and helped guide the focus of the Bicycle Plan to best meet the needs of existing cyclists and encourage a greater uptake of cycling.

A 'blank slate' public consultation process was undertaken during March and April 2017. This process consisted of a survey questionnaire, which was available both in hard copy and on the City's website. The City and key stakeholders distributed the survey via the City's website, newsletters, social media as well as other advertising channels. Over 200 responses were received, 64% of which were from residents of the Hills portion of the City. Over 20% of the responses were from non-residents of the City, indicating strong interest from cyclists who visit the City from other parts of Perth.

To complement the survey questionnaire, two community workshops were held as follows:

> 21 March, at Woodlupine Community Centre, **Forrestfield**

> 28 March, at Zig Zag Cultural Centre, **Kalamunda**

Over 30 community members attended the two workshops where they were able to discuss their issues, concerns and ideas with the Project Team and other members of the community. The feedback received at the workshops, and through the survey, is an extremely valuable contribution to the development of this Bicycle Plan.

The following section summarises the responses received from the survey.

3.3 Survey Results

3.3.1 Demographics

The majority of the respondents were male (65%) and from the 30 to 49 age group (62%). A total of 85% of the respondents reside in the City of Kalamunda, 64% of whom are from the Perth Hills suburbs and 21% from the Foothills suburbs. The remaining 15% are visitors to the City who reside in other parts of Perth.

High response rates from the Perth Hills area indicates a strong interest for cycling in the area, given its popularity as a 'training ground' for sport cyclists, as well as being the prime destination for mountain bike trails in the Perth Metropolitan Area.

Seventy-three percent of respondents stated that at least 2 people in their household ride and 90% reported to have more than two bicycles at home.

3.3.2 Attitudes, trip purpose, and frequency

The majority of respondents ride for recreational purposes with survey results showing combined responses for 'often' and 'almost always' exceeding 87%. Social is the second most popular trip purpose followed by commuting. The survey also shows that 70.1% respondents ride a bike at least 1-2 time per week. This is reflective of the current infrastructure and land use, which is not conducive to commuter cycling but is very attractive for recreational riders, particularly more confident riders.

40% of the respondents state that they are confident riders that are comfortable riding in mixed traffic situations, while 19% prefer to ride on designated on-road bike lanes. This shows that the majority of the respondents are experienced cyclists. There is also a significant number of respondents (28%) who prefer to only ride along off-road paths.

3.3.3 Route Types

The survey results show that quiet roads are the most used route type in the City, with 63% of respondents riding through them at least 1-2 times a week. This result however does not indicate that roads in the City are suitable for all cyclists as a significant proportion of the respondents are experienced sport cyclists who regularly train in the City. Shared paths are the second most used cycling infrastructure in the City. 40% of respondents using PSPs at least weekly is interesting given the only PSP presently within the City is a short section of the Roe Highway PSP between Tonkin Highway and Berkshire Road. This indicates that there is a demand for additional high quality infrastructure within the City.

Footpaths are the least popular infrastructure in the City, which is consistent with Cardno's findings for other Local Governments. This is likely due to sub-standard width and alignment of many footpath sections in the network, which are not convenient for cycling, particularly at road crossings.

3.3.4 Visitors to the City

Questions 11 to 13 were targeted towards non-residents who currently cycle within the City, in order to understand the frequency of riding and the extent to which these riders visit local businesses and contribute to the City's economy.

Weekends were the most popular time to ride for the respondents of the survey with 40% claiming to 'almost always' ride through the City on the weekends. Sixty percent of respondents stated that they stopped within the City during their ride to buy food and/or drinks. The overwhelming majority of respondents stop at shops and cafes around the Kalamunda Town Centre. For people who did not stop, better and safer bike parking was an improvement they would most like to see around the City, especially at the Kalamunda Town Centre. The City could assist local businesses in this regard by providing 50-50 funding for bike parking to eligible businesses. Other preferred improvements include safer paths and improved path connectivity towards the shops.

3.3.5 Less Frequent Riders

Respondents who rarely cycle were asked to nominate the main reasons for not currently riding. The main reasons respondents listed for not riding a bike were “don’t feel safe riding”, “unsafe road conditions”, “speed and volume of traffic” and “lack of bicycle lanes or path.” These results indicate a definite need for the City to invest in providing dedicated on-road cycling facilities to create a safer cycling environment. Over 35% of respondents to these questions listed “do not own a bike” as a key reason they do not ride – this indicates that a Kalamunda Bike Hire or Bike Library could be effective at encouraging uptake of cycling in the City.

3.3.6 Issues and Suggestions

Respondents were also asked to identify issues they encountered along their route or within the City in general and improvements they like to see. See **Table 3-1** for a summary of these responses.

Table 3-1 Summary of Complaints/Issues and Suggestions Submitted by Survey Respondents

Category	Issues	Suggestions
Infrastructure	▪ Lack of cycle lanes on major roads. Welshpool Road, Mundaring Weir Road, Canning Road, and Kalamunda Road have the highest number of mentions ▪ Traffic calming treatments are not suitable for cyclists, particularly treatments which narrow the road and make it more difficult for drivers to safely overtake cyclists ▪ Poor path quality along Welshpool Road east of Hale Road. ▪ Lack of secure bike parking	▪ Cycle lanes along Major roads around the Hills area. Mundaring Weir Road, Welshpool Road, Kalamunda Road, and Canning Road ▪ Convert Zig Zag Scenic Drive to uphill only. Additional suggestion to ban vehicular traffic to improve safety further. ▪ More off-road paths around the Hills to provide safe routes for children to go to schools. ▪ Additional bike parking
Safety	▪ Unsafe crossing at busy roads due to traffic volumes and speeds. Hale Road near Forrestfield Shopping Centre and Canning Road are some of the locations mentioned. ▪ Lack of shoulder along truck routes. ▪ Cars passing too closely ▪ Poor behaviour from some drivers and cyclists.	▪ Install islands at busy intersections for staged crossings ▪ Widen roads where possible and install cycle lanes ▪ More driver and cyclists awareness education initiatives
Connectivity	▪ Very limited cycling options to go from the foothills to the hills and vice versa ▪ Connection from Wattle Grove (south of Hale Road) to the wider network is very poor. ▪ Lack of shared path and discontinuous footpath.	▪ Provide more cycling connections from Wattle Grove Area to amenities around Forrestfield, including to Roe Highway PSP and Tonkin Highway PSP ▪ Alternative connection(s) between the Hills and the Foothills other than Kalamunda Road and Welshpool Road. ▪ Improved connection to Midland and Guildford.
Maintenance	▪ Debris, such as glass and gravel on the side of the road and path forces cyclists to ride closer to the centre of the carriageway, which further aggravates drivers.	▪ Regular debris removal and sweeping

3.3.7 Popular Routes

Respondents were asked to nominate the routes they regularly cycled to and through the City. A map compiling the routes nominated by survey respondents is shown in **Figure 3-1.**

Most respondents noted that their route selection was based on traffic volumes (with a preference for lower volumes), and related perceptions of safety. It should be noted that the map is likely to reflect the route choices of recreational and training riders more than commuter cyclists due to the current composition of cyclist types within the City as outlined in **Section 3.3.2**.

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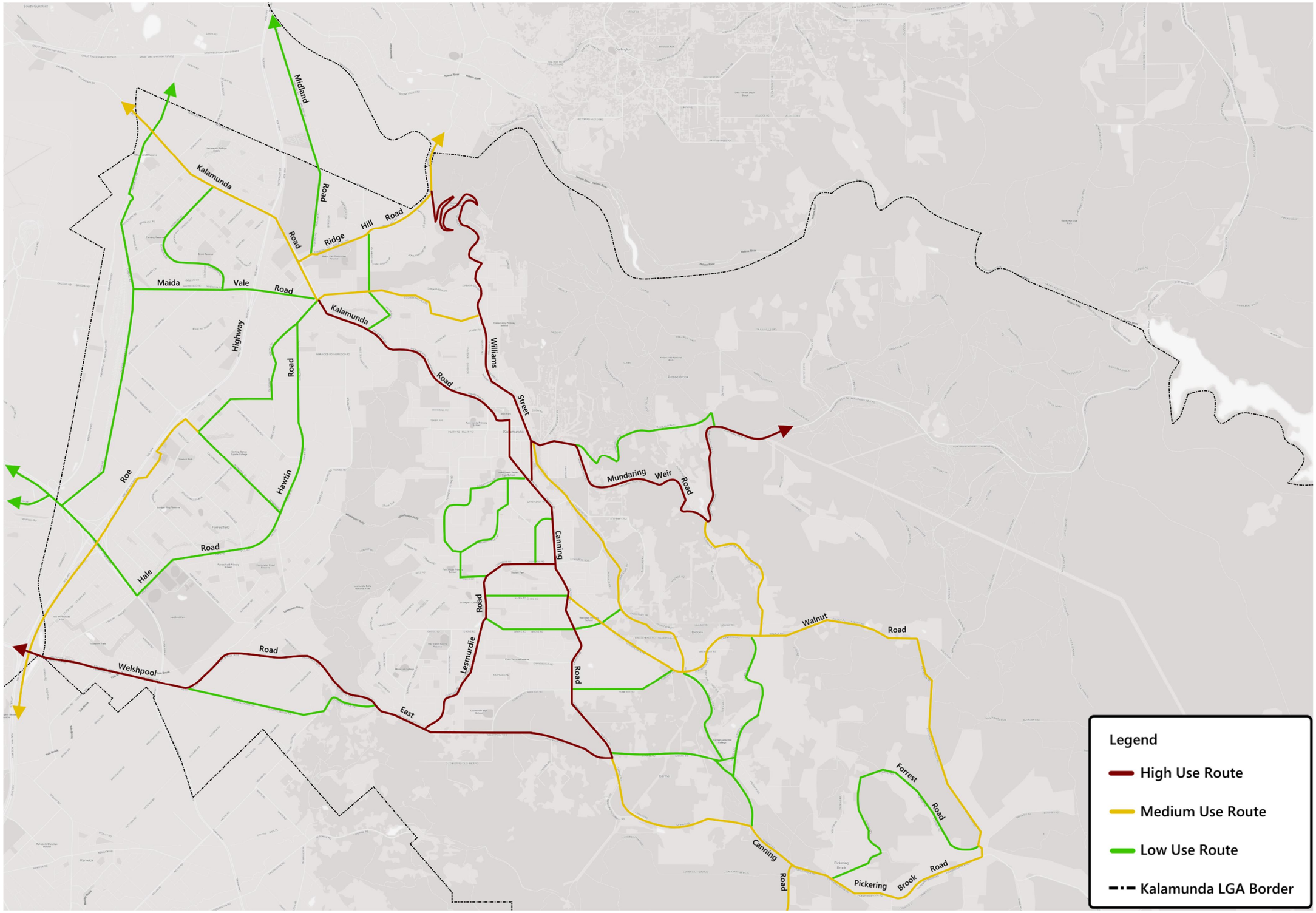
Figure 3-1 Popular Cycling Routes



Source: Compiled from community survey responses

4 Bicycle Counts and Crashes

Data regarding the existing cycling patterns and facilities within the City was obtained from a variety of sources and used to inform the development of the Ultimate Network Plan. Some of the data sources utilised are outlined in the following sections.

4.1 Bicycle Counts

Video surveys were undertaken at 18 strategic intersection locations within the City over two days, on Thursday, 6 April 2017 and Sunday, 9 April 2017. These counts provide a snapshot of current cycling demand within the City as well as a baseline from which to measure the anticipated growth in cycling demand as this Bicycle Plan is implemented. The survey days were selected in order to capture a typical commuter day as well as a typical recreational / training ride day.

The results of the survey are tabulated in **Table 4-1** and illustrated in **Figure 4-1** and **Figure 4-2**. The results of the bicycle counts give several insights into the current demand for cycling within the City:

> Sunday demand was observed to be approximately 2.5 times higher than Thursday demand, indicating that there is currently much higher demand for recreational and training type riding than for commuter or utility cycling. However even on the Thursday count there was demand observed at locations typically associated with training riders – e.g. Mundaring Weir Road and Zig Zag.

> On Thursday, the highest demand entering the City was recorded at the Roe Highway/Tonkin Highway PSP intersection. Other entry routes (Kalamunda Road, Zig Zag, and Welshpool Road East) were observed to be significantly lower. The single most highly trafficked road section was Railway Road, north of Mead Street, closely followed by Welshpool Road East at Lesmurdie and Canning Road near the town centre.

> On Saturday the busiest entry point to the City was Welshpool Road East, followed closely by Zig Zag. The single most highly trafficked road section was Railway Road, north of Mead Street, in Kalamunda town centre, which recognises the concentration of riders passing through the town centre.

It must be noted that the count is only a snapshot in time, taken towards the end of the peak riding season. The Sunday count was taken the weekend after the 3 Dams/5 Dams cycling event which may also contribute to lower numbers of recreational riders compared to typical Sundays between October and April.

4.2 Saddle Surveys

Site inspections and saddle surveys were undertaken by the project team in order to inspect the existing cycling environment from a rider's perspective, identify missing links and undertaken preliminary investigations into potential projects for the ultimate cycling network.

4.3 Strava Data

The Strava 'Heat Map' is a one-off visualisation of aggregated data from users of the Strava mobile phone app, which is used by walkers, runners and cyclists to track their trips. The 'Heat Map' provides a visual snapshot of the most popular riding routes for users of the app.

Whilst the Strava data is from 2015, and only represents part of the total cycling demand, it is a useful dataset for identifying popular riding routes and barriers to cycling. The dataset is particularly useful for identifying the most popular riding routes in the semi-rural parts of the City where reliable bicycle count data does not exist.

An excerpt from the Strava 'Heat Map' showing the City of Kalamunda and surrounds is presented in **Figure 4-3**.

Table 4-1 Summary of Bicycle Counts

Location		Number of Cyclists per day	
		Thursday	**Sunday**
1	Kalamunda - Railway Rd/Mead St	90	360
2	Kalamunda - Kalamunda Rd/Canning Rd	19	73
3	Kalamunda - Canning Rd/Recreation Rd	56	93
4	Lesmurdie - Canning Rd/Lesmurdie Rd	54	179
5	Lesmurdie - Canning Rd/Pomeroy Rd	41	63
6	Lesmurdie - Canning Rd/Welshpool Rd	2	75
7	Carmel - Welshpool Rd/Crystal Brook Rd	62	222
8	Wattle Grove - Tonkin Hwy/ Welshpool Rd	40	122
9	Wattle Grove - Welshpool Rd/Hale Rd	51	164
10	Wattle Grove - Tonkin Hwy/Hale Rd	27	19
11	Forrestfield - Roe Hwy/Tonkin Hwy PSP	63	64
12	Forrestfield - Hawtin Rd/Berkshire Rd	23	47
13	Forrestfield - Roe Hwy/Berkshire Rd	51	43
14	Maida Vale - Maida Vale Rd/Priory Rd	34	33
15	Maida Vale - Kalamunda Rd/Gooseberry Hill Rd	48	63
16	Maida Vale - Roe Hwy/Kalamunda Rd	11	35
17	Gooseberry Hill - Zig Zag Scenic Dr/Ridge Hill Rd	37	168
18	Piesse Brook - Mundaring Weir Rd/Aldersyde Rd	36	154
	TOTAL*	**745**	**1977**

** The total number of cyclists is provided purely to compare total demand between the Thursday and Sunday counts. It is likely that the same individual cyclists pass through at least two or three of the intersections and therefore the aggregate totals may double or triple count the actual number of cyclists on a given day.*

Figure 4-1 Bicycle Counts – Thursday

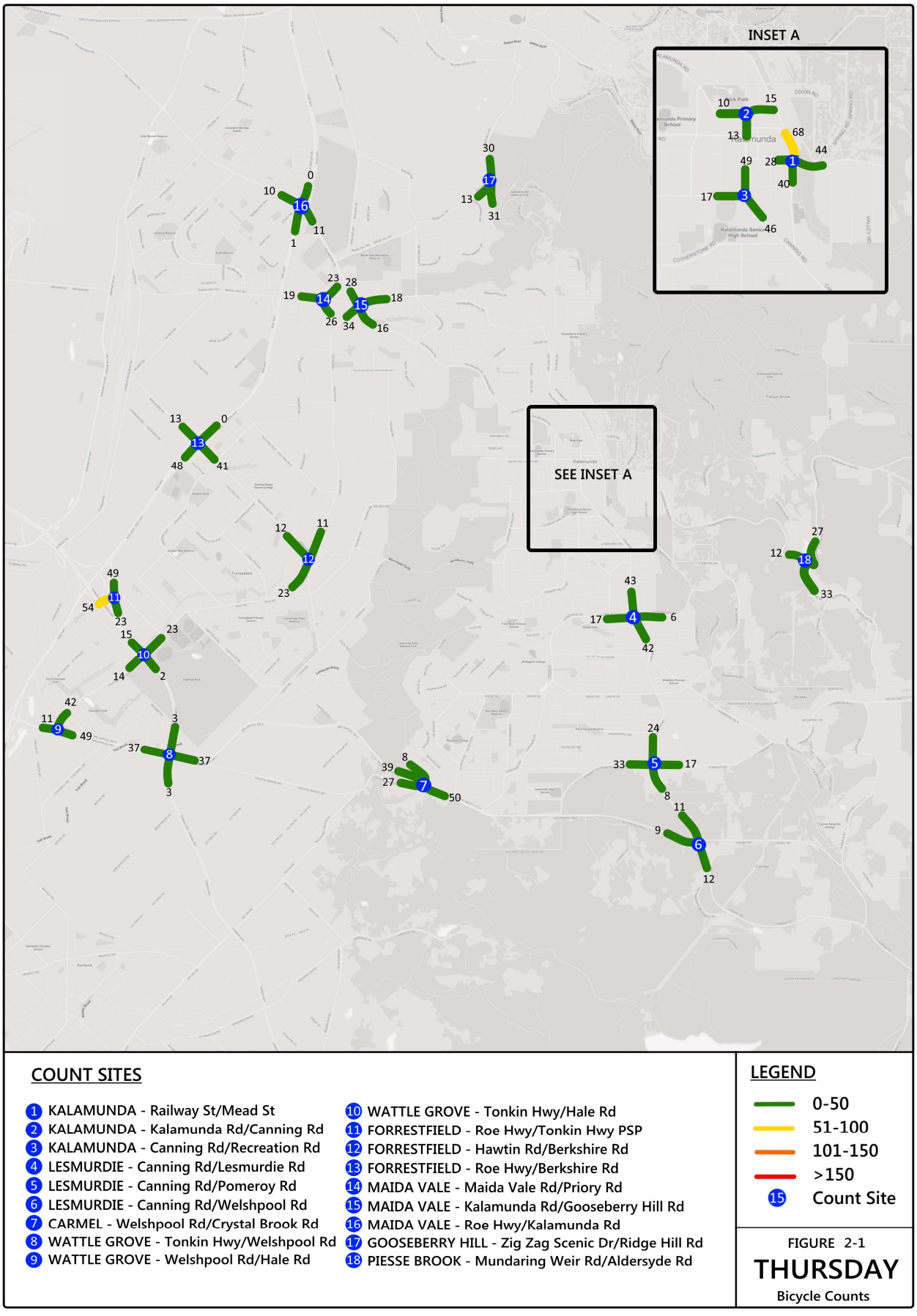


Figure 4-2 Bicycle Counts – Sunday

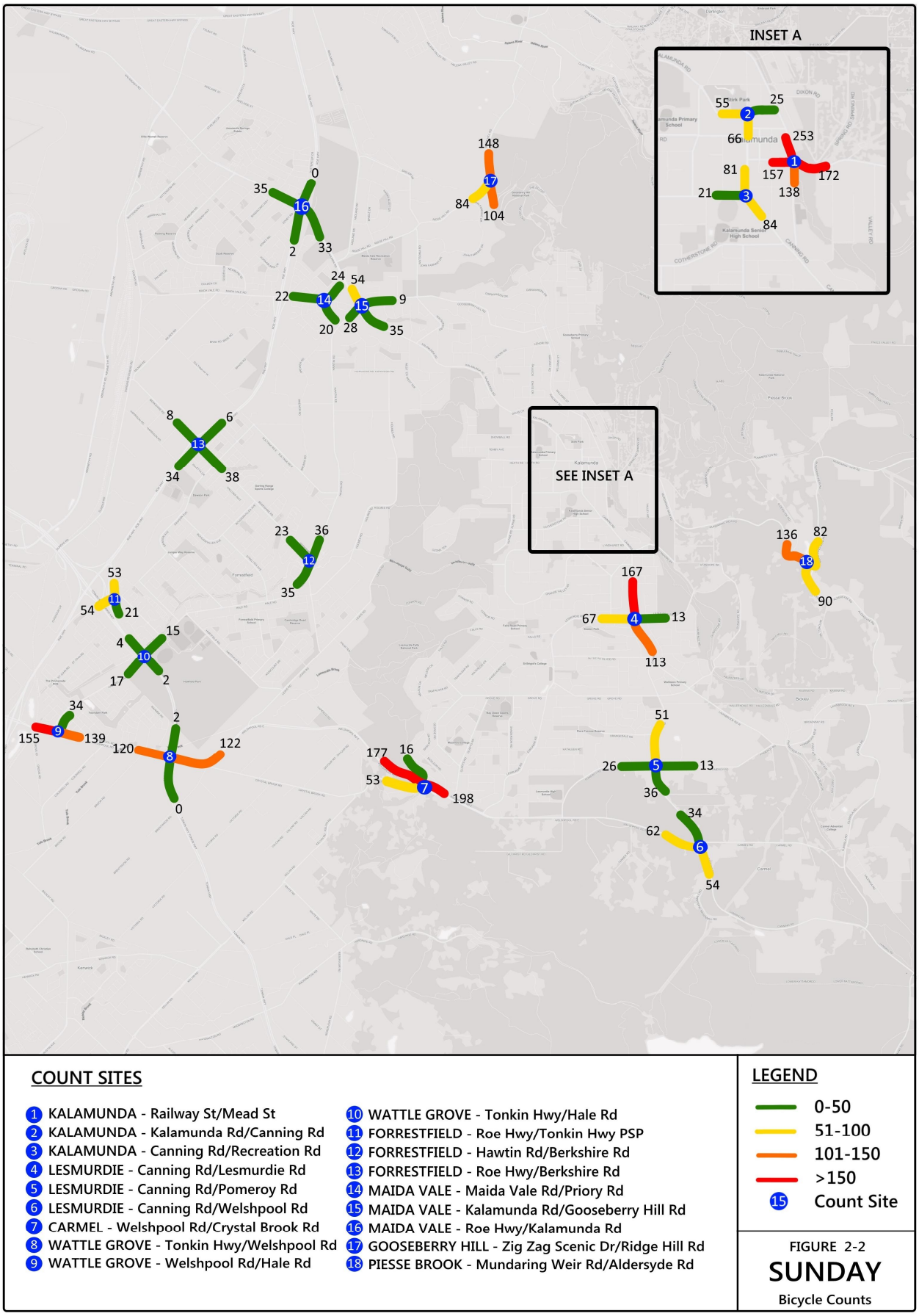
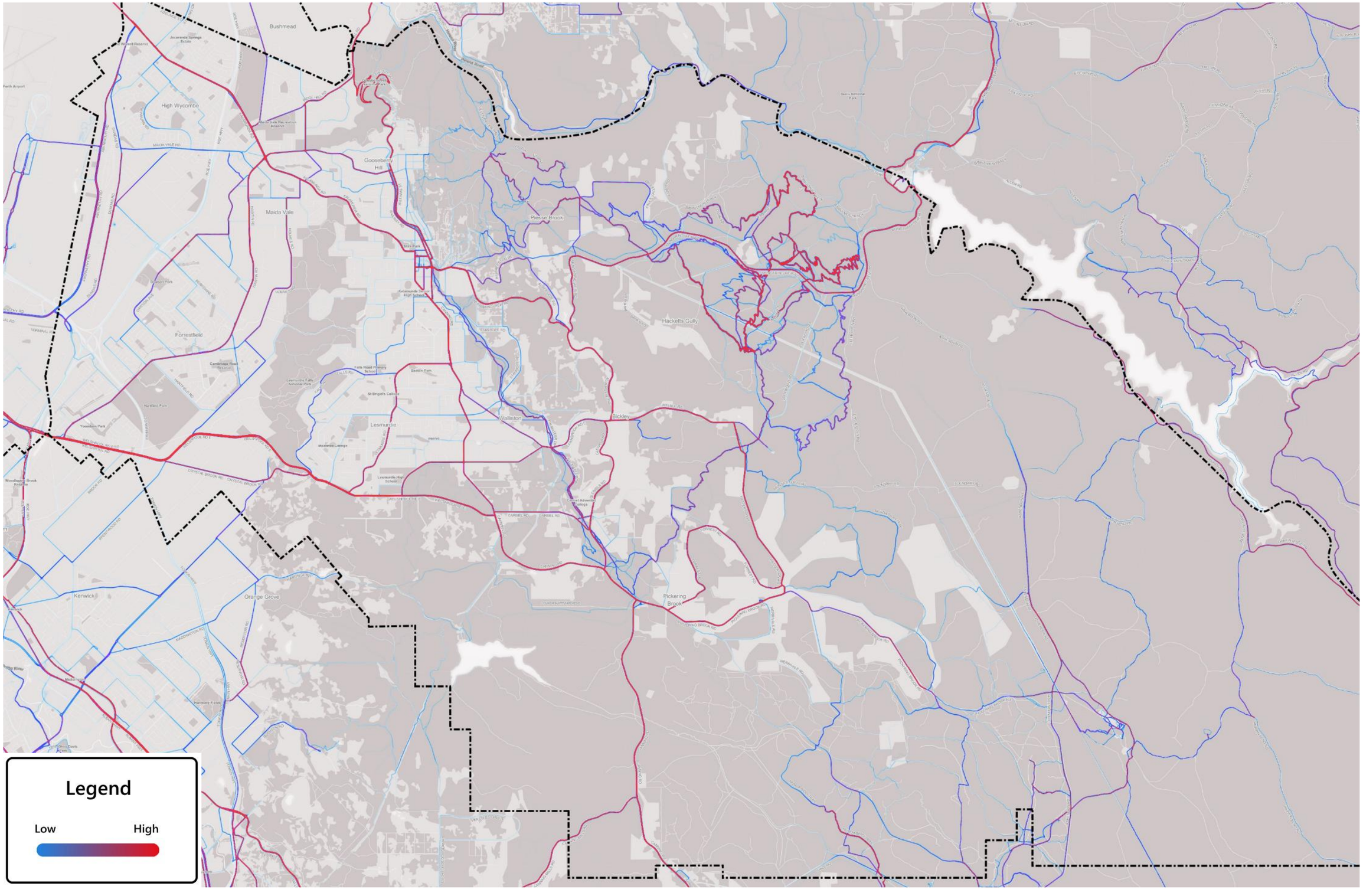


Figure 4-3 Strava Heat Map (2015)

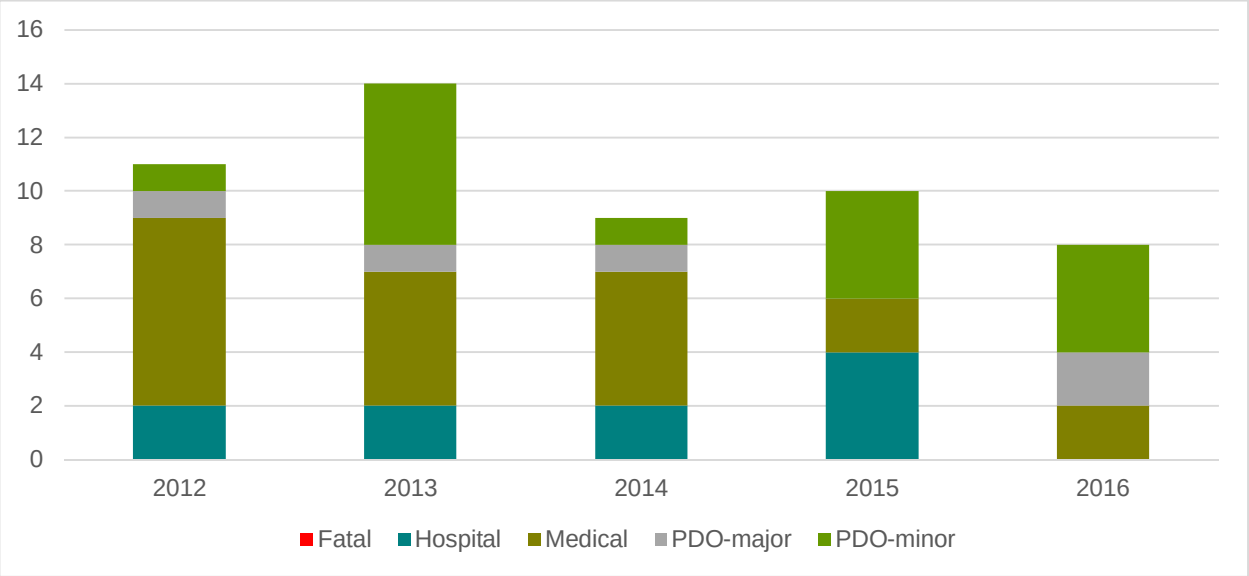


4.4 Bicycle Crash Data

A review of reported bicycle crashes from the Main Roads crash database was undertaken to identify particular locations of concern for cycling safety. Over the past five-year period from 1 January 2012 to 31 December 2016, approximately 3,300 crashes have occurred within the City, with approximately 1.6% (52 crashes) involving cyclists. The number and severity of crashes involving cyclists per year is shown in **Figure 4-4.**

Out of a total of 52 crashes, 60% of crashes required medical attention or hospital treatment. No fatalities were recorded in the five-year period from 1 January 2012 to 31 December 2016.

Figure 4-4 Number and Severity of Crashes Involving Bicycles



The number of crashes over the five-year period do not fluctuate significantly. With the exception of the year 2013, the total number of crashes have remained relatively stable, although it is noted that there were no crashes requiring hospitalisation in 2016.

The number of reported crashes includes only 3 single-vehicle (i.e. bicycle only) crashes – i.e. 49 of the 52 crashes involved motor vehicles. It is likely that other single-vehicle (bicycle only) crashes may not have been reported, particularly if hospitalisation was not required.

The locations of reported bicycle crashes are plotted in **Figure 4-5**. This location plan illustrates one very significant crash cluster at the Welshpool Road East / Lesmurdie Road intersection and several smaller clusters at the following locations:

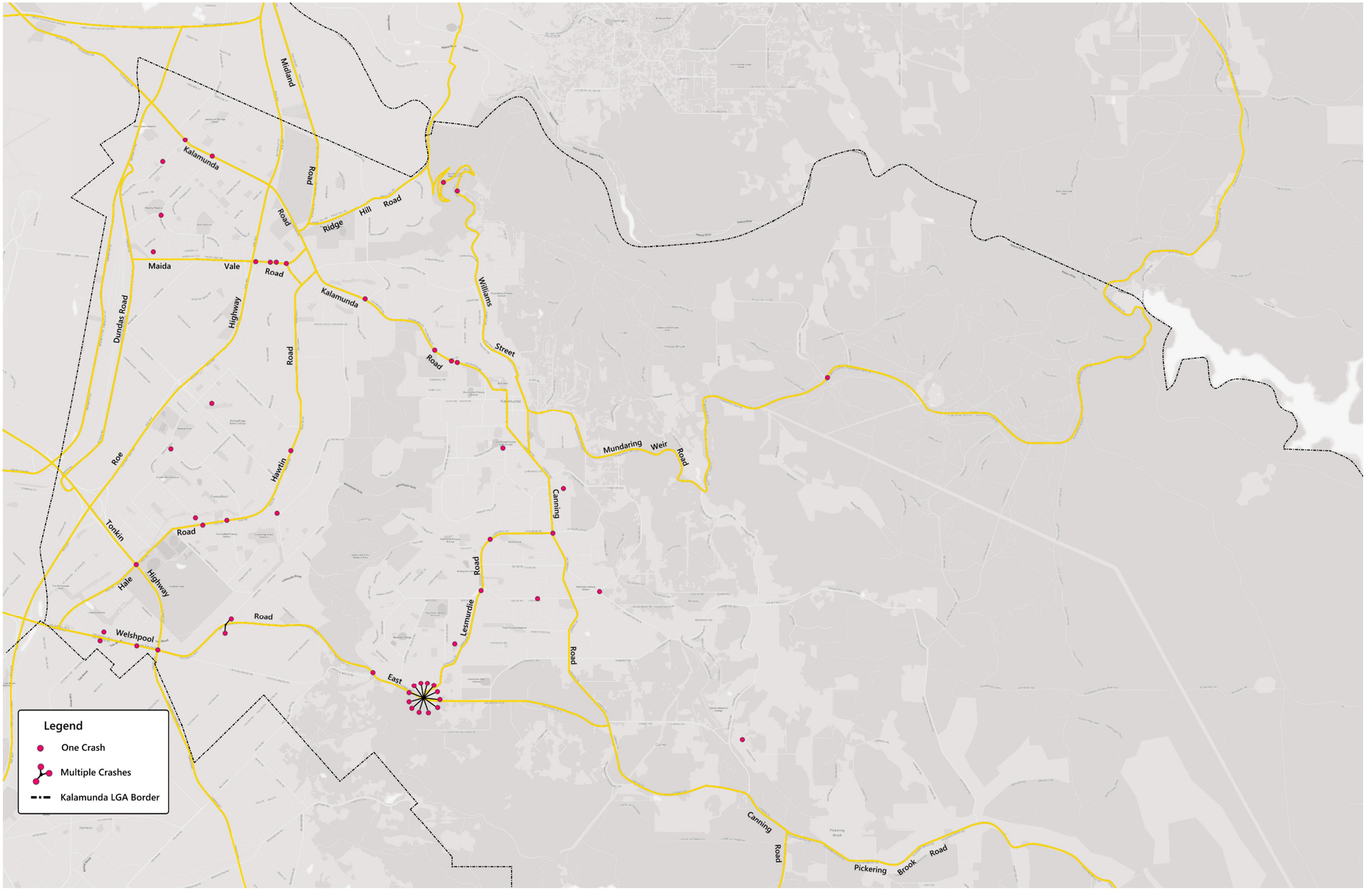
> Welshpool Road East between Coldwell Road and Tonkin Highway

> Maida Vale Road between Roe Highway and Priory Road

> Kalamunda Road between Fayes Crescent and Mt Emilies Road

The most significant crash cluster at Welshpool Road East / Lesmurdie Road intersection includes 12 crashes, which is nearly 25% of the total reported bicycle crashes in the entire City. A reconfiguration of this intersection was undertaken in 2014/15 with the aim of improving safety for cyclists using the intersection; however 5 crashes have occurred since the works were completed in March 2015 which indicates that the works were not effective at addressing the safety risks. Further discussion of this location is included at **Section 7.6.2**.

Figure 4-5 Location of Bicycle Crashes



5 Site Analysis

5.1 Land Use and Attractors

The main land use and attractors within the City are summarised in **Table 5-1** and illustrated in **Figure 5-1**. Key land uses and attractors outside of the City are summarised in **Table 5-2**.

Table 5-1 Key Attractors within Kalamunda

Key Attractor	Description
Kalamunda town centre	The City's major centre
Forrestfield	Major local attractor including town centre, industrial area (west of Roe Highway) and major high school.
Forrestfield North	New railway station and future TOD.
Kalamunda Mountain Bike Trails Hub	Located between Kalamunda and Mundaring is a series of mountain bike trail hubs which are significant attractors of cyclists from outside the LGA. While most mountain bikers would not ride all the way to the trail hubs, there is the opportunity to encourage local residents and cycle tourists to do so.
Bickley Valley / Pickering Brook	Semi-rural / rural type local roads with low traffic volumes and hills, which attract training riders.

Table 5-2 Key Attractors outside Kalamunda

Key Attractor	Description
Midland	The closest major Activity Centre to the City. Includes major retail, employment, health and education facilities.
Kewdale / Welshpool	Major industrial employment centre.
Perth Airport	Major industrial employment centre.
Perth CBD	Major office-based employment centre. Located beyond the 5-10km comfortable cycling distance, however cycling can be used as part of a trip-chain via the future Forrestfield Station.
Maddington / Kenwick	A future major industrial area located adjacent to the City's southern boundary – potential significant employer within comfortable cycling distance from residents of Forrestfield and Wattle Grove

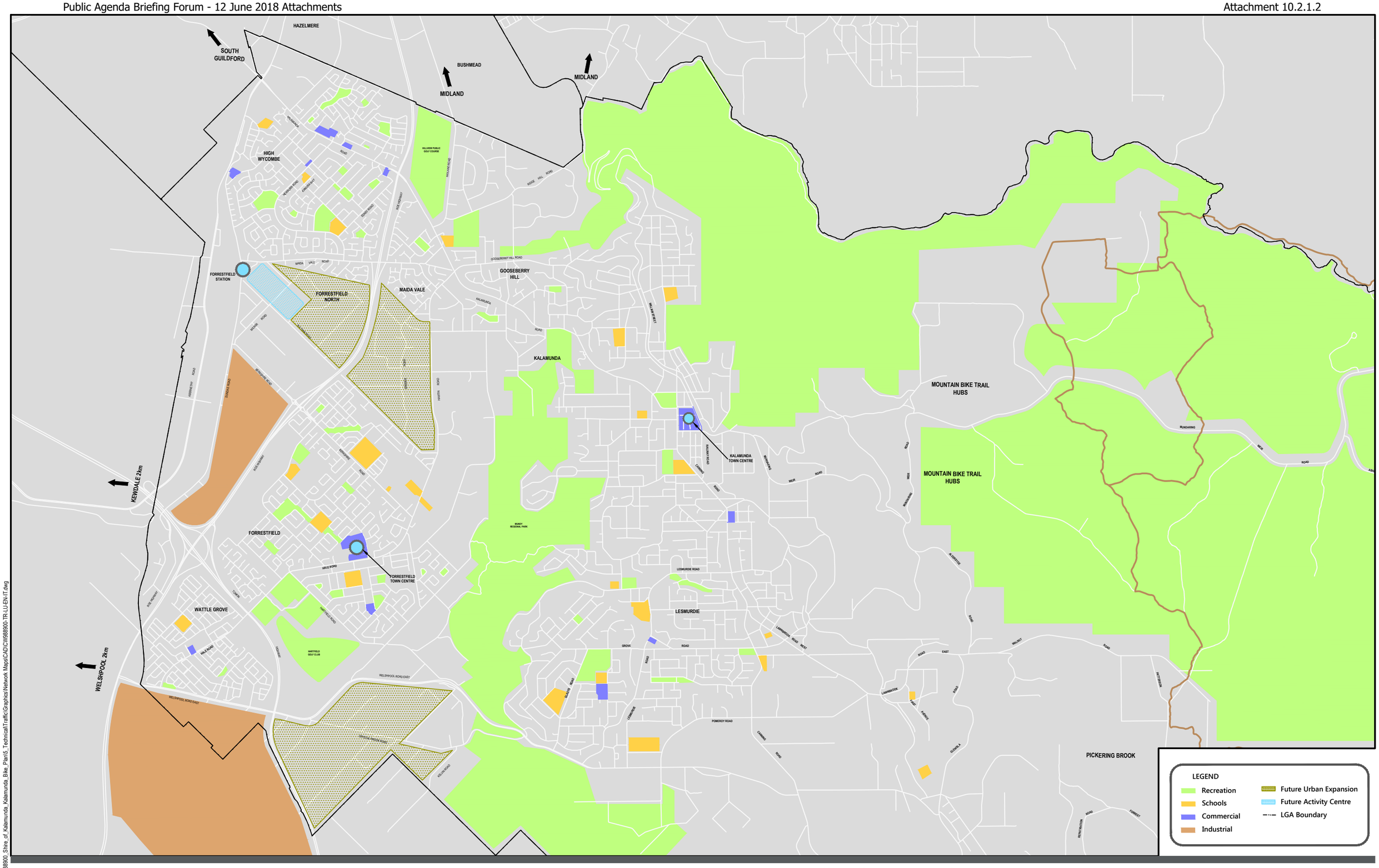
Several significant land uses changes are planned in the City. These include:

> Forrestfield North District Structure Plan and Transit Oriented Development (TOD) for the Forrestfield Train Station

> Maida Vale South future urban expansion area

> Wattle Grove East future urban expansion area

These changes are being developed over the next 20 years with planning currently underway for the Forrestfield North District Structure Plan.



CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 5-1

LAND USE AND ATTRACTORS

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City of Kalamunda

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5.2 Previous Network Planning

The Eastern Metropolitan Regional Council (EMRC) prepared a comprehensive Regional Cycle Network Masterplan in 2010/11, which included the City of Kalamunda, sitting within the context of the Eastern Metropolitan Region as a whole.

The underlying analysis in this document is still valid and has been used as a basis for informing the development of this Bicycle Plan, updated as necessary to account for significant changes in transport and land use planning which have arisen over the past 5 years.

The most significant change between 2010 and 2017 has been a marked improvement in design standards and the quality of infrastructure proposed, funded and constructed in Perth, as well as the emergence of concepts such as Safe Active Streets. This Bicycle Plan builds on the previous work but approaches the provision of infrastructure from a best practice perspective.

5.3 Existing Cycling Infrastructure

The existing walking and cycling infrastructure within the City is presented in **Figure 5-2** through to **Figure 5-6**. These plans show all existing footpaths, shared paths and on-road facilities (typically sealed shoulders) as noted in the City's asset database.

Comprehensive desktop and field reviews were undertaken of the existing cycling infrastructure that confirmed that the existing level of provision is very low when compared to best practice, as well as in comparison to other Local Governments in Perth.

Particular issues with the existing network include:

> Narrow footpaths and shared paths, typically located at the back of kerb with no separation from traffic.

> Paths have been constructed to follow the edge of the road kerb and kerb ramps are typically provided at the narrowest crossing point, which is often 10-12m back from the intersection (and from the desire lines). This type of path and crossing alignment is undesirable for cyclists as they must take their eyes off approaching traffic in order to navigate the tight bends in the path and often cannot clearly see approaching traffic due to the angle of approach to the crossing points. The constant tight bends also make riding along such paths very slow and hard to ride, discouraging less confident cyclists from taking up cycling.

> Minimal on-road dedicated space for cyclists, both on urban roads and rural-type roads. Many of the rural-type roads (e.g. Hawtin Road) lack sealed shoulders, which make them intimidating for less confident or solo cyclists.

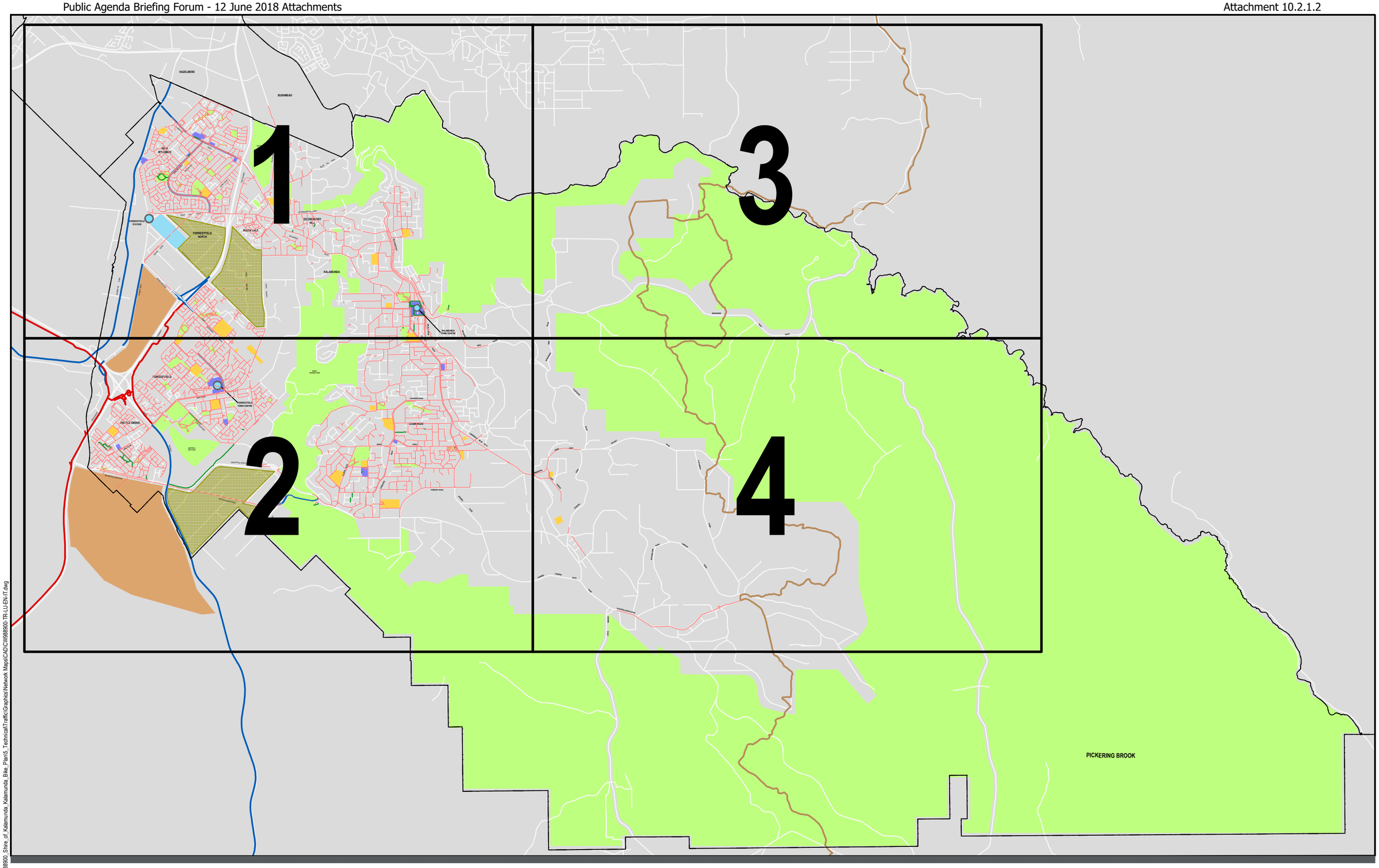
> Traffic calming measures on many streets (e.g. Lillian Road, Brewer Road) push drivers further to the edge of the carriageway where cyclists are riding and make it difficult to safely overtake cyclists.

Some sections of the existing cycling network are of a medium to high standard, or offer significant opportunities for conversion into high quality routes by implementing best practice types of treatments. These include:

> Roe Highway and Tonkin Highway (existing and future PSPs).

> Zig Zag (opportunity for two-way cycling access to create a Secondary Route between Midland and Kalamunda)

> Training routes in the Pickering Brook and Bickley Valley areas (existing rural roads with low traffic volumes)



CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 5-2

EXISTING WALKING & CYCLING NETWORK

OVERALL MAP

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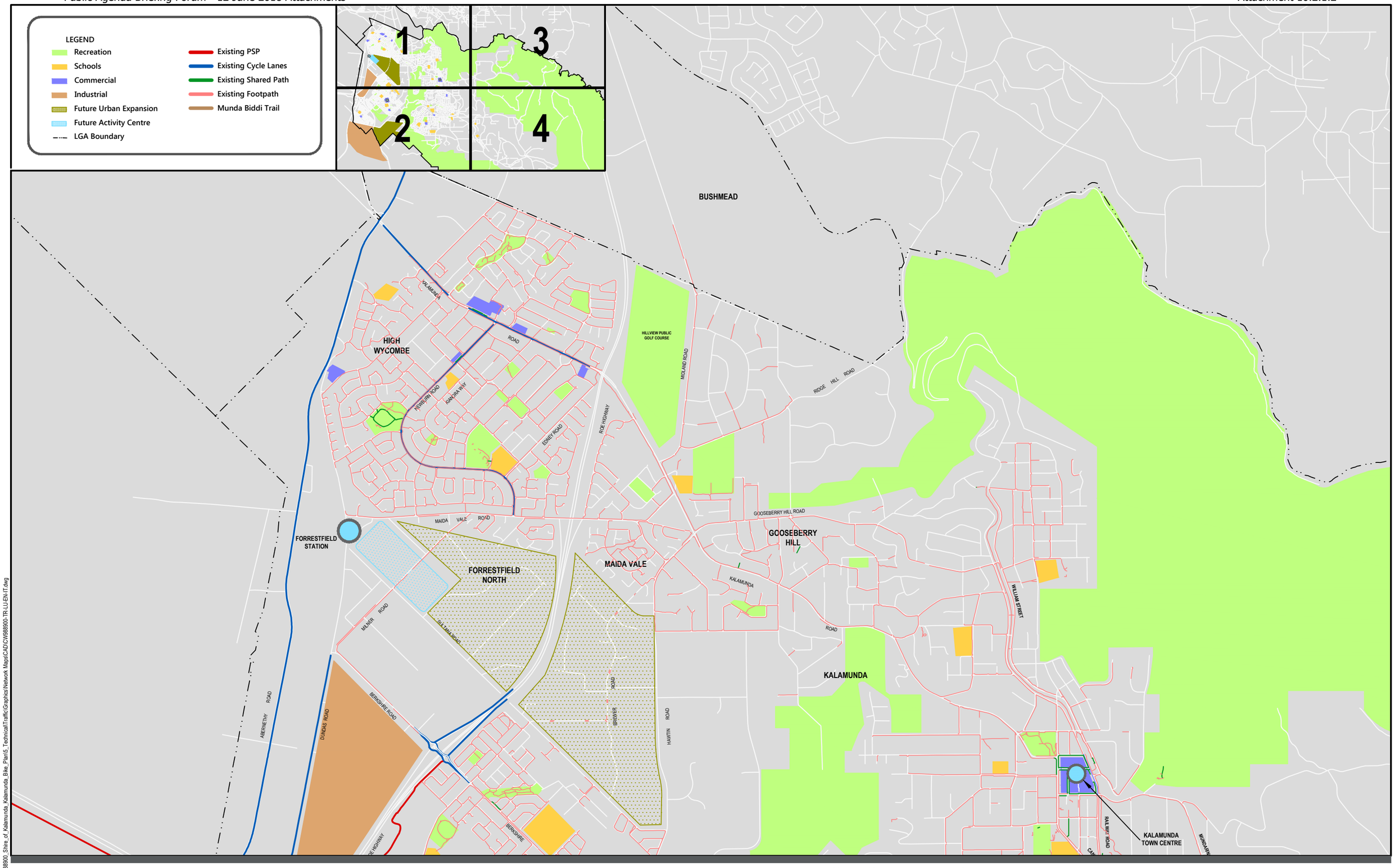

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CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 5-3

EXISTING WALKING & CYCLING NETWORK

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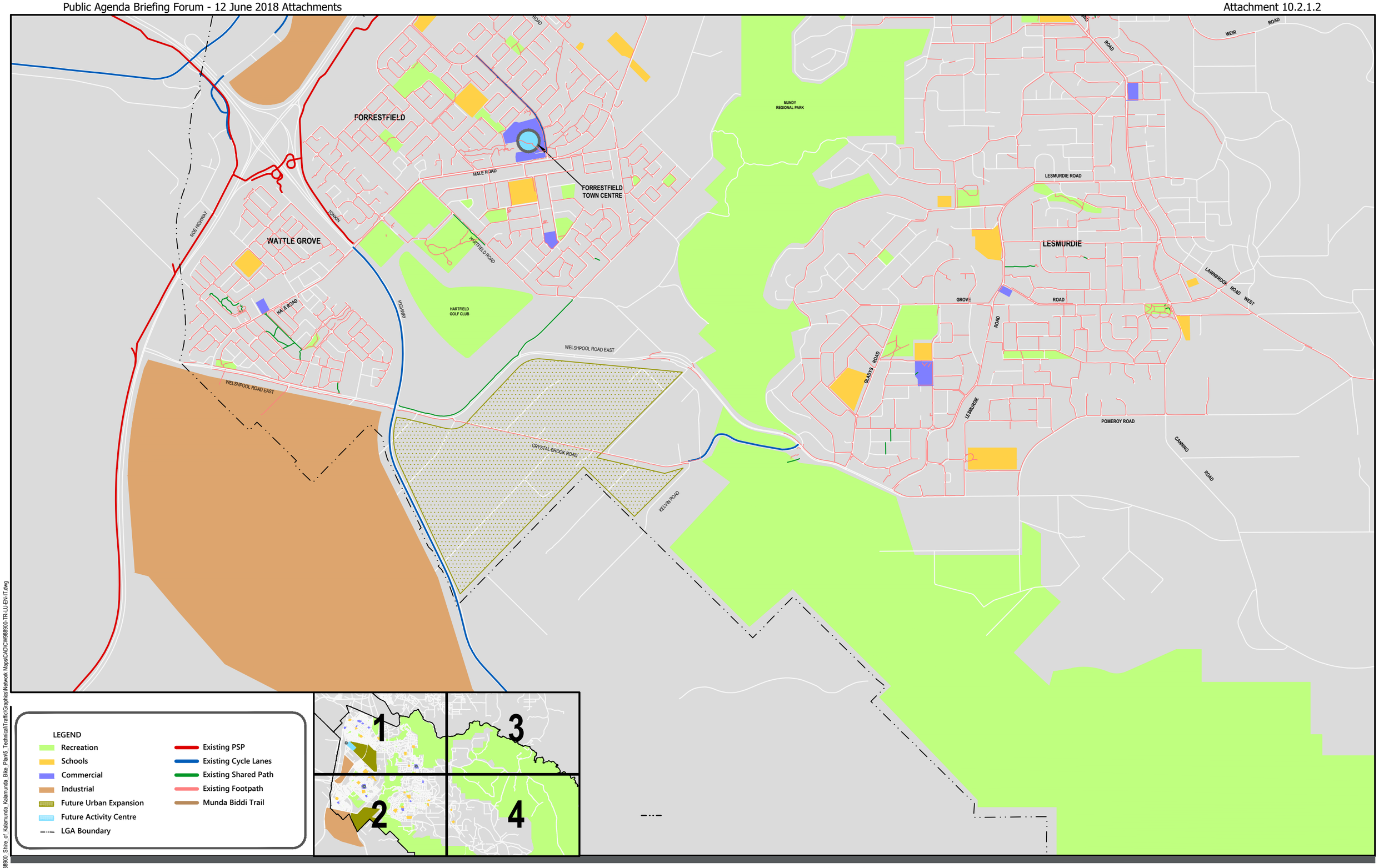

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CITY OF KALAMUNDA
BICYCLE PLAN
FIGURE 5-4
EXISTING WALKING & CYCLING NETWORK
QUADRANT 2

Date	Scale	Size
13.11.2017	NTS	A3

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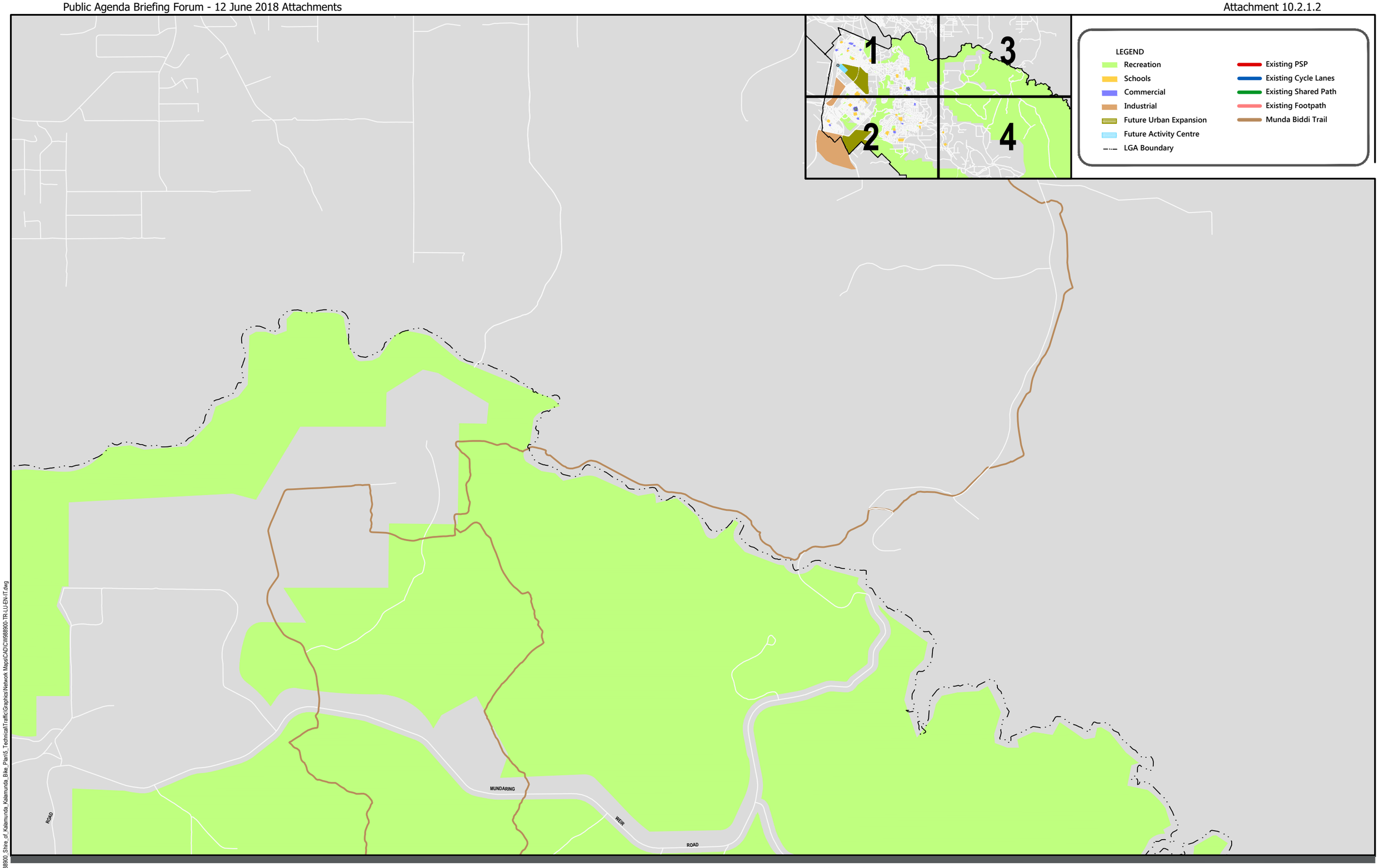

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CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 5-5

EXISTING WALKING & CYCLING NETWORK

QUADRANT 3

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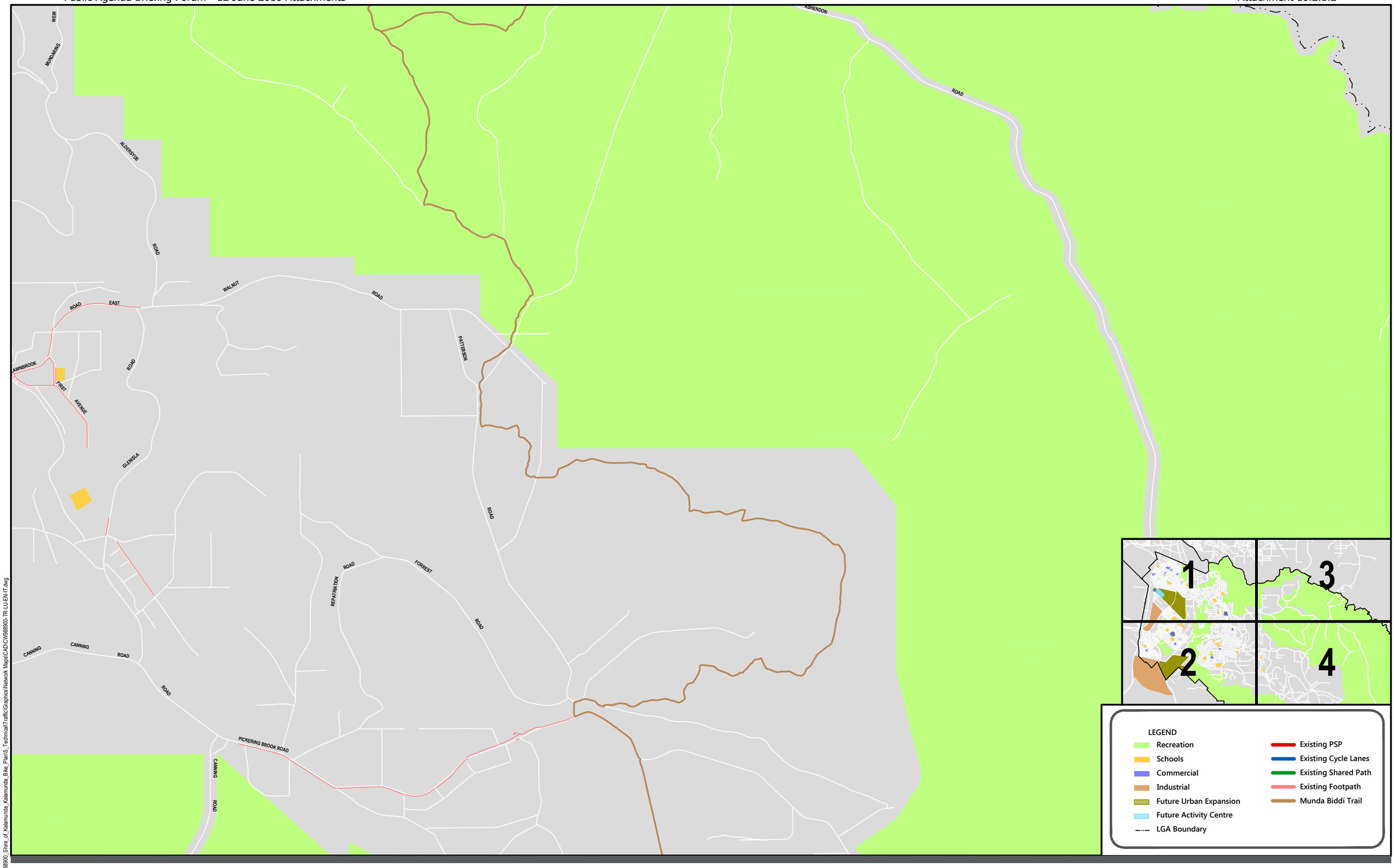

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CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 5-6

EXISTING WALKING & CYCLING NETWORK

QUADRANT 4

Date	Scale	Size
13.11.2017	NTS	A3

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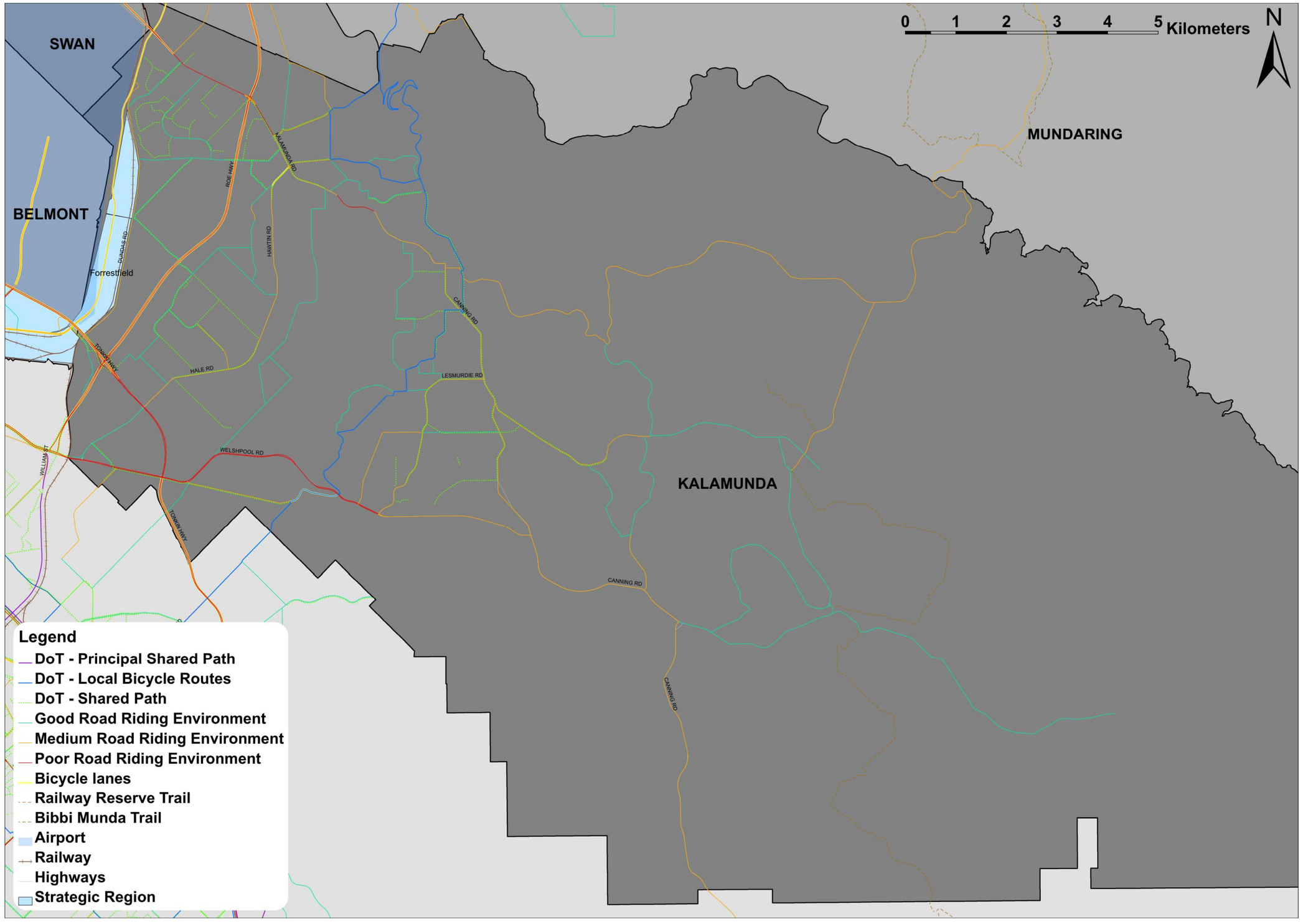
B — Revision

As part of the Regional Cycle Network Masterplan, EMRC identified a network of Strategic Cycling Links within the City, as shown in **Figure 5-7**. These links were revised as part of the development of this Plan and compared against existing infrastructure and land use patterns. The revised list of existing Strategic Cycling Links is summarised in **Table 5-3**.

Table 5-3 Existing Strategic Cycling Links

Route	Description
Roe Highway and Tonkin Highway PSPs	New facilities located at the far south western edge of the LGA with planned extensions south towards Gosnells and north towards Midland.
Midland – Helena Valley – Zig Zag – Kalamunda	No bicycle facilities. Mainly used by training riders and only in a northbound direction (Zig Zag is one-way northbound). Significant opportunities to develop this route for two-way commuter, recreation, tourism and training cycling.
Canning Road (Kalamunda – Carmel)	Central spine for the Hills section of the City. No dedicated facilities.
Kalamunda Road	Mainly used by training riders to access the Hills section of the City. Heavy traffic volumes and no dedicated facilities.
Welshpool Road East / Canning Road	Mainly used by training riders to access the Hills section of the City. RAV route with passing lanes on Lesmurdie Hill but no shoulders on other sections of the route.
Mundaring Weir Road	No Facilities. Mainly used by training riders. Connects Kalamunda with the mountain bike trail hubs, Beelu National Park picnic sites, and the Mundaring Weir Dam.
Bickley Valley / Pickering Brook	A series of local rural-type roads with low traffic and hills which are heavily used by training riders.
PBN Route SE3	Connection between Maddington and Midvale via Lesmurdie, Kalamunda and Zig Zag. Has never been developed with dedicated infrastructure and is not heavily used, particularly through Lesmurdie section.

Figure 5-7 Existing Strategic Cycling Links



Source: EMRC Regional Cycle Network Masterplan

5.4 Network Planning

Planning of the ultimate cycling network in the City has been guided by best practice principles of planning transport networks of identifying key trip attractors and generators and linking them together with infrastructure types suitable for the target demographics.

Once the main cycling corridors were identified, the route hierarchy and a gap analysis of the existing network informed the determination of appropriate infrastructure types for each corridor. The infrastructure types are intended to match the needs of the 'Interested but Concerned' segment of the cycling population (refer to Roger Geller's Cycling Segmentation in **Section 11.1**) for whom a safety and separation from vehicles, except at low speed, is of critical importance. The network plan also caters for the ongoing needs of training riders who cycle throughout the City and the nominated infrastructure types are selected so as not to exclude these groups from using the routes.

The proposed Ultimate Cycling Network Route Hierarchy for the City is illustrated in **Figure 7-1** This Network is presented in a Route Hierarchy format that is consistent with the strategic planning work being undertaken by Department of Transport (DoT). This ensures that the Kalamunda Bicycle Plan sits neatly within the overall network planning for the Perth and Peel Region. The Transport Plan @ 3.5 Million Cycle Network will be updated with the endorsed routes outlines in this bike plan.

The corridors that form part of the Ultimate Cycling Network are outlined in detailed in **Section 6**.

6 Route Hierarchy

Cycling infrastructure proposed for the City of Kalamunda will be categorised under the hierarchy shown in **Table 6-1.** Infrastructure for all route hierarchy should be designed for the 8 to 80 age group, except for training circuit, which should be designed for confident cyclists. Examples are provided for context only and the preferred built form will be determined following detailed analysis of each route.

Table 6-1 Route Hierarchy

Hierarchy	Colour Coding	Function	Built Form	Design Infrastructure For:	Examples
Primary Route	**RED**	Primary routes are high demand corridors that connect to major destinations. They provide high quality, safe, convenient (and where possible uninterrupted) routes that form the spine of the cycle network. These routes are conducive to medium or long distance commuting/utility, recreational, training and tourism trips	Primary routes are high quality cycle only or shared paths, located adjacent to major roads, rail corridors, rivers and ocean foreshores. Where the environment allows, these are in the form of a Principal Shared Path (PSP). A PSP is a fully lit and separated facility. In locations where vehicles have been grade separated the cycle route will also be grade separated. PSPs are to be designed in accordance with the WA Transport Portfolio's PSP Policy.	'8-80' group	    
Secondary Route	**BLUE**	Secondary routes have a lower demand than primary routes, but provide similar levels of quality, safety and convenience. These routes provide connections between primary routes and major activity centres such as shopping precincts, industrial areas or major health, education, sporting and civic facilities.	Secondary routes can take on a number of forms and are designed to suit the environment in which they are located. These forms include: ▪ High quality shared paths; ▪ Bi-directional protected bike lanes; ▪ Protected on-road bike lanes; and Safe Active Streets (Bicycle Boulevards).	'8-80' group	    
Local Routes	**GREEN**	Local routes are low demand and are predominantly located in local residential areas. They provide access to higher order routes and local amenities and recreational spaces.	Local routes can take on various forms depending on the environment in which they are located. These forms include: ▪ Shared paths; ▪ Bi-directional protected bike lanes; ▪ Protected on road bike lanes; and Safe Active Streets (Bicycle Boulevards).	'8-80' group	    

Hierarchy	Colour Coding	Function	Built Form	Design Infrastructure For:	Examples
Training Route	**YELLOW**	Training routes are designated routes for training, sports or recreational cyclists to undertake long distance rides in on-road environments	Training routes are normally located on rural or semi-rural roads on the outskirts of cities and towns. These routes support cyclists undertaking challenging longer distance rides by raising awareness and encouraging safe behaviour by all road users. This is achieved through advisory signage, warning technology and other road safety initiatives.	Confident Cyclists	    
Tourist Trail	**BROWN**	Tourist trails provide long-distance, off-road (unsealed) riding experiences through natural settings, away from motorised traffic. They often support recreational and tourism trips between regions.	Trails are typically located within underutilised transport and service corridors in rural areas. Due to their relatively gentle gradients, former railways make excellent candidates for trails. Purpose built trails may be constructed to connect existing corridors. Trails should be constructed from well drained, compacted gravel with supporting infrastructure such as way-finding signage. They can be sealed when they run through towns, busy road crossings or in special circumstances.	‘8-80’ group	    

7 Ultimate Network Plan

The Ultimate Network Plan for the City of Kalamunda is set out in **Figure 7-1.** The following sections outline the recommended development for each segment of the Ultimate Network.

7.1 Primary Routes

Primary Routes within the City of Kalamunda are present in the form of Principal Shared Paths (PSPs), which are also the backbone of the cycling network in Perth Metropolitan Area. These paths generally follow major controlled-access roads and railway corridors, providing high-quality direct cycling connections completely separated from road traffic.

PSPs are the construction and maintenance responsibility of MRWA, however the City has a key role in contributing to the design process to ensure optimum integration to the local cycling network. The City also has an important advocacy role in persuading the State Government to invest in extensions and upgrades.

7.1.1 Roe Highway

The Roe Highway PSP currently extends 21km from the Kwinana Freeway to Berkshire Road, with grade-separation at all intersecting roads. From Berkshire Road northward, cyclists are permitted to use the shoulder of Roe Highway however this is a very intimidating and hazardous environment for cyclists with narrow shoulders and high speed heavy vehicles. The Strava 'Heat Map' shows that even the most confident cyclists rarely use this section of Roe Highway.

Completing the Roe Highway PSP from Berkshire Road to Midland would be a game-changer for cycling transport in the foothills area, providing a safe cycling connection to the nearest Activity Centre, as well as further loop for longer distance riders travelling through the City.

It is understood that the Roe Highway / Kalamunda Road intersection will be grade-separated in the near future and this project presents an important opportunity for the completion of further sections of the Roe Highway PSP. It is recommended that the City advocate and work with the State Government to ensure that the following is included in the project:

> Grade-separation of the PSP under Kalamunda Road

> Extension of the PSP from Berkshire Road to Kalamunda Road, including an underpass at Maida Vale Road

> Extension of the PSP north from Kalamunda Road to the Brinsmead Road area, subject to a suitable connection being available to Midland Road

If these sections were completed, they would open up a significant north-south spine through the foothills, enabling easy access to the Tonkin Highway PSP and significant employment centres in the Welshpool/Kewdale/Airport area. If these sections are not included as part of the Roe Highway / Kalamunda Road interchange project, separated State Government funding would need to be obtained.

The priority of the remaining sections would be as follows:

1. Bushmead Road to Midland section – in the City of Swan but forms part of the Secondary Route from Midland to Kalamunda
2. Kalamunda Road to Bushmead Road section – in the City of Swan but would complete the link from Maida Vale to Midland.

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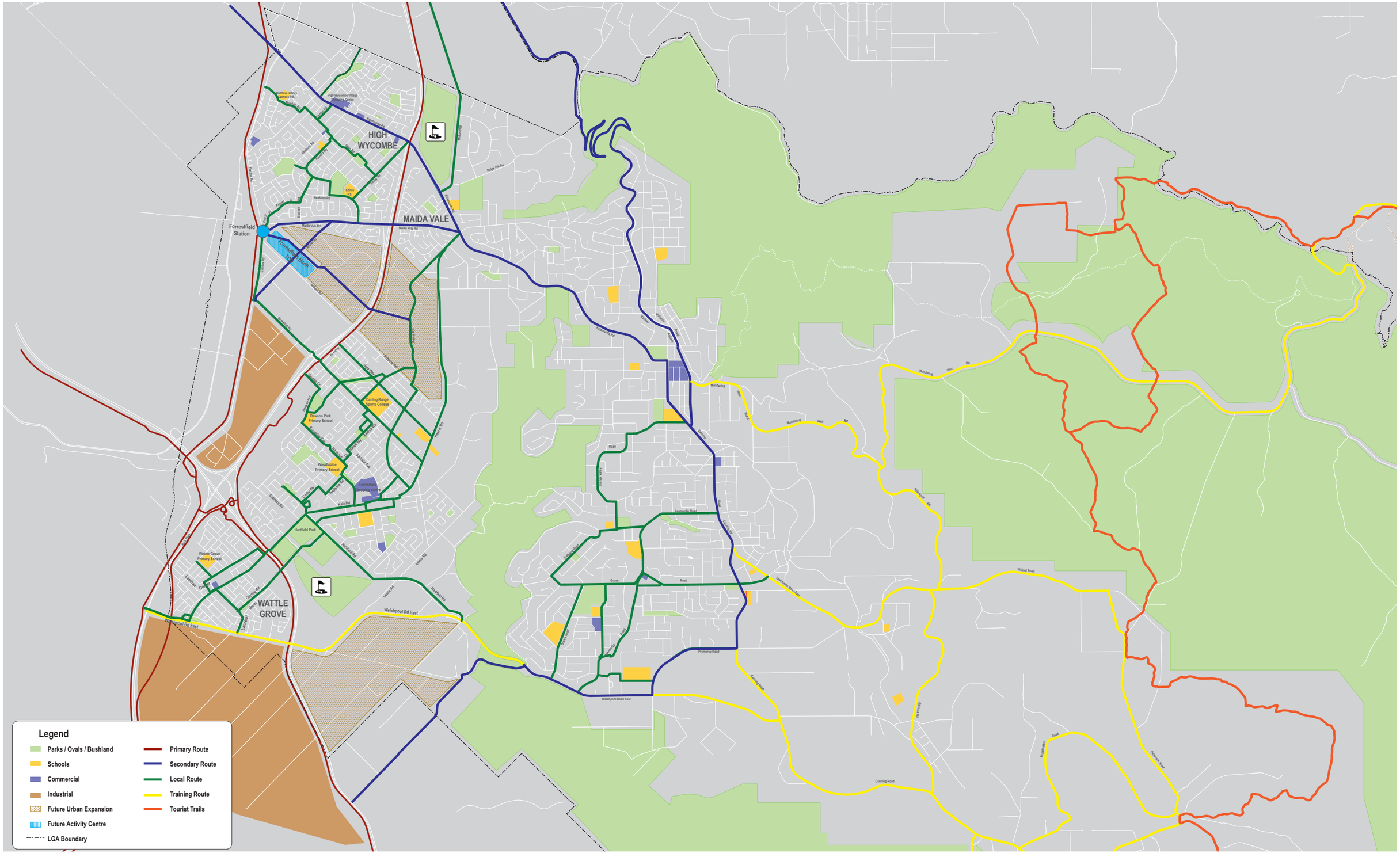


CITY OF KALAMUNDA - ULTIMATE CYCLING NETWORK (ROUTE HIERARCHY)

DATE: 15.11.2017 FIGURE: 7-1 REV B

7.1.2 Tonkin Highway

Figure 7-2 Tonkin Highway PSP – Recommended Arrangement



Tonkin Highway PSP will be a significant connection for the southern edge of the City, connecting Wattle Grove with the wider network and the significant employment areas in Maddington and Gosnells. The priorities for extension are as follows:

1. PSP along the southern side of Tonkin Highway from Roe Highway to Hale Road (parallel to Hardey East Road)
2. PSP along the southern side of Tonkin Highway connecting to the Coyong Road/Maamba Road shared paths in Wattle Grove
3. Connection across Tonkin Highway between Coyong Road/Maamba Road and Hartfield Park
4. Extension of PSP from Hale Road to Welshpool Road East
5. Extension of PSP from Welshpool Road East to Kelvin Road and beyond

The recommended arrangement for the Tonkin Highway PSP between Roe Highway and Welshpool Road East is shown in **Figure 7-2**.

7.1.3 Freight Railway / Dundas Road

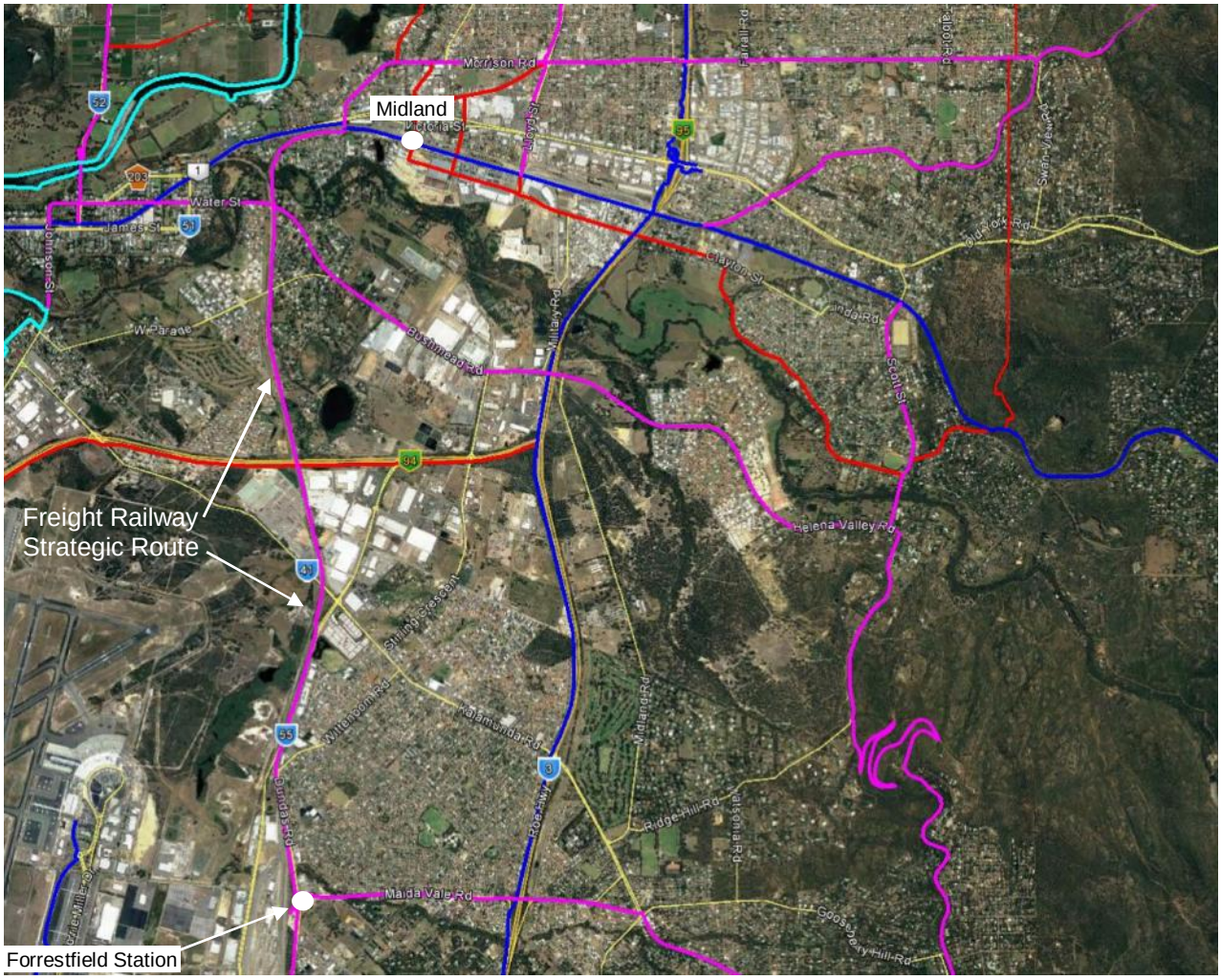
The main freight railway runs north-south along the western edge of the City, parallel to Abernethy and Dundas Roads and passing the new Forrestfield Station. Both Abernethy and Dundas Roads are heavily used by confident road cyclists at the moment; however the lack of protected infrastructure and the heavy volumes of trucks makes it a very intimidating riding environment for less confident cyclists. This is particularly the case during weekdays when most of the industrial business are operating.

With the development of the Forrestfield North TOD, there will be a significant increase in the residential population near Dundas Road and therefore a safe, convenient cycling link to the Tonkin Highway PSP and the major employment centres at Welshpool/Kewdale/Airport will be critical.

As part of the State Government's METRONET plan, a passenger railway line is identified as linking the new Forrestfield Station with the Thornlie spur and its future extension to Cockburn Central. The timing of this project is not known, however it is desirable that plans for a PSP along this rail corridor be included in any planning and design.

To the north of Forrestfield Station, the Department of Transport has included the freight railway corridor as a Secondary Route in its future planning, as shown in **Figure 7-3**. This corridor would provide a convenient link to Midland and Guildford, although is longer than a route following Abernethy Road and Lloyd Street would be. The State Government is planning for the long-term relocation of the freight railway to bypass Midland, which could open up the existing railway corridor for partial or full use for alternative transport modes such as cycling. While this section of the railway is located outside the City boundary, it is recommended that the City liaise with the City of Swan and Department of Transport to ensure that future planning takes into account the needs of Kalamunda residents and visitors.

Figure 7-3 Freight Railway Secondary Cycling Route



Source: Department of Transport

7.2 Secondary Routes

Four Secondary Routes have been nominated as the key corridors for cycling to and through the City. These routes connect the key destinations within the City with the wider cycling network and nearby Activity Centres.

7.2.1 Hills Spine (Midland – Kalamunda – Lesmurdie)

The key component of the cycling network for the hills portion of the City is a north-south spine linking Midland, Kalamunda and Lesmurdie. This spine was selected as the preferred route for many reasons, including:

> Midland is the closest major Activity Centre to the hills portion of the City, located just 11km north of Kalamunda. Midland provides employment, education and shopping facilities for City residents, as well as access to inner Perth via the Perth-Midland PSP.

> The Zig Zag is the only available crossing of the escarpment with reasonable grades for cyclists. The grades on alternative routes such as Gooseberry Hill Road, Kalamunda Road and Welshpool Road East are steep which would deter most casual and potential commuter cyclists.

> The scenic views at the Zig Zag would be a significant drawcard for recreational, training and tourist cyclists, and the ability to ride up the Zig Zag would encourage additional tourism spending within the town centre.

> Canning Road runs north-south along the main ridgeline and could generally be widened to provide buffered bike lanes at a feasible cost. The Canning Road corridor also serves Kalamunda State High School, Kalamunda Christian School and Lesmurdie State High School (via Pomeroy Road).

> It would allow mountain-bikers a convenient, safe route to access the mountain bike trails without having to mixing with heavy traffic on Kalamunda Road.

The recommended concept for the Hills Spine is shown in **Figure 7-4** and includes the following key elements within the City:

> Two-way bicycle access via Zig Zag Scenic Drive;

> Safe Active Street treatment between the top of Zig Zag and Hill Street;

> Upgrade of the Kalamunda Railway Heritage Trail to a high-quality shared path standard from Hill Street to Elizabeth Street;

> Multiple options for the link through Kalamunda Town Centre between Elizabeth Street and the southern end of Railway Road;

> Protected cycle lanes along Railway Road from Mead Street to Canning Road;

> Buffered cycle lanes along Canning Road from Railway Road to Pomeroy Road;

> Existing shared path on Pomeroy Road to connect to Lesmurdie State High School.

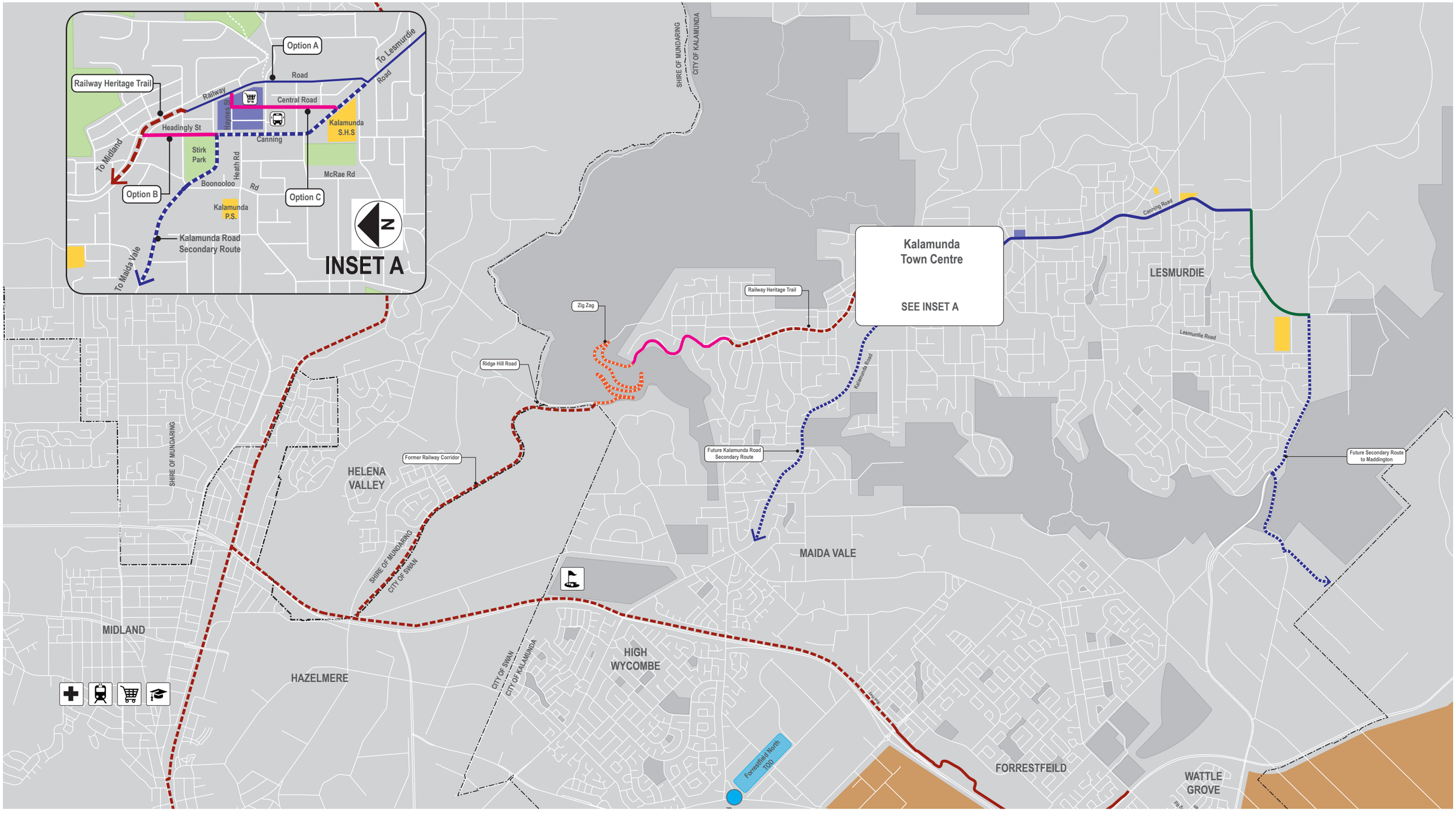
Each of these elements is discussed in more detail in the following sections.

7.2.1.1 Midland to Zig Zag

This portion of the route is located outside the City of Kalamunda and will be the primary responsibility of the Department of Transport, Main Roads (for the PSP portion) and City of Swan to develop. However, its existence is critical for the success of the route as a whole. City of Swan has been consulted and preliminary indication shows that the City of Swan do not object the proposal, however support would be contingent on their own cycle network review that is slated to start in the 2017 -2018 timeframe.

Commencing from Midland Train Station, the indicative route follows the proposed PSP extension along the railway line to Roe Highway, then following the proposed Roe Highway south to the Bushmead Road / Helena Valley Road / Midland Road intersection.

From this point, the former railway reserve (Lots 7894 and 6726 – owned by the State Government and under the management of the City of Swan) could be utilised to develop a PSP-standard link to Ridge Hill



Infrastucture Type

- Existing PSP
- Future PSP
- Proposed Protected Bike Lane
- Existing 1.8m - 2m Wide Footpath
- Proposed Safe Active Street

Connecting Routes

- Future Secondary Route
- Zig Zag

Land Use

- Shopping Centre
- Schools
- Parks / Oval / Bushland
- Industrial

Kalamunda Town Centre Options

- (A) Railway Road
- (B) Headingly Street
- (C) Central Road / Central Mall

CITY OF KALAMUNDA - HILLS SPINE SECONDARY ROUTE (Midland - Kalamunda - Lesmurdie)

DATE: 15.11.2017 FIGURE: 7-4 REV B

Road, which would save 1.0-1.2km in distance compared to following Helena Valley Road. This link would serve both Bushmead and Helena Valley residential areas with appropriate connections to existing streets.

Where the former railway reserve meets Ridge Hill Road, the PSP-standard path could utilise an existing cleared power line corridor parallel to the road, then cross Ridge Hill Road near the bottom of Zig Zag.

7.2.1.2 Zig Zag

Zig Zag Scenic Drive is currently a one-way downhill roadway constructed mostly on the old zig zag railway formation. The pavement is generally 3.0-3.2m wide with some wider sections such as at the hairpin bends. Cycling up the hill is permitted only during special events although some unsanctioned 'wrong-way' cycling does occur outside of these times. Being an old railway alignment with low gradient, it is an ideal cycling route for all ages and abilities.

Formalised two-way cycling on the Zig Zag is absolutely essential to the functioning of the Hills Spine corridor. There are multiple ways in which this can be achieved; several options are presented below in **Table 7-1**.

Photograph 1 – Zig Zag Scenic Drive



Photograph 2 – Zig Zag Scenic Drive



Table 7-1 Zig Zag Scenic Drive Treatment Options

	Treatment Option	Order of Cost	Advantages	Disadvantages
A	Close Zig Zag to motorised traffic and permit two-way pedestrian and cyclist traffic	Low	▪ Full-time safe access for cyclists and pedestrians as part of a Secondary Cycling Route. ▪ Eliminates risk of head-on conflicts between cyclists and motorised traffic. ▪ Eliminates conflicts between pedestrians and motorised traffic. ▪ Significant cycle tourism potential with safer access to Zig Zag views. Motorised traffic would still have access to top car park and be able to walk to see more views. ▪ Significant reduction in traffic and anti-social behaviour for residents in Lascelles Parade. ▪ Zig Zag would remain available as an evacuation route for bushfires, if/when required. ▪ No impact on heritage values.	▪ Local commuter traffic would need to divert via Gooseberry Hill Road. ▪ Reduction in access for tourists and residents in motorised vehicles as direct connection into Ridge Hill Road is removed.
B	Permit two-way cycling traffic on existing pavement with one-way uphill motorised traffic	Low	▪ Full-time access for cyclists and pedestrians as part of a Secondary Cycling Route. ▪ Significant cycle tourism potential with safer access to Zig Zag views. ▪ Local commuter traffic would need to divert via Gooseberry Hill Road in the AM Peak but could use Zig Zag in the PM Peak. ▪ Motorised tourist traffic would be more likely to spend money in the City after visiting Zig Zag compared to the current situation. ▪ Zig Zag would remain available as an evacuation route for bushfires, if/when required. ▪ No impact on heritage values.	▪ Likely head-on conflicts between motorised traffic and cyclists (and pedestrians) in some locations due to the narrow pavement width. Higher risk to cyclists due to the potential steep fall on the downhill side. ▪ Local commuter traffic would need to divert via Gooseberry Hill Road in the AM Peak but could use Zig Zag in the PM Peak. ▪ No reduction in anti-social behaviour for residents on Lascelles Parade. ▪ Driving uphill is not attractive as there are less opportunity to view the scenery in comparison to driving downhill.
C	Widen carriageway to permit one-way uphill traffic flow and two-way cycling in a 'Safe Active Street' type environment	High	▪ Full-time access for cyclists and pedestrians as part of a Secondary Cycling Route. ▪ Significant cycle tourism potential with safer access to Zig Zag views. ▪ Local commuter traffic would need to divert via Gooseberry Hill Road in the AM Peak but could use Zig Zag in the PM Peak. ▪ Motorised tourist traffic would be more likely to spend money in the City after visiting Zig Zag compared to the current situation. ▪ Zig Zag would remain available as an evacuation route for bushfires.	▪ Likely head-on conflicts between motorised traffic and cyclists (and pedestrians) in some locations due to the narrow pavement width. Higher risk to cyclists due to the potential steep fall on the downhill side. ▪ Potential impact on heritage values due to widening of cuttings and sideling sections. ▪ No reduction in anti-social behaviour for residents on Lascelles Parade.

	Treatment Option	Order of Cost	Advantages	Disadvantages
D	Widen carriageway to permit one-way downhill traffic flow and two-way cycling in a 'Safe Active Street' type environment	High	▪ Full-time access for cyclists and pedestrians as part of a Secondary Cycling Route. ▪ Significant cycle tourism potential with safer access to Zig Zag views. ▪ No inconvenience to local commuter traffic. ▪ Zig Zag would remain available as an evacuation route for bushfires.	▪ Likely head-on conflicts between motorised traffic and cyclists (and pedestrians) in some locations due to the narrow pavement width. Higher risk to cyclists due to the potential steep fall on the downhill side. ▪ Potential impact on heritage values due to widening of cuttings and sideling sections. ▪ No reduction in anti-social behaviour for residents on Lascelles Parade.
E	Timed closure – night-time access for motorised traffic (e.g. from 5PM to 10PM)	Medium	▪ Daytime access for cyclists and pedestrians, serving 99% of cycling and walking demand. ▪ Retains motorised vehicle access at night-time to view the city lights.	▪ Active management required – e.g. a ranger to open and close gates or bollards. ▪ No reduction in anti-social behaviour for residents on Lascelles Parade.
F	Timed closure – weekday access for motorised traffic	Medium	▪ Weekend access for cyclists and pedestrians, serving mainly recreational riders. ▪ Significant cycle tourism potential with safer access to Zig Zag views on weekends only. ▪ Local commuter traffic is low on weekends, so only a minor inconvenience for local residents.	▪ Would not serve commuter cyclists and therefore the overall Secondary Route would not achieve its objectives. ▪ Active management required – e.g. a ranger to open and close gates or bollards. ▪ No reduction in anti-social behaviour for residents on Lascelles Parade.

Following discussion with the City, Option A is the preferred option for Zig Zag Scenic Drive as it provides the best outcomes in terms of safety and is relatively simple to implement compared to other options. The City would need to consult with the community before implementing any treatment to Zig Zag Scenic Drive.

7.2.1.3 Lascelles Parade / William Street (Zig Zag to Hill Street)

This section carries relatively low traffic volumes of traffic, which may reduce further in the future, depending on the final arrangement provided at Zig Zag Scenic Drive. The terrain makes it difficult to construct a shared path of suitable standard so a Safe Active Street style treatment is the preferred option. This treatment would be consistent with the existing traffic calming devices and the intent to slow traffic through the area.

The vicinity of Hill Street a new, high-quality connection to the railway reserve is proposed.

7.2.1.4 Kalamunda Railway Heritage Trail (Hill Street to Elizabeth Street)

The Railway Heritage Trail is currently unsealed and this would need to be updated to high-quality shared path standards similar to a PSP. The type of crossings to be provided at Gooseberry Hill Road, Noel Road and Headingly Road would need to be investigated in more detail; raised crossings with pedestrian and cyclist priority should be considered for the ultimate development of this route.

The anticipated volume of pedestrian and cyclist traffic on this section indicates that a shared pedestrian and cyclist facility will be adequate; it is likely that more confident, faster cyclists will prefer to use Williams Street.

7.2.1.5 Kalamunda Town Centre (Elizabeth Street to Canning Road)

South of Elizabeth Street the railway reserve has been built over; therefore an alternative route through the town centre is required. Given the verge constraints and volume of pedestrians in the Kalamunda town centre, an on-road cycling environment is preferred over a shared path; however the on-road facility will need to cater for a wide range of ages, abilities and confidence levels.

Multiple options for the route through the Kalamunda town centre have been developed, as follows:

> **Option A: Railway Road** – a combination of slow-speed, mixed traffic environment and protected bicycle lanes, pending more detailed investigation and consultation. This route would provide access to the top of Haynes Street, the start of the Zig Zag Cultural Centre and the start of the Mundaring Weir Road cycling route.

> **Option B: Headingly Street** – a Safe Active Street treatment along Headingly Street connecting to the proposed buffered bicycle lanes along Canning Road. This option results in an overall lower cost network for the town centre, avoiding duplicated routes on Canning and Railway Roads, however it does not provide convenient access to the start of Mundaring Weir Road. The route also places cyclists at the bottom of Haynes Street.

> **Option C: Central Road / Central Mall** – a Safe Active Street treatment along Central Road and a low-speed cycling route through Central Mall. This route would be attractive to less confident cyclists; however the training riders are likely to continue using Canning or Railway Roads.

Further investigations will be required to determine which of the above options is preferred for the town centre, including preferred treatments for the Mead Street / Railway Street roundabout which carries the largest number of cyclists in the City.

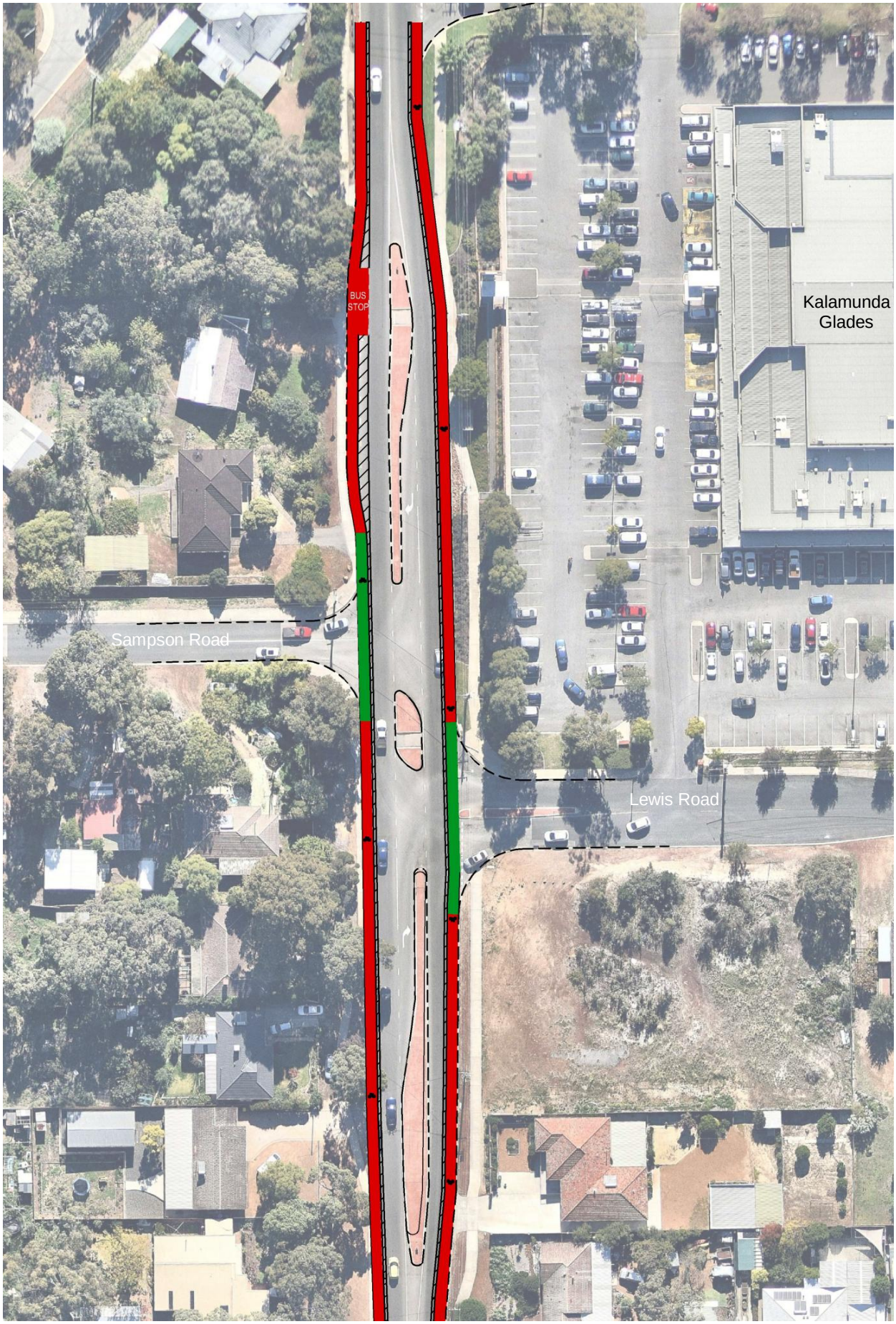
7.2.1.6 Canning Road

Buffered bicycle lanes in each direction are proposed for Canning Road between Railway Road and Pomeroy Road. Painted separation rather than physical separation between the bicycle lanes and general traffic lanes is recommended given that this route is heavily used by riding groups who prefer to travel 2-abreast and/or overtake.

Between Railway Road and Lawnbrook Road, Canning Road is typically 9.0m wide. South of Lawnbrook Road the carriageway narrows to between 7.2 and 7.5m in width.

Widening will be required over the full length to achieve an ultimate form of 2.0m wide cycle lane and 0.5m wide painted buffer (refer to typical section in **Figure 7-5)**, however 1.5m wide sealed shoulders with no buffer could be implemented in the short term with minimal widening required north of Lawnbrook Road. South of Lawnbrook Road, widening will be required to achieve even the minimum standard of sealed shoulders. It should be noted that DoT's minimum standard for on-road bicycle lanes includes a 300mm painted buffer which cannot be achieved without widening of the carriageway.

Figure 7-5 Canning Road Cycle Lanes – Typical Arrangement



7.2.1.7 Pomeroy Road

There is an existing 2m wide path along Pomeroy Road, which allows high school students to connect from the Canning Road corridor to Lesmurdie State High School. During the community consultation, existing cyclists expressed satisfaction with the current arrangements on Pomeroy Road, indicating no need for widening or dedicated cycle lanes in the short-to-medium term.

In the long term, Pomeroy Road should be widened to provide 1.5-2.0m wide sealed shoulders with painted buffer to provide additional separation from traffic, thus improving safety for High School students as well as providing space for sport cyclists to be able to ride 2 abreast.

7.2.1.8 Future Extension: Lesmurdie to Maddington

Refer to **Section 7.2.4**.

7.2.2 Kalamunda Road

Kalamunda Road is the primary traffic route to the hills and one of only two two-way traffic routes ascending the escarpment. It is marked for a single lane of traffic in each direction on the escarpment section with a carriageway width of between 10.5 and 12.0m. It carries regular bus services but does not carry Restricted Access Vehicles (RAVs) which are required to use Welshpool Road East.

Kalamunda Road is regularly used by training groups generally travelling from South Guildford right through to the hills. Use of the road by other cyclist types is very low given the steep grades on the escarpment, high traffic volumes and lack of cycle lanes. There are discontinuous sections of sealed shoulders through High Wycombe however these do not present connect to other cycling facilities and are therefore of limited use.

The development of Forrestfield Station presents a significant opportunity for encouraging commuter cycling in the hills. Kalamunda town centre is located only 6.5km east of Forrestfield Station via Maida Vale and Kalamunda Roads – this is close to comfortable cycling distance, and significantly shorter than the distance between Midland Station and Kalamunda Town Centre (11km). Kalamunda Road is also the only direct link between the hills and the foothills, serving internal commuter and recreational trips within the City.

Kalamunda Road, along with Maida Vale Road, forms a Secondary Route between Kalamunda town centre and Forrestfield Station. The section of Kalamunda Road from Maida Vale through High Wycombe towards South Guildford is also a Secondary Route but of lesser importance. This section of the Secondary Route will mainly serve training riders, as well as a smaller catchment of commuters in High Wycombe.

The recommended strategy for the Kalamunda Road Secondary Route is shown in **Figure 7-6** and outlined below:

> Implement 2.0m wide buffered bicycle lanes from **Canning Road to Hawtin Road** generally using the existing carriageway with minor widening where required. A typical plan and section is shown in **Figure 7-7**.

> Install 1.5m wide sealed shoulders between **Hawtin Road and Roe Highway**.

> Maintain the existing sealed shoulders between **Roe Highway and Fernan Road**, and include 1.5m wide sealed shoulders in the future upgrade between **Fernan Road and Abernethy Road**.

> Maintain a continuous 2.5m wide shared path between **Hawtin Road and Abernethy Road**.

> Work with the City of Swan and Main Roads to implement sealed shoulders over the railway bridge immediately **west of Abernethy Road**.

Buffered bicycle lanes – with a painted buffer rather than a raised island – are recommended so that the large groups can make use of these lanes while riding two-abreast and/or overtaking.

Figure 7-6 Kalamunda Road Secondary Route



Figure 7-7 Kalamunda Road – Typical Plan and Section



7.2.3 Forrestfield Station Connections

The Forrestfield Station presents a significant opportunity to encourage greater uptake of cycling in the life of this Bicycle Plan and therefore the links to and through the station are critical to the Plan's success. As the station is located in a largely undeveloped or lightly developed area, there are minimal to no cycling facilities. With the anticipated growth in population in Forrestfield North and corresponding changes to the road environment, there is a significant opportunity to provide high-quality cycling facilities from the beginning, encouraging new residents to establish sustainable travel behaviours from the day they move in rather than trying to change established behaviours at a later date.

Within the Ultimate Network Plan, Forrestfield Station is served by two Secondary Routes and two Local Routes:

> **Maida Vale Road Secondary Route** – the primary connection from the areas east of Roe Highway to the train station, and the strategic connection to Kalamunda and the hills part of the City.

> **New TOD Connector Road Secondary Route** – Connecting Forrestfield Station through Forrestfield North and over Roe Highway to Maida Vale

> **High Wycombe Local Route –** connection to the nearest existing residential area to the station.

> **Berkshire Road Local Route –** a short-term connection to Forrestfield residential area pending completion of the New TOD Connector Road bridge over Roe Highway.

The proposed infrastructure types of these routes are shown on the map at **Figure 7-8** and outlined in the following sections.

7.2.3.1 Maida Vale Road

As shown in **Figure 4-5**, Maida Vale Road is a significant bicycle crash cluster, particularly near the Roe Highway interchange. It currently has no dedicated cycling facilities and has fast-moving traffic with frequent crossovers and intersections. Traffic volumes can be expected to increase further upon opening of the station, as 2,500 commuter vehicles from all parts of the City are expected to park at the station.

Taking into consideration the available road reserve width, the existing and likely future traffic volumes, and the frequent crossovers, it is recommended that protected bicycle lanes be provided between Forrestfield Station and Priory Road. Low-speed mixed traffic cycling is considered suitable along Old Maida Vale Road, with appropriate connections to Kalamunda Road at the Hawtin Road/Gooseberry Hill Road intersection.

An indicative cross section for Maida Vale Road is shown in **Figure 7-9**, utilising the existing road reserve width of 20m. This cross section has been prepared primarily to illustrate the preferred cycling infrastructure and should, as far as possible, be used as part of the detailed design process for this road.

As this Secondary Route is critical to the success of the Forrestfield Train Station and the Forrestfield North Structure Plan as a whole, the City should seek funding support from the State Government for the upgrade of Maida Vale Road.

Figure 7-8 Forrestfield Station Connections

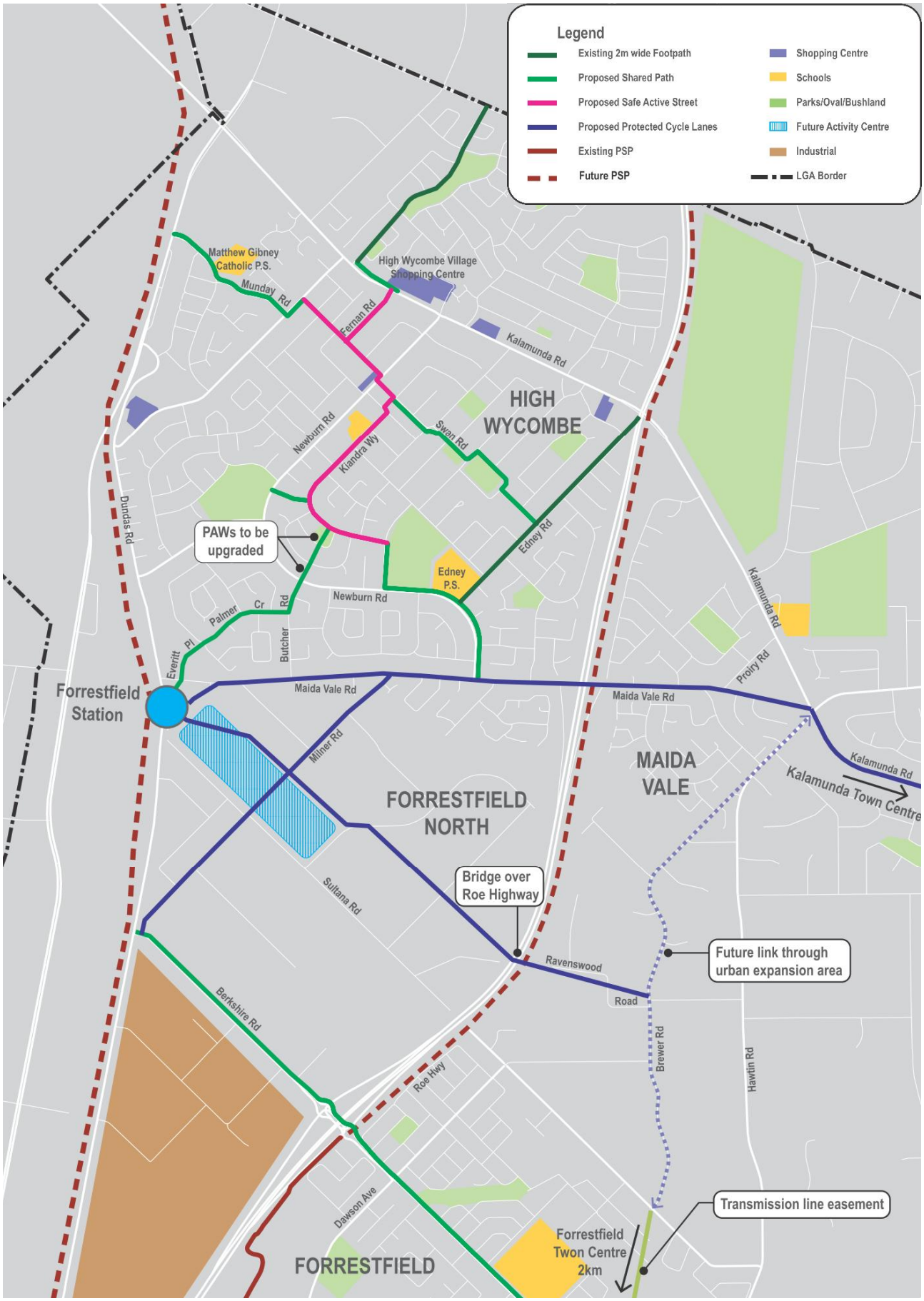


Figure 7-9 Recommended Cross Section – Maida Vale Road

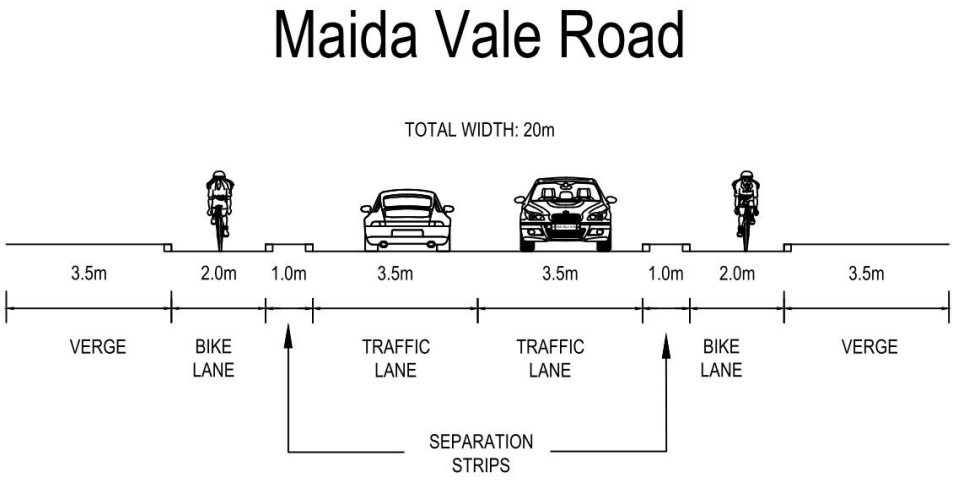
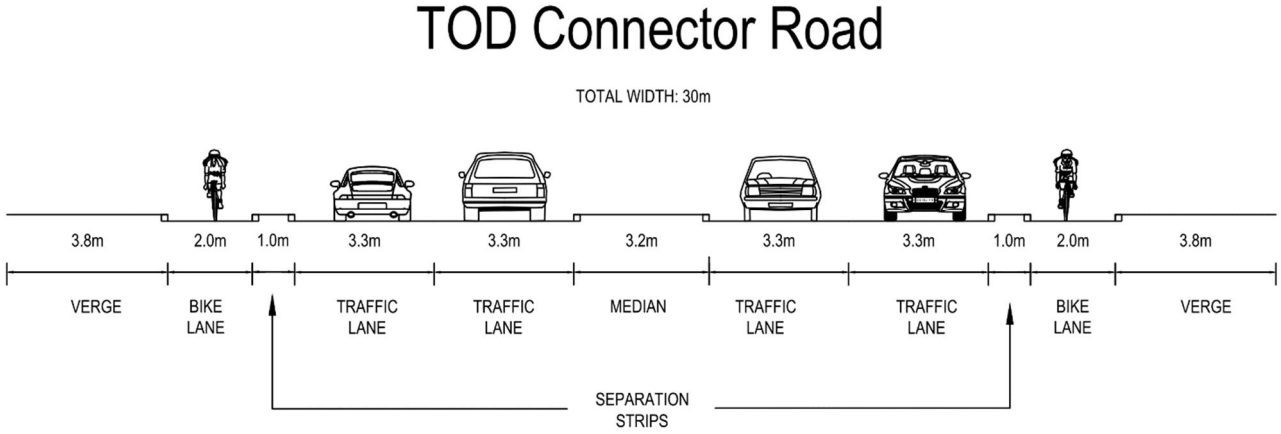


Figure 7-10 Recommended Cross Sections – TOD Connector Road



7.2.3.2 TOD Connector Road

TOD Connector Road is nominated as the Secondary Route connection between Forrestfield Station and the Roe Highway PSP for several reasons:

> It is the shortest link between the Forrestfield Train Station and the Roe Highway PSP.

> It will bisect the Forrestfield North Activity Centre and serve the adjacent higher density residential areas.

> It does not connect directly to Roe Highway and therefore will only carry local motorised traffic rather than through traffic (which will use Berkshire Road).

With construction of a bridge over Roe Highway, the route can link directly into the extension of the Foothills Spine Local Route, which is proposed run along Brewer Road Transmission Line easement into Forrestfield town centre, almost free from traffic. It will also provide a link to Darling Range Sports College, which is likely to be the local high school for Forrestfield North residents. As a Secondary Route, the recommended infrastructure type for TOD Connector Road is protected bicycle lanes. Indicative cross sections for TOD Connector Road are shown in **Figure 7-10**.

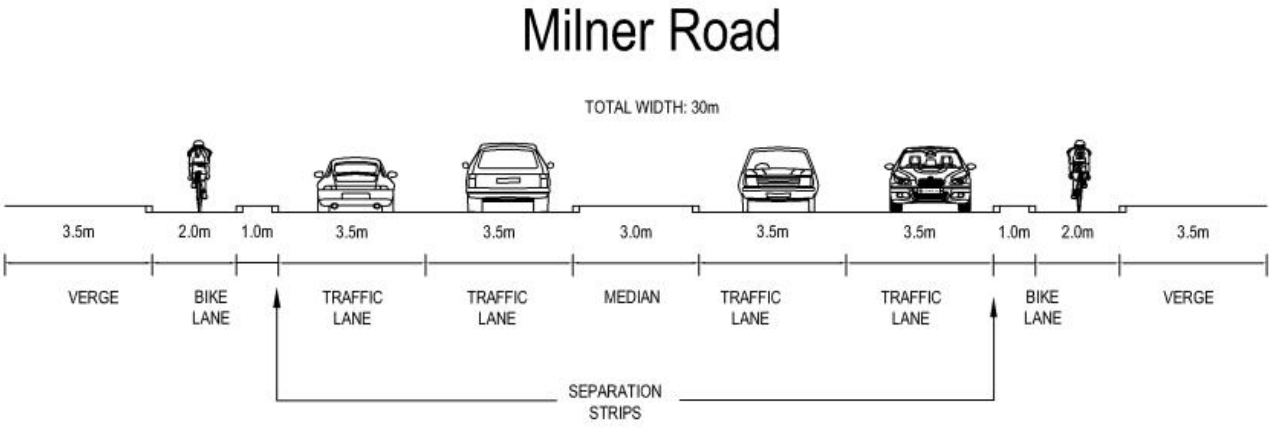
The TOD Connector Road connection across (but not to) Roe Highway will be critical to the success of this Secondary Route and critical to encouraging residents of Forrestfield to cycle to Forrestfield Station. Accordingly, the City should seek State Government funding support for construction of the bridge and approaches.

7.2.3.3 Milner Road

Milner Road does not connect directly to the Forrestfield Station but serves as a connection between the Maida Vale Road, Sultana Road and Berkshire Road corridors, serving the heart of the Forrestfield North Activity Centre. Due to the importance of this road as the only connection between Forrestfield North and Maida Vale Road, protected bicycle lanes should be provided as part of any future upgrading.

An indicative cross section for Milner Road is shown in **Figure 7-11**, based on the road reserve widths nominated in the District Structure Plan.

Figure 7-11 Recommended Cross Section – Milner Road



7.2.4 Lesmurdie to Maddington

In the future (beyond the life of this Bicycle Plan), the Hills Spine Secondary Route should be further developed to connect to Maddington, via Welshpool Road East, Crystal Brook Road and Kelvin Road. This would provide an entry to the hills area from the southern part of the metropolitan area and facilitate commuting to the growing employment centres in Maddington and Gosnells.

In the meantime, any upgrades to these roads should provide for the future Secondary Route, e.g. through the provision of sealed shoulders on Kelvin Road.

7.3 Local Routes

7.3.1 Foothills Spine (Wattle Grove – Forrestfield – Forrestfield North)

This route has been developed as a spine linking the Roe Highway PSP at Orrong Road with Wattle Grove, Forrestfield, and then to both to Roe Highway PSP and Forrestfield North via Sultana Road. It is intended to serve local demand through the suburbs of Wattle Grove and Forrestfield, as well as commuters from these suburbs accessing the wider cycling network. A future extension through the Maida Vale South urban expansion area is also proposed to provide a continuous link through to Maida Vale and the Kalamunda Road Secondary Route.

The overall route concept is shown in **Figure 7-12** and comprises the type of infrastructure that is suited to an '8 to 80' demographic – i.e. school students, parents, casual cyclists in order to maximise the potential uptake in cycling generated. The key elements of the route are as follows:

> New shared path along the northern side of **Welshpool Road East from Roe Highway to Hale Road** – this is the critical link from Wattle Grove to the Roe Highway PSP and the wider cycling network – refer to **Figure 7-14**.

> An upgrade to the existing shared path along **Hale Road**, including improvements to the crossings of Extensa Road, Sheffield Road and Lenihan Corner to remove the right-angle bends and path deviations. Priority crossings or potential raised threshold crossings should be considered for these locations.

> Through Wattle Grove, the route splits in two. The **western route** consists of a shared path parallel to The Promenade, serving Wattle Grove Primary School, then rejoining Hale Road at Tonkin Highway. The **eastern route** utilises the existing shared path through public open space parallel to Kalari Drive and Coyong Road, then continues via a new crossing of Tonkin Highway into Hartfield Park. Both routes combined again at the intersection of Hartfield Road and Sussex Road.

> **Sussex Road** was selected as the preferred route through Forrestfield as it serves Forrestfield Primary School and avoids the heavy traffic and constrained road reserve on Hale Road. A Safe Active Street treatment is proposed for this section. Extensive consultation will be required with the community to manage accessibility to the school for motorised traffic while still providing a safe environment for primary school-aged students to ride to school.

> From **Sussex Road to the Transmission Line Easement,** east of Strelitzia Avenue, there are two route options (see **Figure 7-13**). One option is to continue east along Sussex Road, Coburg Street and Holmes Road to near Mallow Way, where the route would transition into a shared path and cross Hale Road into the transmission line easement. The other option is to use Hanover Road (Safe Active Street) then run along an upgraded shared path on the southern side of Hale Road to Strelitzia Avenue. At Strelitzia Avenue the existing signalised intersection would facilitate crossing Hale Road, and the route would run as a shared path from Strelitzia Avenue along Woodlupine Brook to the transmission line easement. Only minor upgrades to the existing shared path in this section would be required.

> The preferred route then follows the **Transmission Line Easement** to Sultana Road East. Shared path branch connections would be provided to each of the local streets adjacent to the corridor. The route is envisaged to continue through Brewer Road and split in two at Ravenswood Road – one branch uses protected bicycle lanes along the TOD Connector Road to reach the Forrestfield North TOD and Forrestfield Station, the other branch largely follows Brewer Road to Maida Vale. The Maida Vale branch would be refined as part of the Structure Planning for this urban expansion area with a view to providing either a high-quality shared path through public open space or protected bicycle lanes.

Completion of the Foothills Spine would create a continuous, mostly traffic-free cycling route through Wattle Grove and Forrestfield, linking to both Forrestfield Station and Maida Vale. The Foothills Spine would serve as the main cycling route for Darling Range Sports College, as well as a local route for students attending Wattle Grove and Forrestfield Primary Schools, and commuters and shoppers accessing the Forrestfield town centre.

Figure 7-12 Wattle Grove – Forrestfield Spine

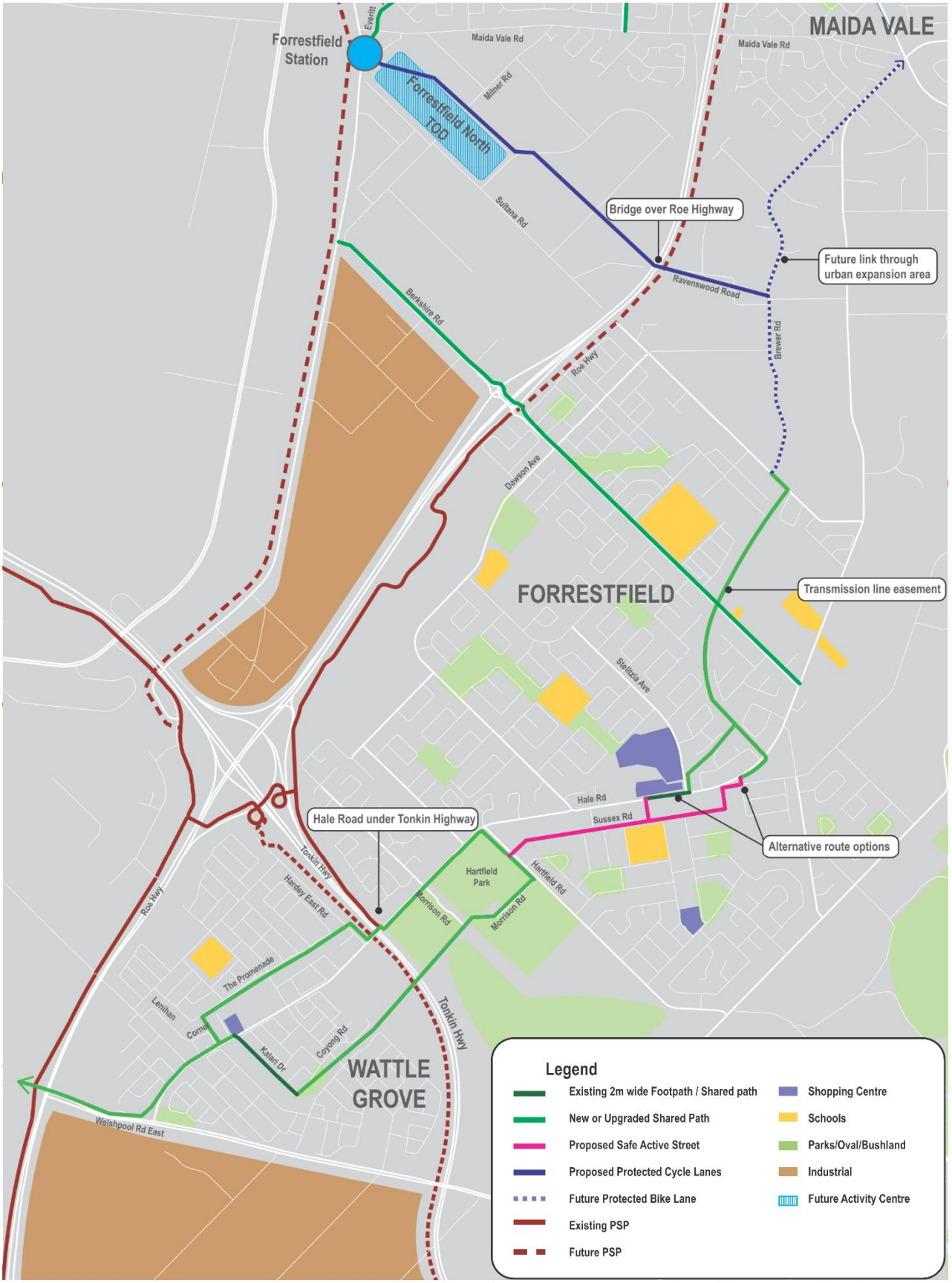


Figure 7-13 Sussex Road to Transmission Line Eastment Route Options

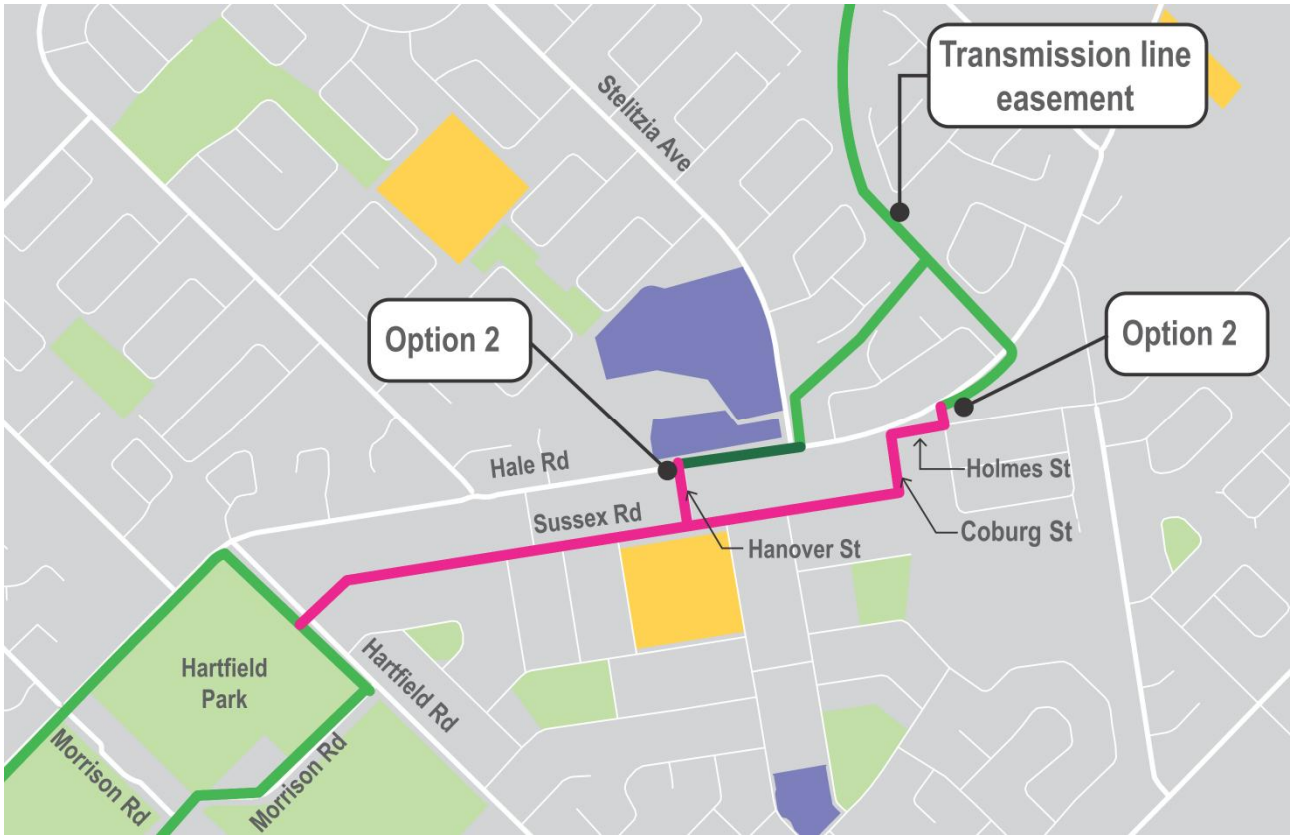
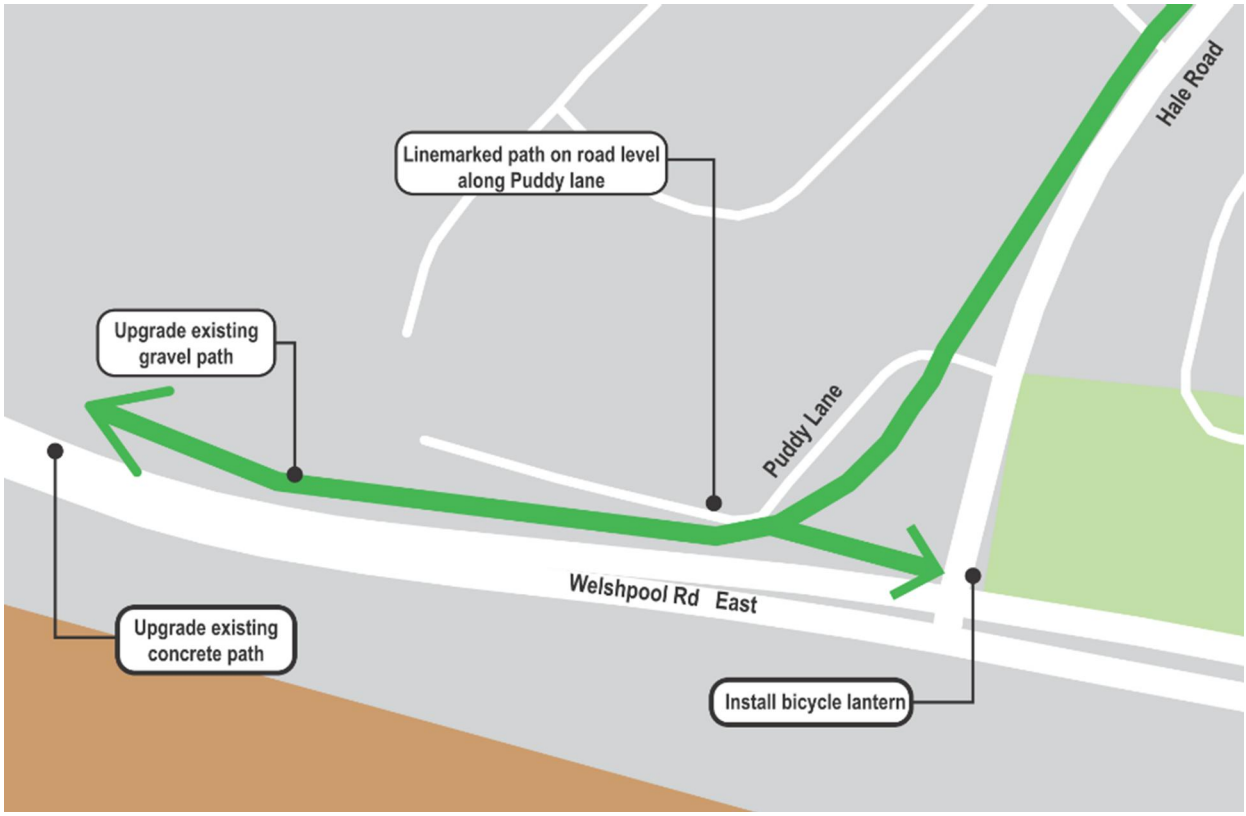


Figure 7-14 Foothills Spine – Welshpool Road East / Hale Road intersection



7.3.2 High Wycombe Local Route

The High Wycombe Local Route has been developed to link Forrestfield Station with its closest residential catchment, as well as serve the three primary schools located in the suburb – Edney, Matthew Gibney and High Wycombe. With the focus on school students and local commuters travelling short distances to the train station, the selected infrastructure types reflect low-speed mixed traffic cycling environments and/or path-based links. Cyclists that are more confident may elect to use the existing sealed shoulders on Newburn Road in preference to the Safe Active Streets.

As shown in **Figure 7-15**, the spine of the route follows Everitt Place, Palmer Crescent and Butcher Road to Newburn Road. North of Newburn Road, it is proposed to upgrade two Public Access Ways (PAWs) and a path through a small park to reach Kiandra Way. Kiandra Way would then be developed as a Safe Active Street to High Wycombe Primary School. From the end of Kiandra Way, the route follows Hamilton Road and Fernan Road, both of which would be developed as Safe Active Streets.

Three spurs along this route are proposed in order to serve the primary schools:

> **Matthew Gibney Catholic Primary School** – a continuation of the Hamilton Road Safe Active Street then an upgraded shared path connection to the school. Beyond the school, the path should connect to the future Freight Railway PSP to provide connectivity to the wider network.

> **High Wycombe Primary School** – an upgraded shared path link along Swan Road, connecting to the Edney Road shared path.

> **Edney Primary School** – a new shared path link via Norling and Newburn Roads, connecting to Maida Vale Road.

The highest priority section of this route is from Forrestfield Station to Kiandra Way, as this would serve the station's main residential catchment from opening day. Given its importance to the station and the FAL project, the City should seek State Government funding support for this first stage.

7.3.3 Berkshire and Dundas Roads

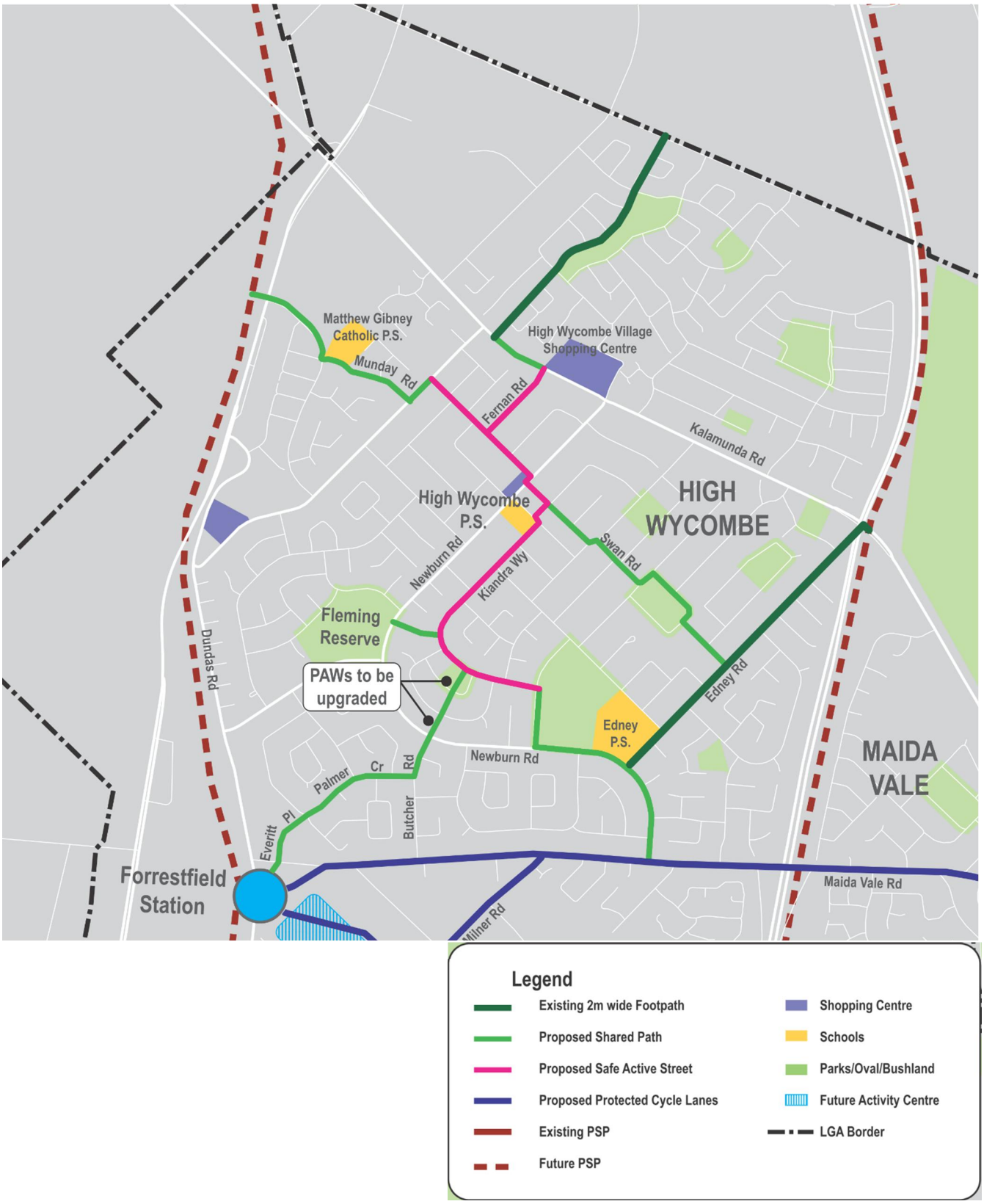
Berkshire Road connects the residential and industrial segments of Forrestfield, providing the only crossing of Roe Highway south of Maida Vale Road. MRWA has provided sealed shoulders and shared paths through the Roe Highway interchange as part of upgrade works, and there is a footpath along most of its length on the northern verge. At the western end, Berkshire Road intersects with Dundas Road, which is links into the Forrestfield Station.

Until the TOD Connector Road bridge can be constructed, indicatively within the next 20 years, and the Dundas Road PSP is built, Berkshire Road will be the only cycling connection between Forrestfield Station and the Forrestfield residential areas. Therefore, in the interim, a high quality shared path is proposed along Berkshire Road. The shared path is recommended to continue along Dundas Road until Forrestfield Station, given that the timeframe of the future Dundas Road PSP is not known. The shared path should be built close or within the completion timeframe of the Forrestfield Station. Alternatively, the City could advocate for the section of the future Dundas Road PSP from Berkshire Road to the Forrestfield Station be completed alongside the opening of the station.

Once TOD Connector Road bridge is completed, Berkshire Road will revert to being a community route for local connections to the proposed Dundas Road and Roe Highway PSP and to Darling Range Sports College.

In addition, it is recommended that any upgrade works on Berkshire Road include sealed shoulders in both directions, including a minimum 300mm painted buffer where practical.

Figure 7-15 High Wycombe Local Route



7.3.4 Hale / Hawtin Roads

Hale Road and Hawtin Road form a continuous connection between Wattle Grove, Forrestfield and Maida Vale. As there are limited available routes in this area, there is likely to be demand for using these roads by more confident cyclists who find the alternatives too slow and/or indirect. Accordingly, a minimum of 1.5m wide sealed shoulders should be provided continuously along this route as any upgrade works are undertaken. The use of roundabouts should also be minimised along this route to maximise safety for cyclists.

A continuous shared path along one side of this route should also be provided to cater for local cycling traffic – e.g. children riding to school.

7.3.5 Midland Road

Midland Road connects Maida Vale with Midland and the new Bushmead development in the City of Swan. The Roe Highway PSP will serve as the main connection between Maida Vale and Midland, however Midland Road will still attract some cycling demand from existing and future residential land uses in the area.

As per the Hale / Hawtin Road corridor, 1.5m wide sealed shoulders should be provided on the section within the City of Kalamunda. The City should also encourage the City of Swan to provide a similar level of infrastructure on their section of the road. A continuous shared path along one side of this route should also be provided to cater for local cycling traffic – e.g. children riding to school.

7.3.6 Lesmurdie Local Routes

The hilly terrain and irregular road network in the Lesmurdie area makes it difficult to identify and develop high-quality cycling links. The number of schools in this area justify the provision of shared paths to facilitate students riding to school and the more important of these links have been identified as Local Routes as shown in **Figure 7-16**.

> ***Lesmurdie Road*** – is the main north-south spine through Lesmurdie, serving Lesmurdie Senior High School, St Brigid's College and Falls Roads Primary School. There is a continuous shared path from Canning Road to Rootes Road but only narrow footpaths continuing to Welshpool Road East. In the medium to long term at least one of these paths will need widening to shared path standard to provide a function connection to Welshpool Road East.

> ***Kalamunda – Falls Road – Lesmurdie*** – This route follows Cotherstone Road, Betti Road, Orange Valley Road, Burma Road, Trafalgar Road, part of Grove Road, and Gladys Road, connecting the western residential areas of Kalamunda and Lesmurdie with schools and shops. There are several missing links in this route, including:

- ***Burma Road, Orange Valley Road to Connor Road*** – narrow footpath
- ***Trafalgar Road and Kimbarlee Way, Waterloo Crescent to Falls Road***– narrow footpath
- ***Grove Road, George Road to Gladys Road*** – missing section of shared path on north verge
- ***Gladys Road*** – narrow footpath

> ***Grove Road*** – this east-west link connects the Gladys Road, Lesmurdie Road and Canning Road routes as well as serving three schools.

7.3.7 Forrestfield to Lesmurdie

Following an extensive review of route options up and down the escarpment, a future Local Route has been nominated from Forrestfield to Lesmurdie via Hartfield Road and Welshpool Road East. This route is intended to provide a local commuter and utility cyclist connection between the hills and the foothills, as well as connecting to the wider cycling network via the Tonkin Highway PSP. Indicatively, the route would consist of:

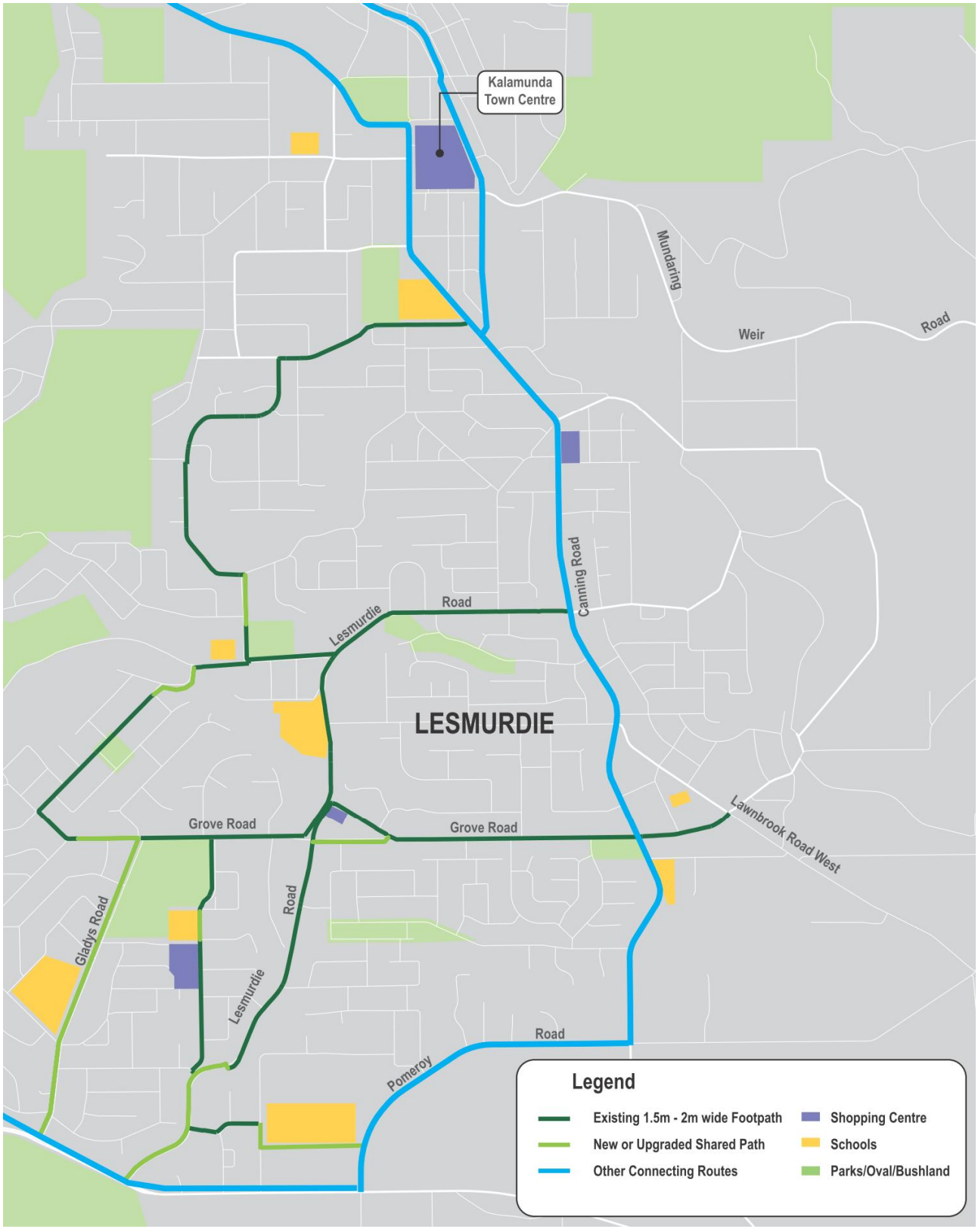
> A high-quality shared path along the southern verge of Hartfield Road from Morrison Road (junction with Foothills Spine Local Route) to Lewis Road;

> Improvements to the on-road environment along Hartfield Road from Lewis Road to Welshpool Road East to encourage low-speed mixed traffic cycling, with the potential for a shared path in the long term; and

> Construction of a shared path along the northern side of Welshpool Road East, from Hartfield Road to Lesmurdie Road.

The latter section will be an expensive, long-term project involving extensive cutting into rock and treatment of the cuttings to prevent loose rocks from falling onto the pathway. During the preparation of this Bicycle Plan, a number of existing walking and management trails within Mundy Regional Park were reviewed as possible alternatives to constructing a shared path on Welshpool Road East. Each trail that was reviewed was constrained by very steep grades, however it was noted that could be the potential to develop a 'zig zag type alignment to ease the grades. It is recommended that the City consult with the Parks and Wildlife Service (DPAW) to understand their attitude towards providing a shared path type facility through the park. If DPAW is favourable to the idea, more detailed investigations of grades and potential alignments should be undertaken with a view to identifying one or more feasible route options to compare against the cost and feasibility of constructing a shared path along Welshpool Road East.

Figure 7-16 Local Routes – Lesmurdie



Photograph 3 – Example of the steep grades encountered on existing trails in Mundy Regional Park



Photograph 4 – Challenging terrain on Welshpool Road East at Lesmurdie Hill



Source: Google Street View

7.4 Safe Active Streets

This Section outlines recommended Safe Active Street infrastructure that is not part of a Local Route discussed in **Section 7.3.**

As previously described in **Section 6**, Safe Active Streets are cycle routes on quiet local streets, where speeds have been reduced to 30 km/h to allow people in cars and on bikes to share the street safely. With lower traffic speeds, streets are also much safer for pedestrians and children, and additional tree planting and landscaping make them more attractive places to walk or ride. Safe Active Streets are designed to create safe and comfortable riding environments for bike riders with all levels of experience. People on bikes can ride closer to the middle of the lane, with cars passing only if there is enough space to do so safely.

Along the routes, bike symbols and red asphalt are typically used to mark out bike boulevards and suggest where bikes should ride. Various measures may be used to slow traffic, discourage through-travel by cars, and improve bike flow, including, for example:

> Single-lane slow points, where approaching vehicles should give way to any car or bike already at or passing through the slow point;

> Raised platforms at intersections;

> Narrowing carriageway widths by introducing on-street parking and plantings

The Safe Active Street program has successfully completed several pilot trials in Western Australia, with the first three projects completed in Bayswater, Belmont and Vincent in 2016 and 2017. With State Government support and funding, the program is continuing with planning and design underway for Safe Active Streets in other Local Government Areas including Bassendean, Kalgoorlie, Melville, Stirling and Victoria Park.

There several locations in the City that may be suitable for Safe Active Street development, either as part of a continuous local route or as a safe route to school. Some of these locations are outlined below.

7.4.1 Forrestfield

The locations of proposed Safe Active Streets in Forrestfield are shown in **Figure 7-17** and described below:

> ***Sussex Road*** forms part of the Wattle Grove to Forrestfield North Local Route discussed in **Section 7.3.1** and would also serve students attending Forrestfield Primary School.

> ***Hibiscus Drive and Pavetta Crescent*** form part of a connection from Forrestfield town centre to the Roe Highway PSP near Berkshire Road, utilising existing Public Open Space corridors and an existing shared path on Dawson Avenue. This route serves Woodlupine and Dawson Park Primary Schools, as well as connecting residents to the PSP.

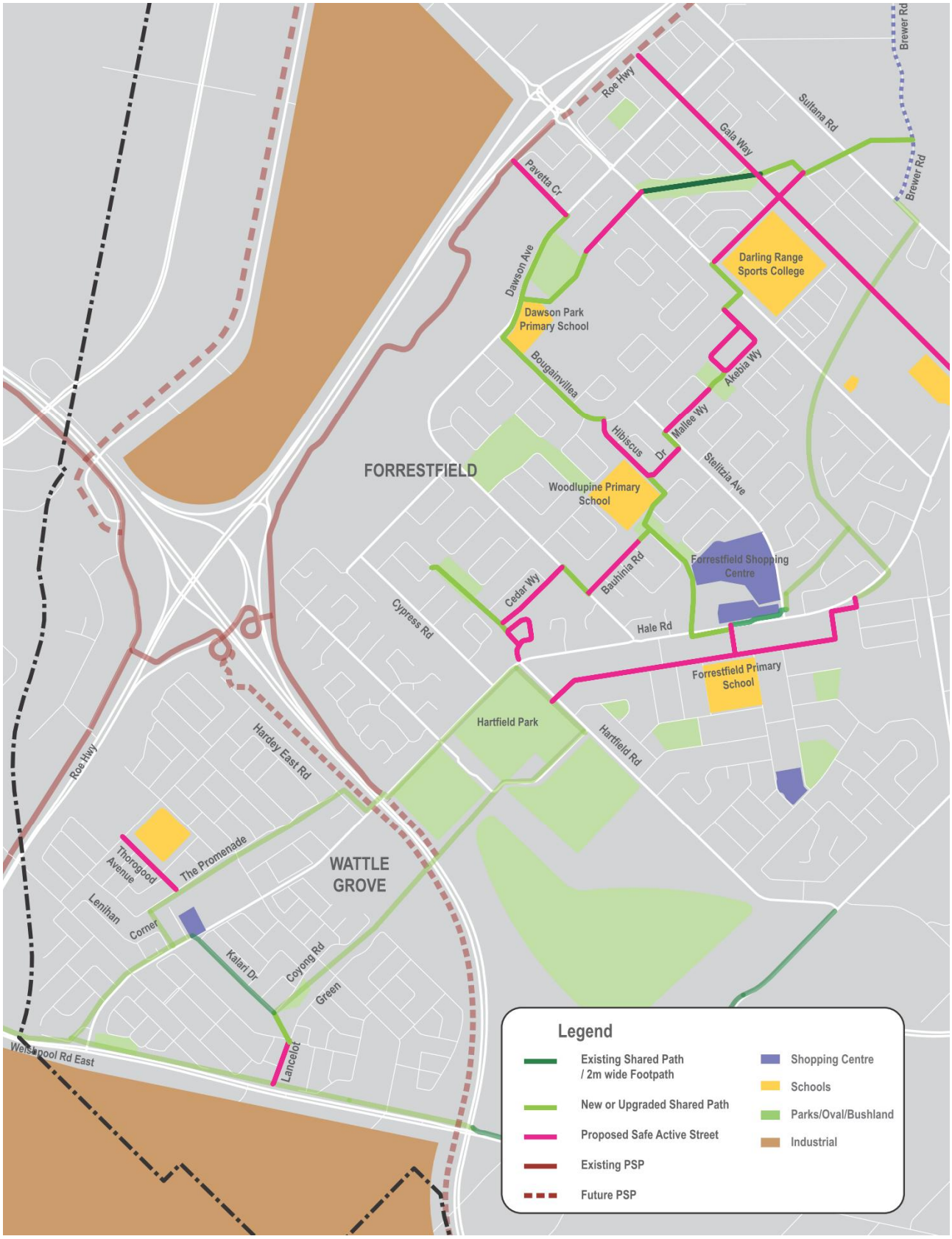
> ***Peach Tree Way, Cedar Way and Bauhinia Road*** form a connection from Hartfield Park and Cypress Road through to Woodlupine Primary School. This link would be a combination of Safe Active Streets and shared path links through Public Open Space. A safer crossing of Hale Road to access Hartfield Park would be required to complete the route.

> ***Hibiscus Drive, Mallee Way and Akebia Way*** form a connection between Woodlupine Primary School and Berkshire Road, utilising the existing school crossing on Strelitzia Avenue. This route would also serve local students riding to Darling Range Sports College.

> ***Ilex Way*** as part of continuous route between Dawson Park Primary School and Brewer Road. The Safe Active Street would link to shared paths through Public Open Space at each end of Ilex Way.

> ***Gala Way,*** once completed, would form a continuous link for the residential area between Sultana and Berkshire Roads that stretch from Roe Highway to Hawtin Road. The Safe Active Street, can link into the transmission line as well as the future Roe Highway PSP extension. This Safe Active Street is proposed to be constructed along with the residential area (known as the Hales Estate) and to be funded under the Developer Contribution Plan.

Figure 7-17 Safe Active Streets – Forrestfield and Wattle Grove



7.4.2 Wattle Grove

Two potential Safe Active Streets in Wattle Grove are shown in **Figure 7-17:**

> ***Thorogood Avenue*** would form a key active transport corridor accessing Wattle Grove Primary School, linking into the extensive existing and proposed shared path networks through the open space corridors. Combined with these shared paths, parents would be able to ride with their children to the school from most parts of Wattle Grove with minimal interaction with traffic.

> ***Lancelot Green*** would form a link between the main Public Open Space corridor and the future signalised intersection of Welshpool Road East / Coldwell Road. This would provide access to the Maddington-Kenwick Strategic Industrial Area as well as the main shared path along Welshpool Road East.

Photograph 5 – Safe Active Street Example – May Street, Bayswater



Source: Department of Transport

7.4.3 Kalamunda

Opportunities for Safe Active Streets in the hills are limited due to the hilly terrain and impermeable road network. Potential Safe Active Streets locations are shown in **Figure 7-18**:

> ***Williams Street / Lascelles Parade*** – this section from Hill Street to the top of Zig Zag forms part of the Midland – Kalamunda – Lesmurdie Secondary Route. Due to the terrain, a Safe Active Street type treatment is preferred.

> ***Headingly Street*** – a potential route option for the Midland – Kalamunda – Lesmurdie Secondary Route, connecting the Railway Heritage Trail to the proposed Canning Road protected bicycle lanes.

> ***Central Road / Central Mall*** – – a potential route option for the Midland – Kalamunda – Lesmurdie Secondary Route, providing a link between the Railway Heritage Trail, Kalamunda State High School, and Canning Road corridor. Careful design would be required for the section through the mall.

> ***Lindsay Street / Boonooloo Road / McRae Road*** – this north-south link would connect the Midland – Kalamunda – Lesmurdie Secondary Route with Kalamunda Primary School and Kalamunda State High School, linking to the residential catchment west of the town centre. A preliminary review of this route indicates that the grades may be prohibitive, however further investigation is warranted.

Figure 7-18 Safe Active Streets – Kalamunda



7.5 Other Shared Paths

In addition to the nominated Secondary Routes, Local Routes and Safe Active Streets outlined in the preceding sections of this report there are many other missing links in the City's shared path network. While these missing links may not form part of major continuous cycling routes they can be the difference between encouraging a parent to ride to school with their child or take up cycling as part of a more active lifestyle.

A review of missing links within the City has been undertaken and the sections listed in **Table 7-2** have been identified for future shared path funding. These links are considered to be a lower priority than the links to Forrestfield Station and the Safe Active Streets program.

Table 7-2 Shared Path Expansion Program

Suburb	Street	From	To	Comments
Bickley	First Ave	Nairn Rd	Lawnbrook Rd E	Serves Carmel Adventist College (Primary), replacing narrow footpath.
Gooseberry Hill	Ledger Rd	Huntley St	Aboyne Rd	Serves Gooseberry Hill Primary School, replacing narrow footpath in front of school.
Kalamunda	Burma Rd	Connor Rd	Orange Valley Rd	Serves Falls Road Primary School, replacing narrow footpath.
Lesmurdie	Albert Rd	Reid Rd	Arthur Rd	Serves Lesmurdie Senior High School, replacing narrow footpath.
Lesmurdie	Gladys Rd	Welshpool Rd E	Grove Rd	Serves Mazenod College and Lesmurdie Primary School, replacing narrow footpaths.
Lesmurdie	Grove Rd	George Rd	Chislehurst Rd	Missing link in a continuous shared path route.
Lesmurdie	Lesmurdie Rd	Welshpool Rd E	Rootes Rd	Missing link in a continuous shared path route, replacing a narrow footpath.
Lesmurdie	Reid Rd	Albert Rd	Pomeroy Rd	Serves Lesmurdie Senior High School, replacing narrow footpath.
Lesmurdie	Sanderson Rd	Wiloughby Rd	Gilroy Rd	Serves Lesmurdie Primary School, replacing narrow footpath in front of school.
Lesmurdie	Trafalgar Road - Kimbarlee Way	Waterloo Cres	Falls Road	Serves Falls Road Primary School, replacing narrow footpath.

7.6 Training Routes

7.6.1 Background

The City of Kalamunda is a premium destination for recreational / training riders; both for single riders and for group / club rides. These types of riders are attracted to relatively low traffic volumes, uncongested riding environments, scenery and the hills, which suit the desired training patterns.

These riders generally do not require dedicated or protected infrastructure and are satisfied to ride in low levels of mixed traffic; most of the perception of safety or congested comes from frustrated motorists who are not able to easily and safely overtake cyclists on many sections of the rural and semi-rural road network.

Accordingly, the recommended strategy for the training routes is to manage the conflicts between cyclists and motorised traffic, mainly through signage and other behavioural strategies, while also implementing certain minor infrastructure improvements where warranted and feasible. The nominated projects provide benefits to both cyclists and other road users – drivers will be able to more easily overtake in a safe manner, reducing delays and frustrations and correspondingly improving safety for riders.

The following sections outline the recommended actions for the key training routes.

7.6.2 Welshpool Road East

Welshpool Road East is the primary access point for training riders entering the City; however, it is also the Restricted Access Vehicle (RAV) route to/from the Brookton Highway, which is major grain haulage corridor to the CBH Metro Grain Centre at Forrestfield and the ports at Kwinana. As a result, there is a mix of local commuter traffic, cyclists and road trains using the route – this leads to conflicts in certain sections and at certain times of day.

> From **Tonkin Highway to Lesmurdie Road** – the route is a four-lane divided road with 70-80km/h speed zones and a very steep climb up the Darling Range. The second lane in each direction allows drivers to easily overtake cyclists in each direction. Additional signage to provide advance warning to drivers is recommended – e.g. ‘Steep Climb Ahead – Watch for Slow-Moving Cyclists’ or ‘Cyclists Ahead – Change Lanes to Overtake’.

> The **Lesmurdie Road intersection** is the location of nearly 25% of bicycle crashes in the entire City, most of which are ‘through-right’ crashes where a driver exiting Lesmurdie Road collides with a cyclist continuing east on Welshpool Road East. Works were undertaken in 2014/15 to address the crash problem however these works have not been effective as a further 5 crashes were reported in the 21 months between the completion of works and the end of the reporting period (April 2015-December 2016). Further works are recommended as shown in **Figure 7-19**. These works may be eligible for Black Spot funding given the crash record at this location.

> From **Lesmurdie to Canning Road** the route is a single lane in each direction with several short, steep sections in a rural-type cross-section. Many cyclists turn off the route onto Pomeroy Road, while others continue to Canning Road and on to Pickering Brook. On this section the main issue is the speed differential between slow-moving uphill cyclists and light vehicles travelling at 70km/h+, with very few opportunities for safe passing. Downhill cyclists are less of a perceived issue, as travel speeds are generally higher.

In the long term it is recommended that Welshpool Road East be widened to provide 2.0m wide sealed shoulders – or an additional traffic lane – in each direction. This would have significant benefits for road users on this route, allowing easy overtaking of slow-moving cyclists, heavy vehicles and other traffic.

Figure 7-19 Lesmurdie Road Intersection – Recommended Improvements



In the short-to-medium term, it is recommended that widening of targeted sections be undertaken, in order to reduce the conflicts between slow moving and fast moving traffic and create a 'release valve' where drivers can safely overtake. On Welshpool Road East, the recommended sections are:

1. Eastbound – Lesmurdie Road (SLK 4.96) to Albert Road (SLK 5.62) – length 600m
2. Eastbound – SLK 6.52 to SLK 6.79 – length 270m
3. Eastbound – Tanner Road (SLK 7.11) to SLK 7.50 – length 400m

The recommended width of shoulders on these sections is 2.0m, which is sufficient for a group riding 2-abreast to ride completely out of the general traffic lane and maximise the safe overtaking opportunities. In some locations, it may be prohibitively expensive to achieve full width shoulders and therefore a reduced width of at least 1.5m could be considered. Shoulder widths below 1.5m are not likely to be effective and may have a negative road safety outcome by encouraging drivers to overtake when not safe to do so.

7.6.3 Canning Road (south of Pomeroy Road)

Canning Road, south of Pomeroy Road, is a two-lane typical rural type road. It is constructed to older design standards with no sealed shoulders and with many crests and curves which makes the safe overtaking of cyclists difficult in many locations. Power poles are located close to the road along most of the length of this road which makes sealing of shoulders and widening of the carriageway difficult in many locations.

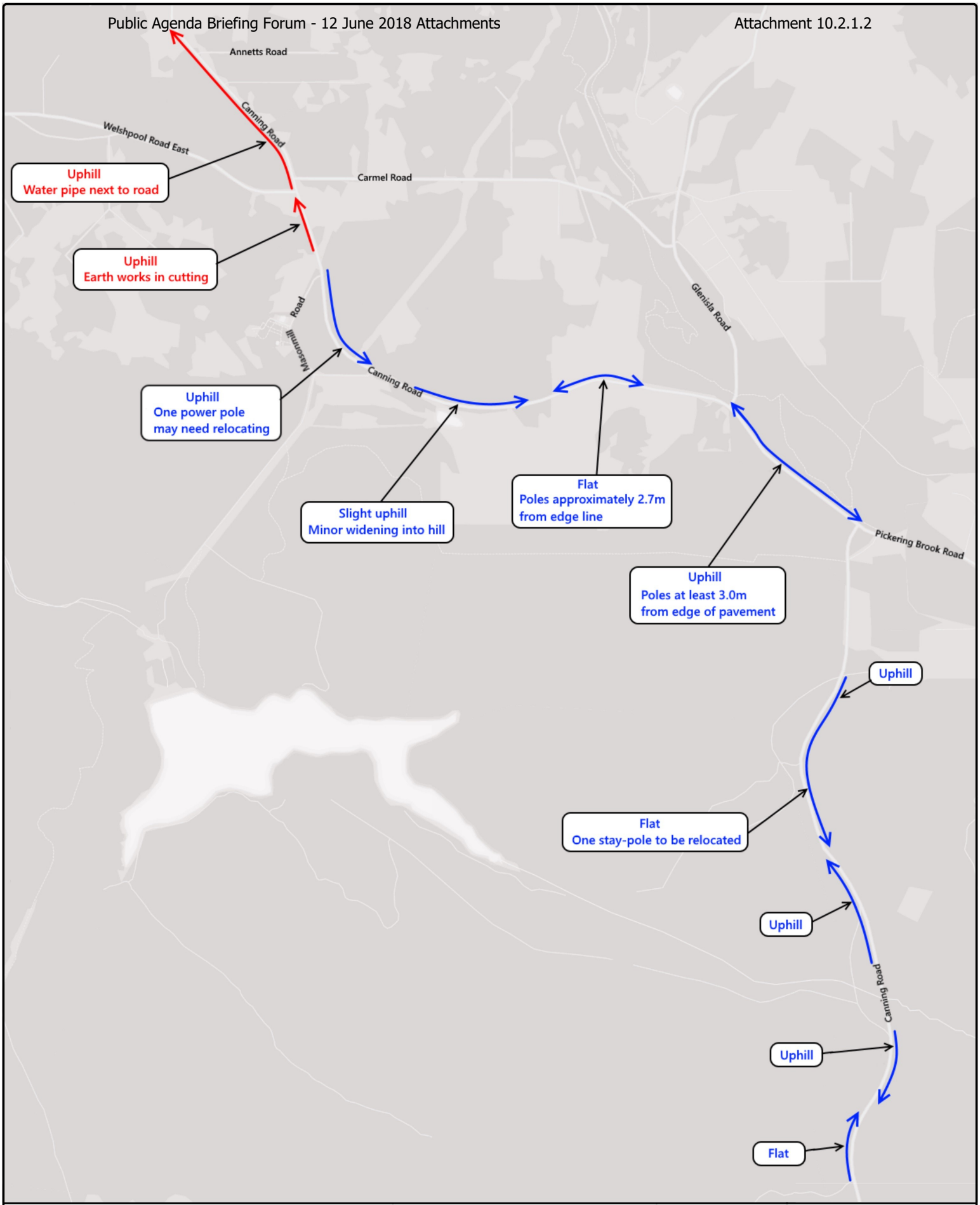
Canning Road is heavily used by training cyclists along its full length. The section between Welshpool Road East and Pickering Brook Road provides access to the training routes in the Pickering Brook area. The section south of Pickering Brook Road provides access to other popular training routes such as Canning Mills Road and the Canning Dam area. Sections of Canning Road have been identified by the public as high-risk areas as a result of the combination of steep grades, restricted visibility, vehicle speeds and heavy haulage.

In the long term, it is recommended that Canning Road be widened to provide 2.0m sealed shoulders in each direction between Welshpool Road East and the City Boundary. Due to the earthworks required and the cost of relocating power poles, this is likely to be an expensive project requiring State or Federal Government funding support given the strategic importance of Canning Road as a heavy vehicle route.

In the short term, a Road Safety Audit should be undertaken to identify the level of risk and assist the City in applying for State and Federal funding assistance. The Audit should identify the highest risk locations and present recommendations for staged improvements to the level of road safety along the corridor.

In the short-to-medium term, it is recommended that widening of targeted section be undertaken in order to reduce the conflicts between slow moving and fast moving traffic and create a 'release valve' where drivers can safely overtake. A preliminary review of Canning Road identified that widening was desirable, and could be undertaken at relatively low cost, at the locations shown in **Figure 7-20**. More detailed investigations would need to be undertaken to determine the feasibility and priority of widening at these locations.

Also shown on **Figure 7-20** is the long uphill climb from Welshpool Road East northbound towards Kalamunda. This section has a large water supply pipeline located very close to the edge of the road on the western side and a narrow road reserve; detailed investigations of this section should also be carried out to determine the feasibility of future widening.



Legend

High difficulty or cost

Low difficulty or cost

(Shoulder widening in the direction shown by the arrow)

Figure 7-20

Canning Road
Preliminary Widening Locations

7.6.4 Mundaring Weir Road

Mundaring Weir Road is a popular training route as part of a loop through Greenmount, Darlington, Mundaring and Kalamunda. It is also a very popular route for recreational driving and motorcycle riding and there has been some public frustration expressed at the conflicts between the various user groups in recent years.

Mundaring Weir Road does not serve any significant commuter function, nor does it carry any appreciable volume of heavy vehicle traffic – it is essentially a tourist and local access route as well as access to many Mountain Bike Trails Hub in the hills. Traffic data sourced from MRWA shows that Mundaring Weir Road carries in the order of 1,500 vehicles per day (vpd) with 7% being heavy vehicles (approximately 100 vpd). Therefore, targeted widening of the route to the same standards recommended for Welshpool Road East and Canning Road cannot be justified based on the volume and type of traffic currently using the route, however there is still a need for some targeted improvements to be undertaken to address higher risk sections of the road.

There are a number of steep and winding sections which are popular with riders, including the climb from Aldersyde Road to Kalamunda and from Aldersyde Road eastbound towards Mundaring. Both of these sections are located in sideling country and would be very expensive to widen to provide significant additional pavement width. The current 60km/h speed limit is appropriate for the winding alignment and slow-moving traffic.

During the community consultation, the key issues raised by existing cyclists included:

> Near misses with drivers overtaking on uphill sections

> Edge of seal in poor condition so cyclists ride further to the centre of the lane than desirable

> A desire for additional warning and behavioural signage such as ‘Shared the Road’ messages.

The recommended strategy for Mundaring Weir Road is three-fold:

> Undertake a Road Safety Audit to identify high risk areas and to inform the scope of the widening.

> Identify flat and straight sections of the road where widening of the seal could be achieved, to increase the safety of overtaking manoeuvres.

> Develop a comprehensive warning and behaviour signage program, targeting the narrow, steep and winding sections of the road where drivers should expect to encounter slow-moving cyclists. The signs could include messages to expect slow-moving cyclists (including activated warning signs) or information as to how far away the next safe passing opportunity is.

7.6.5 Signage and Behavioural Strategies

Behavioural strategies will be critical to the ongoing management of competing road user groups in the hills. The focus should be on informing road users to expect to see cyclists, particularly on the popular training routes, and encourage safe and courteous behaviour from all road users.

The recommended strategy contains a number of elements, including:

1. ‘Entry Statement’ or ‘Welcome’ signage at key entrance points to the training routes, clearly informing road users that they are entering a road network which is shared between multiple user groups, each with the right to use the road safely. Such signage could incorporate either ‘City of Kalamunda’ or ‘Perth Hills’ tourism branding, to clearly link the road safety message with the other information given to tourists. An example of such a sign is shown on **Figure 7-21**, based on similar signage entering the Ferguson Valley in the Shire of Dardanup or **Figure 7-22** for an example of a ‘Welcome’ sign at a local level.

2. Local ‘Gateway’ warning signage at locations where road users enter a designated training route, such as the example shown in **Figure 7-23**. This type of signage is a reminder to road users to anticipate training riders on the road ahead. It should be used on the more lightly trafficked training routes such as in the Bickley Valley and Pickering Brook areas.

3. ‘Behavioural’ signage located at regular intervals along the busier training routes – i.e. Welshpool Road East, Canning Road and Mundaring Weir Road. Some examples of behavioural signage is

shown in **Figure 7-24** and **Figure 7-25**. The purpose of these signs is to encourage safe overtaking manoeuvres and these could be accompanied by supplementary plates that indicate the distance to the next safe passing place – i.e. the widened shoulders sections recommended in **Sections 7.6.2 and 7.6.3**.

4. Warning signs, including activated (via sensors that are triggered by a passing cyclists) warning signs, placed on targeted locations where significant speed differentials can be expected, or there are sight distance restrictions, and insufficient room for drivers to safely overtake in typical conditions. Some examples of these signs are shown in **Figure 7-26**, **Figure 7-27**, and **Figure 7-28**.

A Strategy Plan, incorporating indicative locations for the above sign types, is presented in **Figure 7-29**. This should form the basis of discussions with Main Roads as the approval authority for signs and lines.

Figure 7-21 Possible 'Entry Statement' signage style



Figure 7-22 Example of a Locality Sign

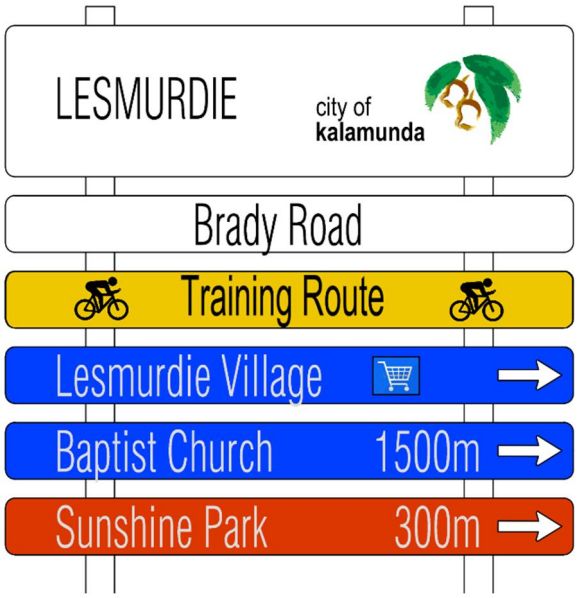


Figure 7-23 Example of Informative Warning Signage – Queensland



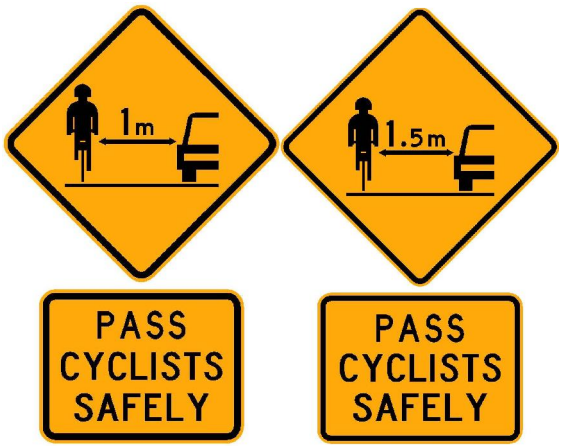
Source: www.glasshouse-mountains.com

Figure 7-24 Example of behavioural signage – Kansas, USA



Source: Kansas Cyclist

Figure 7-25 Example of behavioural signage – Tasmania



Source: Department of State Growth | Transport

Figure 7-26 Examples of activated warning signs - Queensland



Source: TMR Technical Note 137 Bicycle Activated Warning Signs, March 2015

Figure 7-27 Examples of activated warning sign – Victoria



Source: Amy Gillett Foundation

Figure 7-28 Examples of activated warning sign – Cootamundra NSW



Source: Cootamundra Herald

FORRESTFIELD NORTH

FORRESTFIELD

WATTLE GROVE

KALAMUNDA

LESMURDIE

BICKLEY

PICKERING BROOK

MUNDARING WEIR

LESMURDIE HILL

CLIMB FROM MUNDARING WEIR FOR 2.5KM

CLIMBS FROM ALDERSYDE ROAD TOWARDS KALAMUNDA AND MUNDARING

STEEP PINCH AND CORNER

POOR SIGHT DISTANCE, CURVES AND CRESTS

Sign Types

ES	Entry Statement	Primary Routes	
GW	Gateway	Secondary Routes	
B	Behavioural	Training Routes	
AW	Activated Warning		

DATE PLOTTED: 11 April 2018 11:17 AM BY : RAYMOND RACHMAT
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CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 7-29

PRELIMINARY TRAINING ROUTE SIGNAGE AND BEHAVIOURAL STRATEGY

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-TS (Drawing Number)

C (Revision)

7.6.6 Safe Passing Distance Law Review

The State Government has recently implemented a minimum passing distance law that requires a driver of a motor vehicle, when passing a bicycle travelling in the same direction, to do so at a safe distance, being:

> 1 metre on roads where the posted speed limit is 60 km/h or less;

> 1.5 metres on roads where the posted speed limit is more than 60km/h.

The law also allows drivers to cross centre line markings including single and double white lines, as well as painted medians, to overtake cyclists when safe to do so.

Community feedback has indicated that the new law may have changed driver behaviour and potentially increased the level of risk at some locations on some trainings. It is recommended that the City undertake a review of the Safe Passing Distance Law relative to the Training Routes and identify any high-risk locations and remedial measures. This review should include consultation with road users, including cyclists.

7.7 Schools Analysis

Schoolchildren are a key element of the 'Interested but Concerned' cycling demographic and a key target market for any Bicycle Plan. It well documented that if schoolchildren can develop a habit of cycling to school they are more likely to continue cycling into adulthood even after obtaining a driving licence.

To ensure the Bicycle Plan targets this demographic, the schools within the City have been analysed to identify gaps in the existing path network that may be barriers to children cycling to school. In addition, schools have been identified as key traffic generators for the Local Routes developed in the foothills portion of the City. A distinction has been made in the network planning process between local intake schools whose students generally live within easy cycling distance and semi-rural communities and specialist schools where a much higher proportion of students travel long distances to school. High schools have also been prioritised over primary schools as students of high school age are more likely to be travelling to school alone and their parents are generally more comfortable letting them ride to school if the infrastructure is suitable.

Table 7-3 presents a summary of the issues identified for each school and the components of the network plan that serve each school. It should be noted that very few responses to the surveys were received from the schools and/or school students. The City should consider a targeted consultation strategy in the future to encourage a greater interest in the Bicycle Plan from these important stakeholders.

Table 7-3 Schools Analysis – Summary

Suburb	School	Issues	Proposals
Bickley	Carmel Adventist College (Primary)	Independent specialised school with a wide student catchment.	Widen existing footpath on First Avenue to shared path standards.
Carmel	Carmel Adventist College (Secondary)	Independent specialised school with a wide student catchment.	Maintain existing path links.
Forrestfield	Darling Range Sports College	Lack of safe and convenient cycling routes through Forrestfield, connecting to the school. No cycling infrastructure connecting school to Maida Vale and High Wycombe residential areas.	Foothills Spine Local Route, with future extension through Maida Vale South urban expansion area. Sultana Road Secondary Route to connect residents of Forrestfield North with the school.
	Dawson Park Primary School	Low quality footpaths and shared paths	Forrestfield Safe Active Streets
	Forrestfield Primary School	Low quality footpaths and shared paths	Forrestfield Safe Active Streets
	Hill Side Christian College	Independent specialised school with a wide student catchment.	Foothills Spine Local Route, with future extension through Maida Vale South urban expansion area. Sultana Road Secondary Route
	Woodlupine Primary School	Low quality footpaths and shared paths	Forrestfield Safe Active Streets with path connections through public open space.
Gooseberry Hill	Gooseberry Hill Primary School	Low quality footpaths and shared paths.	New shared path along Ledger Road to replace existing narrow footpath in front of school.
	Mary's Mount Primary School	Low quality footpaths and shared paths.	Maintain and improve existing path links.
High Wycombe	Edney Primary School	Low quality footpaths and shared paths.	Safe Active Street along Kiandra Way and path connection to school as part of High Wycombe Local Route.
	High Wycombe Primary School	Low quality footpaths and shared paths.	Safe Active Street along Kiandra Way and Hamilton Road, plus improved path link along Swan Road as part of High Wycombe Local Route.
	Mathew Gibney Primary School	Low quality footpaths and shared paths.	Safe Active Street along Hamilton Road with improved shared path link along Munday Road as part of High Wycombe Local Route.
Kalamunda	Kalamunda Primary School	Low quality footpaths and shared paths.	Safe Active Street along Boonooloo Road.
	Kalamunda Senior High School	Low quality footpaths and shared paths.	Canning Road buffered cycle lanes as part of the Hills Spine Secondary Route. Central Road/Central Mall Safe Active Street

Suburb	School	Issues	Proposals
Lesmurdie	Falls Road Primary School	Low quality footpaths and shared paths. Missing link in continuous shared path route along Trafalgar Road. Some quiet streets missing footpaths	Construct missing link in shared path on Trafalgar Road. Construct missing link in shared path on Burma Road.
	Lesmurdie Primary School	Low quality footpaths and shared paths.	Replace narrow footpath in front of school with a shared path. Construct shared path along Gladys Road to replace narrow footpaths.
	Lesmurdie Senior High School	Low quality footpaths and shared paths.	Canning Road buffered bicycle lanes. Reid Road shared path to replace narrow footpath.
	Mazenod College	Independent specialised school with a wide student catchment.	Construct shared path along Gladys Road to replace narrow footpaths.
	St Brigid's College	Independent specialised school with a wide student catchment.	Maintain existing path links.
Maida Vale	Maida Vale Primary School	Low quality footpaths and shared paths.	Maintain existing path links.
Pickering Brook	Pickering Brook Primary School	Semi-rural school with a wide catchment and low population density.	Maintain and improve existing path links
Walliston	Kalamunda Christian School	Independent specialised school with a wide student catchment.	Canning Road buffered cycle lanes as part of the Hills Spine Secondary Route.
	Walliston Primary School	Low quality footpaths and shared paths.	Maintain and improve existing path links.
Wattle Grove	Wattle Grove Primary School	Low quality footpaths and shared paths Disconnected path network due to development of suburb not yet being completed	Thorogood Avenue Safe Active Street Connected path network as part of Foothills Spine Local Route

8 Infrastructure Upgrade Implementation Plan

8.1 Network Plan

The recommended Infrastructure Upgrades, as summarised in the Schedule of Works, are illustrated alongside the existing cycling infrastructure on **Figures 8-1 to 8-5**.

8.2 Schedule of Works

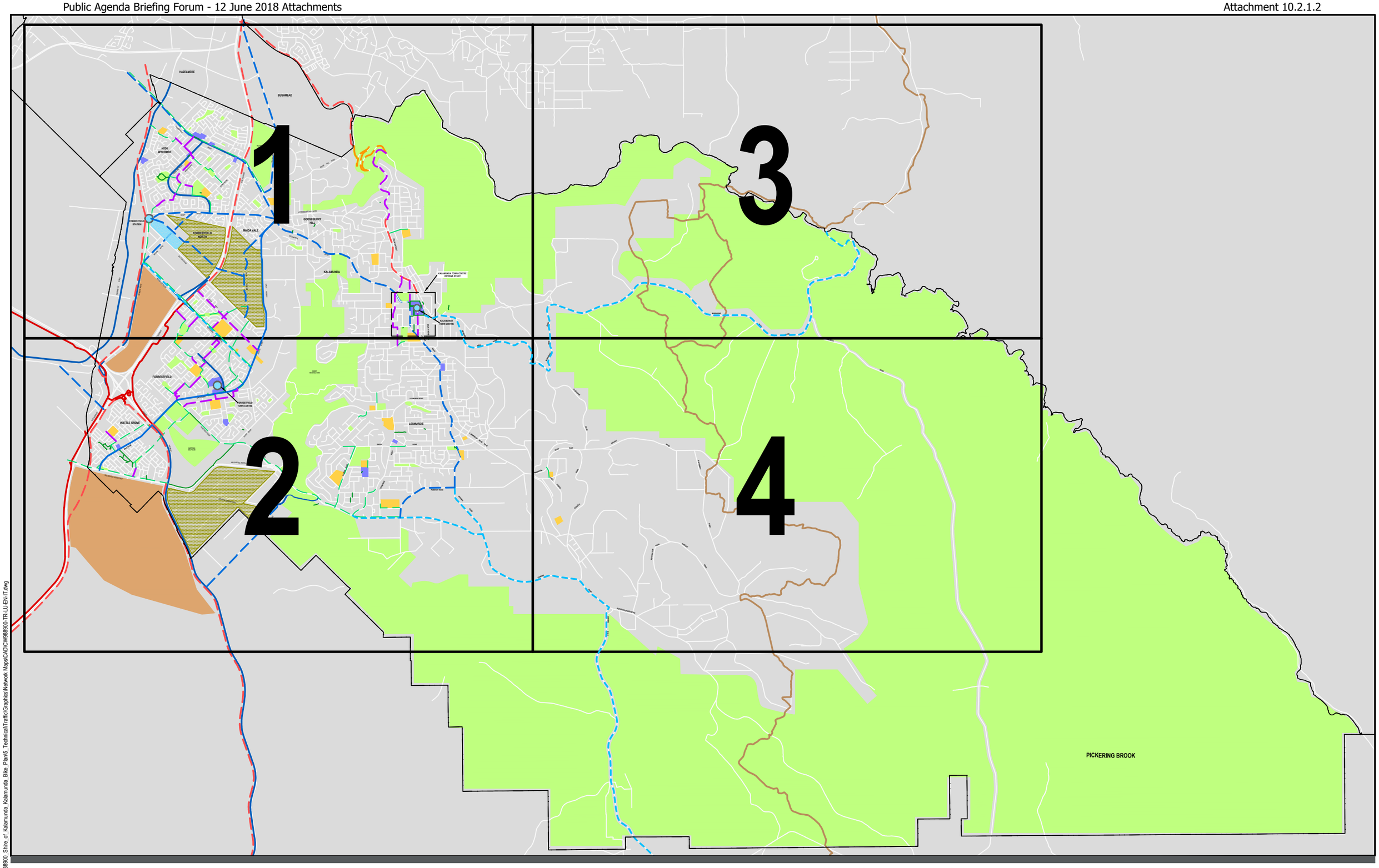
A Schedule of Works has been prepared for two budgeting scenarios: $500,000 per annum and $1,000,000 per annum; and the breakdown of proposed annual spending is shown in **Table 8-1** and **Table 8-2** for the $500,000 per annum and $1,000,000 per annum scenarios respectively. A full Schedule of Works and Maps illustrating the timing for both scenarios are provided in **Appendix C** and **Appendix D.** It should be noted that these estimates are preliminary in nature and will need to be verified after all the required works have been identified following the detailed design phase.

Table 8-1 Cost Allocations based on Indicative Timing - $500,000 per year

Period	Indicative Costs		
	City Funded	Potential External Funding	Total Cost
0-5 years	$2,710,000	$8,655,000	$11,365,000
5-10 years	$2,620,000	$7,660,000	$10,280,000
10-15 years	$2,688,000	$4,467,000	$7,155,000
15-20 years	$2,720,000	$3,085,000	$5,805,000
Beyond 20 years	$13,805,000	$1,030,000	$14,835,000

Table 8-2 Cost Allocations based on Indicative Timing - $1,000,000 per year

Period	Indicative Costs		
	City Funded	Potential External Funding	Total Cost
0-5 years	$4,900,000	$8,805,000	$13,705,000
5-10 years	$5,023,000	$8,392,000	$13,415,000
10-15 years	$5,065,000	$5,355,000	$10,420,000
15-20 years	$5,000,000	$2,210,000	$7,210,000
Beyond 20 years	$4,690,000	$-	$4,690,000



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CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 8-1

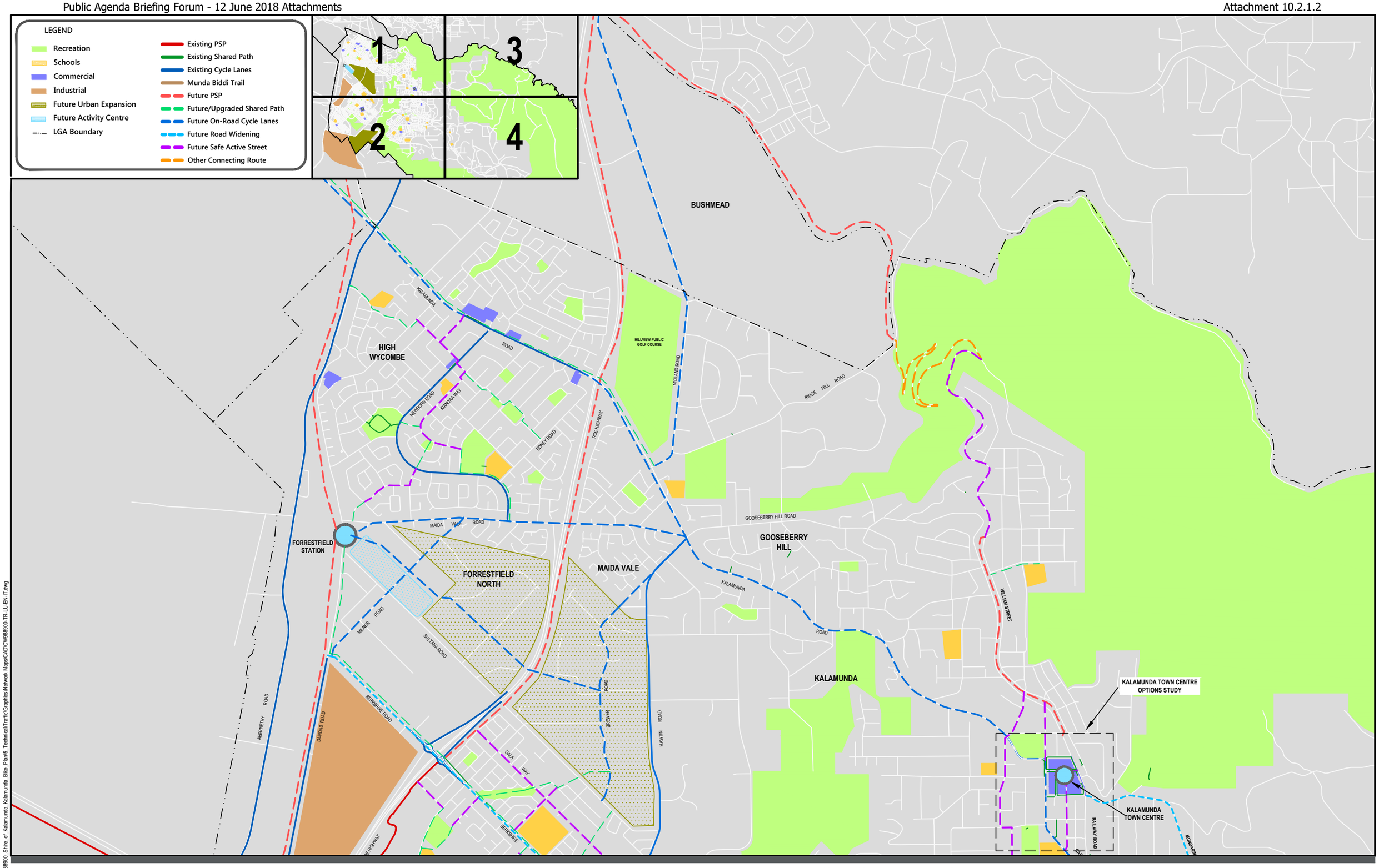
EXISTING & PROPOSED INFRASTRUCTURE

OVERALL MAP

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-OA2
Drawing Number

D
Revision



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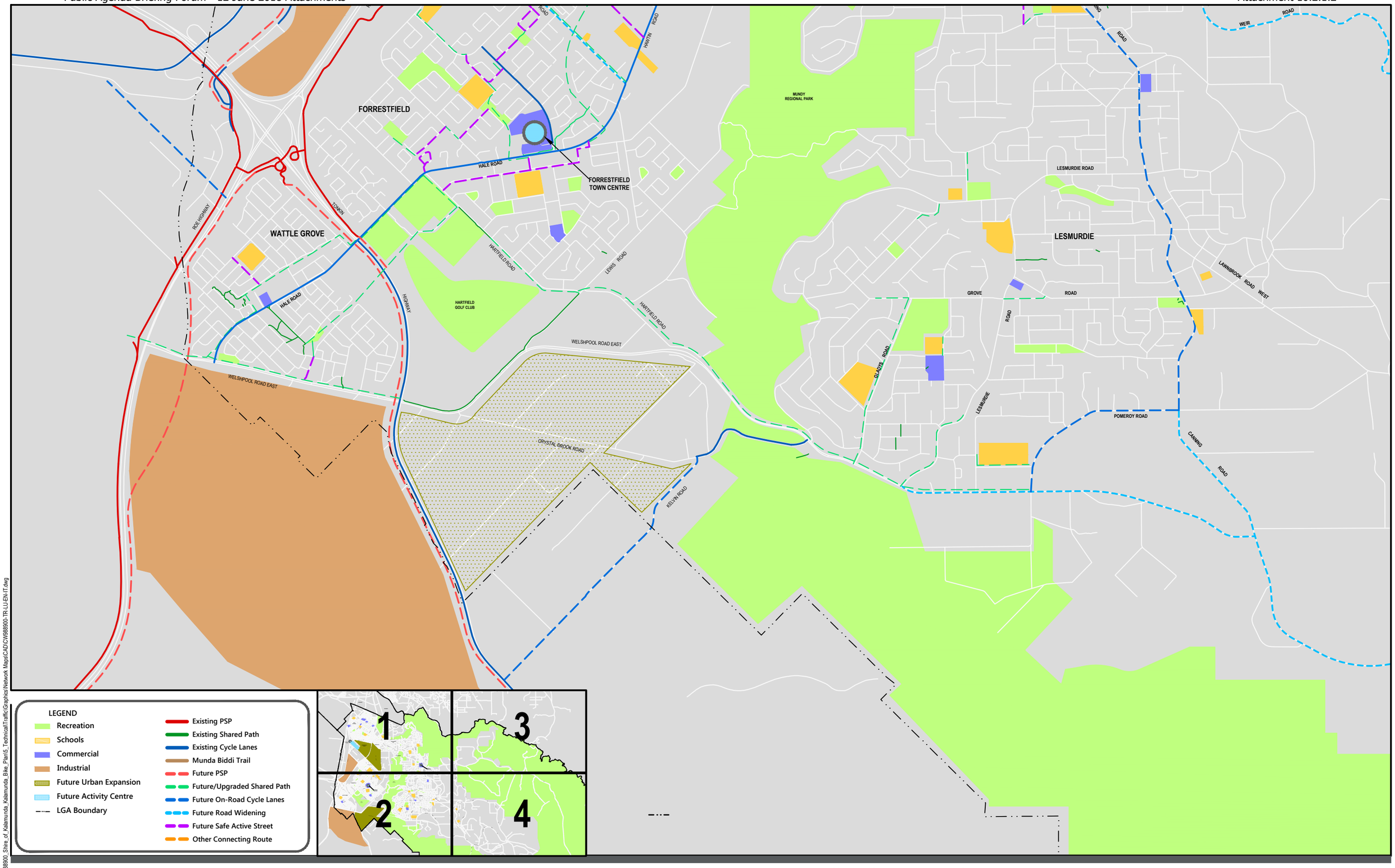
CITY OF KALAMUNDA
BICYCLE PLAN
FIGURE 8-2
EXISTING & PROPOSED INFRASTRUCTURE
QUADRANT 1

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IT1
Drawing Number

D
Revision



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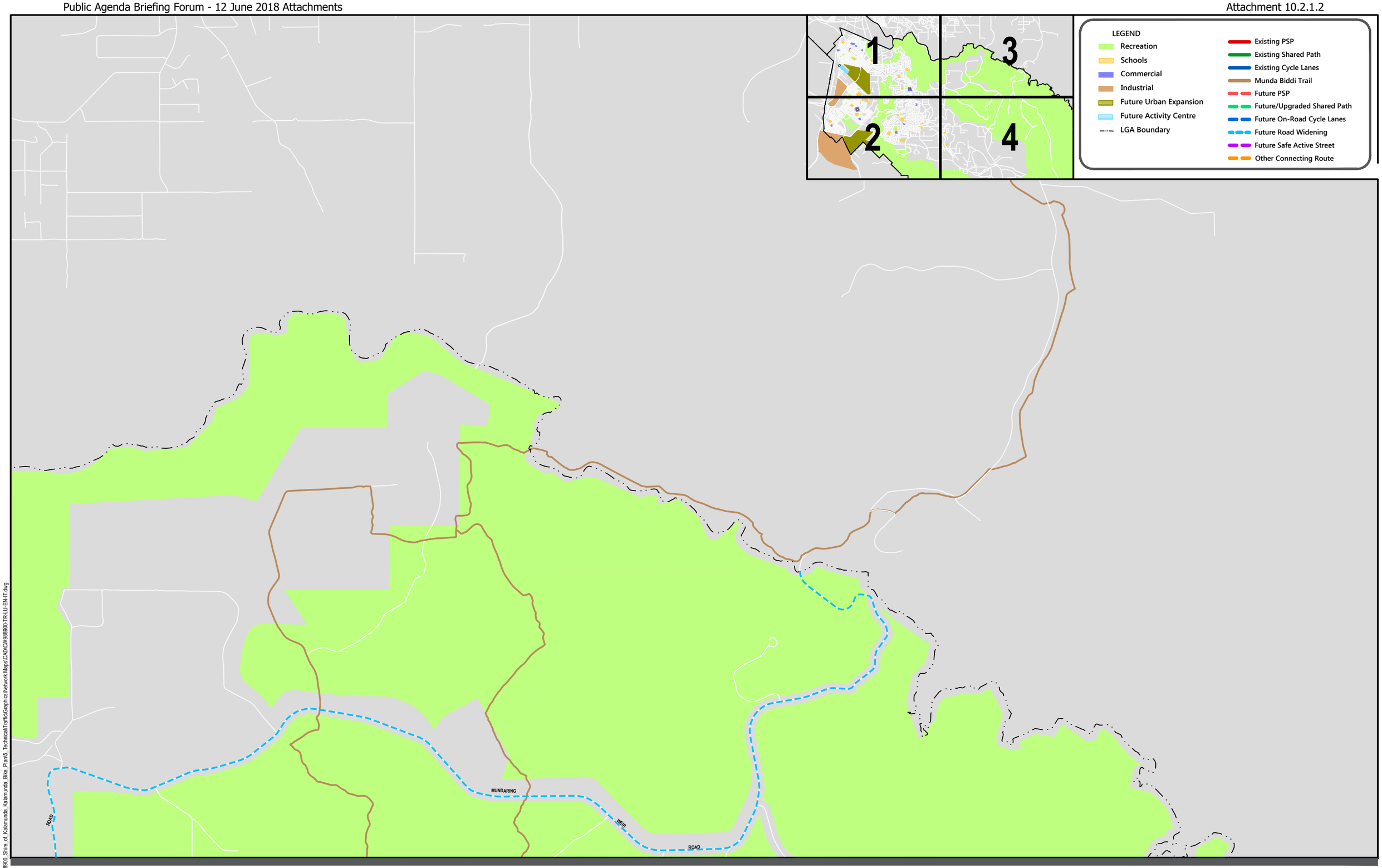
CITY OF KALAMUNDA
BICYCLE PLAN
FIGURE 8-3
EXISTING & PROPOSED INFRASTRUCTURE
QUADRANT 2

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IT2
Drawing Number

D
Revision



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CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 8-4

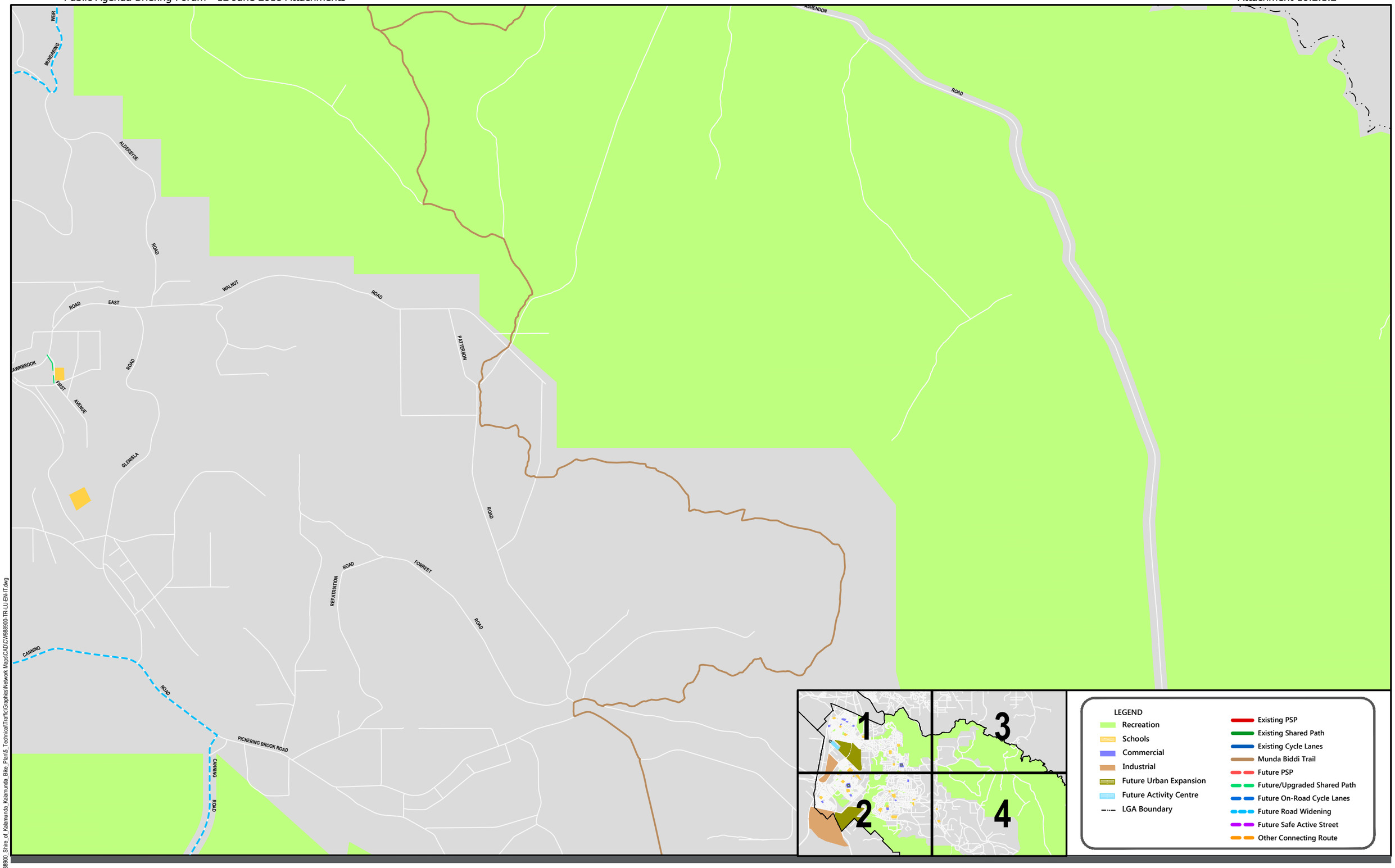
EXISTING & PROPOSED INFRASTRUCTURE

QUADRANT 3

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IT3 — Drawing Number

D — Revision



CITY OF KALAMUNDA

BICYCLE PLAN

FIGURE 8-5

EXISTING & PROPOSED INFRASTRUCTURE

QUADRANT 4

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IT4 (Drawing Number)

D (Revision)

DATE PLOTTED: 12 April 2018 10:48 AM BY : RAYMOND RACHMAT
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Table 8-3 Schedule of Works - $500,000 per annum

Project No.	Routes	Description	Start	End	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
0-5 Years								
80a	**Roe Highway**	PSP Completion Part of Roe Highway/Kalamunda Road Upgrade	Berkshire Road	Kalamunda Road		$2,260,000	$2,260,000	State Government Funded
81a	**Tonkin Highway**	PSP Extension on the Southern Side (including link to Hartfield Park)	Roe Highway	Welshpool Road East		$1,430,000	$1,430,000	State Government Funded
82a	**Freight Railway / Dundas Road**	Dundas Road PSP	Tonkin Highway	Forrestfield Station		$2,580,000	$2,580,000	State Government Funded
82b	**Freight Railway / Dundas Road**	Dundas Road PSP	Forrestfield Station	Wittenoom Road		$730,000	$730,000	State Government Funded Review priority when Forrestfield Station design is released
1a	**Hills Spine**	Zig Zag Option A	Ridge Hill Road	Ocean View Parade	$35,000		$35,000	
1d	**Hills Spine**	Kalamunda Town Centre Section Options Study	Canning Road	Elizabeth Street	$25,000	$25,000	$50,000	Potential WABN Grant Funding
2c	**Kalamunda Road**	Sealed Shoulder	Fernan Road	Abernethy Road	$560,000		$560,000	Include as part of existing planned upgrade
3d	**Forrestfield Station Connection**	Milner Road Protected Cycle Lanes	Maida Vale Road	Dundas Road		$620,000	$620,000	To be funded and constructed as part of the Forrestfield North District Structure Plan
20a	**Foothills Spine**	Welshpool Road East Shared Path (including to connection from Puddy lane to Hale Road)	Roe Highway (City Boundary)	Puddy Lane	$65,000	$65,000	$130,000	Potential WABN Grant Funding
20b	**Foothills Spine**	Puddy Lane Shared Path	Welshpool Road East Shared Path	Hale Road	$85,000	$85,000	$170,000	Potential WABN Grant Funding
20c	**Foothills Spine**	Hale Road Shared Path Extension	Extensa Road	Puddy Lane	$50,000		$50,000	
20d	**Foothills Spine**	Hale Road Existing Shared Path Upgrade (Western Side)	Extensa Road	Lenihan Corner	$320,000		$320,000	
21d	**High Wycombe Local Route**	Public Access Way Upgrades (through McLarty Way, and Walker Crescent)	Kiandra Way	Newburn Road	$95,000		$95,000	Potential external funding (non WABN)
21e	**High Wycombe Local Route**	Butcher Road & Palmer Crescent Safe Active Street	Newburn Road	Palmer Crescent	$390,000		$390,000	Potential external funding (non WABN)
21f	**High Wycombe Local Route**	Everitt Place Shared Path	Palmer Crescent	Maida Vale Road	$85,000		$85,000	Potential external funding (non WABN)
22a	**Berkshire & Dundas Road**	Berkshire Road (West of Roe Highway) Shared Path Upgrade	Roe Highway	Dundas Road	$230,000	$230,000	$460,000	Potential WABN Grant Funding
22c	**Berkshire & Dundas Road**	Dundas Road Shared Path	Berkshire Road	Forrestfield Station	$180,000	$180,000	$360,000	Potential WABN Grant Funding
44	**Forrestfield (Gala Way)**	Gala Way Safe Active Street	Fruit Tree Crescent	Hawtin Road	$50,000		$50,000	Allowance to supplement existing traffic calming
61a	**Canning Road**	Road Safety Audit	-	-	$25,000		$25,000	
61b	**Canning Road**	Targeted Shoulder Widening Stage 1	Pickering Brook Road	City Boundary	$225,000	$225,000	$450,000	Black Spot Funding
63	**Welshpool Road East**	Lesmurdie Road Intersection Safety Improvement	-	-	$40,000		$40,000	
64a	**Mundaring Weir Road**	Road Safety Audit	-	-	$15,000		$15,000	
64b	**Mundaring Weir Road**	Targeted Shoulder Widening Stage 1	Railway Road	City Boundary	$225,000	$225,000	$450,000	Black Spot Funding
65	**City of Kalamunda**	Safe Passing Law Review	-	-	$10,000		$10,000	
					TOTAL COST ESTIMATE (0-5 Years)		$11,365,000	
					CITY FUNDED		$2,710,000	

Project No.	Routes	Description	Start	End	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
5-10 Years								
80b	**Roe Highway**	Roe Highway PSP Completion	Kalamunda Road	Brinsmead Road (Northern City Boundary)		$660,000	$660,000	State Government Funded
81b	**Tonkin Highway**	PSP Completion	Welshpool Road East	Kelvin Road/Mills Road		$1,310,000	$1,310,000	State Government Funded
1b	**Hills Spine**	Lascelles Parade / William Street Safe Active Street	Zig Zag Scenic Drive	Hill Street	$320,000	$320,000	$640,000	Potential WABN Grant Funding
1c	**Hills Spine**	Kalamunda Railway Heritage Trail Sealed Path	Hill Street	Elizabeth Street	$150,000	$150,000	$300,000	Potential WABN Grant Funding
1e	**Hills Spine**	Canning Road Buffered Bike Lanes Stage 1	Kalamunda Road	Railway Road	$380,000	$380,000	$760,000	Potential WABN Grant Funding
1f	**Hills Spine**	Canning Road Buffered Bike Lanes Stage 2	Railway Road	Lesmurdie Road	$600,000	$600,000	$1,200,000	Potential WABN Grant Funding
3a	**Forrestfield Station Connection**	Maida Vale Road Protected Cycle Lanes Stage 1	Forrestfield Station	Priory Road		$1,090,000	$1,090,000	To be funded and constructed as part of the Forrestfield North Developer Contributions Plan
3b	**Forrestfield Station Connection**	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 1	Forrestfield Station	Roe Highway		$1,460,000	$1,460,000	Include as part of Forrestfield North District Structure Plan
21c	**High Wycombe Local Route**	Kiandra Way Safe Active Street	Western Avenue	Norling Road		$660,000	$660,000	SAS Program Funding
41a	**Forrestfield (Hibiscus Drive)**	Hale Road Shared Path	Hannover Street	Hibiscus Drive	$430,000		$430,000	
41b	**Forrestfield (Hibiscus Drive)**	Hibiscus Drive SAS	Bougainvillea Avenue	Strelitzia Avenue		$330,000	$330,000	SAS Program Funding
41c	**Forrestfield (Hibiscus Drive)**	Bougainvillea Avenue Shared Path	Hibiscus Drive	Dawson Avenue	$240,000		$240,000	
41d	**Forrestfield (Hibiscus Drive)**	Dawson Avenue Shared Path Upgrade	Bougainvillea Avenue	Pavetta Crescent	$260,000		$260,000	
41e	**Forrestfield (Hibiscus Drive)**	Pavetta Crescent SAS	Dawson Avenue	Roe Highway		$200,000	$200,000	SAS Program Funding
61c	**Canning Road**	Targeted Shoulder Widening Stage 2	Pomeroy Road	Pickering Brook Road	$250,000	$250,000	$500,000	Black Spot Funding
64c	**Mundaring Weir Road**	Targeted Shoulder Widening Stage 2	Railway Road	City Boundary	$250,000	$250,000	$500,000	Black Spot Funding
					TOTAL COST ESTIMATE (5-10 Years)		$10,280,000	
					CITY FUNDED		$2,620,000	

Table 8-4 Schedule of Works - $1,000,000 per annum

Item	Route	Primary Route	Start	End	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
0-5 Years								
80a	**Roe Highway**	PSP Completion Part of Roe Highway/Kalamunda Road Upgrade	Berkshire Road	Kalamunda Road		$2,260,000	$2,260,000	State Government Funded
81a	**Tonkin Highway**	PSP Extension on the Southern Side (including link to Hartfield Park)	Roe Highway	Welshpool Road East		$1,430,000	$1,430,000	State Government Funded
82a	**Freight Railway / Dundas Road**	Dundas Road PSP	Tonkin Highway	Forrestfield Station		$2,580,000	$2,580,000	State Government Funded
82b	**Freight Railway / Dundas Road**	Dundas Road PSP	Forrestfield Station	Wittenoom Road		$730,000	$730,000	State Government Funded Review priority when Forrestfield Station design is released
1a	**Hills Spine**	Zig Zag Option A	Ridge Hill Road	Ocean View Parade	$35,000		$35,000	
1c	**Hills Spine**	Kalamunda Railway Heritage Trail Sealed Path	Hill Street	Elizabeth Street	$150,000	$150,000	$300,000	Potential WABN Grant Funding
1d	**Hills Spine**	Kalamunda Town Centre Section Options Study	Canning Road	Elizabeth Street	$25,000	$25,000	$50,000	Potential WABN Grant Funding
1f	**Hills Spine**	Canning Road Buffered Bike Lanes Stage 2	Railway Road	Lesmurdie Road	$1,200,000		$1,200,000	
2c	**Kalamunda Road**	Sealed Shoulder	Fernan Road	Abernethy Road	$560,000		$560,000	Include as part of existing planned upgrade
3d	**Forrestfield Station Connection**	Milner Road Protected Cycle Lanes	Maida Vale Road	Dundas Road		$620,000	$620,000	To be funded and constructed as part of the Forrestfield North District Structure Plan
20a	**Foothills Spine**	Welshpool Road East Shared Path (including to connection from Puddy lane to Hale Road)	Roe Highway (City Boundary)	Puddy Lane	$65,000	$65,000	$130,000	Potential WABN Grant Funding
20b	**Foothills Spine**	Puddy Lane Shared Path	Welshpool Road East Shared Path	Hale Road	$85,000	$85,000	$170,000	Potential WABN Grant Funding
20c	**Foothills Spine**	Hale Road Shared Path Extension	Extensa Road	Puddy Lane	$50,000		$50,000	
20d	**Foothills Spine**	Hale Road Existing Shared Path Upgrade (Western Side)	Extensa Road	Lenihan Corner	$320,000		$320,000	
20g	**Foothills Spine**	Hartfield Road Shared Path	Hale Road or Morrison Road	Sussex Road	$85,000		$85,000	
21d	**High Wycombe Local Route**	Public Access Way Upgrades (through McLarty Way, and Walker Crescent)	Kiandra Way	Newburn Road	$95,000		$95,000	Potential external funding (non WABN)
21e	**High Wycombe Local Route**	Butcher Road & Palmer Crescent Safe Active Street	Newburn Road	Palmer Crescent	$390,000		$390,000	Potential external funding (non WABN)
21f	**High Wycombe Local Route**	Everitt Place Shared Path	Palmer Crescent	Maida Vale Road	$85,000		$85,000	Potential external funding (non WABN)
21i	**High Wycombe Local Route Spurs**	Norling Road & Newburn Road Shared Path	Kiandra Way/Norling Road	Maida Vale Road	$320,000		$320,000	
21j	**High Wycombe Local Route**	Crake Court Public Access Way Upgrade	Kiandra Way	Newburn Road	$25,000		$25,000	Potential external funding (non WABN)

Item	Route	Primary Route	Start	End	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
22a	**Berkshire & Dundas Road**	Berkshire Road (West of Roe Highway) Shared Path Upgrade	Ashby Close	Dundas Road	$230,000	$230,000	$460,000	Potential WABN Grant Funding
22c	**Berkshire & Dundas Road**	Dundas Road Shared Path	Berkshire Road	Forrestfield Station	$180,000	$180,000	$360,000	Potential WABN Grant Funding
25b	**Lesmurdie Local Routes**	Burma Road Shared Path Extension	Orange Valley Road	Connor Road	$70,000		$70,000	
25c	**Lesmurdie Local Routes**	Trafalgar Road - Kimbarlee Way Path Upgrade	Waterloo Crescent	Falls Road	$110,000		$110,000	
25d	**Lesmurdie Local Routes**	Grove Road Shared Path Missing Link 1	George Road	Gladys Road	$110,000		$110,000	
25e	**Lesmurdie Local Routes**	Grove Road Shared Path Missing Link 2	Lesmurdie Road	Rooth Road	$120,000		$120,000	
44	**Forrestfield (Gala Way)**	Gala Way Safe Active Street	Fruit Tree Crescent	Hawtin Road	$50,000		$50,000	Allowance to supplement existing traffic calming
63	**Welshpool Road East**	Lesmurdie Road Intersection Safety Improvement	-	-	$40,000		$40,000	
61a	**Canning Road**	Road Safety Audit	-	-	$25,000		$25,000	
61b	**Canning Road**	Targeted Shoulder Widening Stage 1	Pickering Brook Road	City Boundary	$225,000	$225,000	$450,000	Black Spot Funding
64a	**Mundaring Weir Road**	Road Safety Audit	-	-	$15,000		$15,000	
64b	**Mundaring Weir Road**	Targeted Shoulder Widening Stage 1	Railway Road	City Boundary	$225,000	$225,000	$450,000	Black Spot Funding
65	**City of Kalamunda**	Safe Passing Law Review	-	-	$10,000		$10,000	
						TOTAL COST ESTIMATE (0-5 Years)	**$13,705,000**	
						CITY FUNDED	**$4,900,000**	
5-10 Years								
80b	**Roe Highway**	Roe Highway PSP Completion	Kalamunda Road	Brinsmead Road (Northern City Boundary)		$660,000	$660,000	State Government Funded
81b	**Tonkin Highway**	PSP Completion	Welshpool Road East	Kelvin Road/Mills Road		$1,310,000	$1,310,000	State Government Funded
1b	**Hills Spine**	Lascelles Parade / William Street Safe Active Street	Zig Zag Scenic Drive	Hill Street	$320,000	$320,000	$640,000	Potential WABN Grant Funding
1e	**Hills Spine**	Canning Road Buffered Bike Lanes Stage 1	Kalamunda Road	Railway Road	$380,000	$380,000	$760,000	Potential WABN Grant Funding
3a	**Forrestfield Station Connection**	Maida Vale Road Protected Cycle Lanes Stage 1	Forrestfield Station	Priory Road		$1,090,000	$1,090,000	To be funded and constructed as part of the Forrestfield North Developer Contributions Plan
3b	**Forrestfield Station Connection**	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 1	Forrestfield Station	Brewer Road		$1,460,000	$1,460,000	Include as part of Forrestfield North District Structure Plan
20i	**Foothills Spine**	Transmission Line Easement Shared Path	Berkshire Road	Sultana Road East	$340,000	$340,000	$680,000	Potential WABN Grant Funding
20j	**Foothills Spine**	Transmission Line - Strelitzia Avenue Shared Path Link	Strelitzia Avenue	Proposed Transmission	$170,000		$170,000	

Item	Route	Primary Route	Start	End	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
				Line Shared Path				
21a	**High Wycombe Local Route**	Fernan Road Safe Active Street	Kalamunda Road	Hamilton Road	$80,000	$120,000	$200,000	60% funding from SAS Program
21b	**High Wycombe Local Route**	Hamilton Street Safe Active Street	Wittenoom Road	Kiandra Way	$188,000	$282,000	$470,000	60% funding from SAS Program
21c	**High Wycombe Local Route**	Kiandra Way Safe Active Street	Western Avenue	Norling Road		$660,000	$660,000	SAS Program Funding
21g	**High Wycombe Local Route Spurs**	Munday Road Shared Path	Wittenoom Road/Hamilton Street	Dundas Road	$270,000		$270,000	
22b	**Berkshire & Dundas Road**	Berkshire Road (East of Roe Highway) Shared Path Upgrade	Apricot Street	Hawtin Road	$890,000		$890,000	Timing will be influenced by the Forrestfield North District Structure Plan
25f	**Lesmurdie Local Routes**	Gladys Road Shared Path Section 1	Grove Road	George Road	$370,000		$370,000	
40a	**Forrestfield (Bauhinia Road)**	Bauhinia Road SAS	Dawson Avenue	Magnolia Way		$240,000	$240,000	SAS Program Funding
40b	**Forrestfield (Bauhinia Road)**	Dawson Ave Shared Path	Cedar Way	Bauhinia Road	$65,000		$65,000	
40c	**Forrestfield (Bauhinia Road)**	Cedar Way SAS	Cedar Way	Dawson Avenue		$240,000	$240,000	SAS Program Funding
40d	**Forrestfield (Bauhinia Road)**	Shared Path Upgrade - Bridge Over Woodlupine Brook	Cedar Way	Peach Tree Way	$270,000		$270,000	
40e	**Forrestfield (Bauhinia Road)**	Peach Tree Way SAS	-	-		$260,000	$260,000	SAS Program Funding
41a	**Forrestfield (Hibiscus Drive)**	Hale Road Shared Path	Hannover Street	Hibiscus Drive	$430,000		$430,000	
41b	**Forrestfield (Hibiscus Drive)**	Hibiscus Drive SAS	Bougainvillea Avenue	Strelitzia Avenue		$330,000	$330,000	SAS Program Funding
41c	**Forrestfield (Hibiscus Drive)**	Bougainvillea Avenue Shared Path	Hibiscus Drive	Dawson Avenue	$240,000		$240,000	
41e	**Forrestfield (Hibiscus Drive)**	Pavetta Crescent SAS	Dawson Avenue	Roe Highway		$200,000	$200,000	SAS Program Funding
47b	**Kalamunda Township**	Central Road / Central Mall Option	Canning Road	Railway Road	$510,000		$510,000	SAS Program Funding
61c	**Canning Road**	Targeted Shoulder Widening Stage 2	Pomeroy Road	Pickering Brook Road	$250,000	$250,000	$500,000	Black Spot Funding
64c	**Mundaring Weir Road**	Targeted Shoulder Widening Stage 2	Railway Road	City Boundary	$250,000	$250,000	$500,000	Black Spot Funding
					TOTAL COST ESTIMATE (5-10 Years)		$13,415,000	
					CITY FUNDED		$5,023,000	

8.3 Maintenance

Regular maintenance is required to keep cycling facilities in a reasonable condition. Cyclists are particularly vulnerable to punctures and crashes caused by broken glass, loose gravel and vegetation. Regular maintenance activities should include the following:

> Regular sweeping of paths to remove gravel, sand/earth, broken glass and vegetation;

> Targeted sweeping of known problem areas – e.g. paths through parks after a Saturday night;

> Prompt clean up from storms, fires and other one-off events which cause damage to paths;

> Regular pruning of vegetation to ensure the full path width is available; and

> A regular, documented system of visual path inspections to identify surface or structural defects. An allocation should be made in each financial year for preventative or remedial maintenance to address this type of issue.

9 Funding Opportunities

There are a number of funding opportunities available for implementing cycling facilities within Western Australia. **Table 9-1** shows funding streams that are relevant to the City of Kalamunda.

Table 9-1 Funding Opportunities

Funding Opportunities	Description
Western Australia Bicycle Network (WABN) Grants Program	> State funding initiative to assist local governments in Western Australia. > Funding for the design and implementation of bicycle network infrastructure and programs in accordance with the State's priorities set out in the WABN Plan. > Funding is available for up to 50 per cent of the total project cost. > Projects are encouraged to be spread over two financial years to facilitate high quality planning and design.
Connecting Schools Program (Local Government Based Grant)	> Grants for Local Government Area (LGA) to connect schools to cycling infrastructures and fill missing links in the path network around schools. > Application needs to submitted through the WABN Grants Program
Your Move Program	> Schools can receive grants for end of trip facilities and bike education programs from the DoT's Your Move Program for schools
Safe Active Street Program	> A new initiative by the DoT to fund and develop Bicycle Boulevard Projects in Western Australia > Application needs to submitted through the WABN Grants Program
Bikeweek Grants	> Community groups, organisations and local governments can apply to share in $30,000 in grants to support local cycling events and activities as part of Bikeweek.
Healthier Workplace WA	> Healthier Workplace WA offer small grants of up to $10 000 for workplaces to implement projects that promote and support workers' health and wellbeing.
RAC Community Sponsorships	> The program has a range of sponsorship categories for community groups to access including Grass Roots, Project and Partnership categories.
Office of Road Safety Community Grants	> To encourage community groups to participate in road safety, the Road Safety Community Grant Program provides from $50 to $1000 in event grants.
Black Spot Program	> National funding initiative to assist in implementing measures at roads with proven history of crashes. > Subject road would need to be nominated as a 'black spot' to be considered for funding. > Project proposals should be able to demonstrate a benefit to cost ratio of at least 2 to 1
Lotterywest Trail Grants	> A partnership between Lotterywest and the Department of Sport and Recreation to assist in developing trails in WA. The grant categories are planning, construction, and trail promotion.

10 Advocacy

The City has an important role to play in advocating for improvements to the cycling network that might be outside of its control or funding ability but are likely to bring significant benefits for the City's residents and visitors. This role includes two distinct elements:

> **Advocating** the State Government agencies and elected members to allocate funding for major projects, such as the Roe Highway upgrades (including the PSP) and Forrestfield Airport Link.

> **Participating** in the planning and design process to ensure that major projects are planned and designed to maximise the benefits for active transport within the City, and ensure that appropriate local connections are included within the scope.

The following is a summary of the major projects that it is recommended the City both advocate for and participate in the planning and design process.

Table 10-1 Major Projects

Project	Priority	Objective
Roe Highway PSP		
Berkshire Road to Kalamunda Road	High	Ensure that the PSP extension is included in the Roe Highway / Kalamunda Road interchange project, including grade-separation at Maida Vale and Berkshire Roads.
Kalamunda Road to City Boundary	Medium	Encourage the State Government to include an extension of the PSP from Kalamunda Road to connect to Midland Road near Brinsmead Road (City of Swan)
City Boundary to Midland	Medium	Advocate for early completion of the PSP to connect the foothills with Midland
Forrestfield Airport Link		
Maida Vale Road Protected bicycle lanes	High	Seek State Government funding support for the construction of protected bicycle lanes on Maida Vale Road to maximise the benefits of Forrestfield Station and encourage sustainable commuting behaviour from opening day
Sultana Road Bridge over Roe Highway	High	Seek State Government funding support for the construction of a bridge on Sultana Road over Roe Highway, including protected bicycle lanes, to encourage access by bicycle to Forrestfield North and Forrestfield Station
Midland to Kalamunda Secondary Route		
All sections	High	Seek State Government and City of Swan support for the route as a whole and collaborate with the City of Swan to seek State Government funding support to implement key sections.
Tonkin Highway PSP		
Roe Highway to Welshpool Road East Extend PSP along southern side	High	Participate in the planning and design process to ensure that the extension of the PSP on the southern side of Tonkin Highway is included within the scope of the Tonkin Highway upgrade. Seek State Government support for including the pedestrian and cyclist crossing under or over Tonkin Highway between Coyong Road and Hartfield Park.
Welshpool Road East to City Boundary	Low	Participate in the planning and design process
Welshpool Road East		
Hale Road to Tonkin Highway	Medium	Advocate for cycle lanes to be included in any upgrade works on Welshpool Road East.
Lewis Road to Lesmurdie Road	Low	Seek State Government funding support for future construction of a shared path on the Lesmurdie Hill section.

11 Encouragement and Education

While constructing new infrastructure is crucial to the promotion of cycling in the City, it is imperative to engender usage of new infrastructure through encouraging behaviour change. The following sections outline a variety of factors that influence cycling behaviour. In addition, methods to stimulate cycling change by encouraging those who do not currently cycle to take up cycling, as well as ensuring that existing cyclists will continue to ride throughout the City, will be outlined.

11.1 Cycling Segmentation

To achieve the City's strategic target to increase cycling activity within the LGA, segments of the population should be identified that may be more likely to cycle, cycle more often or to take up cycling for specific trips (to work, school or for recreation). When reviewing information regarding the City of Kalamunda's mode choices by residents and visitors, consideration should be made of those:

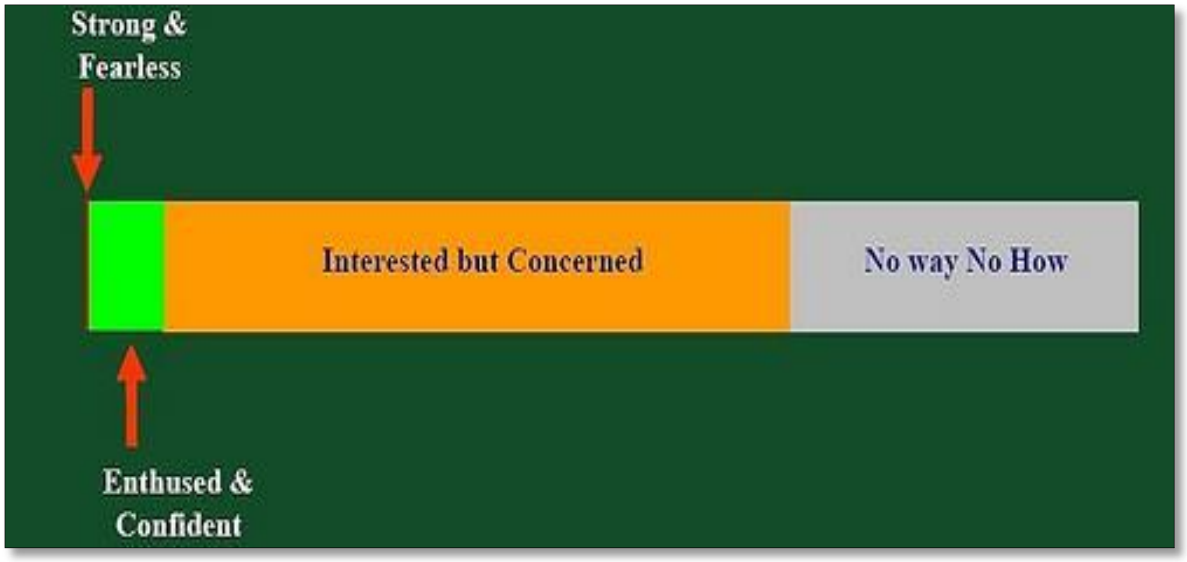
> travelling distances or journeys that could be made by bike;

> that own a bicycle (or have access to one); and

> that have a willingness to cycle.

Roger Geller's cycling segmentation (as illustrated in **Figure 11-1** below with the segments described in **Table 11-1)** is a best practice model for identifying the type and needs of existing and potential cyclists. Geller proposed this cycling segmentation during his work with the City of Portland in Oregon, which has since been supported through surveys and adopted as a schematic model for the purposes of cycling development.

Figure 11-1 Geller's Cycling Segmentation



Source: http://web.pdx.edu/~jdill/Dill_VeloCity_Types_of_Cyclists.pdf

Table 11-1 Geller's Cycling Segmentation – Descriptions

Type	Approximate Proportion	Description
Strong and Fearless	1%	Will ride anywhere and in any weather conditions.
Enthused and Confident	6%	Relatively comfortable on busy roads with bike lanes
Interested but Concerned	60%	Uncomfortable around traffic, feel unsafe.
No way, no how	33%	Not interested in cycling for transport

As it is recognised that the 'Strong and Fearless' group will likely cycle with or without specific behaviour change activities or infrastructure, and represent only a small proportion of the population of the City, an

emphasis for activities has therefore been placed on encouraging the remaining portion of the population that may cycle occasionally or for recreation. Cycling participation survey results estimate that approximately 77% of the population cycle at least occasionally for recreation. This proportion is likely to make up the 'Interested but Concerned' segment and even some of those who would never consider themselves "cyclists".

This segment will require the implementation of cycling infrastructure to start cycling, but holds the most potential for increasing cycling mode share. The purpose of behaviour change activities for this group is therefore to encourage the development of an appreciation of the benefits, provision of the tools and culture of support for cycling while the network develops.

This research and methodology has informed the proposed approach and activities for the City of Kalamunda.

11.2 Recommended Behaviour Change Approach and Activities

There are many models for using promotion to encourage behaviour change. **Table 11-2** provides an overview of the considerations based on Prochaska's model of the Stages of Change. This model is considered appropriate for the City, and provides a clear framework for identifying suitable promotional activities in order to increase the uptake of cycling for transport purposes. Specifically, for the 'Enthused and Confident' and 'Interested but Concerned' segments it provides focus on activities that promote 'everyday' cycling in a positive manner and focuses on tools to overcome identified barriers to cycling.

Table 11-2 Behaviour Change Approach

Stage of Change	Individuals Perception	Potential Activities and Interventions
Pre-contemplation	Not considering bike riding	**Raising the awareness of cycling** Introduce messages that portray riding as an activity that individuals associate with in a positive manner.
Contemplation	Aware of bike riding, the benefits and interested in finding out more	Ensure that **tools and resources are available** to support potential riders seeking *information*.
Preparing	Would like to give riding a go	**To be able to ride appropriately**, have access to a bicycle, to know how to ride it and have the relevant resources and facilities provided.
Action	Riding for the first time	Ensure **infrastructure and supporting facilities** are well maintained, safe, legible and convenient so that the new rider has a positive initial experience.
Maintaining	Riding again	**Positive reinforcement** – or the rider may not choose to ride again and relapse into their old behaviour (non-bike riding).
Relapse	Stopping riding	The rider may re-enter the stages of change at any of the above steps.

Source: Gatersleben and Appleton 2007, Contemplating cycling to work: Attitudes and perceptions in different stages of change, Transportation Research Part A: Policy and Practice, Vol.41, No.4, pp.302-312.

11.2.2 Raising the Awareness of Cycling

These activities ensure that positive messages regarding cycling are included wherever possible in order to raise awareness of cycling throughout the community. Particularly for the City, celebrating the introduction of new infrastructure should provide an important opportunity to raise awareness of cycling and encourage the wider public to give the new infrastructure a go.

Examples: Information regarding cycling related activities being included on the Council website, newsletters and community events. Opportunities to capture and promote feedback from riders regarding why they enjoy riding in the City of Kalamunda could also be included within this material. Positive imagery of cycling, and local infrastructure where possible, should be included in Council publications, plans and reports whenever appropriate.

11.2.3 Tools and Resources

In order to support those who may be considering cycling, knowledge of the provision of infrastructure through route maps, visible bicycle parking in convenient locations, guidance on cycling etiquette, road rules and cycling safely is recommended to help encourage and equip them to take action.

Examples: Relevant information could be supplied electronically in downloadable format from the Council's website, made available in printed format from the Library and Community Centre. As the Council will be looking to introduce new types of cycling and road user infrastructure, it is recommended that additional education and promotion is associated with these changes to ensure all users are informed and advised of appropriate use of the new facilities.

11.2.4 To be Able to Ride Appropriately

In order to ride a bike, you must have access to a bike to ride, and know how to ride it appropriately. Several councils within Western Australia work to address this barrier through providing cycle training courses, in order to introduce new riders or increase confidence for the inexperienced rider.

Some councils also provide cycling training specifically for women. These initiatives have been proven successful in getting the 'interested and concerned' group into cycling.

Examples: Cycling education courses and lead rides could be provided.

11.2.5 Infrastructure and Supporting Facilities

This Bike Plan provides a detailed list of recommendations regarding potential cycling infrastructure requirements, supporting facilities (such as bike racks) and the importance of maintenance. Cycling and other community events could be associated with the opening of specific bicycle routes and facilities as completion of the recommended infrastructure programs occurs, alongside ensuring appropriate promotion and education regarding the new facilities. Other supporting infrastructure could include signage and wayfinding tools, bicycle maintenance facilities such as air pumps and so on.

11.2.6 Positive Reinforcement

To encourage those who start riding, to continue riding, infrastructure must continue to meet users' needs and provide for a positive experience. To further reinforce this behaviour, opportunities to recognise and/or reward bike riders should be considered.

Examples: Cycling surveys and counts to demonstrate and promote improvements to the wider public, alongside using community events to recognise bike riders. Several authorities also participate in Super Tuesdays, which is a national annual bike count event. Others use Bike Week to provide an opportunity to both promote cycling and recognise existing riders, often through cycling breakfasts.

11.3 Bicycle Library

One of the major barriers to encouraging residents to take up cycling is not owning a bicycle. Purchasing a bicycle is a significant investment for many people and one which is unlikely to be made without some confidence that it will be frequently used.

To help overcome the barrier of "no bike" in getting people cycling, the City of Vincent invested in 10 bicycles with funding assistance from the Royal Automobile Club (RAC) and Zap Electric Vehicles, and set up a 'Bike Library" at the City's Beatty Park Library. Vincent residents are permitted to borrow the bicycles for a few hours at no cost, whilst longer riders attract a nominal fee. Non-residents with appropriate ID are also able to avail themselves of the scheme for a higher fee. The City of Vincent reports that the scheme has been a success, with the bicycle booked out most weekends and many weekdays – particularly the cargo bike, which allows car-less households to do shopping that would otherwise be prohibitive on foot or a regular bicycle.

The City should investigate the feasibility of a Bicycle Library scheme, potentially based at the Kalamunda, Forrestfield and High Wycombe libraries. The launch of the scheme could be tied to the opening of significant sections of Secondary Routes and Local Routes – e.g. the Hills Spine and the Foothills Spine – or the opening of Forrestfield Station as a way to encourage residents to ride to the station.

11.4 Targeted Driver Education

Driver education, when targeted properly, can be an effective tool in encouraging better road user behaviour. Safety focused industries, such as mining, focus significant training resources on driver education in order to protect the safety of employees, contractors and the public, forming a key component of their obligations under Occupational Health and Safety legislation. As a major employer, the City of Kalamunda has a responsibility to ensure that staff who are required to drive or cycle as part of their employment, are educated in appropriate road user behaviour, including sharing the road with cyclists.

It is recommended that the City to work with WestCycle to lobby MRWA and the Road Safety Commission (RSC) to implement a targeted driver education program.

11.5 School Programs

School children are a critically important component of the cycling community; they are the next generation of cyclists. The early exposure of children to cycling as an enjoyable way to spend their leisure time and to get to/from school has been proven to contribute significantly to children continuing to cycle into adulthood.

The major opportunities for encouraging school children to ride bicycles include:

> Cycling to/from school – the majority of children live within 5km of their school which is a comfortable cycling distance

> Cycling lessons at school – teaching children the basics of riding a bicycle and safety on and around the roads

> Organised cycling sport, either at school or on weekends, ranging from simple leisurely rides, to road riding and mountain biking

> 'Your Move' Program – participating schools can earn points by share stories regarding active transport. Points can be redeemed for items and services such as bike racks and bike education sessions.

The City, in conjunction with State Government agencies and community groups, could undertake programs to encourage school students to take up cycling. These initiatives should be continued at least once every two years, with different schemes targeting different age groups. A key focus should be children in the 10-14 age bracket, who are reaching the age where they may consider and are permitted by their parents to cycle to school.

A separate school program to target kindergarten or early primary school students (5-9 age bracket) can also be provided. The goal is to instil a good travel behaviour early in the student's life, with the hope that they would continue through to adulthood.

12 End of Trip Facilities

12.1 Background

EoT facilities are a critical, but often forgotten, component of the cycling network. The presence and/or quality of EoT facilities can often be the deciding factor for many cycling trips. Different trip purposes would have different needs when it comes to EoT facilities. For example:

> A commuter may want a secure place to park their bicycle inside their workplace, along with showers, lockers and ironing facilities to enable them to freshen up before commencing work for the day.

> A shopper may only want a secure short stay place to park their bicycle, conveniently located to their destination (e.g. close to the entrance of a shopping centre, or on the footpath in a 'main street' environment) which is ideally protected from wet weather.

> A recreational rider generally has EoT facilities at their own home but may require a secure place to park their bicycle at an intermediate destination, such as a cafe or a park.

Long stay EoT facilities for commuters should generally be provided by the employer. Council's involvement in the provision of end of trip facilities should be in the form of:

> Requiring, through its Town Planning Scheme, new developments to provide a certain standard of end of trip facilities for both employees and visitors.

> Providing suitable EoT facilities for employees and visitors at its offices, depots, library etc.

Short stay EoT facilities should generally be in the form of simple u-rails or other design, which facilitates the secure parking of a bicycle. In accordance with Austroads Guidelines, these should be located approximately every 30 metres along 'main street' type shopping strips and in small clusters at the entrances to shopping centres and other significant destinations.

Photograph 6 – End of Trip Facility – Cottesloe Beach



12.2 Locations

The City is responsible for providing bicycle parking on public land such as road reserves, parks, recreational facilities and City buildings. U-rails, with capacity for a minimum of 10 bicycles, should be provided at all major recreational facilities and City buildings. EoT facilities, such as showers, lockers, secure parking and washing/drying/ironing facilities should also be provided at workplaces for use by staff. Public bicycle parking in the form of U-rails should also be progressively installed in front of shops, businesses, cafes etc. across the urban area.

Bicycle parking adjacent to land uses should consider both the type of destination and the adjacent cycling infrastructure. Where cyclists are encouraged to ride in mixed traffic or within cycle lanes, on-street bike parking is particularly important. This can be provided in attractive 'bike corrals' which provide a high volume of bike parking within a small space, often a single car parking bay. This type of bike parking is ideally suited to main street environments.

One of the key locations with a shortage of bicycle parking is Haynes Street in Kalamunda town centre. It is recommended that at least 30 stylish U-rails be installed along the street, particularly adjacent to cafes that are frequented by training riders.

It is recommended that the City add locations of EoT to cycling related maps and brochures as well as inform DoT of any new additions to allow DoT's Comprehensive Bike Maps to be updated.

12.3 Development Provisions

The City of Kalamunda Local Planning Scheme 3 and relevant Planning Policies do not currently include requirements for long-stay bicycle parking or provision of EoT facilities for new developments.

It is recommended that the City either update Local Planning Scheme 3, or create a new Planning Policy which provides the required parking provision rates for various land use classifications. It is recommended that the bicycle parking requirements include provisions for long and short stay parking:

> Long stay bike parking is provided for all-day parking (e.g. for employees, students) would need to be of higher quality, secure (via bike cage or fully enclosed bike lockers) and would require an accompanying end-of-trip facilities such as lockers and showers.

> Short stay bike parking is for visitors and are usually in the form of a bike rails. As it is less secure than a bike cage or a bike locker, short stay bike rails need to be place close to the building and in well-lit areas where it can be easily seen.

Refer to **Table 12-1** for an example of bicycle parking requirements for various land uses and **Table 12-2** for the recommended quantum of showers and lockers.

Table 12-1 Example of Bicycle Parking Provisions

Land use	Long Stay (e.g. employee/resident)	Short Stay (Visitor/shopper)
Amusement parlour	-	2 plus 1 per 50 m^2 gfa
Apartment house	1 per 4 habitable rooms	1 per 16 habitable rooms
Art gallery	1 per 1500 m^2 gfa	2 plus 1 per 1500 m^2 gfa
Bank	1 per 200 m^2 gfa	2
Café	1 per 25 m^2 gfa	2
Community centre	1 per 1500 m^2 gfa	2 plus 1 per 1500 m^2 gfa
Consulting rooms	1 per 8 practitioners	1 per 4 practitioners
Drive-in shopping centre	1 per 300 m^2 sales floor	1 per 500 m^2 sales floor
Flat	1 per 3 flats	1 per 12 flats
General hospital	1 per 15 beds	1 per 30 beds
General industry	1 per 150 m^2 gfa	
Health centre	1 per 400 m^2 gfa	1 per 200 m^2 gfa
Hotel	1 per 25 m^2 bar floor area 1 per 100 m^2 lounge beer garden	1 per 25 m^2 bar floor area 1 per 100 m^2 lounge beer garden
Indoor recreation facility	1 per 4 employees	1 per 200 m^2 gfa
Library	1 per 500 m^2 gfa	4 plus 2 per 200 m^2 gfa
Light industry	1 per 1000 m^2 gfa	-
Major sports ground	1 per 1500 spectator places	1 per 250 spectator places
Market	-	1 per 10 stalls
Motel	1 per 40 rooms	
Museum	1 per 1500 m^2 gfa	2 plus 1 per 1500 m^2 gfa
Nursing home	1 per 7 beds	1 per 60 beds
Office	1 per 200 m^2 gfa	1 per 750 m^2 over 1000 m^2
Place of assembly	-	-
Public hall	-	-
Residential building	1 per 4 lodging rooms	1 per 16 lodging rooms
Restaurant	1 per 100 m^2 public area	2
Retail show room	1 per 750 m^2 sales floor	1 per 1000 m^2 sales floor
School	1 per 5 pupils over year 4	-
Service industry	1 per 800 m^2 gfa	-
Service premises	1 per 200 m^2 gfa	-
Shop	1 per 300 m^2 gfa	1 per 500 m^2 over 1000 m^2
Swimming pool	-	2 per 20 m^2 of pool area
Take-away	1 per 100 m^2 gfa	1 per 50 m^2 gfa
University/Inst. of Tech	1 per 100p/t students 2 per 100f/t students	-

Source: Austroads Guide to Traffic Management Part 11: Parking

Table 12-2 End of Trip Facilities Requirements

No. of long-stay bicycle spaces provided	No. of Lockers[1]	No. of Showers [2]
1-2	1-2	0
3-5	3-5	1
6-10	6-10	2 (one male, one female)
11-20	11-20	4 (two male, two female)
More than 20	20 or more	4 (two male, two female) **Plus** Additional showers at the rate of 2 showers (one male, one female) for every 10 long-stay parking spaces over 20 provided thereafter

Source: Austroads Guide to Traffic Management Part 11: Parking

Notes:

To be of suitable volume and dimensions to allow storage of clothing, towels, cycling helmets and footwear; well ventilated, secure and lockable; and located close to shower and change room facilities (where provided). A ratio of one locker to one bicycle space is to be provided.

Change room facilities must also be provided and may be either a combined shower and change cubicle or communal change room for each gender directly accessible from the showers.

13 Action Plan

The Action Plan shown below in **Table 13-1** summarises all the recommendations provided in this Bicycle Plan.

Table 13-1 Action Plan

Category	No.	Action
Infrastructure	1	Upgrade and expand cycling network as per the Schedule of Works (refer to **Section 8**)
Maintenance	2	Regularly maintain roads and path to ensure facilities are in good condition.
	3	Regularly prune vegetation to ensure that facilities are accessible
Advocacy	4	Advocate the State Government agencies or elected members for funding of major projects (e.g. Forrestfield Airport Link, PSPs)
	5	Participate in the planning and design process of major projects (e.g. Roe Highway PSP) and ensure connections to local neighbourhood are included within the scope
	6	Assign resource time to implement advocacy actions
Behaviour Change and Awareness	7	Raise awareness of cycling by including information regarding cycling related activities on the City's website, newsletter, and social media
	8	Make cycling related information such as route maps, road rules, safety, and cycling etiquette easily accessible, either electronically or in print form.
	9	Communicate new cycling infrastructure concepts (e.g. Safe Active Street) to residents through easily accessible means.
	10	Promote the completion of new cycling infrastructure or routes through related community or cycling events.
	11	Provide cycling education courses and lead rides to encourage inexperience riders to ride more often
	12	Participate in Super Tuesday annual bike count event and Bike Week to promote cycling and provide positive reinforcement to existing bike riders.
	13	Investigate the feasibility of a bicycle library scheme, potentially in libraries at Kalamunda, Forrestfield, and High Wycombe.
	14	Provide drivers education for City staff to encourage better road use behaviour, including sharing the road with cyclists.
	15	Collaborate with WestCycle to lobby MRWA and the Road Safety Commission to implement a Targeted Driver Education Program.
	16	Assign resource time (e.g. TravelSmart officer) to implement the Behaviour Change and Awareness actions.
School Programs	17	Conduct programs, such as cycling lessons and sport events, at schools within the City to encourage cycling uptake
	18	Encourage schools to participate in Your Move program.
Cycling Tourism	19	Commission a detailed investigation into the opportunities and benefits of promoting cycling tourism in the City and develop an Action Plan
	20	Establish a funding stream to assist businesses in becoming 'Bicycle Friendly Businesses' – e.g. by part-funding additional bicycle parking
End-of-trip (EoT) facilities	21	Conduct an audit of existing EoT facilities to identify and create/update an inventory and map of EoT facilities within the City. Provide updated inventory to DoT for inclusion in the Comprehensive Bike Maps.
	22	Provide suitable EoT facilities at public lands (parks, library) that are managed by the City
	23	Update the Local Planning Scheme to include requirements for EoT facilities for new developments or create a new bicycle parking policy

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APPENDIX A

POLICY CONTEXT

A. Policy Context

A.1 National Policies

A.1.1 National Urban Policy: Our Cities, Our Future (2011)

Our Cities, Our Future is the guiding national framework for shaping the future of our cities, focusing on improving their productivity, sustainability and liveability. The report identifies that although nearly 40% of Australians commute less than 10km to work or study, less than 1.6% cycle (p. 55). The absence of safe and convenient cycling routes is a major contributor to this low mode share. The report also notes that the infrastructure must meet the needs of its target users (p. 63), a key component of the network design philosophy for this Bike Plan.

A.1.2 Moving Australia 2030 (2013)

Moving Australia 2030 – A Transport Plan for a Productive and Active Australia was produced in 2013 by the Moving People 2030 Taskforce. The report outlines a whole-of-system approach to how we fund transport infrastructure, how we move people, how we move goods, and how we better integrate our spatial planning systems with effective transport networks.

Cycling is addressed within the report mainly in the context of a healthy and active Australia. The key relevant recommendation for this Bike Plan is to "Provide sustainable infrastructure funding that supports active travel". This Bike Plan supports this recommendation by identifying the highest priorities for allocating funding to cycling and a clear message that funding needs to be provided in all future years.

A.1.3 National Cycling Strategy (2010)

The Australian National Cycling Strategy 2011-2016 (NCS) was prepared by Austroads and the Australian Bicycle Council in September 2010. The purpose of this strategy is to double the existing rates of cycling in a holistic manner by supporting its myriad of benefits through promotion, infrastructure provision, integrated planning and safety improvements.

Benefits identified in the NCS (pp. 8-11) include:

- Societal Benefits - reduced traffic congestion as a result of commuters shifting to cycling modes, as well as increasing the land area available for urban activity
- Environmental Benefits - reduced carbon footprint as a result of a transition to active, zero-carbon transport
- Health Benefits - increased fitness has both a social and economic benefit to the community by encouraging interaction, improving quality of life and reducing health care costs arising from a sedentary lifestyle
- Equity Benefits - a comprehensive cycling network reduces the proportion of household income necessary to provide mobility. This is particularly beneficial for low income families and households located near the urban fringe, where public transport may be lacking
- Convenience - where cycling infrastructure provides a safe, comprehensive network for access to education, employment and entertainment precincts, cycling presents an efficient travel mode. Short trips are most affected by good cycling facilities.

A series of actions have been identified (pp. 27-29) to achieve the goal of doubling cycling mode share. This implementation framework focuses on the following priorities and objectives:

- Cycling Promotion - Promote cycling as both a viable and safe mode of transport and an enjoyable recreational activity
- Infrastructure and Facilities - Create a comprehensive network of safe and attractive routes to cycle and end-of-trip facilities
- Integrated Planning - Consider and address cycling needs in all relevant transport and land use planning activities
- Safety - Enable people to cycle safely

- > Monitoring and Evaluation - Improve monitoring and evaluation of cycling programs and develop a national decision-making process for investment in cycling
- > Guidance and Best Practice - Develop nationally consistent technical guidance for stakeholders to use and share best practice across jurisdictions.

This Bike Plan incorporates all the key actions listed above. In addition, the Bike Plan aligns with the NCS objective of "creating a comprehensive network of safe and attractive routes to cycle and end of trip facilities" (p. 22).

A.1.4 Walking, Riding and Access to Public Transport (2013)

This document is a Ministerial Statement from the Australian Government, setting out how the Government will increase the proportion of people walking and riding for short trips, and accessing public transport, in our communities. The document provides a summary of the benefits of greater use of active transport and guidelines for the coordination of land use and transport planning and development to achieve high quality outcomes.

There are no direct actions involving Local Government, however this Bike Plan is generally consistent with the aims and objectives of the document.

A.2 State Policies

A.2.1 Western Australian Bicycle Network (WABN) Plan 2014-31

The Western Australian Bicycle Network (WABN) Plan was released by the Department of Transport in 2014. This plan replaces the Perth Bicycle Network (PBN) and provides a framework for infrastructure improvements across Western Australia including Metropolitan and Regional areas.

The WABN Plan focuses on network improvements as a way of creating attractive and safe cycling corridors. The key aspects of this plan are as follows:

- > Implementation - Coordination between Government and non-Government Groups to ensure that the proposed infrastructure is delivered in an effective manner and to identify opportunities to integrate delivery across jurisdictions
- > Principal Shared Path Network Expansion - The Principal Shared Path network forms the backbone of the cycle network through Perth. The WABN focuses on funding improvements within 15km of the CBD to create safe and efficient links along major cycling routes to maximise the benefit of infrastructure funding
- > Perth and Regional Bicycle Network Grants - Additional funding to LGAs to plan and provide cycling infrastructure within their jurisdictions. This includes funding of Local Bike Plans, path infrastructure, signage and line marking
- > Connecting Schools Grant Program – Specific funding to LGAs for projects that improve bicycle access and end of trip facilities for schools, as well as providing behaviour change initiatives to promote cycling.
- > Network Focus - Improvements to the network will be prioritised to promote strategic connections to schools, major rail/bus stations and activity centres. To assist this process, Department of Transport is undertaking studies in consultation with Local Government to identify gaps and potential route alignments which would tend to attract funding
- > Review of Traffic Management on Local Roads- Local Government has a role in undertaking road works to reduce vehicle volumes and speeds through built-up areas. Some of the measures implemented through these programs have resulted in a reduction of on-road cyclist safety and an increase in conflict. The review will include a mix of what is seen as best practice and situations of reduced cycling safety, and consider safety aspects for all roads users, in keeping with the state road safety strategy 'Towards Zero'.

Significant increases in Local Government Regional Bicycle Network Grants funding for bicycle facilities were recommended in the WABN and committed to by the State Government. Many of the projects recommended as part of this Bike Plan will be eligible for grant funding and the City should apply for grants each year.

A.2.2 Perth Metropolitan Transport Strategy 1995-2029

The Metropolitan Transport Strategy (MTS) is a strategic transport plan for the Perth Metropolitan Region for the years 1995 to 2029, published by the Department of Transport and others. The MTS recognises that Perth is, and will continue to be, a car-dominated city. However, the MTS is clear that current trends in car use, as opposed to other modes of transport, are either not sustainable or would incur great costs to the community if this were to continue unrestrained. The main elements of the MTS recognise that:

> increased co-ordination of the development and use of the transport system as a whole;

> greater integration and mutual support between the transport system and land uses and;

> improved efficiency in the use of transport infrastructure and services.

The main elements provide a strong basis for the direction of transport management within Perth by ensuring that future development will be more efficient and integrated. The strategy also recommends an objective and target that is applicable to the Bike Plan.

Objective	Target
Promote walking and cycling	Incorporate walking and cycling guidelines in all metropolitan local authority town planning and transport planning schemes by 2000.

A further objective of the MTS is to more than double the non-commercial mode share of cycling trips to 11.5% of non-commercial trips by 2029. Current trends indicate that if no action is taken, cycling mode share will not reach this target.

A.2.3 Western Australia Planning Commission Development Control Policy 1.5 – Bicycle Planning (1998)

This policy describes the planning considerations which should be taken into account in order to improve the safety and convenience of cycling. Both State and Local Government agencies have been encouraged to promote cycling as a mode of transport because of:

> recognition of the adverse environmental effects of motor vehicles, particularly the private car
> moves towards the development of low-energy lifestyles, initially as a response to the “energy crisis” of the mid-1970s
> the need to make more efficient use of transport infrastructure
> increasing awareness that cycling reduces congestion and the need for car parks.

The policy sets out a requirement to ensure cycling is considered in all aspects of land use and transport planning. In particular, the policy recommends (pp. 5-6) that a cycling network should be developed for urban areas by:

> improving the existing road network and new subdivisional roads to meet the needs of cyclists more effectively
> providing off-road facilities of adequate standard where there is a strong demand (such as near schools) and where the opportunity exists
> providing information to enable cyclists to make the most effective use of the network
> ensuring that the needs of cyclists are adequately catered for in the planning, design and construction of extensions to the existing road network.

This Bike Plan has been prepared in accordance with these principles. The Bike Plan contains proposals to improve the existing road network, provide off-road facilities, provide information (by way of pavement markings and signs) to enable cyclists to use the network and ensure that cyclists are adequately catered for in future infrastructure projects.

The policy also supports the provision of appropriate end of trip facilities through the imposition of development conditions dealing with such matters as the type, number and location of bicycle parking facilities, and the installation of showers and change rooms with an emphasis on locations including:

> shopping centres
> factories
> offices
> educational establishments
> sport, leisure and entertainment centres
> health centres and hospitals
> libraries and other public
> buildings
> rail and bus stations
> major places of employment
> parks
> beaches and recreation venues
> tourist attractions

Recommendations for the location of future end-of-trip facilities have been included in this Bike Plan.

A.2.4 Bike Ahead: Bicycle Strategy for the 21st Century

The Bike Ahead plan recognises the significance of cycling to minimise the reliance people have towards using their cars as a sole mode of transport. According to the plan, an interconnected cycling network has the capacity to vastly enhance accessibility, which is an increasingly salient facet given the displacement of the growing population to the urban fringe. The Bike Ahead strategy emphasises a network of cycle facilities which:

> is convenient, accessible and safe;

> is comprehensive, providing access to most destinations for most cyclists;

> establishes connectivity; and

> has regional coverage.

The Perth Bike plan approach strategies are also covered within this document, with a broad array of information relating to cycling behaviour outlined.

> Cycling is primarily a transport mode, serving major trip attractors and generators, rather than purely a recreational activity.

> It is neither practical nor necessary to provide segregated cycling facilities on each and every street, or even on the majority of streets.

> The majority of cycling is, and will continue to be, on the road/street system, and cycling must be actively incorporated into the planning and design of roads and streets.

> The majority of cyclists have never been taught to ride a bicycle as a vehicle.

> The majority of non-cyclists have never been taught to regard the cyclist as a legitimate road user nor how to share the road with cyclists.

> The majority of bicycle/motor vehicle accidents have, as one contributory factor, poor cyclist behaviour or, in the case of adult cyclists' accidents, poor motorist behaviour.

> Bicycle/motor vehicle accidents represent only 1 in 5 serious injury accidents and only 1 in 30 injury accidents for cyclists.

The Bike Ahead strategy builds on 12 key objectives of the MTS and adds three further objectives. In 1996, these objectives were written as follows:

1. Bikewest to continue to be an advocate for cycling facilities and services and to co-ordinate cycling programs.
2. Review legislative basis for cycling and cycling facilities as a recognised transport mode.
3. Establish more effective links with road safety programs.
4. Introduce safe cycling programs target at motor vehicle users and pedestrians.

5. Identify, develop and signpost safe routes to defined local destinations including schools and commuter routes.
6. Encourage bicycle-friendly local area traffic management.
7. Provide appropriate on-road and published information and traffic signing.
8. Integrate bicycle use with public transport.
9. Promote design standards which encourage cycling without the need for totally separate facilities.
10. Define, establish and maintain continuous local cycling routes.
11. Define, protect and implement a regional cycle network.
12. Incorporate cycle requirements in local government planning schemes and policies.
13. Educate cyclists and other road users about rights, needs and responsibilities of cyclists.
14. Ensure bicycle facilities serve the needs of all cycle users.
15. Continue to implement the Perth Bikeplan of 1985.

The Perth Bicycle Network Plan (PBNP), which was produced as a supplementary document to Bike Ahead, expands upon the Perth Bikeplan by setting out the proposed cycle network for the Perth Metropolitan Region, to serve regional and, wherever possible, local cycle trips. Additional strategies are also covered throughout the Perth Bikeplan, and these include;

> public transport integration is primarily addressed in Bike Ahead, but the PBNP will ensure good cyclist access to train stations and other major public transport interchanges;

> local area traffic management is a key issue in the specific design of on-road bicycle routes, but needs to be addressed on the broader basis that 'every street is a bicycle street'.

In addition to maintaining the approach that every street is a bicycle street, opportunities for the development of the Perth Bicycle Network include;

> On-Road Bicycle Routes- linked local streets with special provision for and priority to cyclists;

> Principal Transport Routes- high standard bicycle facilities along the alignments of suburban railways and freeways; and

> Regional Recreational Paths- combined recreational and commuter cycle facilities following linear areas of public open space, such as river and coastal foreshores.

A.2.5 Liveable Neighbourhoods (2009)

Liveable Neighbourhoods was produced to implement the objectives of the previous State Planning Strategy which guides the sustainable development of Western Australia to 2029. Its primary function is as a guide to more sustainable structure planning and subdivision, applicable to new urban areas and large urban infill sites.

The key element of Liveable Neighbourhoods relevant to, and consistent with, this Bike Plan is Element 2, Objective 9:

> To provide a safe, convenient and legible bike movement network to meet the needs of both experience and less experienced cyclists, including on-street and off-street routes.

A.2.6 Main Roads WA (MRWA) Policy for Cycling Infrastructure (2000)

This document sets out MRWA's policies for the provision of cycling infrastructure on its network. All new road works and upgrades involving road widening will meet the requirements of these guidelines. Existing roads and cycling facilities that do not meet the above requirements will be progressively upgraded. The timing of retrofit work will be determined by the availability of funds and priorities.

Key elements of this policy relevant to the Shire of Kalamunda include:

On-Street Facilities

> New urban roads will be constructed with an edge line separated sealed shoulder in accordance with the desirable standards within Austroads' Guide to Traffic Engineering Practice "Bicycles" Part 14 (1999). Where this cannot be achieved, a shared path will be constructed adjacent to the road.
> On existing highways and main roads, the facility described above for new roads, will only be provided in conjunction with any upgrades involving widening the road where land is available within the existing road reserve or, if land is being resumed for other purposes, the cost of acquiring the additional land is not proportionately higher than that for the other purpose.
> Sections of rural main roads that are regularly used by more than 25 cyclists per day will comply with urban area guidelines indicated above. Roads not used regularly by cyclists will comply with MRWA Technical Standards for the provision of shoulders.

Off-Street Facilities

> Main Roads will provide shared paths adjacent to highways and main roads which are not considered appropriate for cyclists or where the lane widths required by these guidelines cannot be achieved.
> Path widths and layouts will generally be in accordance with Austroads Part 14 (1999), with the use of red oxide coloured asphalt for the path surface.

Note that the previous Austroads Guide to Traffic Engineering Practice Part 14 - Bicycles has now been integrated throughout the new Austroads series of guides.

A.2.7 Activity Centres for Perth and Peel

The State Planning Policy 4.2- Activity Centres for Perth and Peel made under part 3 of the Planning and Development Act 2005 describes the Perth and Peel regional planning framework. The policy provides an overview of the requirements for the planning and development of new activity centres and the redevelopment and renewal of existing centres in Perth and Peel. It is mainly concerned with the distribution, function, broad land use and urban design criteria of activity centres, and with coordinating their land use and infrastructure planning.

Section 5.3.2: Traffic and parking: General requirements (2) states that the planning of activity centres should:

> take account of the need for access and parking priority accorded to different users and modes including public transport, freight/delivery, people with a disability, bicycles, pedestrians and private cars, and balance competing user needs such as workers and visitors; and

> identify necessary improvements to public transport, walking and cycling infrastructure and capital and recurrent service funding needs.

Appendix 2: Model Centre Framework within the policy engenders a framework that incorporates planning considerations and activity centre structure plan requirements in the development phase of works. Section 3.4 within Appendix 2 covers the cycling guidelines for activity centres and outlines planning considerations. The planning considerations include:

Network Provision	To promote cycling as a viable mode of transport provision should be made for a comprehensive network that connects the Centre safely and conveniently to other local destinations. This includes dedicated or shared paths and the reallocation of road space to provide more space for cyclists, such as cycle lanes or bus lanes where cyclists are permitted.
End of trip facilities	Facilities should be provided to cater for and promote cycling within commercial and community developments such as showers, change rooms and lockers.
Cycle Parking	Standards to ensure the supply of adequate cycle parking for public and private use should be adopted and mandated as part of the development control process.

A.2.8 Our Bike Path 2014-2020

This document is published by WestCycle and provide a strategic framework to guide the future and growth of cycling in Western Australia. The document envisaged Western Australia as a state that embraces all forms of cycling with safe cycling environment and strong cycling culture with targets set out below:

Category	Description
Participation	Over 1 million Western Australians regularly riding by 2020.
Transport	5% transport mode share for cycling.
Female Participation	Reduce disparity between men's and women's participation in cycling.
Children's Participation	Increasing the percentage of kids riding to school closer to 1970 levels (84% of children walked, cycle or used public transport in 1970).
Safety	Reduce the number of serious bicycle injuries every year.
Image	Dramatically improve community perceptions of cycling as a safe and enjoyable activity.
Sporting Success	Increase the number of Western Australian cyclists winning gold at national championships.
Infrastructure	increase the number of cycling infrastructure facilities in metropolitan and regional WA (includes cycle paths, mountain bike trails and cycle sport facilities) every year

To achieve its vision, the document focuses on 5 key actions that are described below:

Action	Description
Grow a cycling culture	Creating a place where riding is encouraged, supported, and celebrated by creating an environment where cycling is free from negative association and embraced as a normal activity.
Create a bike friendly communities	Transform the streets, roads, and local communities into a place where cycling is safe for adult and children
Build the capability of our community	Support and build the capacity and capability of cycling groups and organisations to effectively deliver cycling initiatives in communities
Strengthen our sporting pathway	Develop pathway structure that enables all Western Australian to achieve their full potential
Develop a cycling economy	Maximise the economic benefits of cycling in Western Australia.

A.2.9 Perth Transport Plan for 3.5 Million People and Beyond

Perth Transport Plan provides long term vision for Perth's transport network as its population grow to 3.5 million people published by the Department of Transport. The plan covers 4 major transport network: Public Transport, Road, Active Transport, and Freight.

The plan recognised that Perth has the attributes for a great cycling city and cycling will be a big part in reducing congestion, air pollution, and encourage more people to live a healthy and active lifestyle.

The emphasis of the plan for cycling in Perth is to provide high quality, safe, and comfortable cycling infrastructure, especially around activity centres, as well as high quality end-of-trip facilities with a broad objective of increasing cycling trips from 100,000 per day (2011 Census Data) to 500,000 and to extend the off-road cycle network from 172km to 850km when the population of Perth reaches 3.5 Million in 2050. On-road cycling routes will be assessed on a case-by-case basis and developed as appropriate to the local road environment, e.g. bike boulevards for older suburbs with grid-like road network.

Objectives from the plan that can be applied directly to the bike plan include:

> Gaps in the current off-road cycle network will be filled

> End-of-trip facilities will be available at all major centres

> Strengthen on-road strategic network

The document proposes new (or formalised) routes for the Shire including:

> Guildford to Kalamunda Town Centre via Bushmead Road, Helena Valley Road, Zig Zag Scenic Drive, and Railway Road

> Kalamunda Town Centre to future Forrestfield Train Station via Maida Vale Road and Kalamunda Road.

> Kalamunda to Stoneville in the Shire of Mundaring via Mundaring Weir Road and Stoneville Road

A.2.10 Cycling Network Plan Transport at 3.5 Million

This document informs the Perth Transport Plan (section A.2.9). It identifies a number of cycling related projects in the Kalamunda area:

> Roe Highway PSP – Berkshire Road to Great Eastern Highway

> Tonkin Highway PSP – Mills Road West to Hale Road

> Darling Scarp training circuit review to ensure it meets the aspirations of sports cyclists.

A.2.11 Perth and Peel Mountain Bike Master Plan 2016 – 2026

The Perth and Peel Mountain Bike Master Plan is developed to guide future strategic investment in mountain bike recreation, tourism, and event development across the Perth and Peel regions of Western Australia.

In the context of the Shire of Kalamunda, Perth Hills Trails are identified as a high priority location of national significance. The plan envisions Perth Hills as a mountain bike precinct and the primary recreational mountain biking destination for the Perth and Peel region.

The strategic objectives of the Master Plan are presented below:

Objectives	Description
Economic Benefits	▪ Identify the economic outcomes to meet with the wider objectives of the Perthand Peel regions ▪ Identify the right trail models to generate income and potentially secure significant economic benefits ▪ Identify diversity of land tenure (including private)
Tourism	▪ Develop mountain biking experiences to meet with the wider objectives for the Perth and Peel regions ▪ Provide product to cater for domestic tourism - day visitors and short breaks
Environmental	▪ Maintain a sense of place Conduct a best practice trail demonstration project ▪ Build a sustainable gravity-focused trail project with land manager support to demonstrate mitigation measures and what can be achieved ▪ Reduce the impacts of unsanctioned trails in the region
Social	▪ Provide trail diversity, enabling access for all ▪ Consider heritage (Indigenous and non-Indigenous) and local culture ▪ Consider integration with and potential conflict with other user groups ▪ Facilitate broad societal community benefits ▪ Provide suitable and accessible facilities for underrepresented groups including young people and families
Recreation	▪ Provide a diversity of accessible trails types and experiences ▪ Increase trail quality ▪ Provide trail networks accessible by bike ▪ Identify locations and networks that facilitate community ownership (both local and club)
Events	▪ Identify sites suitable for national and international events, and any associated constraints ▪ Identify suitable locations for local events ▪ Provide accessible facilities for events.

A.3 Local Policies and Planning Documents

A.3.1 Shire of Kalamunda Local Planning Scheme No.3

The Local Planning Scheme No.3 (LPS No.3) for the Shire of Kalamunda acts an instrument to control, regulate and co-ordinate public and private development, the use of land and buildings and other activities to improve the amenity, convenience, economy and attractiveness of the environment within the municipality. The document provides direction for the implementation of future infrastructural works, encompassing a broad scope of development which includes buildings, roads and paths.

The LPS does not currently have requirements for bicycle parking or end of trip facility requirements, which is a key gap identified in this policy. Future revision of the LPS should include requirements for bicycle parking facility by land use.

A.3.2 Kalamunda Advancing: Strategic Community Plan to 2023

Kalamunda Advancing: Strategic Community Plan to 2023 outlines the overriding direction and framework for the Shire. Key objectives and strategy of the plan that are related to cycling are as follow:

Strategic Priority	Objective	Strategy
Strategic Priority 2 Kalamunda Interacts: Providing Our People with Enjoyment	**2.3** To encourage and facilitate healthy lifestyles through regular participation in recreational and leisure oriented activities.	**2.3.3** Plan for the improvement and expansion of the existing shared pathways network to ensure a high quality and consistent network is provided for walking, cycling and recreational hiking.
Strategic Priority 4 Kalamunda Develops: Using Our Land and Assets Diversely and Effectively	**4.7** To ensure the selection, maintenance, inspection, renewal and disposal of all categories of assets within the Shire is managed efficiently.	**4.7.1** Maintain, refurbish or upgrade existing infrastructure, including public buildings, parks, reserves, local roads, footpaths, cycle ways, verges and drainage networks to encourage increased utilisation and extension of asset life.
Strategic Priority 5 Kalamunda Employs: Supporting Our Industries And Businesses	**5.5** To be courageous and tenacious in the pursuit of benefits from the State and Federal Governments through effective advocacy.	**5.5.1** Continue to advocate to all levels of government for the delivery of appropriate public transport options including cycling and walkways for the Shire and the region.

A.3.3 Shire of Kalamunda Bike Plan 2009

The 2009 Bike Plan was developed to assist the Shire in planning for future infrastructure needs, to maximise the efficiency and effectiveness of the existing bicycle network and to enhance bicycle facilities for all users. Existing road and path network were audited to determine the scope for future upgrades to the cycle network.

The proposed cycling network within the 2009 bike plan was designed to enhance connectivity between higher order commuter routes. Key activity nodes within the Shire are also proposed to be connected by a legible, off-street path network.

A review of the bike plan showed that most of the proposed infrastructure upgrades have not been implemented. Refer to the table below for completed or partially completed recommendations.

Action	Location	Description	Completion
Install Shared Path	Welshpool Road East	Install 4000m of 3.0m bitumen path north side of Welshpool East between Tonkin and Crystal Brook. Signpost and line markings	Complete Welshpool East to Lewis Street
Install Shared Path	Hale Road	Install 1500m section of 2.3m concrete path, between Hardey East and Tonkin Signpost and centre line markings	Complete between Hardey East Road and Sheffield Road
Install PSP Link	Tonkin Highway	After initial designation to sealed shoulder, install 2700m of 3.5m Principal Shared Path (PSP) between Welshpool and Roe along west side of Tonkin Hwy.	Complete between Roe Highway and Hale Road on the eastern side

A.3.4 EMRC Regional Cycle Network Masterplan 2011 – Report Card 2016

The EMRC Regional Cycle Network Masterplan was created to improve the planning and development of cycling infrastructure of Perth's Eastern Region. A report card released in 2016 provides progress update to the 20-year works program featured in the Masterplan. The following table provide a list of works within the Shire and its status.

Corridor	Works	Status
Roe Highway	Principal Shared Path – Orrong Road / Welshpool Road to Tonkin Highway	Under Construction
	Principal Shared Path – Tonkin Highway to Berkshire Road	Completed
	Principal Shared Path – Berkshire Road to Kalamunda Road	Not Completed
	Principal Shared Path – Kalamunda Road to Great Eastern Highway Bypass	Not Completed
Tonkin Highway	Welshpool Road East to Kelvin Road	Not Completed
	Principal Shared Path – Hale Road, Forrestfield to Victoria Street, Redcliffe	Completed
Welshpool Road East	Roe Highway to Tonkin Highway	Not Completed
	Shared Path – Tonkin Highway to Lewis Road	Completed

A.3.5 Zig Zag Community Action Plan (2012/2013)

This document summarises findings from community consultation which originally set out to combat antisocial behaviour in the area but the scope widened to general improvements which would benefit users of the zone.

Four recommendations were made one of which related specifically to cycling (create and promote a walking, hiking and cycling zone along the whole Lower Zig Zag section), and required the closure of the existing one way road to motor vehicles.

A.3.6 Shire of Kalamunda Health and Wellbeing Plan 2013-2016

This document recognises the need to encourage physical activity of residents and visitors. It references the 2009 Bike Plan and the need to support active living by providing "well linked and attractive cycle and walk ways"

A.3.7 Perth Hills Trail Master Plan (2013)

This purpose of this document is to prepare a Master Plan for all trails within the boundaries of the Shire of Kalamunda and the Shire of Mundaring, which are collectively referred to as the Perth Hills Trails. The Master Plan provides an overview of the existing trail network, which include audit, assessment, analysis, and mapping of the network to identify opportunities and provide strategic direction over the next 15 – 20 years.

The Strategy and Action Plan within the document has four key strategic themes:

> Integrated Planning and Management

> Sustainable Trail Provision and Enhancement

> Participation and Utilisation

> Economic, Tourism, and Community Development

A.3.8 Perth Hills Trail Loop Concept Design Report (2016)

The Perth Hills Trail Loop Concept Design Report was commissioned to achieve two recommendations in the Perth Hills Trail Master Plan:

> Improve the link between Kalamunda, Bickley, and Pickering Brook areas for both walkers and cyclists

> Create a link through the western end of the Helena Valley between the northern area of Kalamunda and Railway Reserves Heritage Trail to enable a complete Mundaring to Kalamunda Loop Trail

The main outcome of this report is the development of the above trail links alignment, development details, costing, and implementation plan.

A.3.9 Forrestfield North District Structure Plan (2016)

The Forrestfield North District Structure Plan (DSP) was developed in order to provide strategic guidance for the development of the Forrestfield North Area into a Transit Oriented Development with the future Forrestfield Train Station as its focus. The structure plan would include medium to high density housing, employment opportunities, and new parklands.

As part of the DSP, a network of shared paths and cycle lanes are proposed to be built throughout major roads within the Structure Plan area, providing connectivity from the station to future developments in the area and the future Roe Highway Principal Shared Path (PSP) extension.

Sultana Road East and West is also proposed to be connected and grade separated from Roe Highway, providing an additional link into the future station. This future upgrade presents an opportunity to incorporate cycling facility along Sultana Road with connection with the future Roe Highway PSP extension

A.3.10 North-East Sub-regional Planning Framework: Towards Perth and Peel @3.5 Million

This document was created to establish a long-term and integrated planning framework for land use and infrastructure provision for the North-East planning sub-region, comprising of City of Swan, Shire of Kalamunda, and Shire of Mundaring.

Urban expansion areas currently proposed within the Shire of Kalamunda include the Wattle Grove South District Centre located south of Crystal Brook Road, and Forrestfield North District Centre.

With regards to cycling, the framework supports the provision of comprehensive path networks to provide an alternative to private car use. The State Government will continue to deliver Principal Shared Path Network within the North-East sub-region, including along the Midland Rail Line, Roe Highway and Reid Highway.

A.3.11 2016 Community Scorecard

The 2016 Community Scorecard for the Shire of Kalamunda presents the results of community perception survey to evaluate community priorities and to measure the Shire's performance on various aspects, such as governance, economic development, built environment, and natural environment.

In relation to the bike plan, the Shire's footpaths and cycleways were rated. 63% of the respondents gave a performance rating of either 'okay', 'good', and 'excellent' to the Shire's footpath and cycleways. While this a positive result, the Shire's performance index score of 44 (out of 100) is currently lower than the average of 60 of all participating Local Governments and below the highest performance index score of 72.

Improving the footpaths and cycleways, are one of the top 4 priorities for the Shire to address moving forward. The community would like to see more and better quality footpaths, better cycleways connection to adjacent suburbs, more on-road cycle lanes, as well as safety improvement for cyclists on major roads.

Bicycle Plan 2017

APPENDIX B

FORRESTFIELD NORTH DISTRICT STRUCTURE PLAN

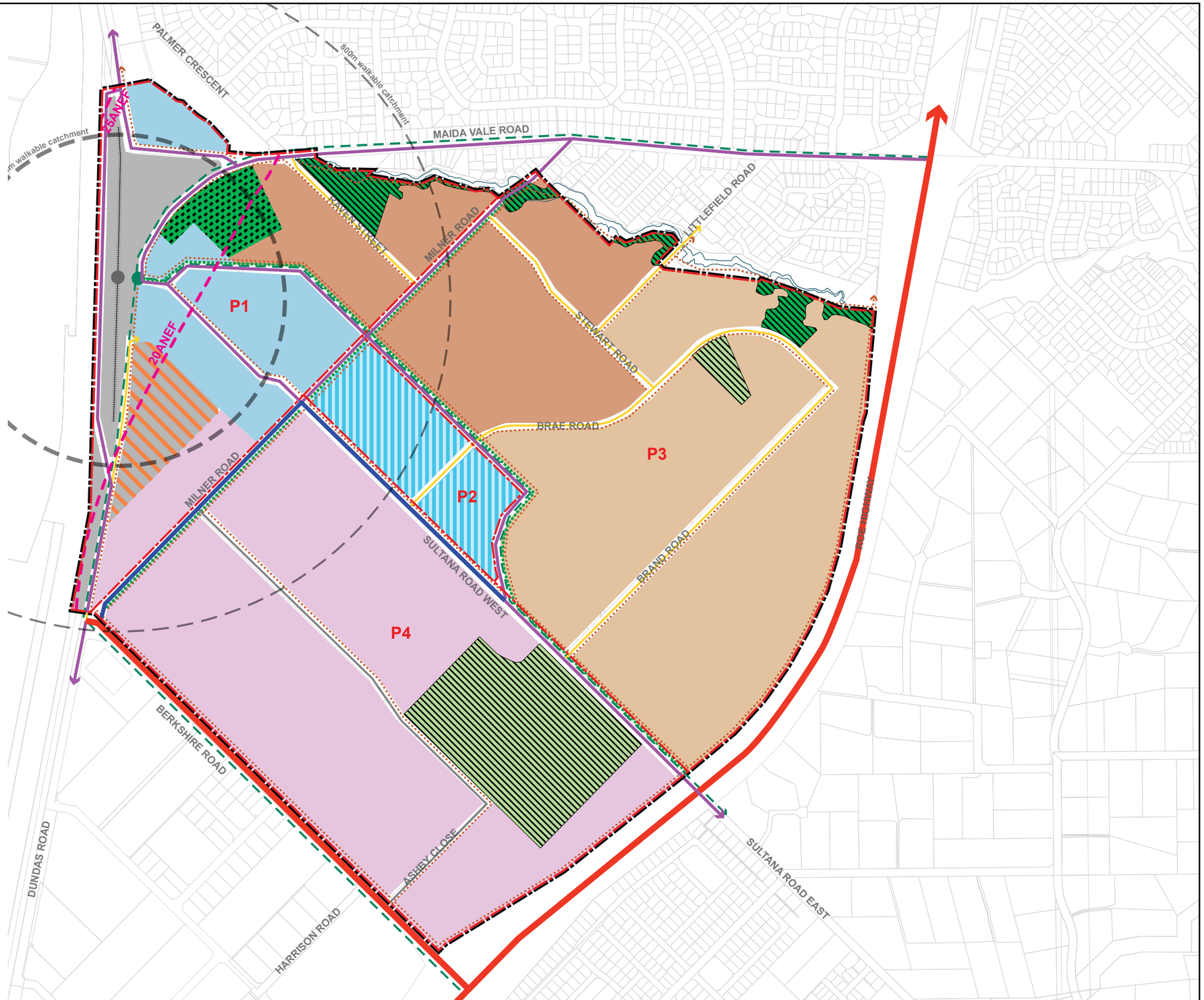
LEGEND

- Medium Density Residential
- High Density Residential
- Activity Centre
- Mixed Use
- Light industry
- Parks and Recreation - Local
- Parks and Recreation - Regional
- Bush Forever
- Conservation
- Railway
- ANEF Contour
- Primary distributor road
- District distributor integrator A
- District distributor integrator B
- Neighbourhood connector
- Industrial road
- Shared Path
- On-road cycle paths
- Railway Line
- Bus route
- Transit station
- Railway station
- Walkable catchment (400m)
- Walkable catchment (800m)
- Precinct boundary

P1 Forrestfield Station TOD Precinct
P2 Forrestfield North Activity Centre Precinct
P3 Forrestfield North Residential Precinct
P4 Forrestfield / High Wycombe Light Industrial Area

- Structure plan boundary
- Existing cadastre
- Preferred ultimate permanent parking location (subject to further investigation).

It is noted that Precinct 3 features a concentration of Threatened Ecological Communities and Declared Rare Flora sites which may affect development potential. Refer to Figure 7 of the District Structure Plan report.



Structure Plan

Forrestfield North District Structure Plan

0 50 100m

Project Manager: MC Date: 24 Aug 2016
Drawn: OP Scale: 1:5,000 @ A3
Checked: MC Drawing No. 714-504 ST-12A

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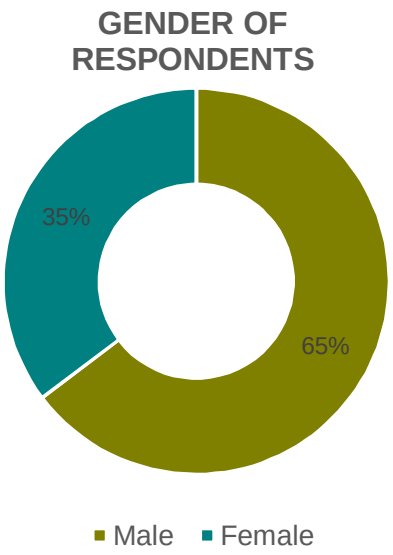
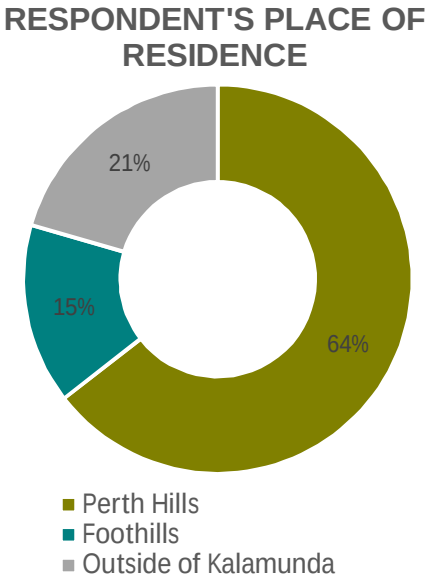
Bicycle Plan 2017

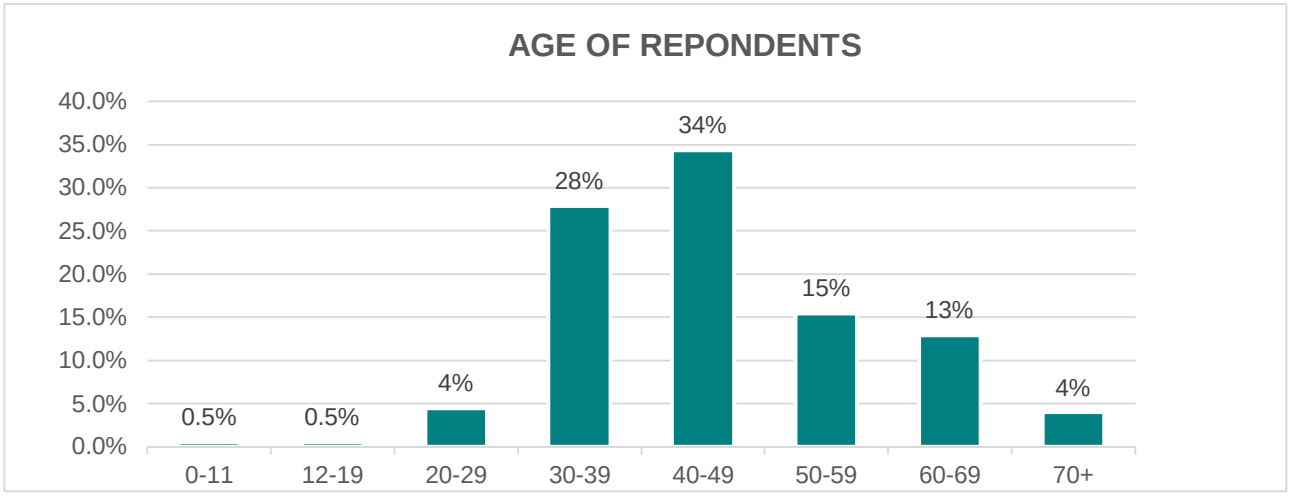
APPENDIX C

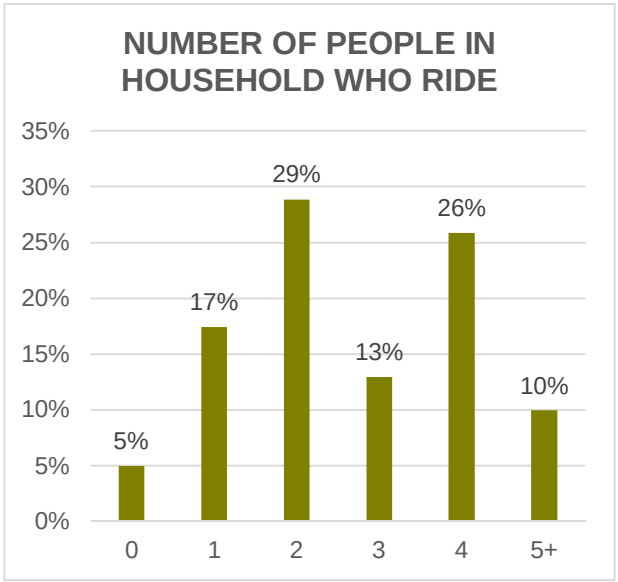
COMMUNITY SURVEY RESULTS

Figure 13-2 Demographics (Questions 1 to 5)









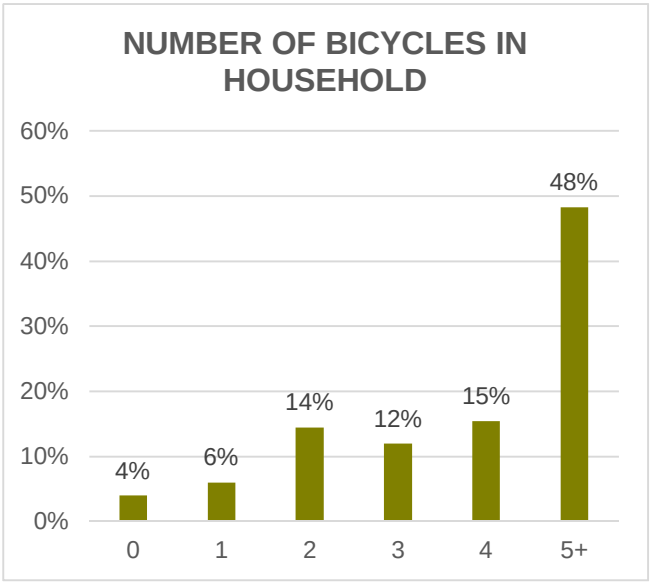
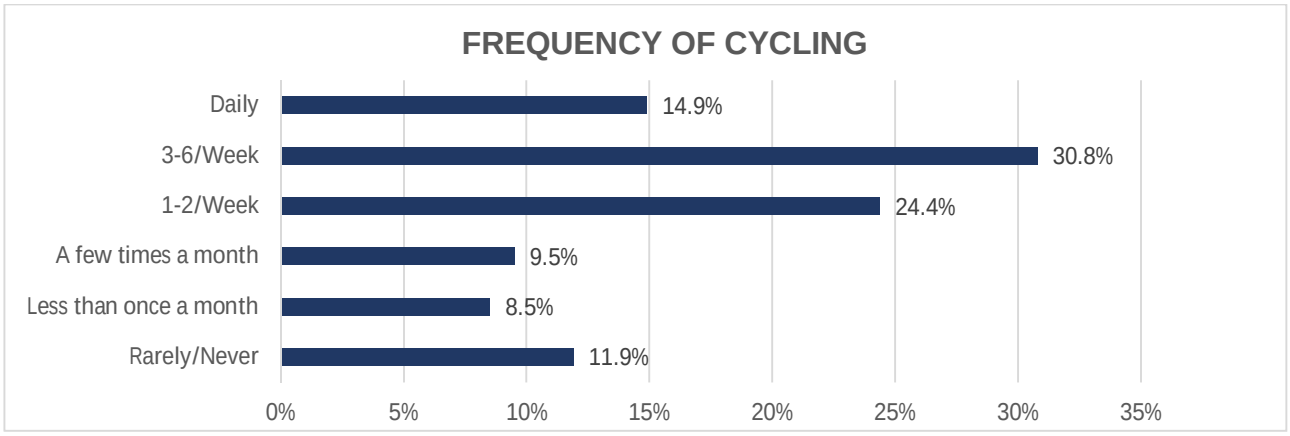
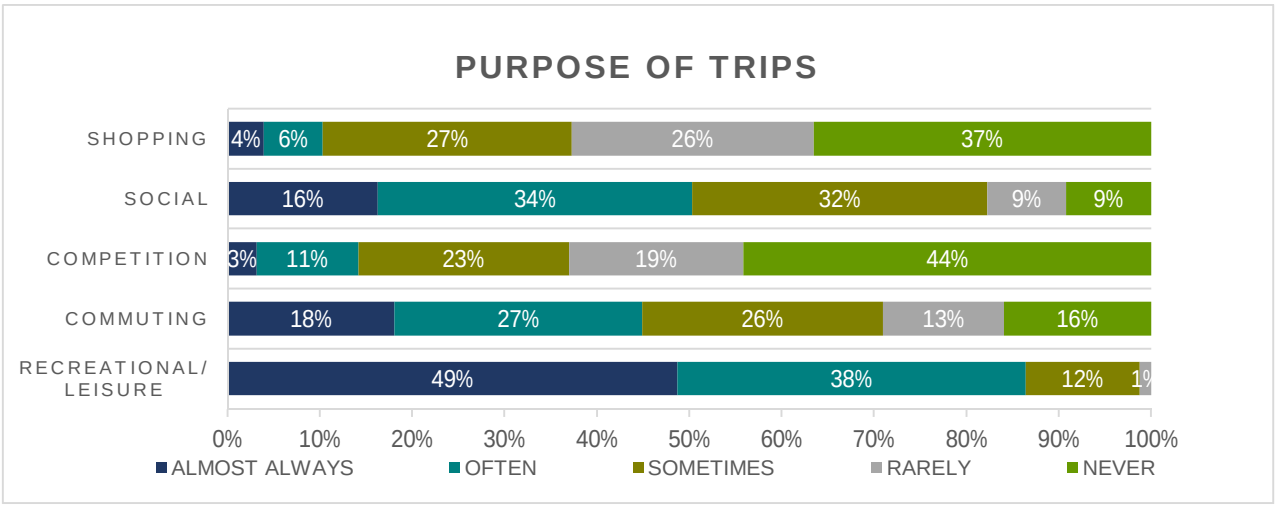


Figure 13-3 Attitudes, trip purpose and trip frequency (Questions 6, 10 & 14)





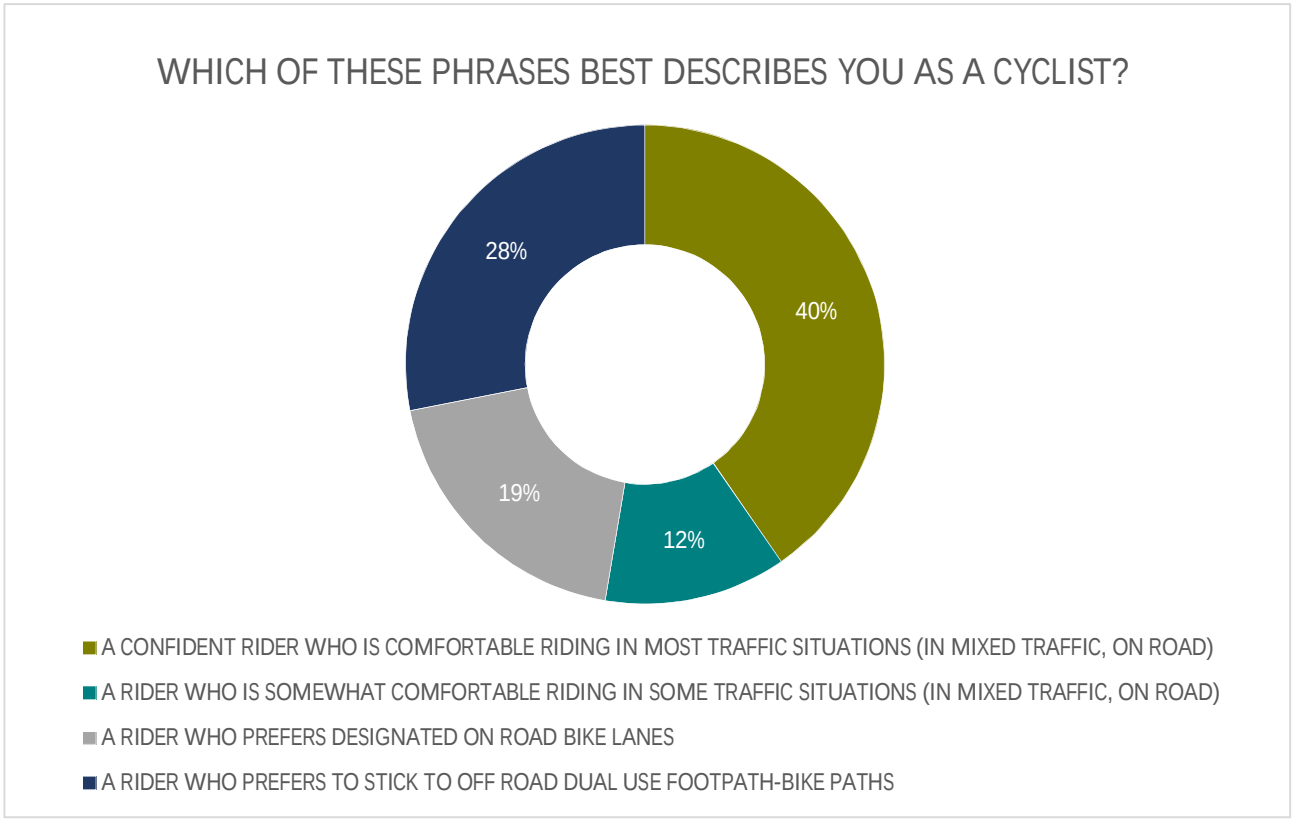


Figure 13-4 Route Types (Q15)

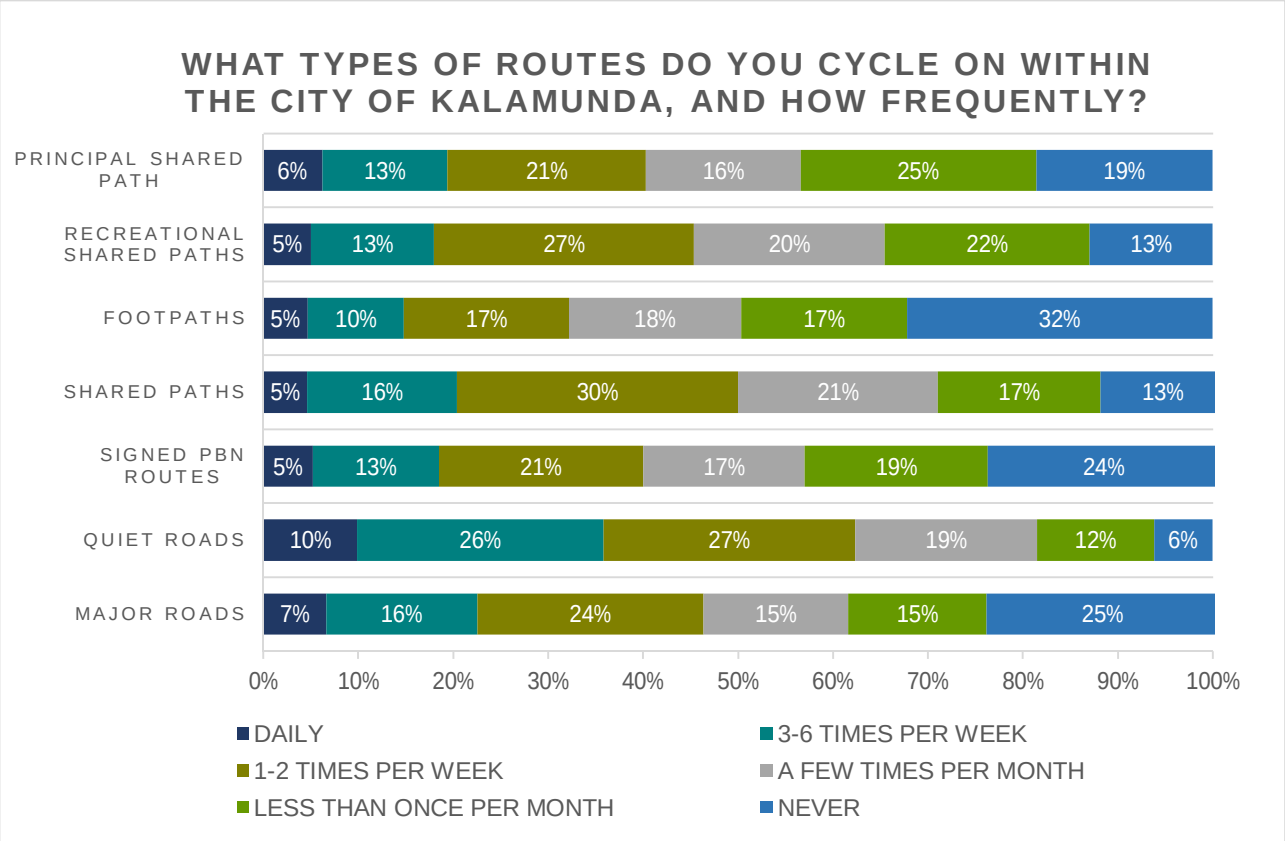
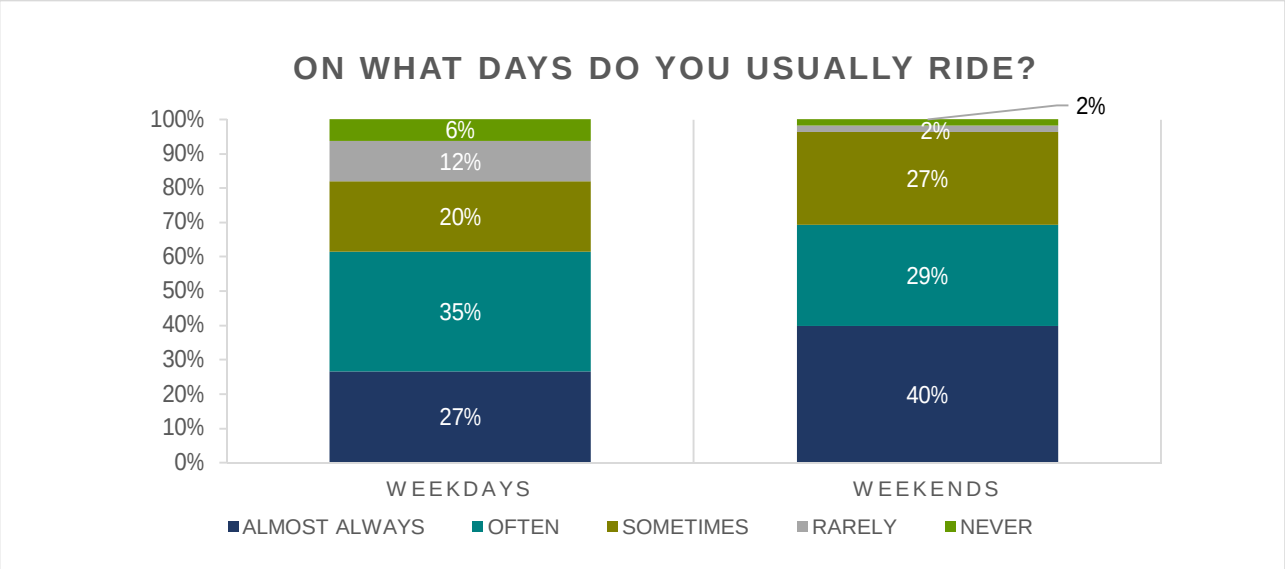


Figure 13-5 Visitors to the City (Q11 Q12 Q13)



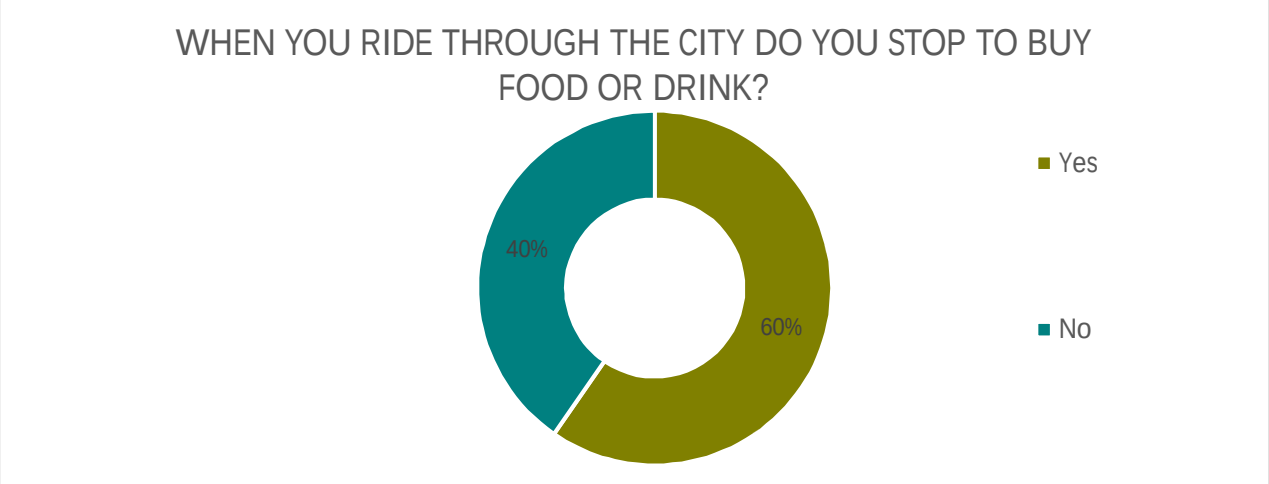
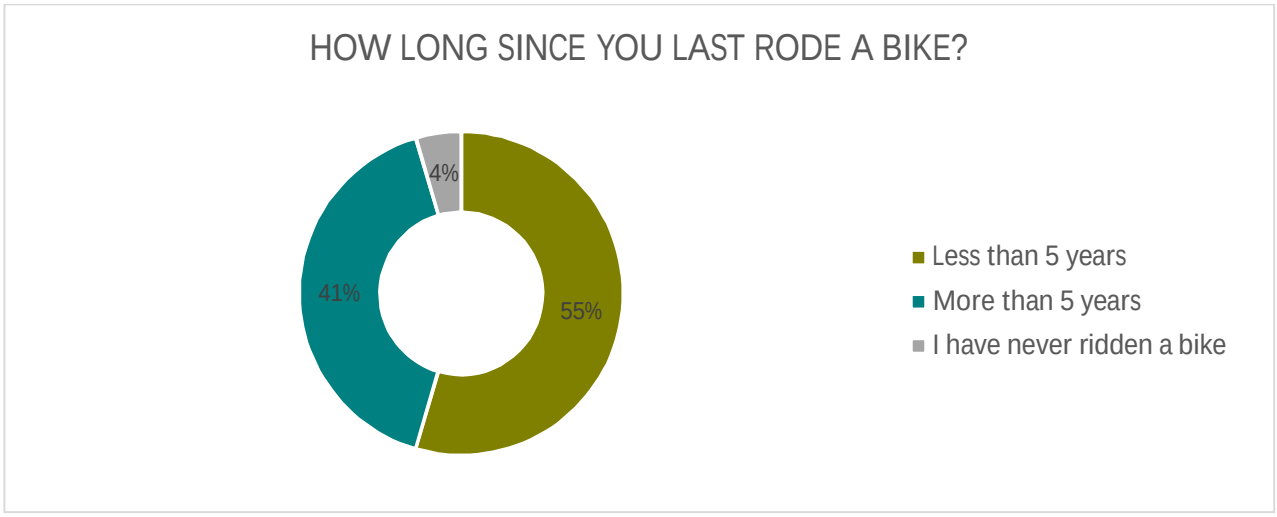
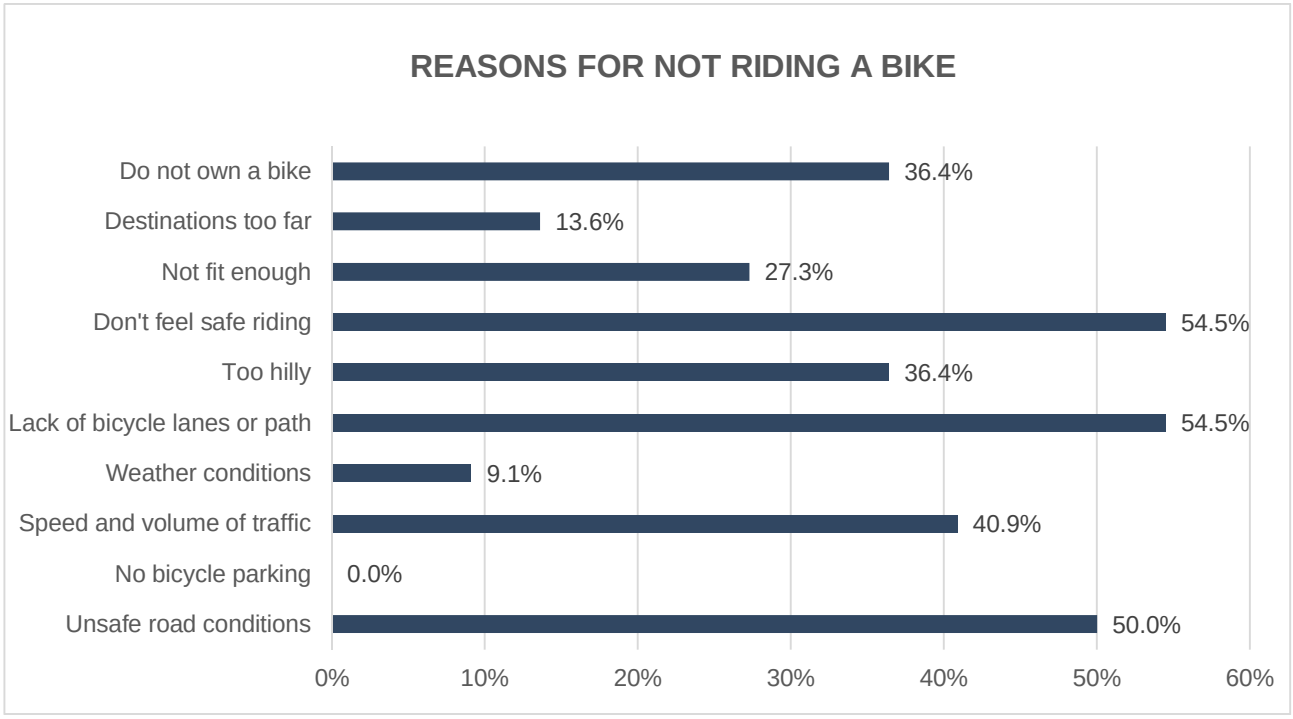


Figure 13-6 Less Frequent Riders (Q7-9)





Bicycle Plan 2017

APPENDIX D

WORKS SCHEULDE & MAP - $500,000

City of Kalamunda Bicycle Plan 2017 - Project Schedule $500,000 per Annum Scenario

0-5 Years

Project No.	Primary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
80a	Roe Highway	PSP Completion Part of Roe Highway/Kalamunda Road Upgrade	Berkshire Road	Kalamunda Road	0-5		$ 2,260,000	$ 2,260,000	State Government Funded
81a	Tonkin Highway	PSP Extension on the Southern Side (including link to Hartfield Park)	Roe Highway	Welshpool Road East	0-5		$ 1,430,000	$ 1,430,000	State Government Funded
82a	Freight Railway / Dundas Road	Dundas Road PSP	Tonkin Highway	Forrestfield Station	0-5		$ 2,580,000	$ 2,580,000	State Government Funded
82b	Freight Railway / Dundas Road	Dundas Road PSP	Forrestfield Station	Wittenoom Road	0-5		$ 730,000	$ 730,000	State Government Funded Review priority when Forrestfield Station design is released
	Secondary Route								
1a	Hills Spine	Zig Zag Option A	Ridge Hill Road	Ocean View Parade	0-5	$ 35,000		$ 35,000	
1d	Hills Spine	Kalamunda Town Centre Section Options Study	Canning Road	Elizabeth Street	0-5	$ 25,000	$ 25,000	$ 50,000	Potential WABN Grant Funding
2c	Kalamunda Road	Sealed Shoulder	Fernan Road	Abernethy Road	0-5	$ 560,000		$ 560,000	Include as part of existing planned upgrade
3d	Forrestfield Station Connection	Milner Road Protected Cycle Lanes	Maida Vale Road	Dundas Road	0-5		$ 620,000	$ 620,000	To be funded and constructed as part of the Forrestfield North District Structure Plan
	Local Route								
20a	Foothills Spine	Welshpool Road East Shared Path (including to connection from Puddy lane to Hale Road)	Roe Highway (City Boundary)	Puddy Lane	0-5	$ 65,000	$ 65,000	$ 130,000	Potential WABN Grant Funding
20b	Foothills Spine	Puddy Lane Shared Path	Welshpool Road East Shared Path	Hale Road	0-5	$ 85,000	$ 85,000	$ 170,000	
20c	Foothills Spine	Hale Road Shared Path Extension	Extensa Road	Puddy Lane	0-5	$ 50,000		$ 50,000	
20d	Foothills Spine	Hale Road Existing Shared Path Upgrade (Western Side)	Extensa Road	Lenihan Corner	0-5	$ 320,000		$ 320,000	
21d	High Wycombe Local Route	Public Access Way Upgrades (through McLarty Way, and Walker Crescent)	Kiandra Way	Newburn Road	0-5	$ 95,000		$ 95,000	Potential external funding (non WABN)
21e	High Wycombe Local Route	Butcher Road & Palmer Crescent Safe Active Street	Newburn Road	Palmer Crescent	0-5	$ 390,000		$ 390,000	Potential external funding (non WABN)
21f	High Wycombe Local Route	Everitt Place Shared Path	Palmer Crescent	Maida Vale Road	0-5	$ 85,000		$ 85,000	Potential external funding (non WABN)
22a	Berkshire & Dundas Road	Berkshire Road (West of Roe Highway) Shared Path Upgrade	Roe Highway	Dundas Road	0-5	$ 230,000	$ 230,000	$ 460,000	Potential WABN Grant Funding
22c	Berkshire & Dundas Road	Dundas Road Shared Path	Berkshire Road	Forrestfield Station	0-5	$ 180,000	$ 180,000	$ 360,000	Potential WABN Grant Funding
	Safe Active Street								
44	Forrestfield (Gala Way)	Gala Way Safe Active Street	Fruit Tree Crescent	Hawtin Road	0-5	$ 50,000		$ 50,000	Allowance to supplement existing traffic calming
	Traning Route								
63	Welshpool Road East	Lesmurdie Road Intersection Safety Improvement	-	-	0-5	$ 40,000		$ 40,000	
61a	Canning Road	Canning Road Road Safety Audit	-	-	0-5	$ 25,000		$ 25,000	
61b	Canning Road	Targeted Shoulder Widening Stage 1	Pickering Brook Road	City Boundary	0-5	$ 225,000	$ 225,000	$ 450,000	Black Spot Funding
64a	Mundaring Weir Road	Mundaring Weir Road Road Road Safety Audit	-	-	0-5	$ 15,000		$ 15,000	
64b	Mundaring Weir Road	Targeted Shoulder Widening Stage 1	Railway Road	City Boundary	0-5	$ 225,000	$ 225,000	$ 450,000	Black Spot Funding
65	City of Kalamunda	Safe Passing Law Review	-	-	0-5	$ 10,000		$ 10,000	
					TOTAL	$ 2,710,000	$ 8,655,000	$ 11,365,000	

5-10 Years

Project No.	Primary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
80b	Roe Highway	Roe Highway PSP Completion	Kalamunda Road	Brinsmead Road (Northern City Boundary)	5-10		$ 660,000	$ 660,000	State Government Funded
81b	Tonkin Highway	PSP Completion	Welshpool Road East	Kelvin Road/Mills Road	5-10		$ 1,310,000	$ 1,310,000	State Government Funded
	Secondary Route								
1b	Hills Spine	Lascelles Parade / William Street Safe Active Street	Zig Zag Scenic Drive	Hill Street	5-10	$ 320,000	$ 320,000	$ 640,000	Potential WABN Grant Funding
1c	Hills Spine	Kalamunda Railway Heritage Trail Sealed Path	Hill Street	Elizabeth Street	5-10	$ 150,000	$ 150,000	$ 300,000	Potential WABN Grant Funding
1e	Hills Spine	Canning Road Bufferred Bike Lanes Stage 1	Kalamunda Road	Railway Road	5-10	$ 380,000	$ 380,000	$ 760,000	Potential WABN Grant Funding
1f	Hills Spine	Canning Road Bufferred Bike Lanes Stage 2	Railway Road	Lesmurdie Road	5-10	$ 600,000	$ 600,000	$ 1,200,000	Potential WABN Grant Funding
3a	Forrestfield Station Connection	Maida Vale Road Protected Cycle Lanes Stage 1	Forrestfield Station	Priory Road	5-10		$ 1,090,000	$ 1,090,000	To be funded and constructed as part of the Forrestfield North Developer Contributions Plan
3b	Forrestfield Station Connection	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 1	Forrestfield Station	Roe Highway	5-10		$ 1,460,000	$ 1,460,000	Include as part of Forrestfield North District Structure Plan
	Local Route								
21c	High Wycombe Local Route	Kiandra Way Safe Active Street	Western Avenue	Norling Road	5-10		$ 660,000	$ 660,000	SAS Program Funding
	Safe Active Street								
41a	Forrestfield (Hibiscus Drive)	Hale Road Shared Path	Hannover Street	Hibiscus Drive	5-10	$ 430,000		$ 430,000	
41b	Forrestfield (Hibiscus Drive)	Hibiscus Drive SAS	Bougainvillea Avenue	Strelitzia Avenue	5-10		$ 330,000	$ 330,000	SAS Program Funding
41c	Forrestfield (Hibiscus Drive)	Bougainvillea Avenue Shared Path	Hibiscus Drive	Dawson Avenue	5-10	$ 240,000		$ 240,000	
41e	Forrestfield (Hibiscus Drive)	Pavetta Crescent SAS	Dawson Avenue	Roe Highway	5-10		$ 200,000	$ 200,000	SAS Program Funding
	Traning Route								
61c	Canning Road	Targeted Shoulder Widening Stage 2	Pomeroy Road	Pickering Brook Road	5-10	$ 250,000	$ 250,000	$ 500,000	Black Spot Funding
64c	Mundaring Weir Road	Targeted Shoulder Widening Stage 2	Railway Road	City Boundary	5-10	$ 250,000	$ 250,000	$ 500,000	Black Spot Funding
					TOTAL	$ 2,620,000	$ 7,660,000	$ 10,280,000	

10 - 15 Year

Project No.	Secondary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
1g	Hills Spine	Canning Road Bufferred Bike Lanes Stage 3	Lesmurdie Road	Pomeroy Road	10-15	$ 850,000	$ 850,000	$ 1,700,000	Potential WABN Grant Funding
2a	Kalamunda Road	Bufferred Cycle lanes	Canning Road	Hawtin Road	10-15	$ 275,000	$ 275,000	$ 550,000	Potential WABN Grant Funding
3a	Forrestfield Station Connection	Maida Vale Road Protected Cycle Lanes Stage 2	Forrestfield Station	Priory Road	10-15		$ 1,090,000	$ 1,090,000	To be funded and constructed as part of the Forrestfield North Developer Contributions Plan
	Local Route								
20e	Foothills Spine	Wattle Grove Option 1 (The Promenade & Hale Road Shared Path)	Lenihan Corner	Hartfield Road	10-15	$ 310,000	$ 310,000	$ 620,000	Potential WABN Grant Funding
20g	Foothills Spine	Hartfield Road Shared Path	Hale Road or Morrison Road	Sussex Road	10-15	$ 85,000		$ 85,000	
20h	Foothills Spine	Sussex Road Safe Active Street	Hartfield Road	Hale Road/Mallow Way	10-15		$ 920,000	$ 920,000	SAS Program Funding
21b	High Wycombe Local Route	Hamilton Street Safe Active Street	Wittenoom Road	Kiandra Way	10-15	$ 188,000	$ 282,000	$ 470,000	60% funding from SAS Program
21j	High Wycombe Local Route	Crake Court Public Access Way Upgrade	Kiandra Way	Newburn Road	10-15	$ 25,000		$ 25,000	Potential external funding (non WABN)
22b	Berkshire & Dundas Road	Berkshire Road (East of Roe Highway) Shared Path Upgrade	Apricot Street	Hawtin Road	10-15	$ 890,000		$ 890,000	Timing will be influenced by the Forresfield North District Structure Plan
	Safe Active Street	Safe Active Street							
40a	Forrestfield (Bauhinia Road)	Bauhinia Road SAS	Dawson Avenue	Magnolia Way	10-15		$ 240,000	$ 240,000	SAS Program Funding
40b	Forrestfield (Bauhinia Road)	Dawson Ave Shared Path	Cedar Way	Bauhinia Road	10-15	$ 65,000		$ 65,000	
40c	Forrestfield (Bauhinia Road)	Cedar Way SAS	Cedar Way	Dawson Avenue	10-15		$ 240,000	$ 240,000	SAS Program Funding
40e	Forrestfield (Bauhinia Road)	Peach Tree Way SAS	-	-	10-15		$ 260,000	$ 260,000	SAS Program Funding
					TOTAL	$ 2,688,000	$ 4,467,000	$ 7,155,000	

15 - 20 Year

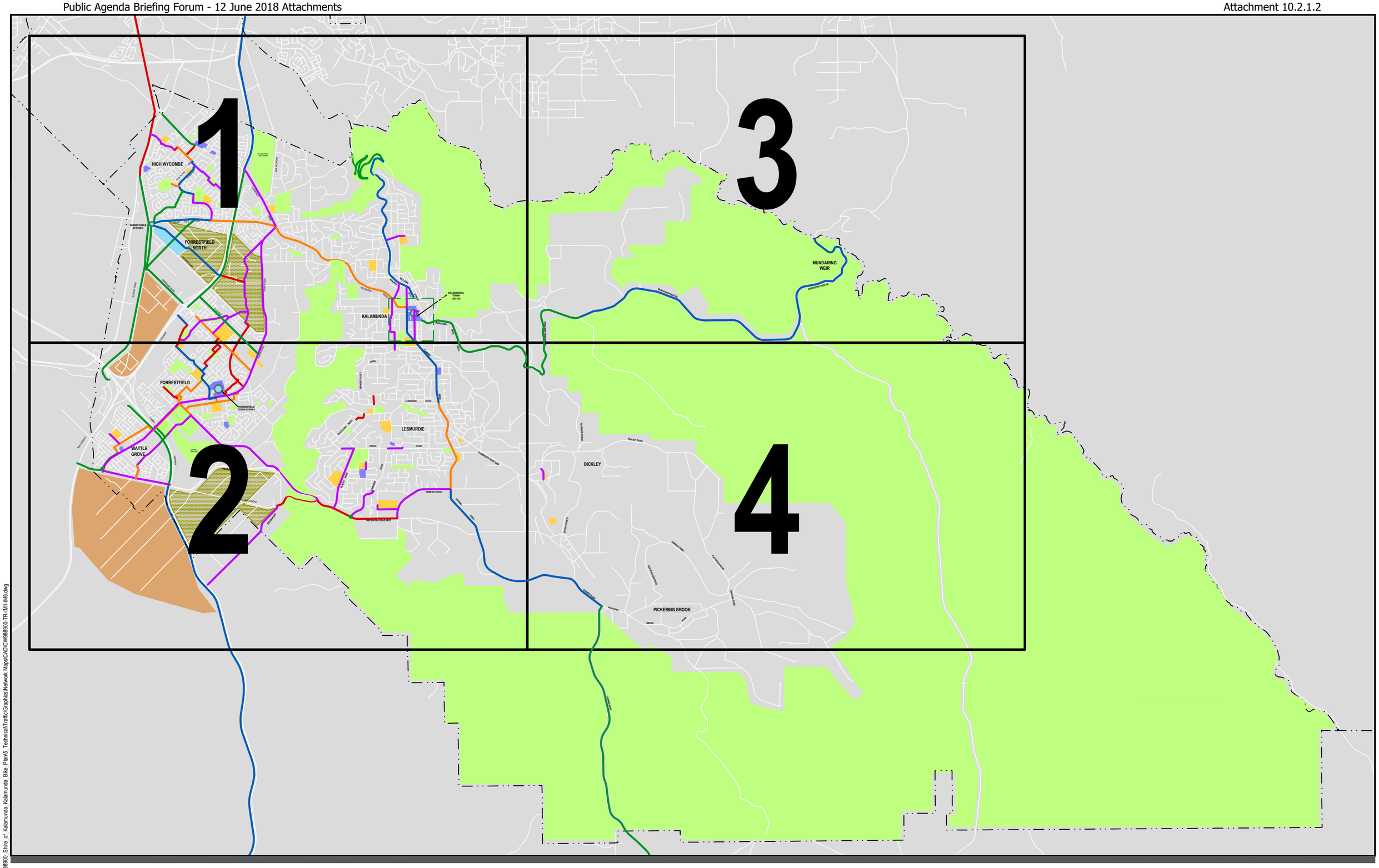
Project No.	Primary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
82c	Freight Railway / Dundas Road	Dundas Road PSP	Wittenoom Street	City Boundary	15-20		$ 1,050,000	$ 1,050,000	State Government Funded
	Secondary Route								
3c	Forrestfield Station Connection	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 2	Roe Highway	Brewer Road	15-20		$ 560,000	$ 560,000	Include as part of Forrestfield North District Structure Plan
4a	Lesmurdie to Maddington	Welshpool Road East Shared Path	Pomeroy Road	Crystal Brook Road	15-20	$ 455,000	$ 455,000	$ 910,000	Potential WABN Grant Funding
4b	Lesmurdie to Maddington	Crystal Brook Road Shared Path	Welshpool Road East	Kelvin Road	15-20	$ 570,000		$ 570,000	
	Local Route								
20i	Foothills Spine	Transmission Line Easement Shared Path	Hale Road	Berkshire Road	15-20	$ 340,000	$ 340,000	$ 680,000	Potential WABN Grant Funding
20j	Foothills Spine	Transmission Line - Strelitzia Avenue Shared Path Link	Strelitzia Avenue	Proposed Transmission Line Shared Path	15-20	$ 170,000		$ 170,000	
21a	High Wycombe Local Route	Fernan Road Safe Active Street	Kalamunda Road	Hamilton Road	15-20	$ 80,000	$ 120,000	$ 200,000	60% funding from SAS Program
25b	Lesmurdie Local Routes	Burma Road Shared Path Extension	Orange Valley Road	Connor Road	15-20	$ 70,000		$ 70,000	
25c	Lesmurdie Local Routes	Trafalgar Road - Kimbarlee WayPath Upgrade	Waterloo Crescent	Falls Road	15-20	$ 110,000		$ 110,000	
	Safe Active Street								
40d	Forrestfield (Bauhinia Road)	Shared Path Upgrade - Bridge Over Woodlupine Brook	Cedar Way	Peach Tree Way	15-20	$ 270,000		$ 270,000	
40f	Forrestfield (Bauhinia Road)	Cedar Way New Shared Path	Peach Tree Way	Poplar Court	15-20	$ 100,000		$ 100,000	
40g	Forrestfield (Bauhinia Road)	Virgillia Way Reserve Path Upgrade	Poplar Court	Linden Way	15-20	$ 85,000		$ 85,000	
41d	Forrestfield (Hibiscus Drive)	Dawson Avenue Shared Path Upgrade	Bougainvillea Avenue	Pavetta Crescent	15-20	$ 260,000		$ 260,000	
42a	Forrestfield (Mallee Way)	Strelitzia Avenue Shared Path	Hibiscus Drive	Mallee Way	15-20	$ 40,000		$ 40,000	
42b	Forrestfield (Mallee Way)	Mallee Way SAS	Strelitzia Avenue	Mallee Way	15-20		$ 170,000	$ 170,000	SAS Program Funding
42c	Forrestfield (Mallee Way)	POS Shared Path Connection	Mallee Way	Akebia Way	15-20	$ 50,000		$ 50,000	
42d	Forrestfield (Mallee Way)	Akebia Way SAS			15-20		$ 390,000	$ 390,000	SAS Program Funding
42e	Forrestfield (Mallee Way)	Bougainvillea Avenue Shared Path	Akebia Way	Berkshire Road	15-20	$ 40,000		$ 40,000	
42f	Forrestfield (Mallee Way)	Berkshire Road Upgraded Shared Path	Bougainvillea Avenue	Moonbooli Street	15-20	$ 80,000		$ 80,000	
					TOTAL	$ 2,720,000	$ 3,085,000	$ 5,805,000	

20+ Years

Project No.	Secondary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
1h	Hills Spine	Pomeroy Road Sealed Shoulders	Canning Road	Welshpool Road	20+	$ 1,090,000		$ 1,090,000	
2b	Kalamunda Road	Sealed Shoulder	Hawtin Road	Roe Highway	20+	$ 1,030,000		$ 1,030,000	
4c	Lesmurdie to Maddington	Kelvin Road Sealed Shoulders	Crystal Brook Road	Southern City Boundary	20+	$ 410,000		$ 410,000	
	Local Route								
20f	Foothills Spine	Wattle Grove Option 2 (Kalari Drive Existing Path and Morrison Road New Shared Path)	Lenihan Corner	Hartfield Road	20+	$ 520,000		$ 520,000	
20k	Foothills Spine	Brewer Road Protected Bike Lanes Stage 1	Sultana Road East	Raveswood Road	20+	$ 830,000		$ 830,000	
20l	Foothills Spine	Brewer Road Protected Bike Lanes Stage 2	Raveswood Road	Maida Vale	20+	$ 1,120,000		$ 1,120,000	
21g	High Wycombe Local Route Spurs	Munday Road Shared Path	Wittenoom Road/Hamilton St	Dundas Road	20+	$ 270,000		$ 270,000	
21h	High Wycombe Local Route Spurs	Swan Road Shared Path	Kiandra Way	Edney Road	20+	$ 370,000		$ 370,000	
21i	High Wycombe Local Route Spurs	Norling Road & Newburn Road Shared Path	Kiandra Way/Norling Road	Maida Vale Road	20+	$ 320,000		$ 320,000	
23a	Hale/Hawtin Roads	Hale/Hawtin Roads Sealed Shoulders	Welshpool Road	Berkshire Road	20+	$ 290,000		$ 290,000	
23b	Hale/Hawtin Roads	Hale/Hawtin Roads Sealed Shoulders	Berkshire Road	Kalamunda Road	20+	$ 1,030,000		$ 1,030,000	
25a	Lesmurdie Local Routes	Lesmurdie Road Shared Path Extension	Welshpool Road East	Rootes Road	20+	$ 470,000		$ 470,000	
25d	Lesmurdie Local Routes	Grove Road Shared Path Missing Link 1	George Road	Gladys Road	20+	$ 110,000		$ 110,000	
25e	Lesmurdie Local Routes	Grove Road Shared Path Missing Link 2	Lesmurdie Road	Rooth Road	20+	$ 120,000		$ 120,000	
25f	Lesmurdie Local Routes	Gladys Road Shared Path Section 1	Grove Road	George Road	20+	$ 370,000		$ 370,000	
25g	Lesmurdie Local Routes	Gladys Road Shared Path Section 2	George Road	Welshpool Road East	20+	$ 190,000		$ 190,000	
25h	Lesmurdie Local Routes	Reid Road Shared Path	Albert Road	Pomeroy Road	20+	$ 170,000		$ 170,000	

25i	Lesmurdie Local Routes	Albert Road Shared Path	Reid Road	Arthur Road	20+	$ 40,000		$ 40,000	
25j	Lesmurdie Local Routes	Sanderson Road	Wiloughby Road	Gilroy Road	20+	$ 55,000		$ 55,000	
26a	Forrestfield to Lesmurdie	Hartfield Road Shared Path	Morrison Road	Lewis Road	20+	$ 450,000		$ 450,000	
26b	Forrestfield to Lesmurdie	Hartfield Road On-street Cycling	Lewis Road	Welshpool Road East	20+	$ 120,000		$ 120,000	
26c	Forrestfield to Lesmurdie	Welshpool Road East Shared Path	Hartfield Road	Crystal Brook Road	20+	$ 890,000		$ 890,000	
	Safe Active Street								
42g	Forrestfield (Mallee Way)	Moonbooli Street SAS	Berkshire Road	Setosa Drive	20+	$ 350,000		$ 350,000	
43a	Forrestfield (Ilex Way)	Dawson Park Shared Path	Dawson Avenue	Ilex Way	20+	$ 180,000		$ 180,000	
43b	Forrestfield (Ilex Way)	Ilex Way SAS	Dawson Park	Berkshire Road	20+		$ 220,000	$ 220,000	SAS Program Funding
43c	Forrestfield (Ilex Way)	Crumpet Creek Upgraded Shared Path	Berkshire Road	Mandon Street	20+	$ 200,000		$ 200,000	
43d	Forrestfield (Ilex Way)	Crumpet Creek New Shared Path	Mandon Street	Brewer Road	20+	$ 300,000		$ 300,000	
45	Wattle Grove	Thorogood Avenue Safe Active Street	The Promenade	St John Road	20+	$ 220,000		$ 220,000	
46a	Wattle Grove	Lancelot Green SAS	Welspool Road East	Kalari Drive	20+	$ 140,000		$ 140,000	
46b	Wattle Grove	Shared Path connection	Lancelot Green	Kalari Drive	20+	$ 50,000		$ 50,000	
47a	Kalamunda Township	Headingly Street Option	Canning Road	Railway Road	20+		$ 300,000	$ 300,000	SAS Program Funding
47b	Kalamunda Township	Central Road / Central Mall Option	Canning Road	Railway Road	20+		$ 510,000	$ 510,000	SAS Program Funding
47c	Kalamunda Township	Lindsay-Boonoloo-McRae Rad SAS	Railway Road	Cotherstone Road	20+	$ 1,110,000		$ 1,110,000	
	Other Shared Path								
90	First Avenue	First Avenue Shared Path	Nairn Road	Lawnbrook Road East	20+	$ 120,000		$ 120,000	
91	Welshpool Road	Welshpool Road Upgraded Shared Path	Hale Road	Tonkin Highway	20+	$ 680,000		$ 680,000	
92	Ledger Road	Ledger Road Shared Path	Williams Street	Waljerin Road	20+	$ 190,000		$ 190,000	
					TOTAL	$ 13,805,000	$ 1,030,000	$ 14,835,000	

Summary $500k Funding Target	City Funded	Potential External Funded	Total Project Cost Estimate
0-5 Years	$ 2,710,000	$ 8,655,000	$ 11,365,000
5-10 Years	$ 2,620,000	$ 7,660,000	$ 10,280,000
10-15 Years	$ 2,688,000	$ 4,467,000	$ 7,155,000
15-20 Years	$ 2,720,000	$ 3,085,000	$ 5,805,000
20+ Years	$ 13,805,000	$ 1,030,000	$ 14,835,000
	$ 24,543,000	$ 24,897,000	$ 49,440,000



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CITY OF KALAMUNDA
BICYCLE PLAN
APPENDIX D
IMPLEMENTATION PLAN - OVERALL MAP
$500,000/YEAR SCENARIO

Date	Scale	Size
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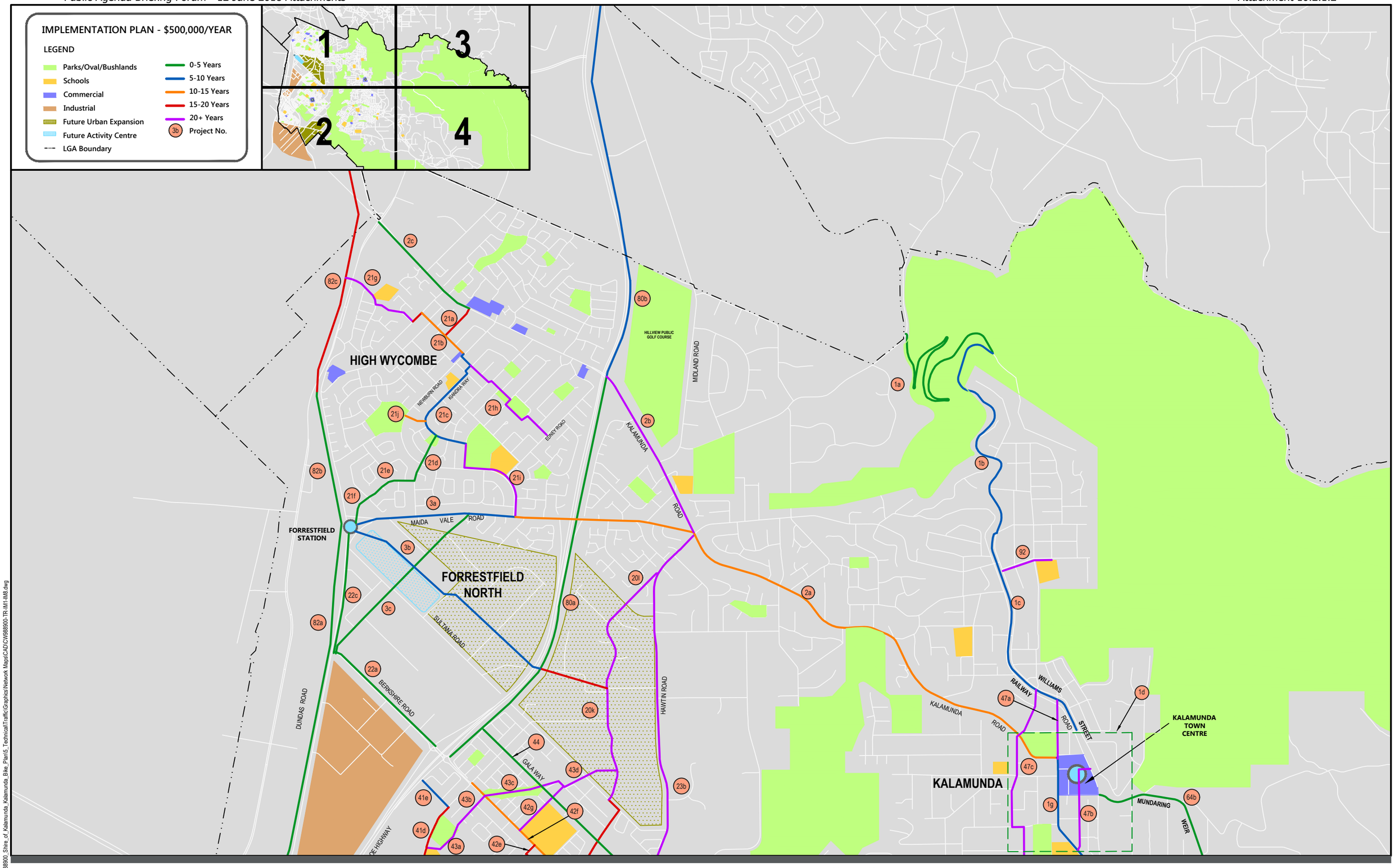
CW988900-TR-OA3		C
Drawing Number		Revision



CITY OF KALAMUNDA
BICYCLE PLAN
APPENDIX D
IMPLEMENTATION PLAN - QUADRANT 1
$500,000/YEAR SCENARIO

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IM1
Drawing Number

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Revision

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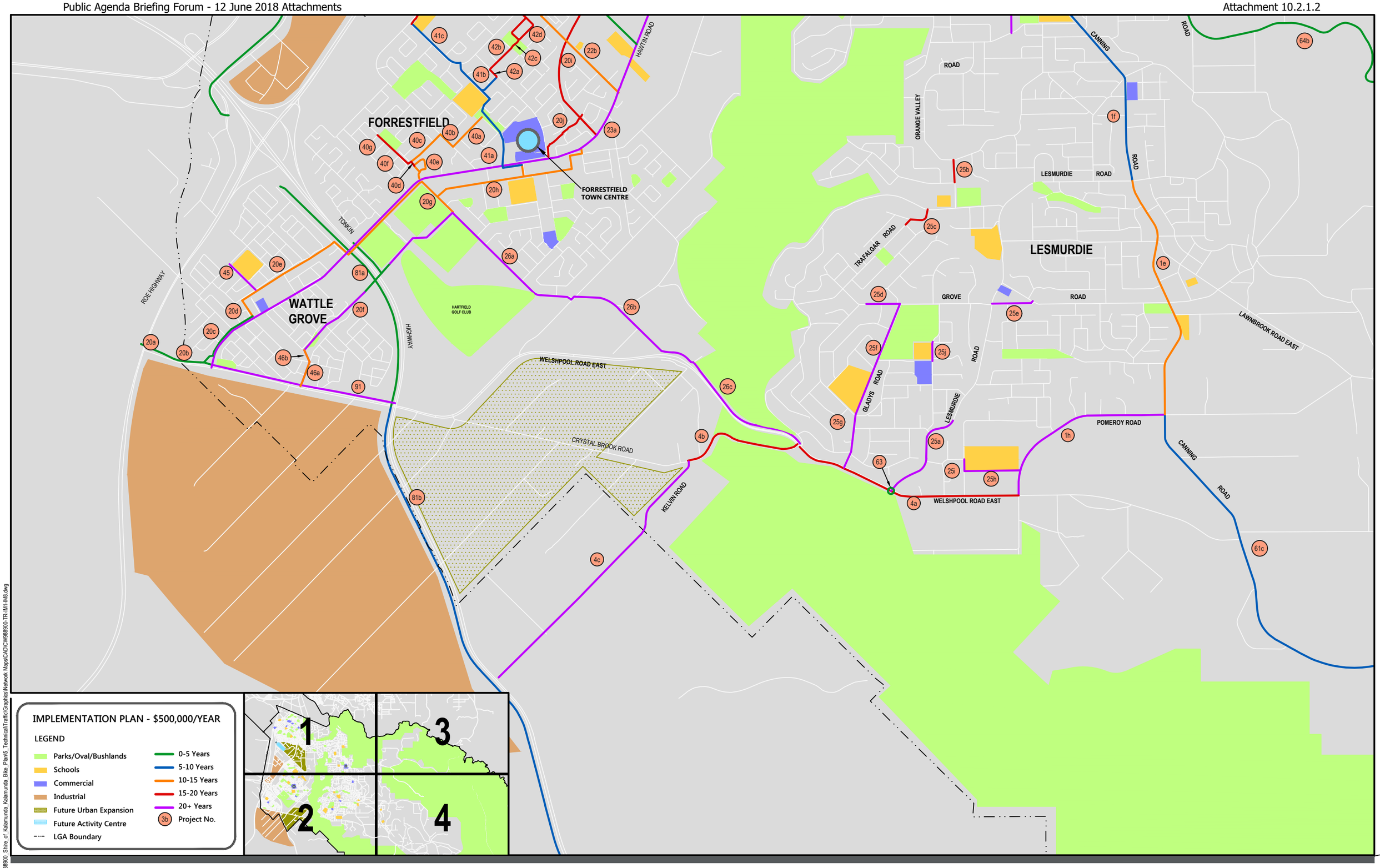

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CITY OF KALAMUNDA
BICYCLE PLAN
APPENDIX D
IMPLEMENTATION PLAN - QUADRANT 2
$500,000/YEAR SCENARIO

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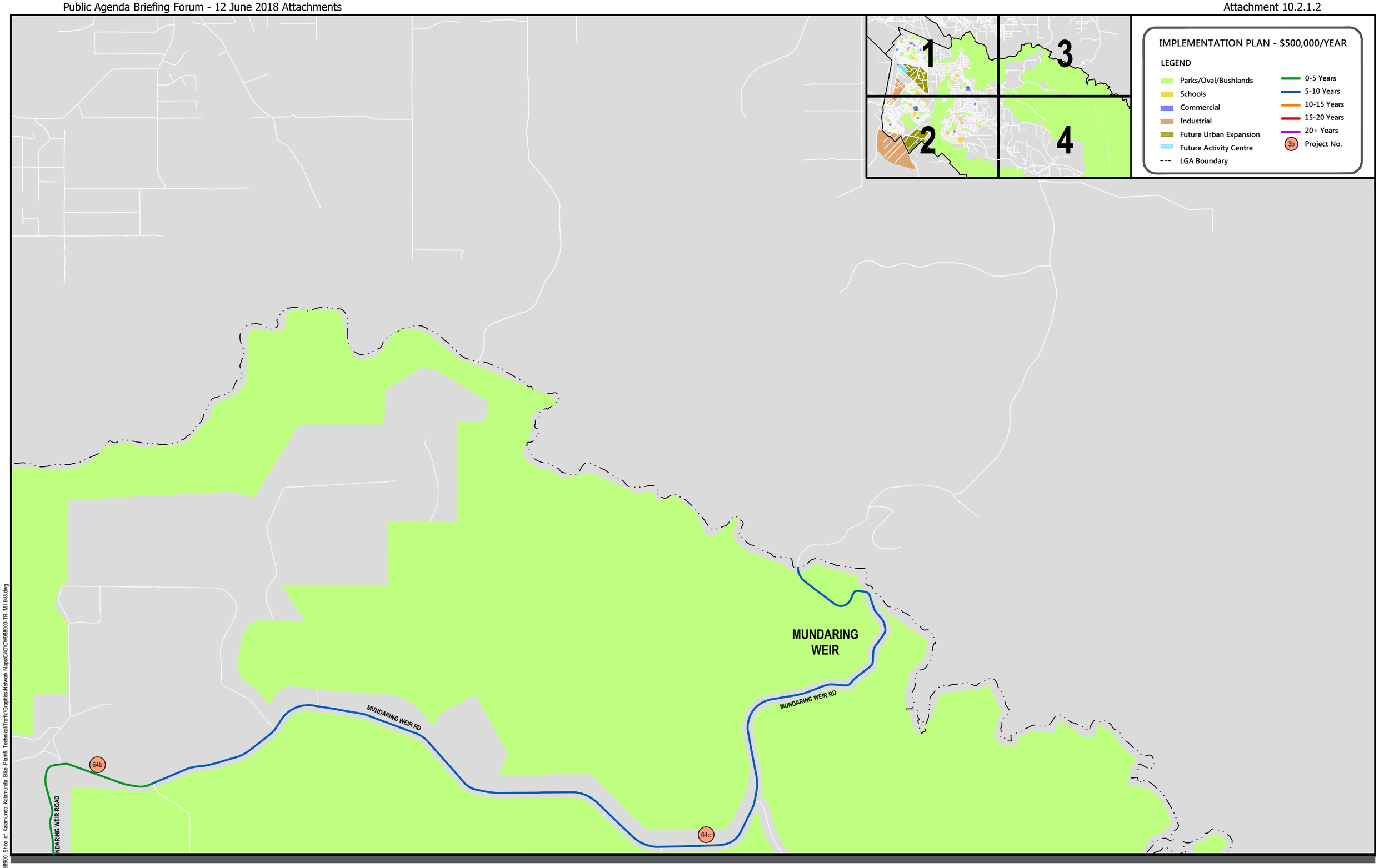
C (Revision)



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CITY OF KALAMUNDA

BICYCLE PLAN

APPENDIX D

IMPLEMENTATION PLAN - QUADRANT 3

$500,000/YEAR SCENARIO

Date	Scale	Size
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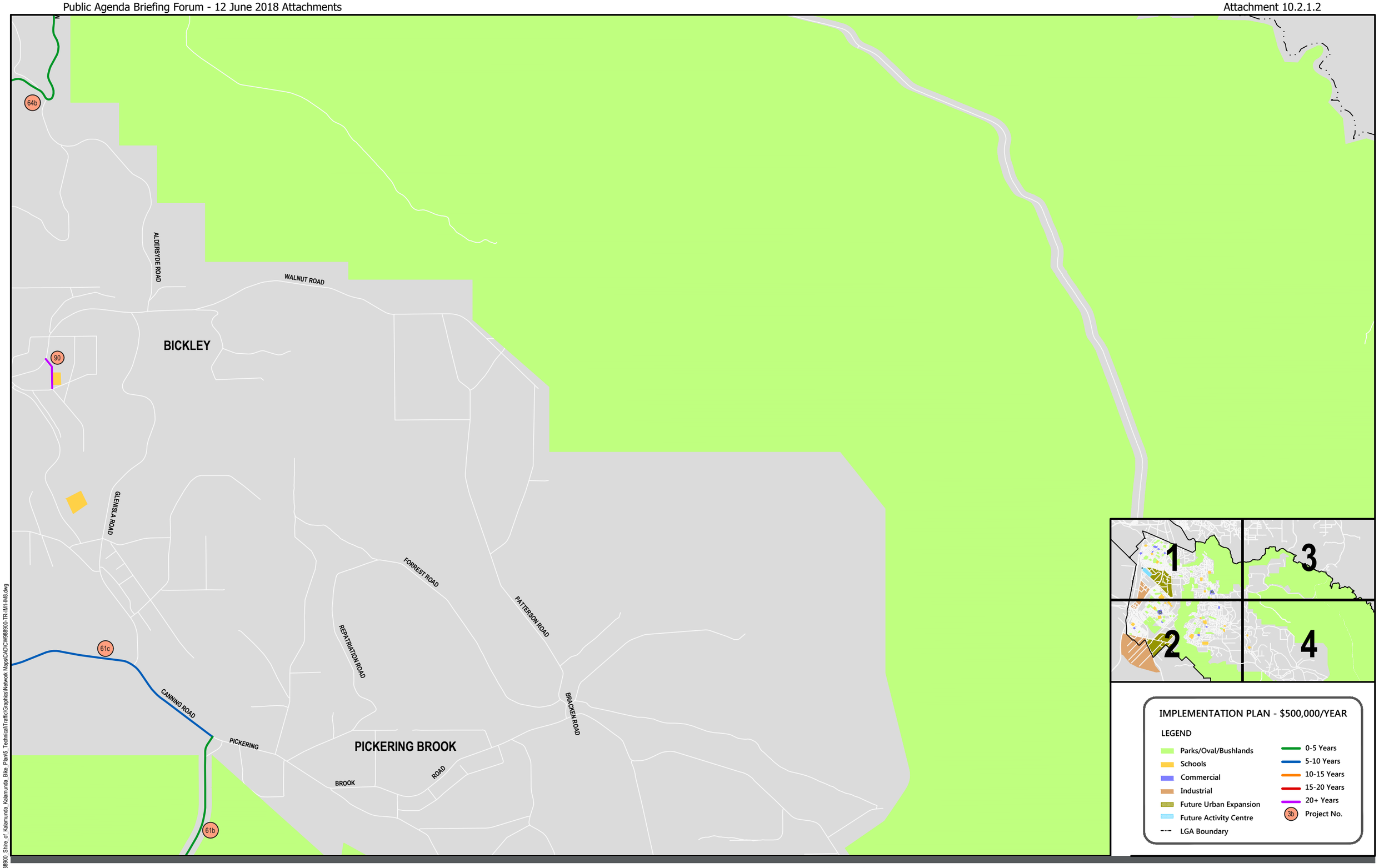
Drawing Number		Revision



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CITY OF KALAMUNDA
BICYCLE PLAN
APPENDIX D
IMPLEMENTATION PLAN - QUADRANT 4
$500,000/YEAR SCENARIO

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IM4 (Drawing Number) — C (Revision)

Bicycle Plan 2017

APPENDIX E

WORKS SCHEDULE & MAP - $1,000,000

City of Kalamunda Bicycle Plan 2017 - Project Schedule based on $1,000,000 per Annum Scenario

0-5 Years

Project No.	Primary Route	Description	Start	End	Timing (1M per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
80a	Roe Highway	PSP Completion Part of Roe Highway/Kalamunda Road Upgrade	Berkshire Road	Kalamunda Road	0-5		$ 2,260,000	$ 2,260,000	State Government Funded
81a	Tonkin Highway	PSP Extension on the Southern Side (including link to Hartfield Park)	Roe Highway	Welshpool Road East	0-5		$ 1,430,000	$ 1,430,000	State Government Funded
82a	Freight Railway / Dundas Road	Dundas Road PSP	Tonkin Highway	Forrestfield Station	0-5		$ 2,580,000	$ 2,580,000	State Government Funded
82b	Freight Railway / Dundas Road	Dundas Road PSP	Forrestfield Station	Wittenoom Road	0-5		$ 730,000	$ 730,000	State Government Funded Review priority when Forrestfield Station design is released
	Secondary Route								
1a	Hills Spine	Zig Zag Option A	Ridge Hill Road	Ocean View Parade	0-5	$ 35,000		$ 35,000	
1c	Hills Spine	Kalamunda Railway Heritage Trail Sealed Path	Hill Street	Elizabeth Street	0-5	$ 150,000	$ 150,000	$ 300,000	Potential WABN Grant Funding
1d	Hills Spine	Kalamunda Town Centre Section Options Study	Canning Road	Elizabeth Street	0-5	$ 25,000	$ 25,000	$ 50,000	Potential WABN Grant Funding
1f	Hills Spine	Canning Road Buffered Bike Lanes Stage 2	Railway Road	Lesmurdie Road	0-5	$ 1,200,000		$ 1,200,000	
2c	Kalamunda Road	Sealed Shoulder	Fernan Road	Abernethy Road	0-5	$ 560,000.00		$ 560,000	Include as part of existing planned upgrade
3d	Forrestfield Station Connection	Milner Road Protected Cycle Lanes	Maida Vale Road	Dundas Road	0-5		$ 620,000	$ 620,000	To be funded and constructed as part of the Forrestfield North District Structure Plan
	Local Route								
20a	Foothills Spine	Welshpool Road East Shared Path (including to connection from Puddy lane to Hale Road)	Roe Highway (City Boundary)	Puddy Lane	0-5	$ 65,000	$ 65,000	$ 130,000	Potential WABN Grant Funding
20b	Foothills Spine	Puddy Lane Shared Path	Welshpool Road East Shared Path	Hale Road	0-5	$ 85,000	$ 85,000	$ 170,000	Potential WABN Grant Funding
20c	Foothills Spine	Hale Road Shared Path Extension	Extensa Road	Puddy Lane	0-5	$ 50,000		$ 50,000	
20d	Foothills Spine	Hale Road Existing Shared Path Upgrade (Western Side)	Extensa Road	Lenihan Corner	0-5	$ 320,000		$ 320,000	
20g	Foothills Spine	Hartfield Road Shared Path	Hale Road or Morrison Road	Sussex Road	0-5	$ 85,000		$ 85,000	
21d	High Wycombe Local Route	Public Access Way Upgrades (through McLarty Way, and Walker Crescent)	Kiandra Way	Newburn Road	0-5	$ 95,000		$ 95,000	Potential external funding (non WABN)
21e	High Wycombe Local Route	Butcher Road & Palmer Crescent Safe Active Street	Newburn Road	Palmer Crescent	0-5	$ 390,000		$ 390,000	Potential external funding (non WABN)
21f	High Wycombe Local Route	Everitt Place Shared Path	Palmer Crescent	Maida Vale Road	0-5	$ 85,000		$ 85,000	Potential external funding (non WABN)
21i	High Wycombe Local Route Spurs	Norling Road & Newburn Road Shared Path	Kiandra Way/Norling Road	Maida Vale Road	0-5	$ 320,000		$ 320,000	Potential external funding (non WABN)
21j	High Wycombe Local Route	Crake Court Public Access Way Upgrade	Kiandra Way	Newburn Road	0-5	$ 25,000		$ 25,000	Potential external funding (non WABN)
22a	Berkshire & Dundas Road	Berkshire Road (West of Roe Highway) Shared Path Upgrade	Ashby Close	Dundas Road	0-5	$ 230,000	$ 230,000	$ 460,000	Potential WABN Grant Funding
22c	Berkshire & Dundas Road	Dundas Road Shared Path	Berkshire Road	Forrestfield Station	0-5	$ 180,000	$ 180,000	$ 360,000	Potential WABN Grant Funding
25b	Lesmurdie Local Routes	Burma Road Shared Path Extension	Orange Valley Road	Connor Road	0-5	$ 70,000		$ 70,000	
25c	Lesmurdie Local Routes	Trafalgar Road - Kimbarlee Way Path Upgrade	Waterloo Crescent	Falls Road	0-5	$ 110,000		$ 110,000	
25d	Lesmurdie Local Routes	Grove Road Shared Path Missing Link 1	George Road	Gladys Road	0-5	$ 110,000		$ 110,000	
25e	Lesmurdie Local Routes	Grove Road Shared Path Missing Link 2	Lesmurdie Road	Rooth Road	0-5	$ 120,000		$ 120,000	
	Safe Active Street								
44	Forrestfield (Gala Way)	Gala Way Safe Active Street	Fruit Tree Crescent	Hawtin Road	0-5	$ 50,000		$ 50,000	Allowance to supplement existing traffic calming
	Traning Route								
63	Welshpool Road East	Lesmurdie Road Intersection Safety Improvement	-	-	0-5	$ 40,000		$ 40,000	
61a	Canning Road	Canning Road Road Safety Audit	-	-	0-5	$ 25,000		$ 25,000	

61b	Canning Road	Targeted Shoulder Widening Stage 1	Pickering Brook Road	City Boundary	0-5	$ 225,000	$ 225,000	$ 450,000	Black Spot Funding
64a	Mundaring Weir Road	Mundaring Weir Road Road Road Safety Audit	-	-	0-5	$ 15,000		$ 15,000	
64b	Mundaring Weir Road	Targeted Shoulder Widening Stage 1	Railway Road	City Boundary	0-5	$ 225,000	$ 225,000	$ 450,000	Black Spot Funding
65	City of Kalamunda	Safe Passing Law Review	-	-	0-5	$ 10,000		$ 10,000	
					TOTAL	$ 4,900,000	$ 8,805,000	$ 13,705,000	

5-10 Years

Project No.	Primary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
80b	Roe Highway	Roe Highway PSP Completion	Kalamunda Road	Brinsmead Road (Northern City Boundary)	5-10		$ 660,000	$ 660,000	State Government Funded
81b	Tonkin Highway	PSP Completion	Welshpool Road East	Kelvin Road/Mills Road	5-10		$ 1,310,000	$ 1,310,000	State Government Funded
	Secondary Route								
1b	Hills Spine	Lascelles Parade / William Street Safe Active Street	Zig Zag Scenic Drive	Hill Street	5-10	$ 320,000	$ 320,000	$ 640,000	Potential WABN Grant Funding
1e	Hills Spine	Canning Road Buffered Bike Lanes Stage 1	Kalamunda Road	Railway Road	5-10	$ 380,000	$ 380,000	$ 760,000	Potential WABN Grant Funding
3a	Forrestfield Station Connection	Maida Vale Road Protected Cycle Lanes Stage 1	Forrestfield Station	Priory Road	5-10		$ 1,090,000	$ 1,090,000	To be funded and constructed as part of the Forrestfield North Developer Contributions Plan
3b	Forrestfield Station Connection	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 1	Forrestfield Station	Roe Highway	5-10		$ 1,460,000.00	$ 1,460,000	Include as part of Forrestfield North District Structure Plan
	Local Route								
20i	Foothills Spine	Transmission Line Easement Shared Path	Berkshire Road	Sultana Road East	5-10	$ 340,000	$ 340,000	$ 680,000	Potential WABN Grant Funding
20j	Foothills Spine	Transmission Line - Strelitzia Avenue Shared Path Link	Strelitzia Avenue	Proposed Transmission Line Shared Path	5-10	$ 170,000		$ 170,000	
21a	High Wycombe Local Route	Fernan Road Safe Active Street	Kalamunda Road	Hamilton Road	5-10	$ 80,000	$ 120,000	$ 200,000	60% funding from SAS Program
21b	High Wycombe Local Route	Hamilton Street Safe Active Street	Wittenoom Road	Kiandra Way	5-10	$ 188,000	$ 282,000	$ 470,000	60% funding from SAS Program
21c	High Wycombe Local Route	Kiandra Way Safe Active Street	Western Avenue	Norling Road	5-10		$ 660,000	$ 660,000	SAS Program Funding
21g	High Wycombe Local Route Spurs	Munday Road Shared Path	Wittenoom Road/Hamilton Street	Dundas Road	5-10	$270,000		$270,000	
22b	Berkshire & Dundas Road	Berkshire Road (East of Roe Highway) Shared Path Upgrade	Apricot Street	Hawtin Road	5-10	$ 890,000		$ 890,000	Timing will be influenced by the Forresfield North District Structure Plan
25f	Lesmurdie Local Routes	Gladys Road Shared Path Section 1	Grove Road	George Road	5-10	$ 370,000		$ 370,000	
	Safe Active Street								
40a	Forrestfield (Bauhinia Road)	Bauhinia Road SAS	Dawson Avenue	Magnolia Way	5-10		$ 240,000	$ 240,000	SAS Program Funding
40b	Forrestfield (Bauhinia Road)	Dawson Ave Shared Path	Cedar Way	Bauhinia Road	5-10	$ 65,000		$ 65,000	
40c	Forrestfield (Bauhinia Road)	Cedar Way SAS	Cedar Way	Dawson Avenue	5-10		$ 240,000	$ 240,000	SAS Program Funding
40d	Forrestfield (Bauhinia Road)	Shared Path Upgrade - Bridge Over Woodlupine Brook	Cedar Way	Peach Tree Way	5-10	$ 270,000		$ 270,000	
40e	Forrestfield (Bauhinia Road)	Peach Tree Way SAS	-	-	5-10		$ 260,000	$ 260,000	SAS Program Funding
41a	Forrestfield (Hibiscus Drive)	Hale Road Shared Path	Hannover Street	Hibiscus Drive	5-10	$ 430,000		$ 430,000	
41b	Forrestfield (Hibiscus Drive)	Hibiscus Drive SAS	Bougainvillea Avenue	Strelitzia Avenue	5-10		$ 330,000	$ 330,000	SAS Program Funding
41c	Forrestfield (Hibiscus Drive)	Bougainvillea Avenue Shared Path	Hibiscus Drive	Dawson Avenue	5-10	$ 240,000		$ 240,000	
41e	Forrestfield (Hibiscus Drive)	Pavetta Crescent SAS	Dawson Avenue	Roe Highway	5-10		$ 200,000	$ 200,000	SAS Program Funding
47b	Kalamunda Township	Central Road / Central Mall Option	Canning Road	Railway Road	5-10	$ 510,000		$ 510,000	SAS Program Funding
	Traning Route								
61c	Canning Road	Targeted Shoulder Widening Stage 2	Pomeroy Road	Pickering Brook Road	5-10	$ 250,000	$ 250,000	$ 500,000	Black Spot Funding
64c	Mundaring Weir Road	Targeted Shoulder Widening Stage 2	Railway Road	City Boundary	5-10	$ 250,000	$ 250,000	$ 500,000	Black Spot Funding
					TOTAL	$ 5,023,000	$ 8,392,000	$ 13,415,000	

10 - 15 Year									
Project No.	Primary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
82c	Freight Railway / Dundas Road	Dundas Road PSP	Wittenoom Street	City Boundary	10-15		$ 1,050,000	$ 1,050,000	State Government Funded
	Secondary Route		Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
1g	Hills Spine	Canning Road Buffered Bike Lanes Stage 3	Lesmurdie Road	Pomeroy Road	10-15	$ 850,000	$ 850,000	$ 1,700,000	Potential WABN Grant Funding
2a	Kalamunda Road	Bufferred Cycle lanes	Canning Road	Hawtin Road	10-15	$ 275,000	$ 275,000	$ 550,000	Potential WABN Grant Funding
3a	Forrestfield Station Connection	Maida Vale Road Protected Cycle Lanes Stage 2	Forrestfield Station	Priory Road	10-15		$ 1,090,000	$ 1,090,000	To be funded and constructed as part of the Forrestfield North Developer Contributions Plan
	Local Route								
20e	Foothills Spine	Wattle Grove Option 1 (The Promenade & Hale Road Shared Path)	Lenihan Corner	Hartfield Road	10-15	$ 310,000	$ 310,000	$ 620,000	Potential WABN Grant Funding
20f	Foothills Spine	Wattle Grove Option 2 (Kalari Drive Existing Path and Morrison Road New Shared Path)	Lenihan Corner	Hartfield Road	10-15	$ 520,000		$ 520,000	
20h	Foothills Spine	Sussex Road Safe Active Street	Hartfield Road	Hale Road/Mallow Way	10-15		$ 920,000	$ 920,000	SAS Program Funding
25a	Lesmurdie Local Routes	Lesmurdie Road Shared Path Extension	Welshpool Road East	Rootes Road	10-15	$ 470,000		$ 470,000	
25g	Lesmurdie Local Routes	Gladys Road Shared Path Section 2	George Road	Welshpool Road East	10-15	$ 190,000		$ 190,000	
25h	Lesmurdie Local Routes	Reid Road Shared Path	Albert Road	Pomeroy Road	10-15	$ 170,000		$ 170,000	
25i	Lesmurdie Local Routes	Albert Road Shared Path	Reid Road	Arthur Road	10-15	$ 40,000		$ 40,000	
25j	Lesmurdie Local Routes	Sanderson Road	Wiloughby Road	Gilroy Road	10-15	$ 55,000		$ 55,000	
	Safe Active Street								
40f	Forrestfield (Bauhinia Road)	Cedar Way New Shared Path	Peach Tree Way	Poplar Court	10-15	$ 100,000		$ 100,000	
40g	Forrestfield (Bauhinia Road)	Virgillia Way Reserve Path Upgrade	Poplar Court	Linden Way	10-15	$ 85,000		$ 85,000	
41d	Forrestfield (Hibiscus Drive)	Dawson Avenue Existing Path	Bougainvillea Avenue	Pavetta Crescent	10-15	$ 260,000		$ 260,000	
42a	Forrestfield (Mallee Way)	Strelitzia Avenue Shared Path	Hibiscus Drive	Mallee Way	10-15	$ 40,000		$ 40,000	
42b	Forrestfield (Mallee Way)	Mallee Way SAS	Strelitzia Avenue	Mallee Way	10-15		$ 170,000	$ 170,000	SAS Program Funding
42c	Forrestfield (Mallee Way)	POS Shared Path Connection	Mallee Way	Akebia Way	10-15	$ 50,000		$ 50,000	
42d	Forrestfield (Mallee Way)	Akebia Way SAS			10-15		$ 390,000	$ 390,000	SAS Program Funding
42e	Forrestfield (Mallee Way)	Bougainvillea Avenue Shared Path	Akebia Way	Berkshire Road	10-15	$ 40,000		$ 40,000	
42f	Forrestfield (Mallee Way)	Berkshire Road Existing Shared Path	Bougainvillea Avenue	Moonbooli Street	10-15	$ 80,000		$ 80,000	
42g	Forrestfield (Mallee Way)	Moonbooli Street SAS	Berkshire Road	Setosa Drive	10-15	$ 350,000		$ 350,000	
46a	Wattle Grove	Lancelot Green SAS	Welspool Road East	Kalari Drive	10-15	$ 140,000		$ 140,000	
46b	Wattle Grove	Shared Path connection	Lancelot Green	Kalari Drive	10-15	$ 50,000		$ 50,000	
47a	Kalamunda Township	Headingly Street Option	Canning Road	Railway Road	10-15		$ 300,000	$ 300,000	SAS Program Funding
	Other Shared Path								
90	First Avenue	First Avenue Shared Path	Nairn Road	Lawnbrook Road East	10-15	$ 120,000		$ 120,000	
91	Welshpool Road	Welshpool Road Upgraded Shared Path	Hale Road	Tonkin Highway	10-15	$ 680,000		$ 680,000	
92	Ledger Road	Ledger Road Shared Path	Williams Street	Waljerin Road	10-15	$ 190,000		$ 190,000	
					TOTAL	$ 5,065,000	$ 5,355,000	$ 10,420,000	

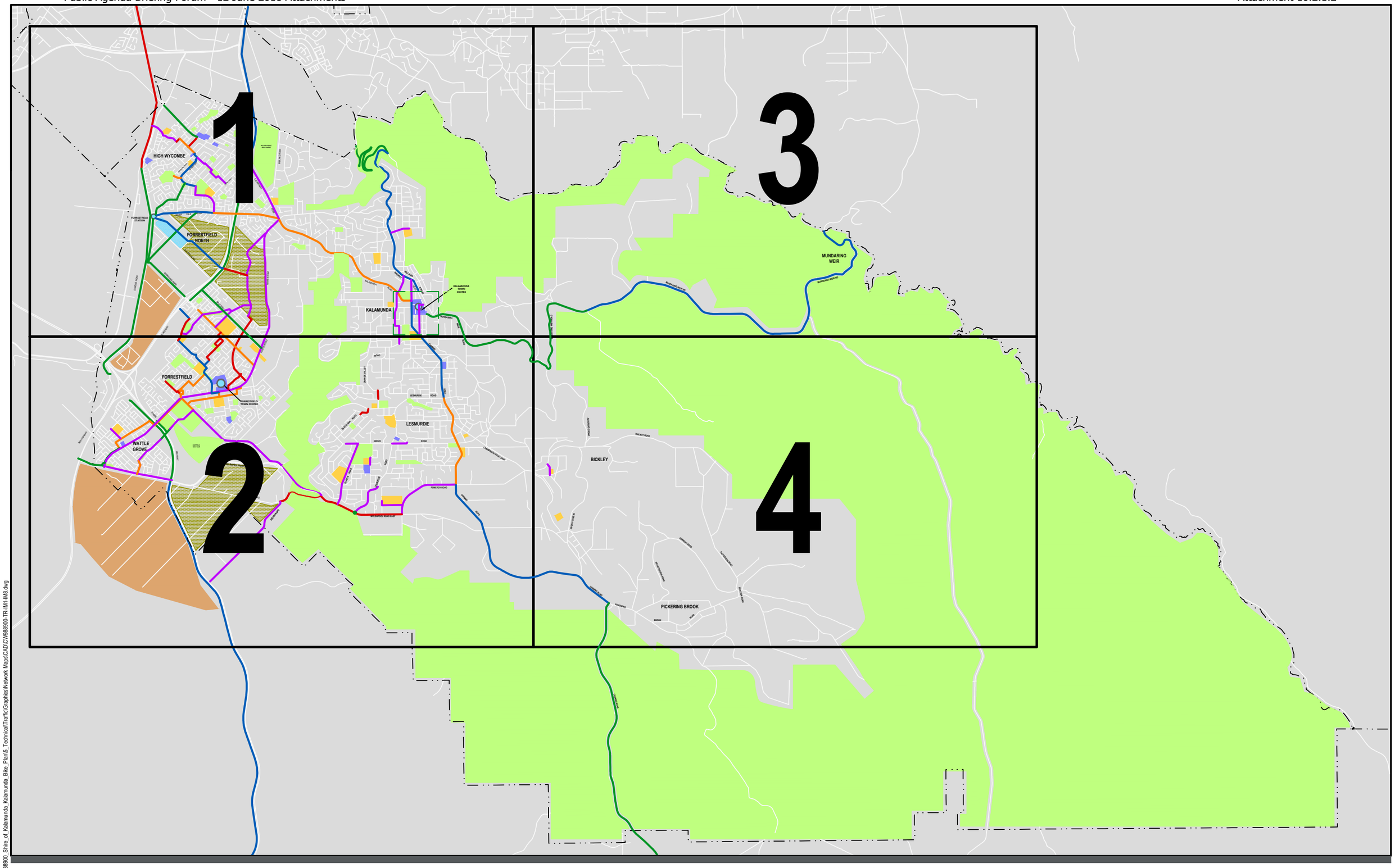
15 - 20 Year

Project No.	Secondary Route	Description	Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
3c	Forrestfield Station Connection	Forrestfield Station TOD Connector Road Protected Cycle Lanes Stage 2	Roe Highway	Brewer Road	15-20		$ 560,000	$ 560,000	Include as part of Forrestfield North District Structure Plan
4a	Lesmurdie to Maddington	Welshpool Road East Shared Path	Pomeroy Road	Crystal Brook Road	15-20	$ 455,000	$ 455,000	$ 910,000	Potential WABN Grant Funding
4b	Lesmurdie to Maddington	Crystal Brook Road Shared Path	Welshpool Road East	Kelvin Road	15-20	$ 570,000		$ 570,000	
4c	Lesmurdie to Maddington	Kelvin Road Sealed Shoulders	Crystal Brook Road	Southern City Boundary	15-20	$ 410,000		$ 410,000	
	Local Route								
20k	Foothills Spine	Brewer Road Protected Bike Lanes Stage 1	Sultana Road East	Roe Highway (via Ravenswood Road)	15-20	$ 415,000	$ 415,000	$ 830,000	Potential WABN Grant Funding
20l	Foothills Spine	Brewer Road Protected Bike Lanes Stage 2	Raveswood Road	Maida Vale	15-20	$ 560,000	$ 560,000	$ 1,120,000	Potential WABN Grant Funding
21h	High Wycombe Local Route Spurs	Swan Road Shared Path	Kiandra Way	Edney Road	15-20	$ 370,000		$ 370,000	
23a	Hale/Hawtin Roads	Hale/Hawtin Roads Sealed Shoulders	Welshpool Road	Berkshire Road	15-20	$ 290,000		$ 290,000	
23b	Hale/Hawtin Roads	Hale/Hawtin Roads Sealed Shoulders	Berkshire Road	Hawtin Road	15-20	$ 1,030,000		$ 1,030,000	
	Safe Active Street								
43a	Forrestfield (Ilex Way)	Dawson Park Shared Path	Dawson Avenue	Ilex Way	15-20	$ 180,000		$ 180,000	
43b	Forrestfield (Ilex Way)	Ilex Way SAS	Dawson Park	Berkshire Road	15-20		$ 220,000	$ 220,000	SAS Program Funding
43c	Forrestfield (Ilex Way)	Crumpet Creek Upgraded Shared Path	Berkshire Road	Mandon Street	15-20	$ 200,000		$ 200,000	
43d	Forrestfield (Ilex Way)	Crumpet Creek New Shared Path	Mandon Street	Brewer Road	15-20	$ 300,000		$ 300,000	
45	Wattle Grove	Thorogood Avenue SAS	The Promenade	St John Road	15-20	$ 220,000		$ 220,000	
					TOTAL	$ 5,000,000	$ 2,210,000	$ 7,210,000	

20+ Years

Project No.	Secondary Route		Start	End	Timing (500k per Year Scenario)	City Funded	Potential External Funded	Total Project Cost Estimate	Comment
1h	Hills Spine	Pomeroy Road Sealed Shoulders	Canning Road	Welshpool Road	20+	$ 1,090,000		$ 1,090,000	
2b	Kalamunda Road	Sealed Shoulder	Hawtin Road	Roe Highway	20+	$ 1,030,000		$ 1,030,000	
	Local Route								
26a	Forrestfield to Lesmurdie	Hartfield Road Shared Path	Morrison Road	Lewis Road	20+	$ 450,000		$ 450,000	
26b	Forrestfield to Lesmurdie	Hartfield Road On-street Cycling	Lewis Road	Welshpool Road East	20+	$ 120,000		$ 120,000	
26c	Forrestfield to Lesmurdie	Welshpool Road East Shared Path	Hartfield Road	Crystal Brook Road	20+	$ 890,000		$ 890,000	
	Safe Active Street								
47c	Kalamunda Township	Lindsay-Boonoloo-McRae Rad SAS	Railway Road	Cotherstone Road	20+	$ 1,110,000		$ 1,110,000	
					TOTAL	$ 4,690,000	$ -	$ 4,690,000	

Summary $500k Funding Target	City Funded	Potential External Funded	Total Project Cost Estimate
0-5 Years	$ 4,900,000	$ 8,805,000	$ 13,705,000
5-10 Years	$ 5,023,000	$ 8,392,000	$ 13,415,000
10-15 Years	$ 5,065,000	$ 5,355,000	$ 10,420,000
15-20 Years	$ 5,000,000	$ 2,210,000	$ 7,210,000
20+ Years	$ 4,690,000	$ -	$ 4,690,000
	$ 24,678,000	$ 24,762,000	$ 49,440,000



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CITY OF KALAMUNDA

BICYCLE PLAN

APPENDIX E

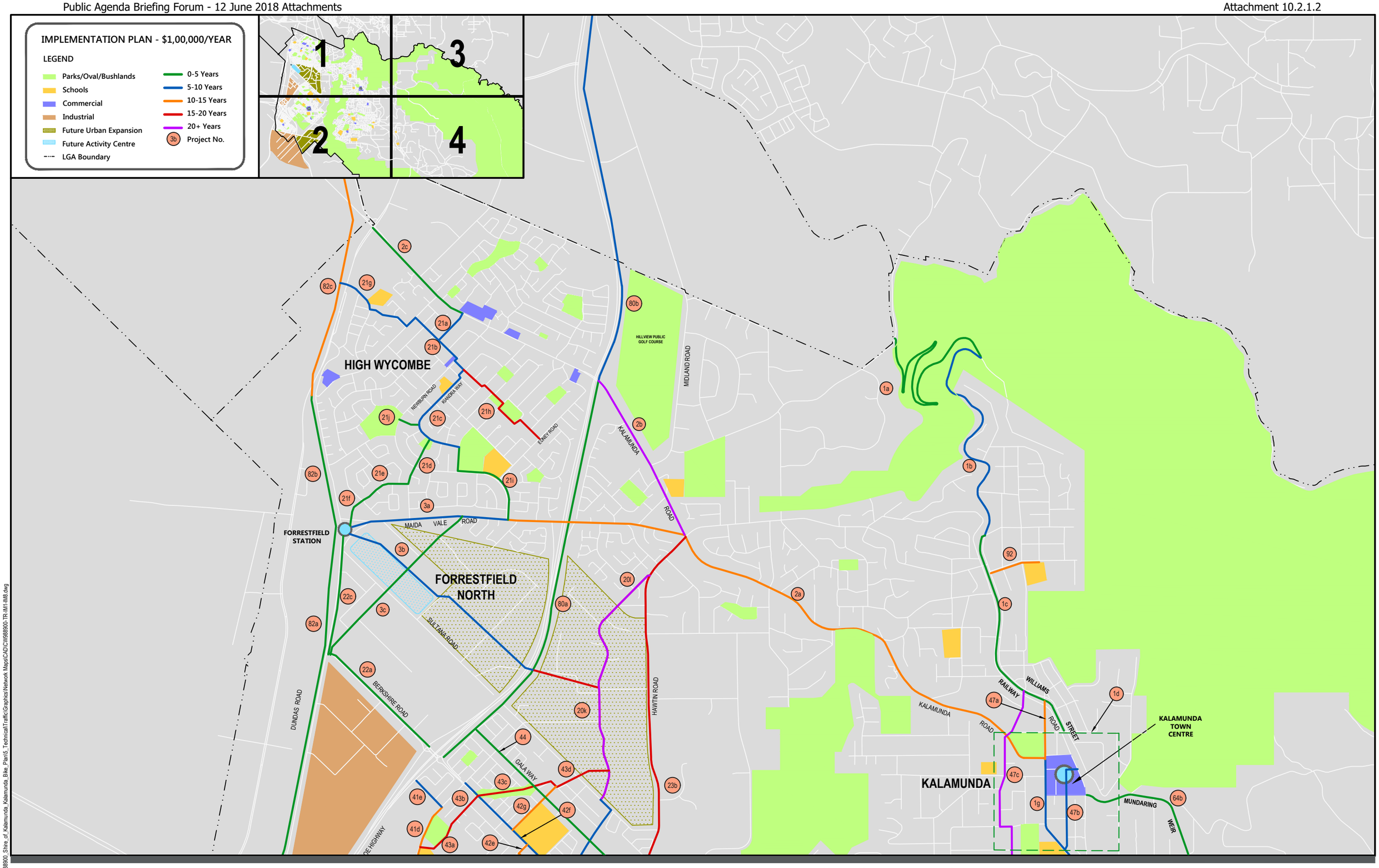
IMPLEMENTATION PLAN - OVERALL MAP

$1,000,000/YEAR SCENARIO

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-OA4 (Drawing Number)

C (Revision)



CITY OF KALAMUNDA

BICYCLE PLAN

APPENDIX E

IMPLEMENTATION PLAN - QUADRANT 1

$1,000,000/YEAR SCENARIO

Date	Scale	Size
10.04.2018	NTS	A3
CW988900-TR-IM5		C
Drawing Number		Revision

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FORRESTFIELD

FORRESTFIELD TOWN CENTRE

WATTLE GROVE

LESMURDIE

HARTFIELD GOLF CLUB

ROE HIGHWAY

TONKIN HIGHWAY

HAWTIN ROAD

ORANGE VALLEY ROAD

CANNING ROAD

LESMURDIE ROAD

TRAFALGAR ROAD

GROVE ROAD

GLADYS ROAD

LESMURDIE ROAD

LAWNBROOK ROAD EAST

POMEROY ROAD

WELSHPOOL ROAD EAST

CRYSTAL BROOK ROAD

KELVIN ROAD

IMPLEMENTATION PLAN - $1,000,000/YEAR

LEGEND

- Parks/Oval/Bushlands
- Schools
- Commercial
- Industrial
- Future Urban Expansion
- Future Activity Centre
- LGA Boundary
- 0-5 Years
- 5-10 Years
- 10-15 Years
- 15-20 Years
- 20+ Years
- 3b Project No.

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CITY OF KALAMUNDA

BICYCLE PLAN

APPENDIX E

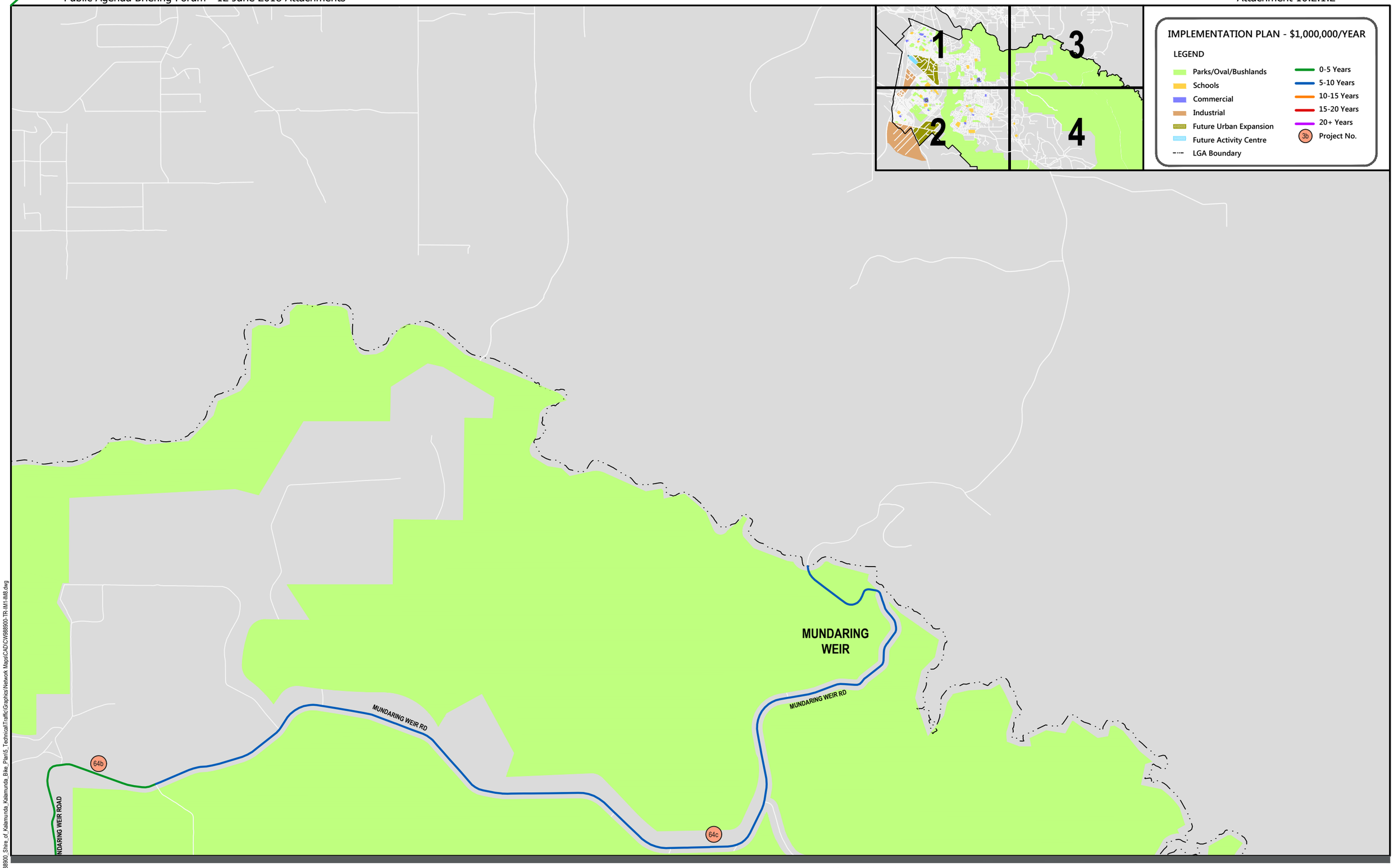
IMPLEMENTATION PLAN - QUADRANT 2

$1,000,000/YEAR SCENARIO

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IM6 (Drawing Number)

C (Revision)



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CITY OF KALAMUNDA

BICYCLE PLAN

APPENDIX E

IMPLEMENTATION PLAN - QUADRANT 3

$1,000,000/YEAR SCENARIO

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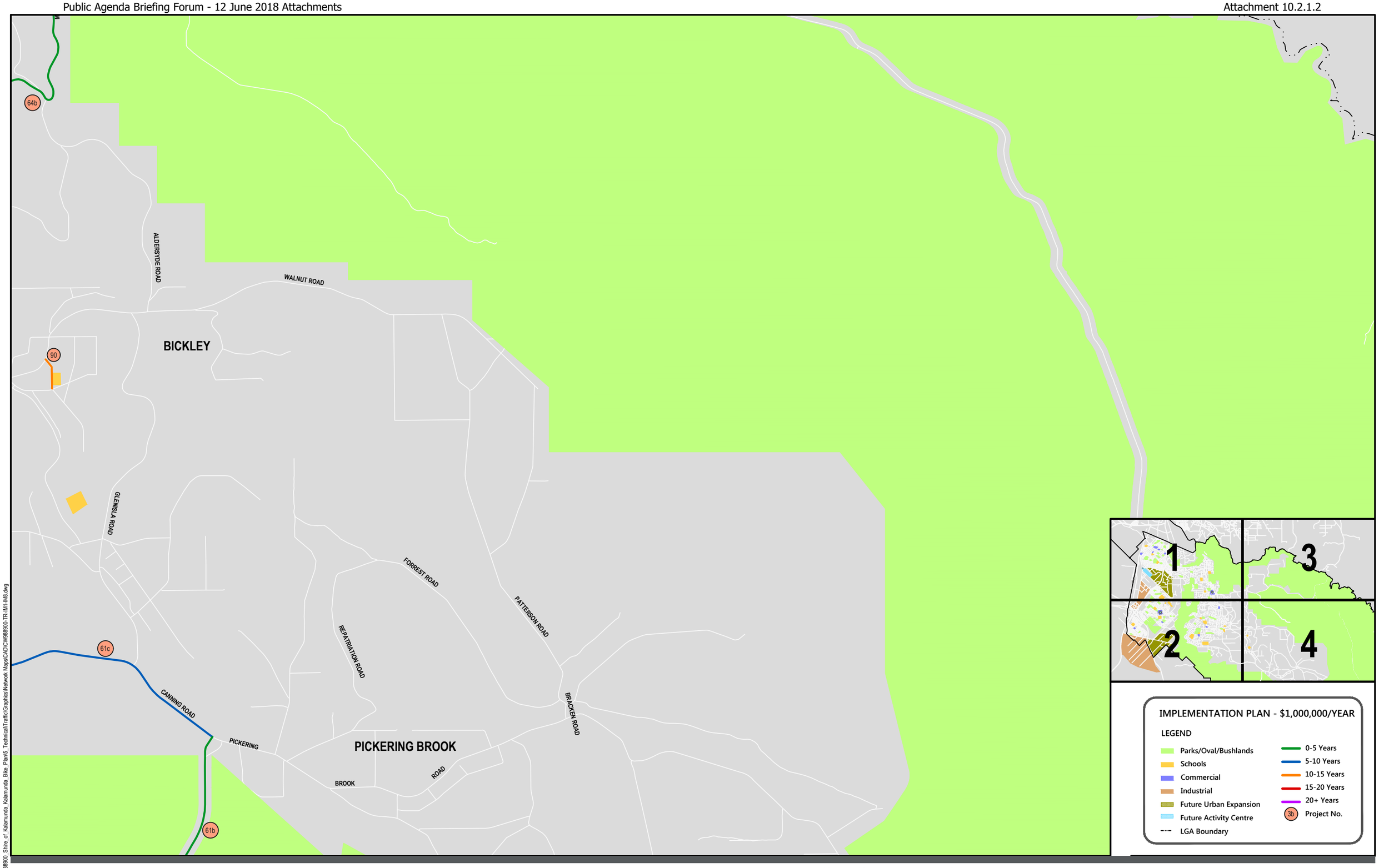
Drawing Number		Revision



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CITY OF KALAMUNDA

BICYCLE PLAN

APPENDIX E

IMPLEMENTATION PLAN - QUADRANT 4

$1,000,000/YEAR SCENARIO

Date	Scale	Size
10.04.2018	NTS	A3

CW988900-TR-IM8 (Drawing Number)

C (Revision)

Bicycle Plan 2017 - Community Engagement

Findings and Outcomes Report

Surveys

History

A Bike Plan was prepared in 2009, following a similar scope, including community consultation, mapping of infrastructure, and proposed five year program of works. The Kalamunda Bike Plan from 2009 was not endorsed by Council and has not been used as an informing document for improving bicycle facilities in the City in 2017-18.

Some key attributes of the 2009 plan that have changed for the Bicycle Plan in 2017 are:

a) Shared paths were the primary infrastructure option for access streets. Shared paths at this time required that they be line marked and signposted as a shared path as the Road Traffic Code prohibited cycling on footpaths.
b) Safe Active Streets (Bike Boulevards) were not considered or known.
c) The plan did not identify the training routes through the hills.
d) The funding was targeting $5 million over five years. This may have included external funding sources.

In 2017 community consultation was undertaken for the new Bicycle Plan, including a survey, community pop-ups and two community workshops (March 2017 – 30 Attendees). A range of data was collected which has provided key insights for the Bicycle Plan. In 2017, over 200 survey responses were received which is a statistically valid representative sample. 64% of respondents were residents of the hills area, and 20% resided outside the City area

Key learnings from the survey and workshops in 2017 were:

a) Many respondents were advanced cyclists, including cyclists who commute to Perth daily, or used the training routes,
b) 14.9% of respondents cycle daily,
c) 49% of respondents almost always ride for Recreational / Leisure,
d) 40% of respondents were confident riding everywhere, while 28% prefer to stick to off road paths, and
e) Top three reasons given for not riding a bike were "Don't feel safe riding", "Lack of bicycle lanes or path" and "Unsafe road conditions".

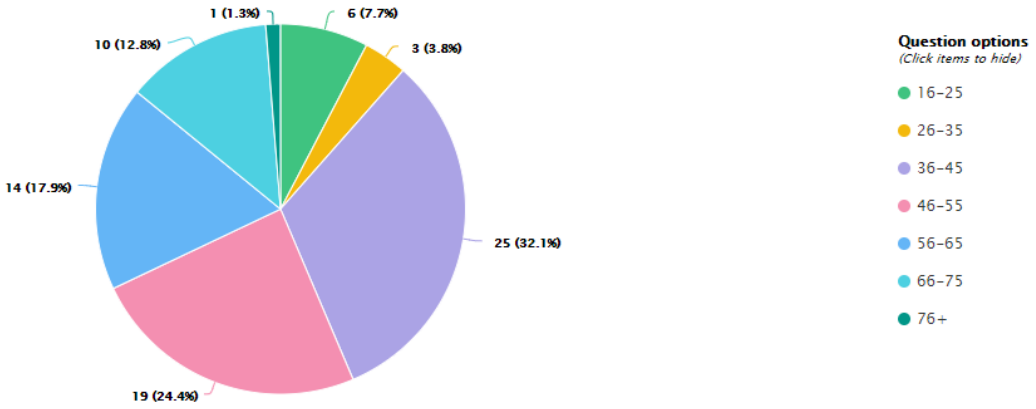
Overview of the Bicycle Plan

The City of Kalamunda (the City) with the services of Cardno and supported by grant funding from the Department of Transport, engaged with the community on the **Draft City of Kalamunda Bicycle Plan 2017.** The plan was aimed at the full range of cyclists and potential cyclists in the City, such as commuting cyclists, recreational riders, professional training cyclists, and families. (excluding off road cycling)

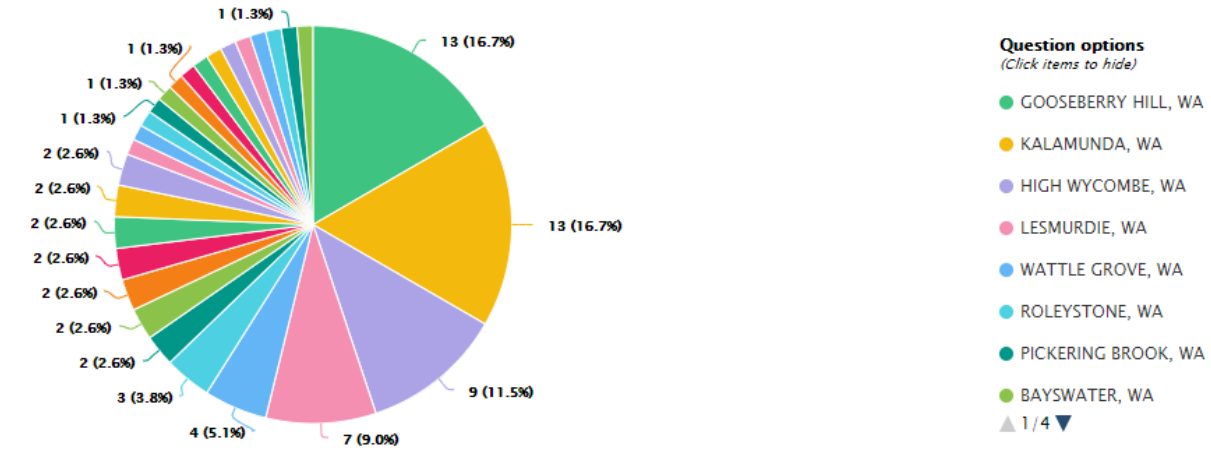
The Bicycle Plan was presented in two formats, one being the Bicycle Plan 2017 Technical Report mainly for internal use, and the other being the Bicycle Plan 2017 Summary Report for public use.

In 2018 the Survey was open from 1st April to the 15TH April 2018. Over that time, a further 78 surveys were completed. 32.8% of the responses were from females and 67.2% from males.

The 36-45 age bracket (parents with children) provided the highest amount of responses, with age brackets of 46-55 and 56-65 having slightly smaller participation rates. The 26-35 and 76+ age brackets had low numbers of participation.

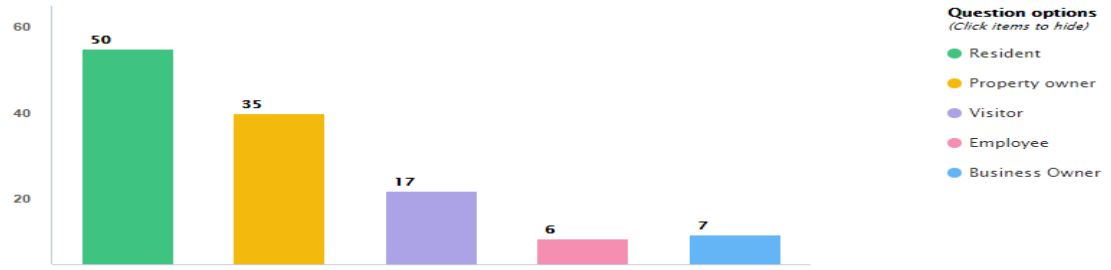


Residents from Kalamunda and Gooseberry Hill were the most engaged with an equal participation rate of 16.7% each, followed by High Wycombe (11.5%), Lesmurdie (9%), Wattle Grove (5.1%) and Roleystone (3.8%).



Overview of the Bicycle Plan

The majority of respondents were residents (50%) and property owners (35%) with visitors being the next group (17%) followed by employees (6%) and business owners (7%). This visitor response could be contributed to the increasing number of cyclists travelling to the hills area to participate in personal training, recreational and cycling events.



Overall the Bicycle Plan project attracted a total of 818 visitors to the project page, 574 visitors to the survey page, resulting in the 78 responses to the survey tool and six written submissions in response to the Bicycle plan.

- The Bicycle Plan 2017 Report – Summary Report: 1041 Downloads
- Bicycle Plan 2017 – Technical Report: 103 Downloads
- FAQ Page – 43 Visitors

Survey Results: Infrastructure

The infrastructure was grouped into: Principal Shared Paths (PSP), Strategic Routes, Local Routes, Safe Active Streets, Other Shared Paths, and Training Routes

5.1 Principal Shared Paths (PSP) are high quality direct and separated cycling connections, usually along major transport corridors.

The responses indicate that this is an issue of significant importance, with praise for the initiatives for the following routes:

- Tonkin Hwy from Roe Hwy to Hale Road
- Tonkin Highway connecting Coyong /Maamba to Hartfield Park
- Extension of PSP from Kalamunda to Berkshire Road, including underpass

Responses of concern include:

- Width to allow walkers/runner and cyclist to safely share the PSP
- Intersection of Kalamunda Road and Roe Highway
- Concerns on who is funding the project – as many cyclists are not from the area

Responses
Supportive - Constructive Comments: 29
Negative: 0
Opposed to Zig Zag options: 2
Negative comments towward cyclist: 1
N/A: 3
Heritage Trail: 1

Survey Results: Infrastructure

5.2 Strategic Routes *connect key destinations within the City with the wider cycling network and nearby Activity Centres. Hills spine.*

Hills Spine & Zig Zag: The responses indicate that there is support for the Hills Spine however the Zig Zag options were divided. There were a larger majority preferring Option A - closing the Zig Zag to local traffic, closley followed by those who have general opposition to any change at this site. There was a small number that highlighted allowing drivers to travel up the Zig Zag is pointless, as the views are only gained travelling down.

ZIG ZAG SCENIC DRIVE TREATMENT OPTIONS

	Treatment Option	Order of Cost
A	Close Zig Zag Scenic Drive to motorised traffic and permit two-way pedestrian and cyclist traffic	Low
B	Permit two-way cycling traffic on existing pavement with one-way uphill motorised traffic	Low
C	Widen carriageway to permit one-way uphill traffic flow and two-way cycling in a 'Safe Active Street' type environment	High
D	Widen carriageway to permit one-way downhill traffic flow and two-way cycling in a 'Safe Active Street' type environment	High
E	Timed closure – night-time access for motorised traffic (e.g. from 5PM to 10PM)	Medium
F	Timed closure – weekday access for motorised traffic	Medium

It is noted that separate, detailed community engagement will be necessary to review the Zig Zag Scenic Drive treatment options

There were a number of responses that praised the proposal of the Hills Spine, but unfortunatley offered no preferred response to the Zig Zag treatment options.

Responses of concern include:

- Closing the Zig Zag to traffic will further sour relationships between drivers and cyclist
- There was opposition to to sealing the Heritage Trail. Comment regarding removing more trees and buldozing the bush, destroying the native habitiat that attracts people to the area.

Responses
Supportive - Constructive Comments: 29
Negative: 0
Opposed to Zig Zag options: 2
Negative comments towward cyclist: 1
N/A: 3
Heritage Trail: 1 negative

Survey Results: Infrastructure

5.3 Local Routes are formed from a mixture of cycling infrastructure types that serve local demand, typically connecting residential areas to schools and shopping centres.

Foothills Spine: General support across the board for these concepts. Safety was the key concern for responders.

Responses
Supportive - Constructive Comments: 22
Nuetral: 5
Opposed to Zig Zag options: 2
Negative comments towward cyclist: 0
N/A: 0
Heritage Trail opposition: 1

5.4 Safe Active Streets are cycle routes on quiet local streets, where speeds have been reduced to 30 kilometres per hour to allow people in vehicles and cyclists to share the street safely. Various measures may be used to slow traffic, discourage through travel by cars and improve bike flow, including:

- Single lane slow points, where approaching vehicles must give way to any car or bike already at or passing through the slow point, such as the City has in Agincourt Drive,
- Raised platforms at intersections, and
- Narrowing carriageway widths by introducing on-street parking and garden beds

General support across the board for these concepts. Safety is the key concern for responders. Some apprehensive that this could conjest traffic further during peak times and that location for these initiatives would have to be carefully concidered in planning.

The majority support this initiatve, with comments such as great initiative & strongly support and agree.

One concern was raised from a truck driver that noted a large increase of Cyclists on Welshpool, Canning Road and around Pickering Brook. As this is a designated truck route, he believes it is becoming a dangerous for both parties and needs urgent attention.

Responses
Supportive - Constructive Comments: 23
Nuetral: 2
Opposed to Zig Zag options: 3
Negative: 2
N/A: 0
Heritage Trail opposition: 1

Survey Results: Infrastructure

5.5 Other Shared Paths

Shared paths are in addition to the nominated Strategic Routes, Local Routes and Safe Active Streets. While these missing links may not form part of major continuous cycling routes they can be the difference between encouraging a parent to ride to school with their child and taking up cycling as part of a more active lifestyle.

The review of missing links within the City and the sections listed below were identified for future shared path funding.

Suburb	Street	From	To
Bickley	First Ave	Nairn Rd	Lawnbrook Rd E
Gooseberry Hill	Ledger Rd	Huntley St	Aboyne Rd
Kalamunda	Burma Rd	Connor Rd	Orange Valley Rd
Lesmurdie	Albert Rd	Reid Rd	Arthur Rd
Lesmurdie	Gladys Rd	Welshpool Rd E	Grove Rd
Lesmurdie	Grove Rd	George Rd	Chislehurst Rd
Lesmurdie	Lesmurdie Rd	Welshpool Rd E	Rootes Rd
Lesmurdie	Reid Rd	Albert Rd	Pomeroy Rd
Lesmurdie	Sanderson Rd	Wiloughby Rd	Gilroy Rd
Lesmurdie	Trafalgar Road - Kimbarlee Way	Waterloo Cres	Falls Road

There were three comments that an education plan should be incorporated to encourage positive shared path behaviour by pedistrians and cyclist and that effective signage is critical. Overall, this initiative is supported if an edcuation plan is incorporated.

Responses
Supportive - Constructive Comments: 13
Nuetral: 0
Opposed to Zig Zag options: 3
Negative comments towward cyclist: 1
N/A: 5
Heritage Trail opposition: 0

5.6 Training Routes

The recommended strategy for the training routes is to manage the conflicts between cyclists and motorised traffic, mainly through signage and other behavioural strategies, while also implementing minor infrastructure improvements. The projects provide benefits to both cyclists and other road users: Drivers will be able to more easily overtake in a safe manner, reducing delays and frustrations and correspondingly improving safety for riders.

This is a question which raised much concern and the majority of responses.

Survey Results: Infrastructure

5.6 Training Routes - Identified Routes

Welshpool Road East – Install additional signage to warn drivers of cyclists, improve the safety at Lesmurdie Road intersection, widening of the road in selected sections from Lesmurdie Road to Canning Road to allow drivers overtake cyclist along this section.

Canning Road (south of Pomeroy Road) – in the long term Canning Road should be widened to provide 2, sealed shoulders. In the short to medium term targeted widening at selected sections is recommended to reduce conflict between cyclist and drivers

Mundaring Weir Road – recondition of road pavement edges to allow cyclist to keep as far left as possible and identify sections where widening can be achieved

Signage and Behavioural Strategies – develop a signage strategy that focuses on informing road users to expect to see cyclists, particularly on the popular training routes, and encourage safe and courteous behaviour from all road users

Response:

Responders all agree that these roads need to be targeted urgently to improve safety for all, particulary on the narrow roads such as Mundaring Weir Road.

Treatment options such as widening of the shoulders (where possible) signage for single lane riders and clear marked lanes were identified as options to assist in improving safety.

Both parties need to be aware of their behaviour. An education program and clear signs were identified as possible solutions, along with stretches of road that cyclist can *only* ride in single file, allowing safe room to overtake. This is particularly important on Mundaring Weir Road, with a 1.5 metre clearance to overtake a cyclist now being required, on narrow, winding and hilly roads, along with blind corners, makes this stretch very hazardous for both cyclist and motorist.

High concern that Canning Road – south of Pomeroy should be prioritised as it is an existing heavy vehicle/truck route, along with Welshpool Road East. There was comment that cyclist should be banned until these roads are upgraded with proper cycle lanes to protect lives.

One concerned Mother commented that for her sons to ride anywhere, including to school, they have to travel on Welshpool Road, with large trucks. She has requested that this should form part of the consideration.

Responses
Supportive - Constructive Comments: 32
Nuetral: 2
Opposed to Zig Zag options: 3
Negative comments towward cyclist: 3
N/A: 0
Heritage Trail opposition: 0

Survey Results: Infrastructure

6.0 Action Plan

6 ACTION PLAN

10.5	No.	Action
Infrastructure	1	Upgrade and expand cycling network as per the Schedule of Works.
Maintenance	2	Regularly maintain roads and path to ensure facilities are in A good condition.
	3	Regularly prune vegetation to ensure that facilities are accessible.
Advocacy	4	Advocate for funding of major projects from the State Government (for example Forrestfield Airport Link, Principal Shared Paths).
	5	Participate in the planning and design of major projects (such as the Roe Highway Principal Shared Path) and ensure connections to the local neighbourhoods are included in the scope.
	6	Assign resource time to implement advocacy actions.
Behaviour Change and Awareness	7	Raise awareness of cycling by including information regarding cycling related activities through the City of Kalamunda's media.
	8	Make cycling related information such as route maps, road rules, safety, and cycling etiquette easily accessible.
	9	Communicate new cycling infrastructure concepts (such as Safe Active Streets) to the community.
	10	Promote the completion of new cycling infrastructure or routes through community and cycling events.
	11	Provide cycling education courses and lead rides to encourage inexperienced cyclists to cycle more often.
	12	Participate in the Super Tuesday annual bike count event and Bike Week to promote cycling and positive reinforcement to existing cyclists.
	13	Investigate the feasibility of a bicycle library scheme, possibly located at libraries at Kalamunda, Forrestfield, and High Wycombe.
	14	Provide driver education for City staff to encourage better road use behaviour, including sharing the road with cyclists.
	15	Collaborate with the Eastern Metropolitan Regional Council, WestCycle, Main Roads WA and the Road Safety Commission to implement a Driver and Cyclist Education Program.
	16	Assign resource time (for example a Sustainable Travel Officer) to implement the Behaviour Change and Awareness actions.
School Programs	17	Conduct programs, such as cycling lessons and sport events, at schools within the City to encourage cycling uptake.
	18	Encourage schools to participate in the 'Your Move' program provided by the Department of Transport (yourmove.org.au).
Cycling Tourism	19	Commission a detailed investigation into the opportunities and benefits of promoting cycling tourism in the City and develop an Action Plan.
	20	Establish a funding stream to assist businesses in becoming 'Bicycle Friendly Businesses' for example by part-funding additional bicycle parking.
End of trip facilities	21	Conduct an audit of existing end of trip facilities to identify and create/update an inventory and map of end of trip facilities within the City. Provide an updated inventory to the Department of Transport for inclusion in the Comprehensive Bike Maps.
	22	Provide suitable end of trip facilities in public places such as parks and libraries that are managed by the City.
	23	Update the Local Planning Scheme to include requirements for end of trip facilities for new developments and create a new bicycle parking policy.

DRAFT

Responses

Feedback highlighted that once these issues are addressed, cycling tourism opportunities could improve providing benefits to the local community.

Further comments for the Zig Zag to remain unchanged, Mundaring Weir Road to be made safer for both cyclist and motorist.

Road sweeping to clear glass and honky nuts was an issue raised as a critical safety concern.

An education program, improved signage advising of rules and etiquette to improve behaviour, safety and awareness.

Responders were positive and constructive in their feedback, and were supportive of the action plan.

Responses
Supportive - Constructive Comments: 24
Nuetral: 0
Opposed to Zig Zag options: 3
Negative comments towward cyclist: 0
N/A: 0
Heritage Trail opposition: 0

Other Comments:

Positive:

"This Bicycle Plan exceeds my expectations. Well done to all involved and all the best in achieving the proposed outcomes"

"These are long overdue and need to be put in place soon."

"You have done an amazing job. I'm really looking forward to the implementation phase. Thank you for your work."

"This is a superb piece of work and really quite inspiring. Thank you."

"Thank you. Really appreciate the effort the City of Kalamunda has put into this project."

Voice of Concern:

"It's great that you're creating greater access for cyclists but at what price? What are we sacrificing? I believe the Zig Zag and Railway Heritage Trail are icons of Gooseberry Hill, where I grew up and came back to reside. I don't think they should be 'urbanised'**."**

"I am strongly against Zig Zags being closed to cars. I have taken every visitor that has ever been to my house in the last 5 years there, usually during the day and again at night. Our family often take our Friday night takeaway up there. Many of the aged care facilities stop there with the oldies for morning tea."

"Don't close the Zig Zag to cars! And get cyclists off Canning Road until it's safe to have them there! Build some cycle lanes ASAP, and in the meantime direct them onto a different route. Someone will die if nothing is done!"

"PLEASE do not seal the heritage trail. It will be an eyesore, walkers/ runners will be at risk - the only reason to seal it is so cyclists can have another option. If group riders use it a walker or runner is likely to be killed. Just don't do it."

Ideas/ Suggestions

"Can we have signs on blind corners in the hills "Beware Cyclists - next 100m", yellow background black letters, this works successfully in the Adelaide hills?"

"Please remove Canning Road, a designated truck route between Welshpool Rd and Brookton Hwy, from the cyclist's reactional shared path and bicycle routes - as suggested on the bicycle plan 2017 before a fatality occurs on this stretch of road which at present is inevitable". This road should not be promoted as training route until dedicated cycle lanes are created and warning signs are installed and it is made as single file cycling only.

"Educate, fix infrastructure, and bring groups together."

"Please review connecting the hills and the foot hills / flat lands with safe bicycle infrastructure. At the moment we are marooned for the average commuter. Particularly along Kalamunda Road?"

With the introduction of the 1.5 metre overtaking rule, stretches on the Canning Road designated truck route and Mundaring Weir road should be changed to strictly single file cycling along with signs reminding motorist not to overtake cyclist on blind corners/hills.

Community Pop Up

Conversation Cafe

On Sunday the Sunday 25 March 2018, the Community Engagement Specialist and the Project consultant met with community members to discuss the Bicycle Plan and provide surveys, gathering the community's ideas. The following location was visited:

42 On Haynes
Haynes Road, Kalamunda

Engaged

Ten cyclist were engaged in awareness conversation, to encourage them to provide feedback. Unfortunately for some, there was no room to take information with them (Lycra), so information was provided to them to locate the information on line. For future engagements with cyclist, a business card with the "Engage Kalamunda" web address or providing key information on a USB with lanyard would be useful.

Nine out of ten spoken to were not aware of the Bicycle plan and were keen to review information and make submissions. Very positive that the City was addressing this issue with the key concerns being safety, connection and education.

We received very good feedback from two community members, Nita and Jim, who kindly sat with us and discussed their key concerns. For Nita, it was Mundaring Weir Road, with its hazardous sharp bends, with the road rising and falling around the hills. In the late afternoon it also has compromised visibility. At around 4:00pm when the sun is lowering there are long flickering shadows across the road, the sun flashes in driver's eyes, coupled with motorist going around corners and encountering Cyclists riding three a-breast, wearing dark colours. Another major issue is the current width of the road (although Nita realises that this will be difficult to address). With cyclists on the road and the new one and a half metre clearance in place to drive around cyclist, it leaves little to no-room without crossing a solid white line. Couple this with a winding road and blind corners, it creates an extremely perilous situation. Many large vehicles (trucks, 4WD) also use this stretch of road which compounds this issue.

Jim was extremely concerned with the Canning Road (90 kph section) between Pickering Brook and Karagullan. He believes there has been a lack of consultation with truck drivers as this route as it is a *designated truck route*. He was agitated that the City was advocating this stretch of road as a training route for cyclist. He travels this road every day, and has been forced onto the shoulder/offroad on two separate occassions when trucks have been compelled to cross the white lines to overtake/avoid groups of cyclist. As noted on our Techical report, this road has restricted vision due to bends, curves and crests. Jim was astounded that it was clear that the City of Kalamunda recognise the risk of this road and yet are promoting it as a possible training route for cyclists.

Leading up to the Kala 100 Challenge, the number of cyclist using this route for training purposes increased, this was with little or no warning to those truck driverss using it as a designated truck route. Large flashing warning signs should have been placed at both ends of this road, well before the event, to clearly identify the risk to both cyclist and truck drivers. Jim mentioned that while some local drivers may have been aware, many of the cyclist were not form the area and may have not known the risk in travelling this road.

Conversation Cafe continued

Jim was very concerned that identifying this area as a training route would encourage more cyclist with little local knowledge to travel this road. He believes that the safety issues, that the City of Kalamunda is already aware of, needs to be addressed first. He suggested that the Draft Plan be edited to note that this is a *"possible future training route once safety issues have been addressed and resolved".*

Jim raised the idea that there should be permanent signs for cyclists warning them of large fast travelling trucks, emus and kangaroos on the road – Warning hazardous conditions.

He felt that more had to be done to engage the truck drivers who use that stretch of road daily, to gain their perspective. He suggested a stand at the Karragullen Store to inform local and truck drivers alike, providing an opportunity for them to raise their concerns.

While he appreciates that trucks, car and cyclists have the right to use this stretch of road, he asks that due to clearly identified and acknowledgment of risk on this particular designated truck route if, it is actually appropriate? Is the risk too great to all concerned allowing cyclist to use this section of road?

Jim has made submission for the Assets Levels of Service project.

Although a lower than expected number of cyclist for the day, largely due to poor weather conditions, believe valuable feedback was still obtained and records show that the engagement website was accessed on that day.

Additional Submissions

A total of 6 submissions were received. Submissions are confidential in nature, and are taken in consideration as part of the final Strategy. The key themes expressed as part of the submissions are explained below:

Create a shared Level of understanding, consideration to an educational campaign for both drivers and cyclist and clear signs to instruct behaviour/rules.

Greater understanding needs to be achieved on the tourism and health benefits of cycling

Engagement with the cycling clubs needs to be undertaken to ensure they see the city as a destination, not just a training route.

Shared use and respectful behaviour campaign to improve the relationship between riders and drivers.

Urgent upgrade of infrastructure, as the existing road network was never designed to accommodate both cyclists and vehicles in such demand.

Better design and placement of bike hitch points, preferably under cover or at least shade, is needed. More bike parking is needed near supermarkets and gyms where it is currently lacking. Possibility of dedicated bike parking areas to unblock paths, streets and seating areas.

Improved surface maintenance and sweeping, hazards including honky nuts, glass rocks and debris, in particular on Orong and Welshpool roads (especially east bound) and improved maintenance/inspection of drainage grates.

Submissions continued.

Corner of Welshpool Road East and Lesmurdie Road is a blackspot for cyclist and needs to be addressed.

Road widening will need to be seriously considered as increased levels of cycling will in turn increase levels of conflict if not addressed. (New 1.5 metre passing rule)

Where a lower standard road network exists and compliance is difficult, riders should be *encouraged to not travel in pelotons* to reduce risk and conflict.

Widening of short steep blind hill, located 500 meters east/uphill from Lesmurdie Road intersection. As cyclist ascend, they create a significant obstruction to cars behind, which often move out toward opposing traffic to avoid cyclist – many close calls have been witnessed when cars are descending the hill westward, move out to avoid cyclist, come over the blind hill and encounter cars travelling in opposing direction. (Lesmurdie to Canning Road to Welshpool Road) (Greg Bargmann submission – greater detail in submission)

Canning Road 90kph section between Pickering Brook and Karragullen is a designated truck route. This road should not be promoted as training route until dedicated cycle lanes are created and warning signs are installed. The hazard of this road has been recognised in the Bike report citing "poor sight distance, curves and crests", coupled with trucks travelling in both directions at 90kph, with reduced braking time (heavy vehicle), around blind bends.
(Jim Spencer submission – greater detail in submission)

This designated truck route should, at the very least, be marked as "Single file riding only" due to the 1.5 metre passing rule and road tolerances given the number of trucks travelling at 90 kph in opposing directions. (Jim Spencer submission)

Greater consideration needs to be given to finding alternative locations for events and training and in turn sharing the responsibility. Engagement with the community to identify potential conflicts prior to finalising approvals would also go a long way to acceptance of cycling events.

The training routes nominated in the report suggest that a primary path for training routes is to turn right at the end of Welshpool road and out along Canning Road. The Plan could encourage all cyclists to turn left at the end of Welshpool and right onto Carmel Road then onto Glen Isla so as to entirely avoid the Canning Road section which is a Heavy Haulage Vehicle Thoroughfare, with crests and bends and is a higher-speed traffic route. Any reduction in Cycling in this zone would be beneficial to cyclists and vehicles (Submission 1)

The same as above could be suggested with regards to Pickering Brook. The training route could be re-directed out in Pickering Brook to turn right onto Carinyah, left at East and left on Merrivale to avoid cyclist traffic through the centre of the residential area of Pickering Brook.

Conclusion

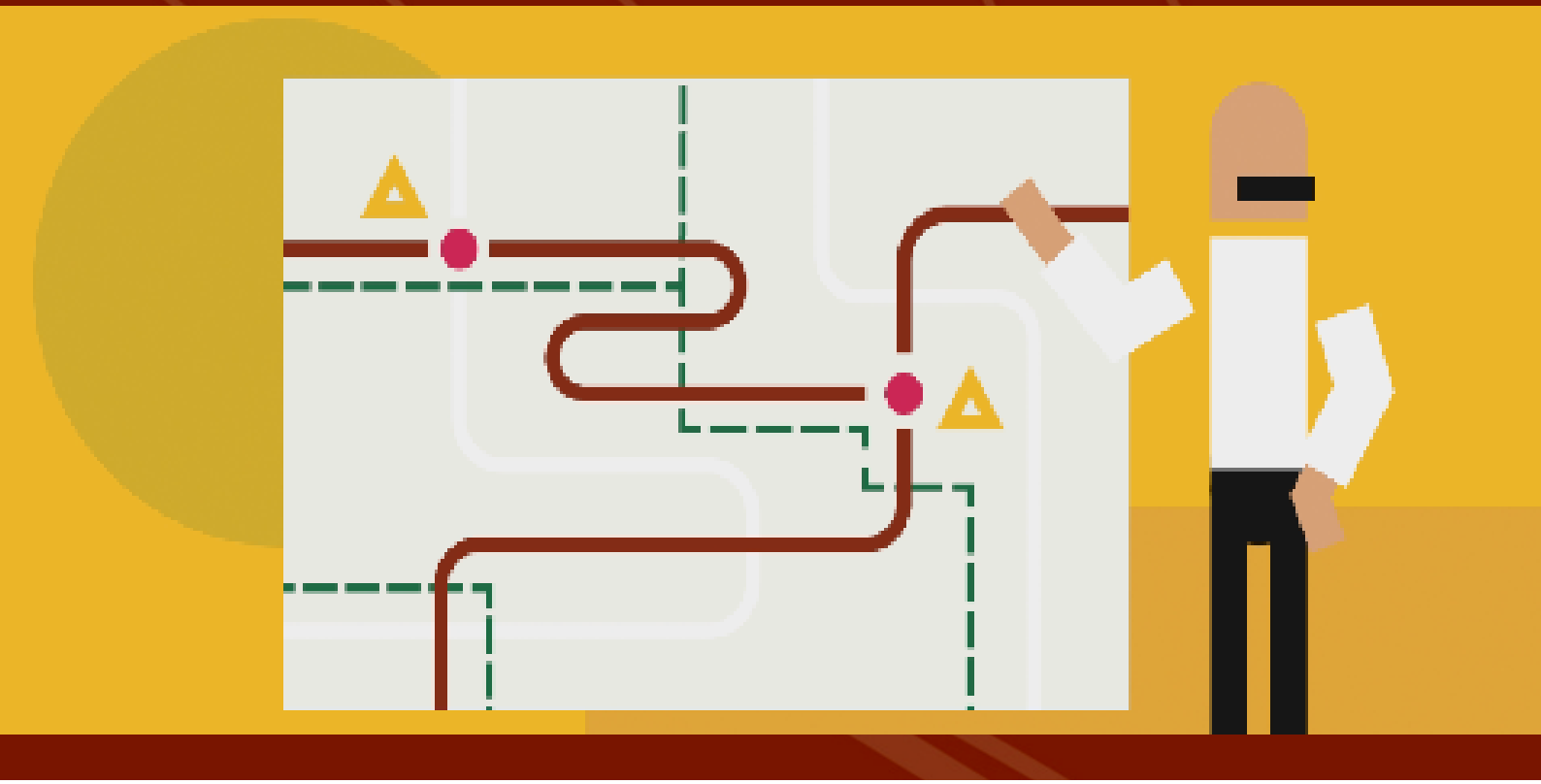
All feedback from the community will be taken into consideration when finalising the final strategy. The key aspects of concern and suggestions for improvements that the community expressed should be taken into consideration during the final planning and implementation phase to gain the best outcome for the wider community.

Given the community expressed a great concern for safety of all using the roads, highlighted a requirement for an education program, clear signage and suggested stretches of single bike riding lanes on difficult and narrow roads, these need to be considered in the final plan. In general the community is accepting of the shared use and increased demand and are actively seeking solutions to issues that the community currently experience.

The community that was engaged conveyed that the standard of research, consultation and consideration that had been invested in the Bike Plan was high, solutions were viable and that changes must take place to ensure safety of all on our roads.

Have Your Say!

Asset Levels of Service: Roads, Drainage and Footpaths



The City of Kalamunda is seeking your input on the City's assets: Do you think the assets are in an acceptable condition? Are they functional?

The information will be used to help the City prepare Asset Management Plans for the asset classes of **Roads, Drainage and Footpaths**. There is a comment section at the end of the survey if you wish to add further explanation, requests or comments, photos or attachments.

The survey should take no more than 15 minutes to complete

Comments close 5:00pm Friday 23 March 2018

SECTION A: Condition of Roads

The following statements relate to the condition of roads

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. The road surfaces in the City of Kalamunda are in acceptable condition	☐	☐	☐	☐	☐
2. Traffic bridges in the City of Kalamunda are in acceptable condition	☐	☐	☐	☐	☐

3. The following pictures show different conditions of road surfaces. Please indicate if you agree or disagree that the condition showing is acceptable



The road condition depicted in **Picture 3A** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The road condition depicted in **Picture 3B** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The road condition depicted in **Picture 3C** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The road condition depicted in **Picture 3D** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The road condition depicted in **Picture 3E** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐

4. The following pictures show different types of road surfaces. Please indicate if the type of road surface is acceptable in the area you live in or visit



The road surface type depicted in **Picture 4A** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The road surface type depicted in **Picture 4B** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The road surface type depicted in **Picture 4C** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The road surface type depicted in **Picture 4D** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐

5. The following statements relate to the quality of assets, such as that they are in good condition and function as they should. In the City of Kalamunda, the following assets are in acceptable condition:

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
Street trees	☐	☐	☐	☐	☐
Street lighting	☐	☐	☐	☐	☐
Verge landscaping	☐	☐	☐	☐	☐

6. The following statements relate to the quantity (number or extent) of assets. In the City of Kalamunda, there is a sufficient number or extent of:

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
Street trees	☐	☐	☐	☐	☐
Street lighting	☐	☐	☐	☐	☐
Verge landscaping	☐	☐	☐	☐	☐

The following statements relate to your experience of the quality of roads when driving:

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
7. I experience difficulties seeing at intersections or corners when driving due to vegetation or other obstructions	☐	☐	☐	☐	☐
8. Roads have an acceptable level of lighting when driving at night	☐	☐	☐	☐	☐

SECTION B: Road Traffic and Speeds

The following statements relate to your experience of the quality of roads when driving:

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
9. I experience traffic delays in the City of Kalamunda	☐	☐	☐	☐	☐
10. I find I can get to my destination in the time I expect to	☐	☐	☐	☐	☐
11. Speed limits in the City are acceptable	☐	☐	☐	☐	☐
12. Speeds of traffic in the City are acceptable	☐	☐	☐	☐	☐
13. Traffic treatments (e.g. islands and chicanes) and intersections to control and slow traffic are acceptable	☐	☐	☐	☐	☐

SECTION C: Footpaths Network, Condition and Safety

14. The following pictures show different conditions of paths. Please indicate if you agree or disagree that the condition showing is acceptable



The footpath condition depicted in **Picture 14A** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The footpath condition depicted in **Picture 14B** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The footpath condition depicted in **Picture 14C** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The footpath condition depicted in **Picture 14D** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐



The footpath condition depicted in **Picture 14E** is acceptable:

Strongly disagree	Disagree	Unsure	Agree	Strongly agree
☐	☐	☐	☐	☐

The following statements relate to the overall accessibility of footpaths in the City of Kalamunda:

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
15. Footpaths in the City of Kalamunda are in acceptable condition	☐	☐	☐	☐	☐
16. There are sufficient footpaths for me to get to where I need to	☐	☐	☐	☐	☐
17. There are paths where I feel unsafe from slipping, tripping or falling	☐	☐	☐	☐	☐
18. Footpath widths are unacceptable	☐	☐	☐	☐	☐
19. When walking, paths have an acceptable level of lighting	☐	☐	☐	☐	☐

SECTION D: Pedestrian Crossings

An example of a pedestrian crossing:



	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
20. There are sufficient pedestrian ramps where I need to cross	☐	☐	☐	☐	☐
21. I am able to cross the road safely	☐	☐	☐	☐	☐

SECTION E: Drainage

The following statements relate to drainage:

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
22. Drainage pits, kerb and channels (on the side of the road) are working to an acceptable level	☐	☐	☐	☐	☐
23. Stormwater drainage flows where it should (through drain pipes and along waterways and creeks)	☐	☐	☐	☐	☐
24. The amount of water running onto and through properties from storms is acceptable	☐	☐	☐	☐	☐
25. The quality of the water in the drainage system is acceptable, for protecting the natural environment	☐	☐	☐	☐	☐
26. Mosquitos are a problem where I live	☐	☐	☐	☐	☐

27. If you had to allocate all the City's maintenance, renewals and upgrade budget for these assets, how much budget would you allocate? Enter a percentage (%) against each asset class, including Parks and Buildings, so that the total for the five asset classes equals 100%. Please note this includes all major asset classes

Roads ____ %

Footpaths ____ %

Drainage ____ %

Parks and Reserves ____ %

Buildings ____ %

About You

Gender

☐ Male ☐ Female

In which suburb do you live?

☐ Wattle Grove
☐ Maida Vale
☐ Walliston
☐ Bickley
☐ Hacketts Gully
☐ Canning Mills
☐ Paulls Valley
☐ Other_____
☐ High Wycombe
☐ Gooseberry Hill
☐ Piesse Brook
☐ Pickering Brook
☐ Forrestfield
☐ Kalamunda
☐ Lesmurdie

What is your age bracket?

(Please tick all that apply)

☐ 15 years and under
☐ 16-25
☐ 26-35
☐ 36-45
☐ 46-55
☐ 56-65
☐ 66-75
☐ 76 +

Contact Details

Name: _____

Email: _____

Phone number: _____

Address: _____

_____

Please keep me informed on:

☐ The development of the City's Asset Management Plan

☐ Services and activities in the City of Kalamunda



Anything else you would like to tell us?

If you wish to include any additional information/pages, please include as an attachment with your survey response

Thank you for completing this survey.
We are interested in what you have to say!

You can return this survey:

By Post: City of Kalamunda, PO Box 42, Kalamunda, WA, 6926

In Person: Administration, 2 Railway Road, Kalamunda

By Email: enquiries@kalamunda.wa.gov.au

This survey is also available online at
engage.kalamunda.wa.gov.au



Comments close
5:00pm 23 March 2018

For further information please contact
E: enquiries@kalamunda.wa.gov.au
Phone: 9257 9999

Asset Levels of Service Consultation and Engagement Results

Introduction

The Asset Levels of Service consultation was undertaken in accordance with a Communications and Engagement Plan, endorsed by the Council in December 2017.

The objectives of the consultation were:

1. Raise awareness of the Asset Management Strategy and consultation process.
2. Create an understanding of the major asset categories and level of service criteria.
3. Influence the perception and attitude of stakeholders that the City has obtained equitable levels of feedback from residents across the districts in the City.
4. Achieve uptake of the engagement process

The media and methods used to communicate the consultation included:

- Presentation of a marketing video on Youtube and through social media,
- Social media releases, paid and unpaid,
- Path stickers in public areas, and
- Notices on community notice boards.

The primary feedback method for the consultation was through a survey, available in hard copy and online at the Engage.Kalamunda portal.

Two community workshops were held to elicit additional feedback.

Graphs of all results are provided in Appendix 1. Some graphs have been included with the commentary for explanation. Comments are provided in Appendix 2.

Response Statistics

The City of Kalamunda consultation on Asset Levels of Service was open from 8 February 2018 to 23 March 2018. Over that time 50 surveys were completed, with the following key statistics:

- 54% of the responses were from females and 44% from males,
- 82% overall were residents,
- Residents from the hills suburbs made up 60% of respondents, and
- The age distribution was reasonable.

The number of stakeholders who became "Aware" of the consultation (as measured by the Engagement website) was 303. Others may have become aware through the advertising and informal discussion, and the publishing of the results as part of a Council report. This does not represent the target percentage of stakeholders.

With 50 responses being received from the questionnaire, sufficient feedback has been provided to give indications of community preference, which will be used in future asset management plans. Ten people attended the workshop.

Workshops and Site Visits

Community workshops were conducted on 12 February 2018 at The City's Function Room, and 27 February 2018 at the Woodlupine Community Centre with ten attendees in total, and proceeded well with valuable comments received.

The public was also asked for feedback at the Forrestfield Shopping Centre.

The workshop at the Woodlupine Community Centre is shown below:



Responses on Roads

Road Condition

An overall question was asked "The road surfaces in the City of Kalamunda are in acceptable condition". The responses were polarised, with 50% disagreeing, and 40% agreeing.

Five example pictures of roads in different conditions were provided for rating.
This provided some clear responses:

- **Picture 3A** depicted a road with a number of potholes in it. This type of surface would typically be repaired in the short term, and resurfaced in around ten years. This was not acceptable to all but one respondent. "The road condition depicted in Picture 3a is acceptable."

Road condition picture 3a



Road Condition

- **Picture 3B** depicted a road with a dark grey, good surface condition but having gum nuts on it. 56% accepted this condition while 38% did not.

Road condition picture 3b



- **Picture 3C** showed a road with a light grey, good surface but having black markings from crack sealing. This generated a mixed response, with 52% accepting the condition and 34% not accepting the condition.

Road condition picture 3c



Road Condition

- **Picture 3D** showed a road with good surface and a small amount of dirt. 86% of respondents accepted this condition.

Road condition picture 3d



- **Picture 3E** showed a road with a rougher looking surface and some patches in the middle. 28% accepted the condition while 64% did not accept this condition.

Road condition picture 3e



During the workshop, some attendees noted that they were also looking at the road condition in terms of whether or not it had a footpath, and other attributes.

The results indicate that the community is very aware of visual road defects such as potholes and patches, and consider their presence to be not acceptable.

This section of the questionnaire also included a question on the condition of bridges. Most respondents were unsure, while 46% reported their condition as being acceptable.

Road Surface Type

Four pictures were provided showing different types of road surface. The pictures were included to get an understanding of the community's acceptance of road surface types, and to confirm the City's selection of resurfacing materials. The material type was not labelled or indicated with the picture.

The results were:

- **Picture 4A** showing a rural road of chip seal was accepted by 92%

Picture 4a



- **Picture 4B** showing an unsealed dirt road was accepted by 50%

Picture 4b



Road Surface Type

- **Picture 4C** showing an urban road of asphalt was accepted by 98%

  (All but one person)

Picture 4c



- **Picture 4D** showing an urban road of red asphalt was accepted by 96%

  (All but two people)

Picture 4d



The results indicate that the community is accepting of all seal types, and possibly not aware of the different seal types. Unsealed roads are accepted by half, and as discussed at the workshop, this is dependent on where they are.

Street Trees, Street Lighting, and Verge Landscaping

These questions were provided to identify issues separate to the road surface type and condition. The questionnaire asked to separately consider the quality of the assets and the quantity of assets.

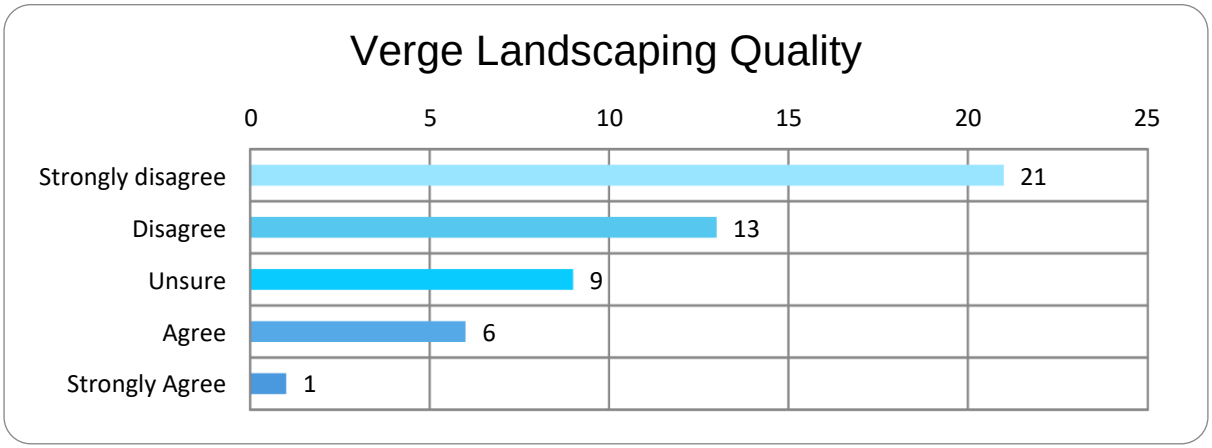
- The quality of street trees was acceptable for 40% of respondents, while the number of street trees were acceptable for 46%. It was not possible to determine if those that rated the number as not acceptable would want more or less trees.
- The quality of street lighting was acceptable for 68% of respondents, while the number of street lighting was acceptable for 52%.
- Only 14% accepted the quality of verge landscaping, and 14% also for the quantity.

The results on street trees indicates that more feedback should be sought on the management of quality of trees (through health and pruning for example) and on whether more or less trees are desired.

The low acceptance scores for the verges indicates that more feedback should be sought on the quality and quantity of verge landscaping that is desired by the community. The feedback from the street trees and verges will need to be explored further, when consultation is undertaken for the Parks and Reserves assets.

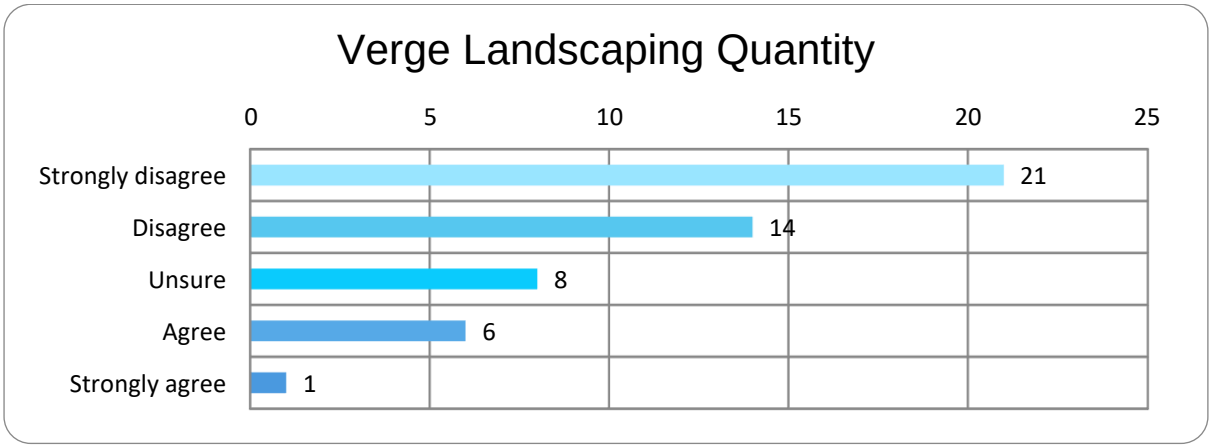
The results on street lighting indicates that more and better quality lighting is desired.

The following graph shows the results of the question relating to verges for quality: "The following statements relate to the quality of assets, such as that they are in good condition, and function as they should. In the City of Kalamunda, the following assets are in an acceptable condition:"



Street Trees, Street Lighting, and Verge Landscaping

The following graph show the results of the question relating to verges for quantity: "The following statements relate to the quantity (number or extent) of assets. In the City of Kalamunda there is a sufficient number or extent of:".



Other Aspects of Roads Assets: Sightlines, Lighting, Traffic, Speed, Traffic Islands

These questions were intended to seek out areas of concern for future investigation and planning. The questions were:

Q 7 I experience difficulties seeing at intersections or corners when driving due to vegetation or other obstructions.
Q 8 Roads have an acceptable level of lighting when driving at night.
Q 9 I experience traffic delays in the City of Kalamunda.
Q 10 I find I can get to my destination in the time I expect to.
Q 11 Speed limits in the City are acceptable.
Q 12 Speeds of traffic in the City are acceptable.
Q 13 Traffic treatments (e.g. islands and chicanes) and intersections to control and slow traffic are acceptable.

Question 7 regarding sight lines resulted in a split response, with 44% indicating no problems and 48% indicating problems. A method is needed to find which locations re causing problems so that this can be resolved.

Question 8 provided a similar response as the street lighting quality, with 54% accepting the level of lighting for driving.

Regarding traffic, 34% indicated they had experienced traffic delays, and 24% of respondents are not able to get to their destination in the time they expect to.

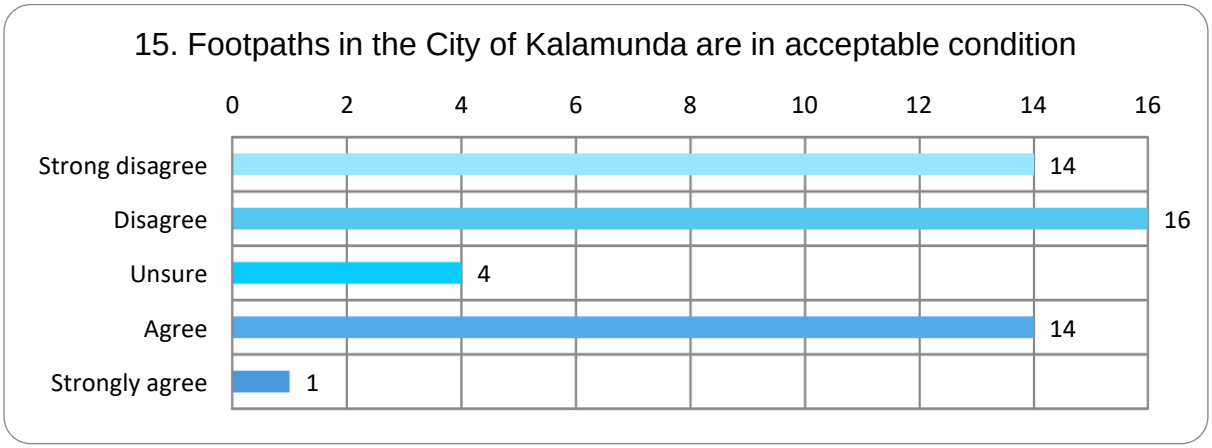
Regarding questions eleven and twelve on speed, 24% of respondents disagreed that speed limits are acceptable, however this does not tell us whether they desired higher or lower speed limits. 30% of respondents did not find that the speed of traffic was acceptable.

There was a strong negative response to question thirteen on traffic treatments, with 78% of respondents not agreeing that traffic treatments are acceptable. This requires further investigation to determine whether more or less traffic treatments are desired, or if the response is based on the types of traffic treatments.

Responses on Footpaths

Footpath Condition

Question fifteen asked the overall question "Footpaths in the City of Kalamunda are in acceptable condition". The responses were negative, with 60% disagreeing. This indicates more effort is needed to improve footpath condition, which is further supported by the results of the picture questions.



Five example pictures of footpaths in different conditions were provided for rating. The responses were:

- **Picture 14A** depicted a path that was uneven and had obvious repairs to it. Only 26% considered this path to be acceptable with 70% not.



Footpath Condition

- **Picture 14B** depicted a path that was badly cracked, with loose stones and having waste bins sitting beside it. Only 14% considered this path to be acceptable with 82% not.

Picture 14b



- **Picture 14C** depicted a red asphalt path with no obvious defects. Only 6% disagreed that this path was acceptable.

Picture 14c



Footpath Condition

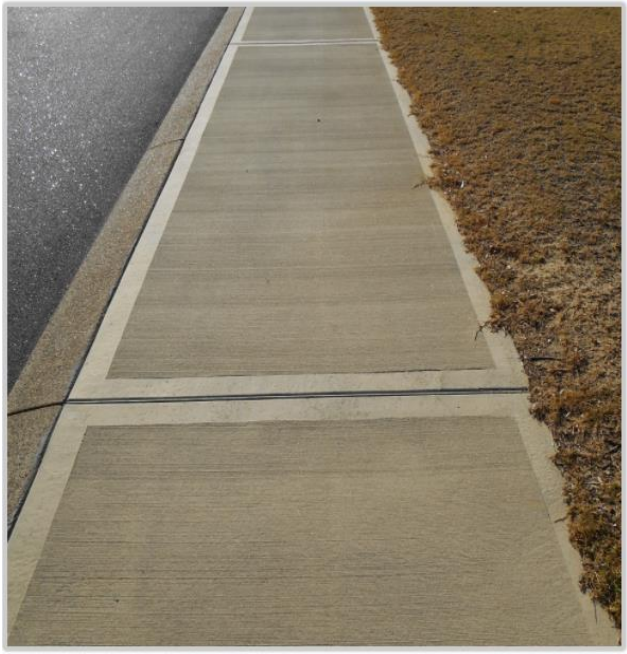
- **Picture 14D** depicted a concrete path with some cracks and possible trip hazard. Only 14% considered this path to be acceptable with 76% not.

Picture 14d



- **Picture 14E** depicted a near new wide concrete path in excellent condition. 96% of respondents agreed that this was acceptable.

Picture 14e



The results indicate that any damage to paths is not acceptable and more effort is needed to repair or replace even smaller cracked or uneven sections.

Other Footpath Questions

Further questions were asked to identify areas for improvement and future planning:

Q 16 There are sufficient footpaths for me to get to where I need to.

Q 17 There are paths where I feel unsafe from slipping, tripping or falling

Q 18 Footpath widths are acceptable.

Q 19 When walking, paths have an acceptable level of lighting.

Q 20 There are sufficient pedestrian ramps where I need to cross

Q 21 I am able to cross roads safely.

Pedestrian crossing



For question sixteen, 50% disagreed that there were sufficient paths.

Question seventeen received 68% agreement that there are paths were people feel unsafe from slipping, tripping and falling. This requires an improvement in maintenance response and repair type.

For question eighteen, 24% of respondents did not find that footpath widths were acceptable. The current Pathways Asset Management plan will upgrade path widths as the respective path is due for renewal. This result however suggests a higher priority should be given to providing wider paths.

For question nineteen, 34% found that footpaths did not have an acceptable level of lighting. This response complements the street lighting responses.

Questions twenty and twenty one are complementary however they gave different results. 36% of respondents disagreed that there were sufficient pedestrian ramps, and 36% disagreed that they were able to cross the roads safely. This identifies a significant need for improvement.

The results of questions sixteen, eighteen, and twenty will be used to inform the Path Expansion Plan that is being prepared.

Responses on Drainage

Drainage Questions

The questions asked about drainage were:

Q 22 Drainage pits, kerb and channels (on the side of the road) are working to an acceptable level.

Q 23 Stormwater drainage flows where it should (through drain pipes, and along waterways and creeks).

Q 24 The amount of water running onto and through properties from storms is acceptable.

Q 25 The quality of the water in the drainage system is acceptable, for protecting the natural environment.

Q 26 Mosquitos are a problem where I live.



Drainage Questions

The survey was conducted during summer, so the answers may not reflect opinions during the winter. The nature of drainage is that issues are usually localised, so where one or two properties may be affected by a heavy rainfall event, the wider neighbourhood may not be aware of the problems. There is also a perception issue that when water ponds in the road this is a drainage problem, where the design may be working as expected.

For question 22, 26% of respondents disagreed, and 64% agreed that drainage was working effectively.

26% of respondents also disagreed that stormwater drainage flows where it should. 60% agreed.

18% of respondents disagreed that the amount of water was acceptable, while 58% agreed.

46% of respondents were unsure whether the quality of water in the drainage system was acceptable. This indicates a lack of awareness of the quality of stormwater in the City. 8% disagreed.

Mosquitoes appear to either be a problem or not, with 44% agreeing that they are a problem, and 50% disagreeing.

It is worth noting that despite the apparent concerns with drainage, no comments were given regarding drainage.

Responses on Budget Spend

The question asked was "If you had to allocate all the City's maintenance, renewals, and upgrade budget for these assets, how much budget would you allocate? Enter a percentage against each asset class including Parks and Buildings, so that the total for the five asset classes equals 100%. Please note this includes all major asset classes."

46 of the 50 respondents answered this question. In the following list, the first value is the average, with the following two values in brackets representing the range of responses:

- Roads 28.9% (20% to 40%)
- Footpaths 20.4% (10% to 30%)
- Drainage 14.9% (0% to 20%)
- Parks and Reserves 20.9% (10% to 30%)
- Buildings 16.0% (0% to 25%)

This means that (for example) the average percentage of budget that the community would like to allocate to roads is 28.9%. The responses from individuals ranged from allocating 20% up to allocating 40%.

In the workshop, the attendees were shown a slide the total value of assets in the different asset classes however no maintenance or renewal expenditure was discussed. No financial information was provided to other respondents, and most respondents are probably not aware of the actual amount that is spent. Consequently the results should be interpreted as indications of preference rather than actual targets.

Conclusion

The number of questionnaire responses (50) is reasonable.

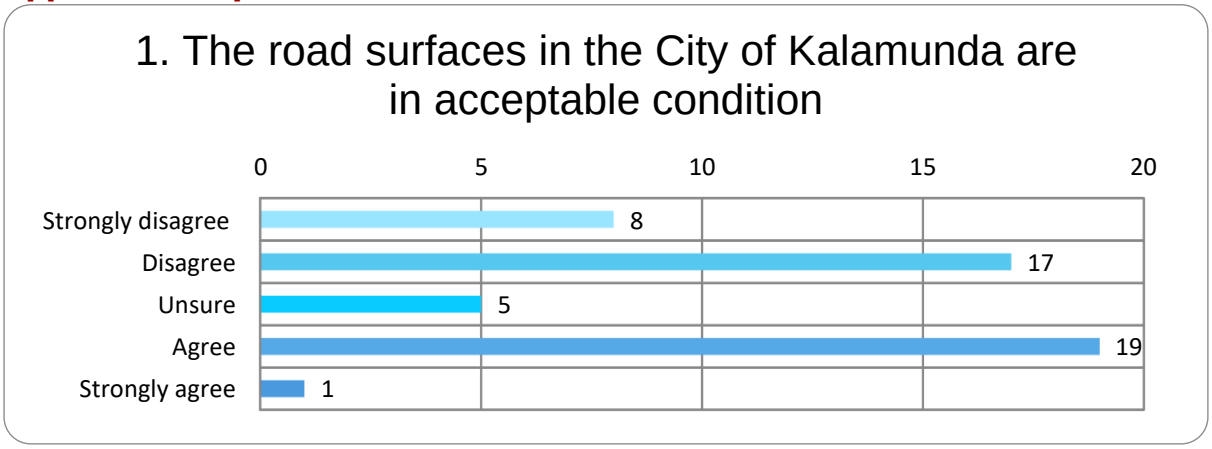
There are areas for improvement identified, that need to be addressed:

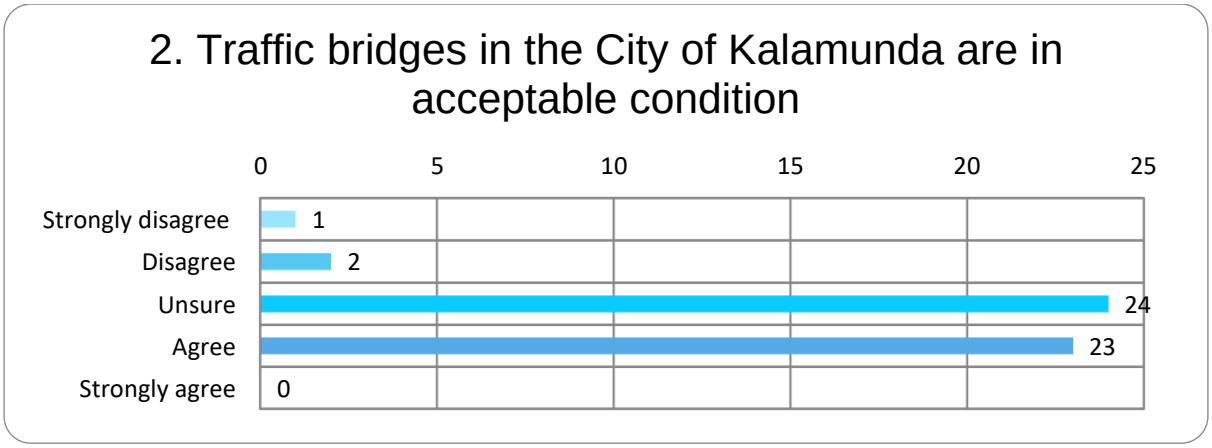
Operational changes, such as improving response and quality of repairs for roads and paths,

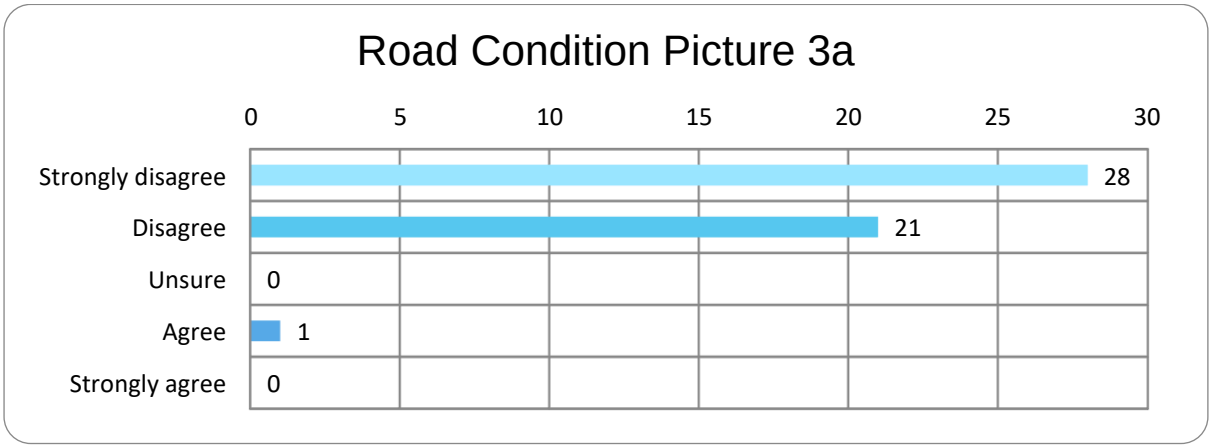
Future plans such as for improving lighting, traffic congestion, street trees and path networks, and

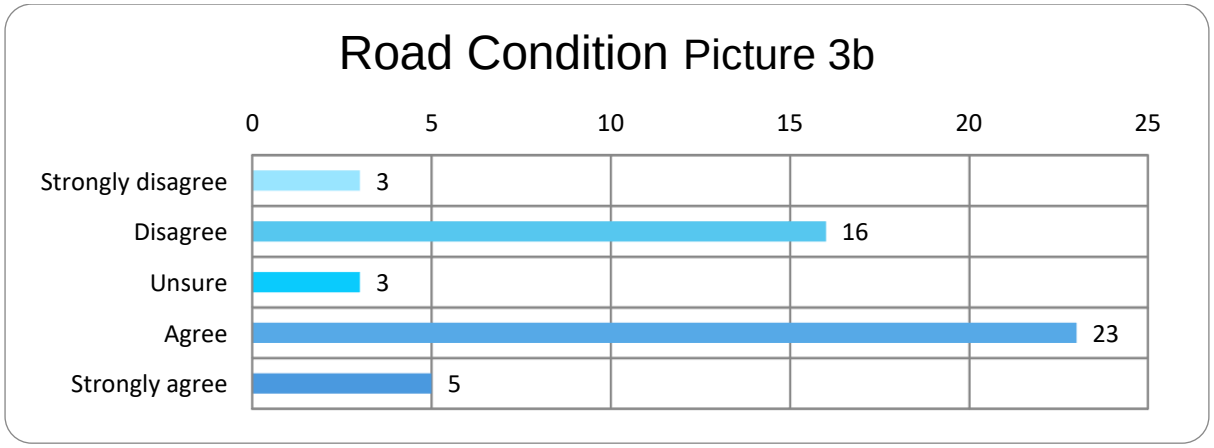
Specific consultation such as for traffic treatments and road sight line problems.

Appendix: Graphs








Road Condition Picture 3b
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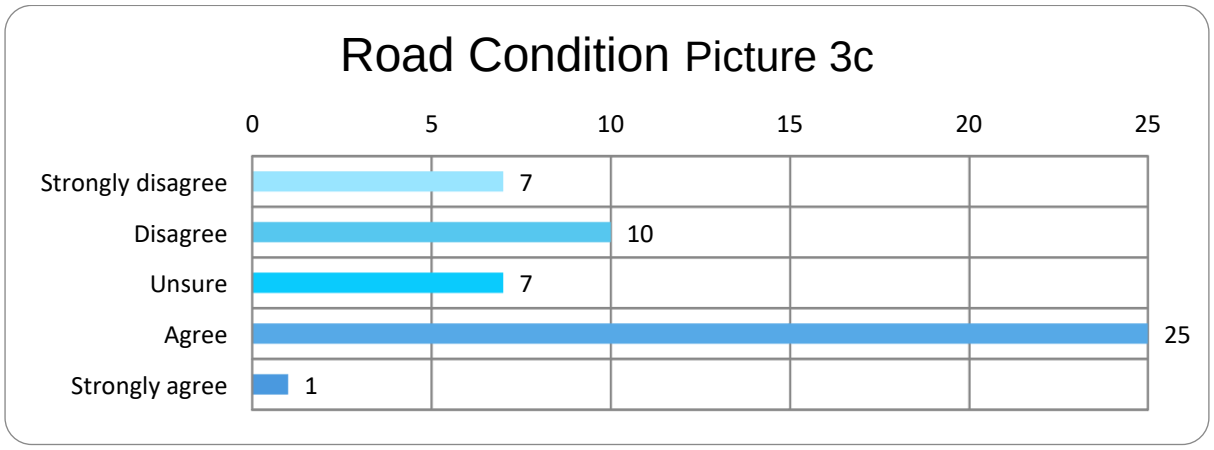
5
10
15
20
25
Strongly disagree
3
Disagree
16
Unsure
3
Agree
23
Strongly agree
5


Road Condition Picture 3c
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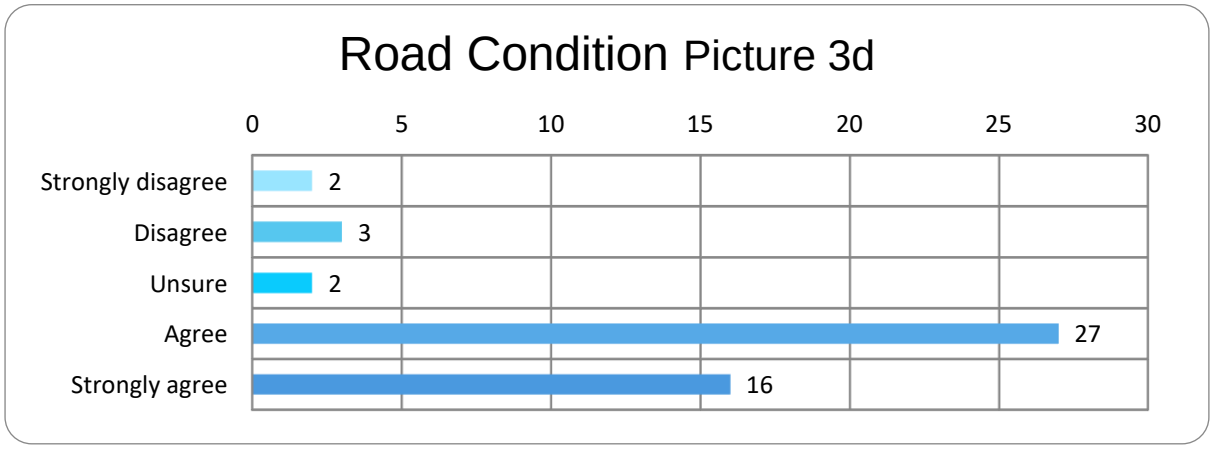
15
20
25
Strongly disagree
7
Disagree
10
Unsure
7
Agree
25
Strongly agree
1


Road Condition Picture 3d
0
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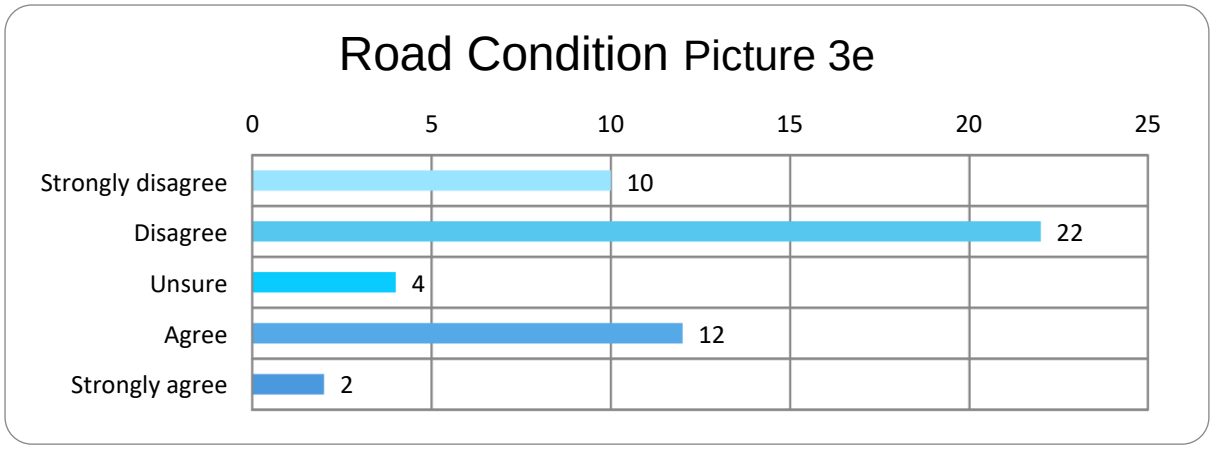
10
15
20
25
30
Strongly disagree
2
Disagree
3
Unsure
2
Agree
27
Strongly agree
16


Road Condition Picture 3e
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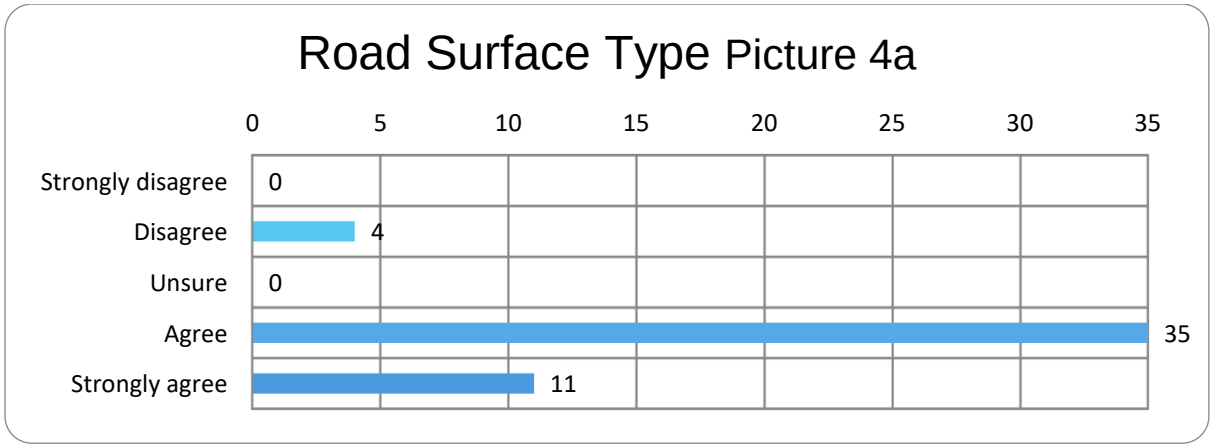
10
15
20
25
Strongly disagree
10
Disagree
22
Unsure
4
Agree
12
Strongly agree
2


Road Surface Type Picture 4a
0
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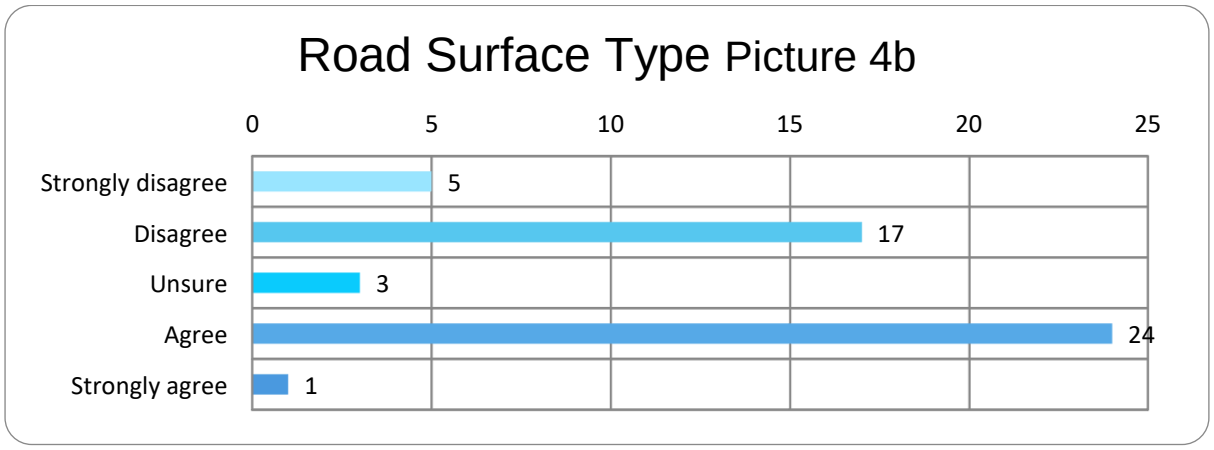
15
20
25
30
35
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
0
4
0
35
11


Road Surface Type Picture 4b
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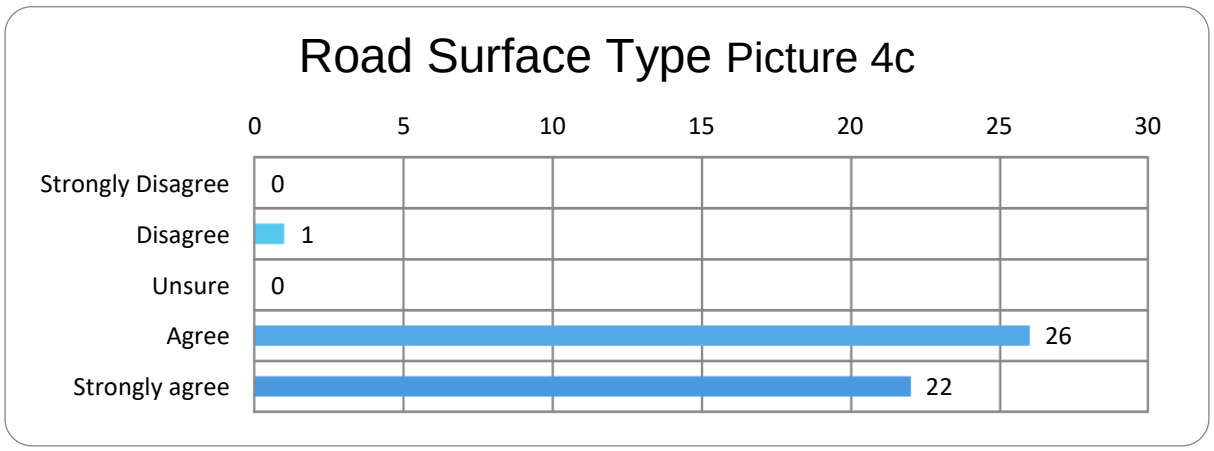
10
15
20
25
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
5
17
3
24
1


Road Surface Type Picture 4c
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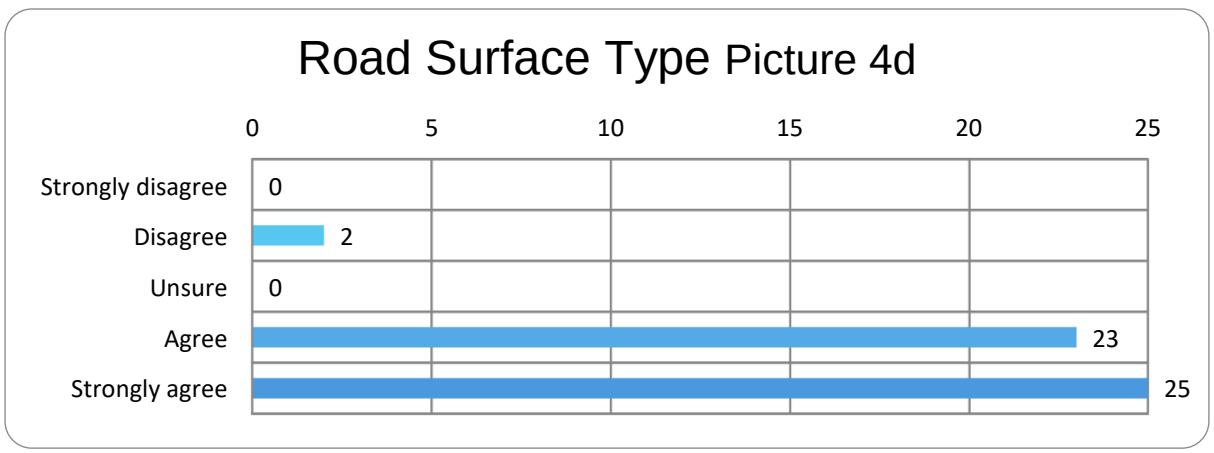
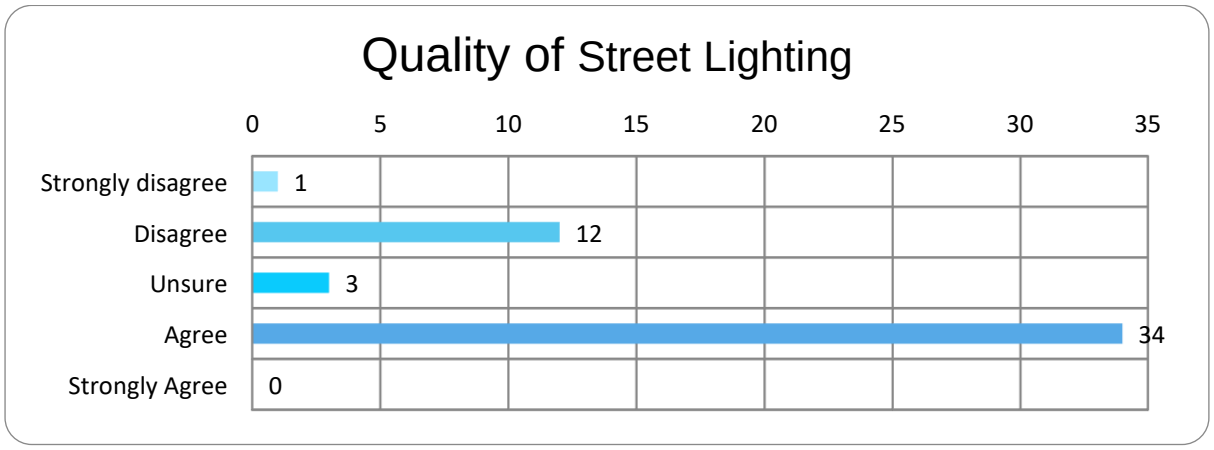
10
15
20
25
30
Strongly Disagree
Disagree
Unsure
Agree
Strongly agree
0
1
0
26
22


Road Surface Type Picture 4d
0
5
10
15
20
25
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
0
2
0
23
25


Quality of Street Trees
0 2 4 6 8 10 12 14 16 18 20
Strongly disagree 7
Disagree 19
Unsure 4
Agree 17
Strongly Agree 3


Quality of Street Lighting
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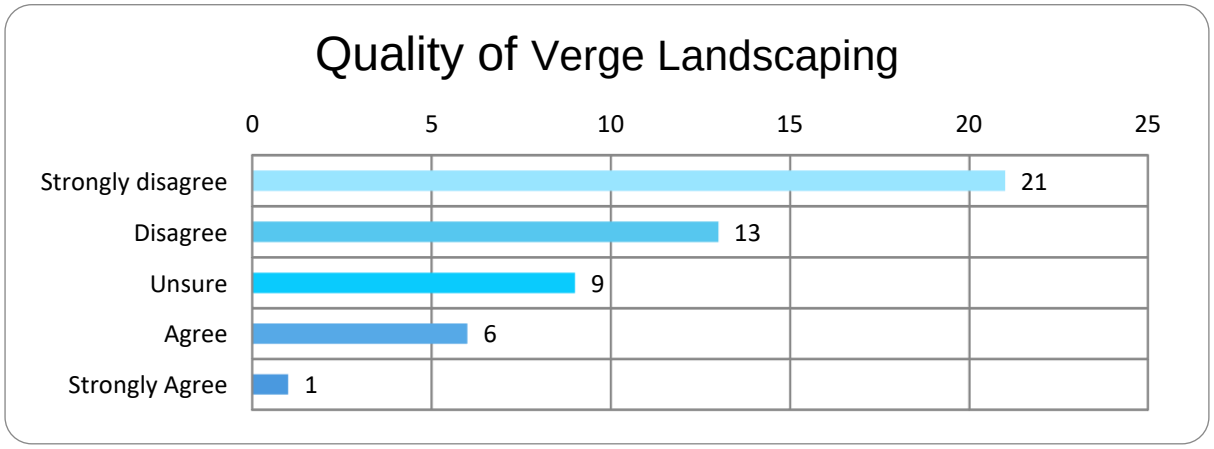
Strongly disagree 1
Disagree 12
Unsure 3
Agree 34
Strongly Agree 0


Quality of Verge Landscaping
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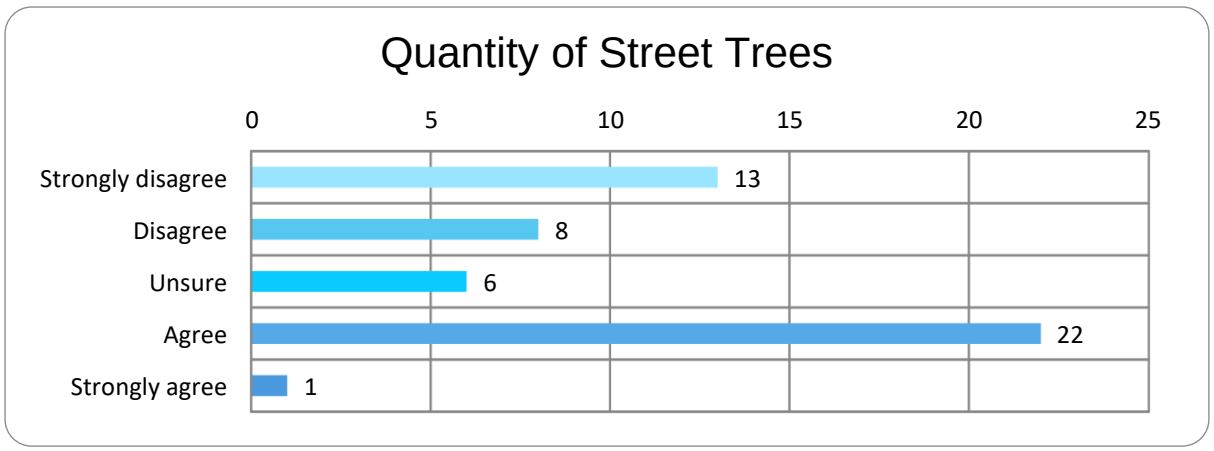
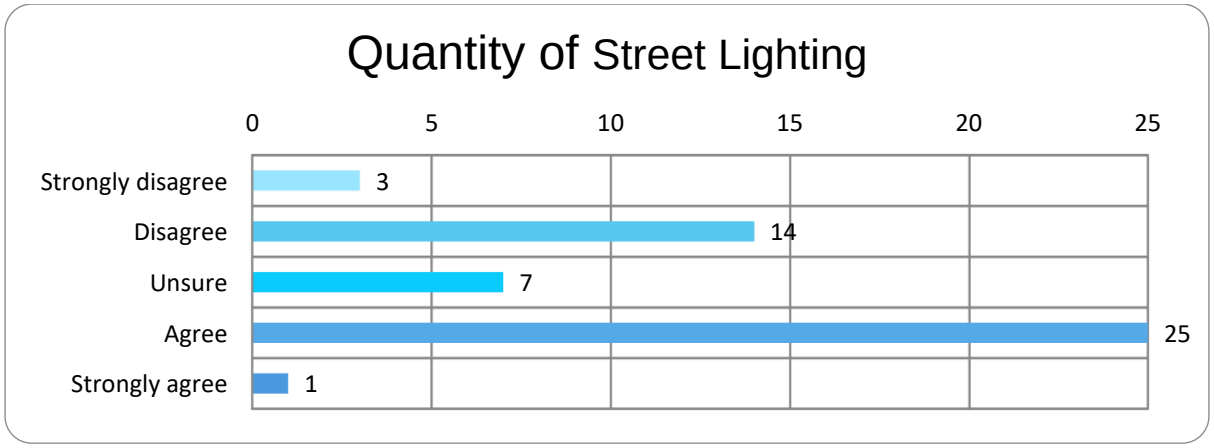
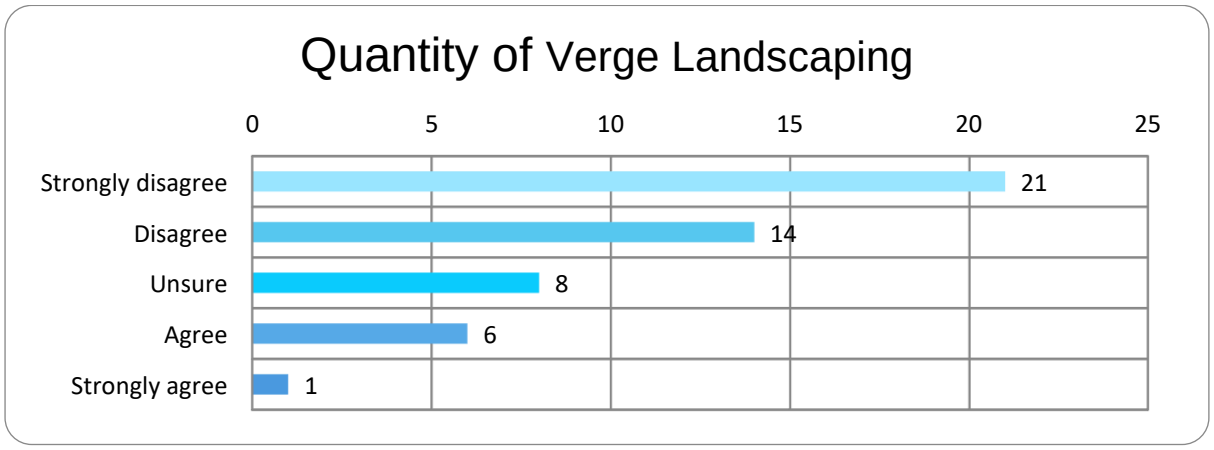
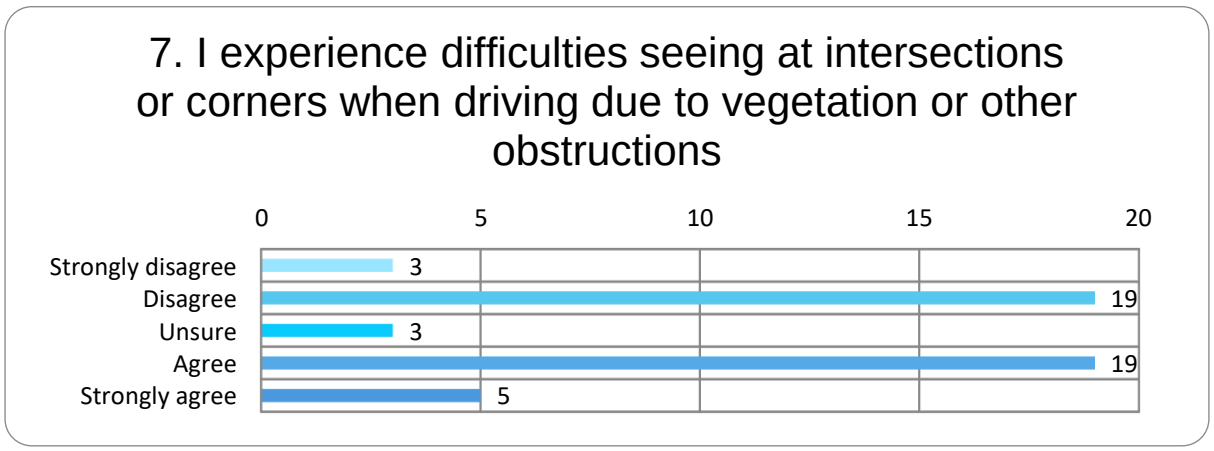
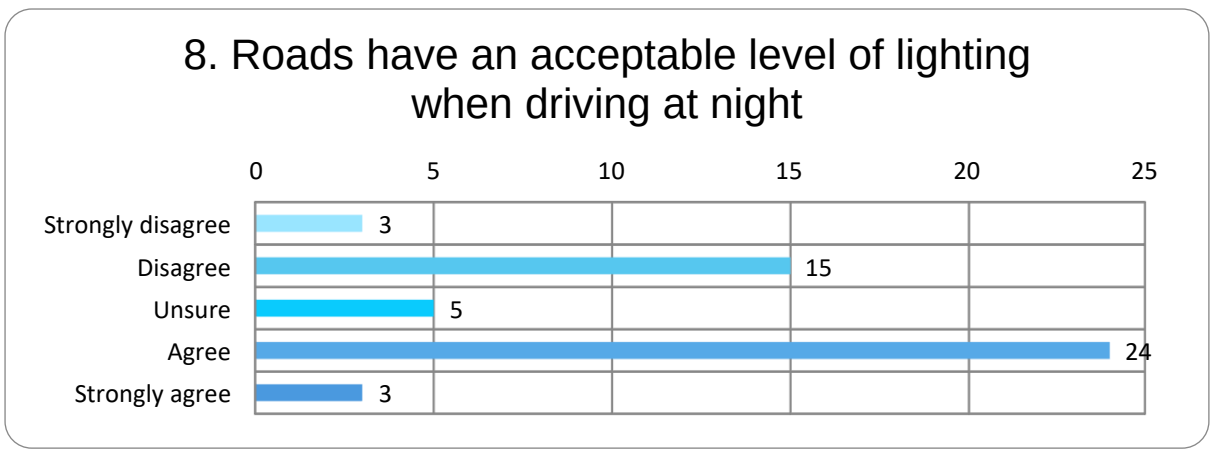
Strongly disagree 21
Disagree 13
Unsure 9
Agree 6
Strongly Agree 1

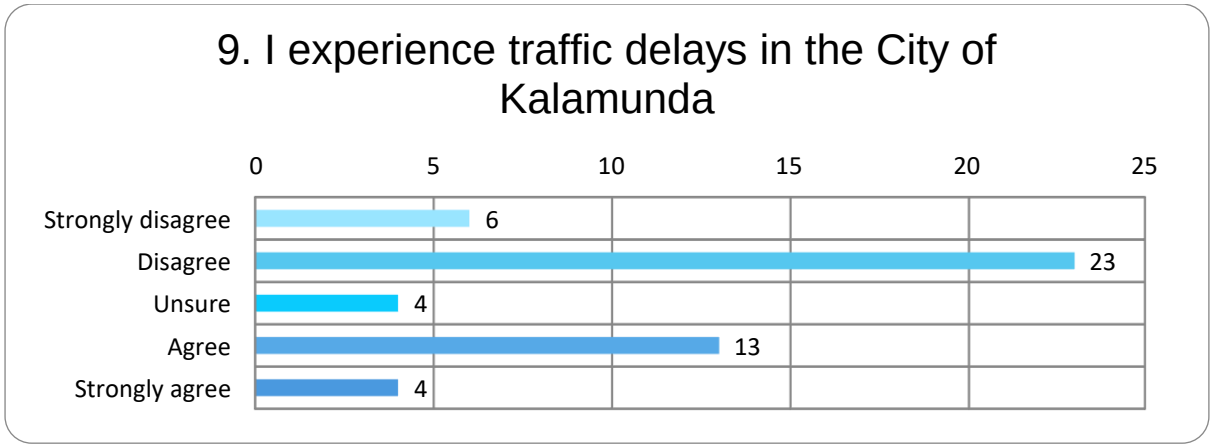

Quantity of Street Trees
0 5 10 15 20 25
Strongly disagree 13
Disagree 8
Unsure 6
Agree 22
Strongly agree 1

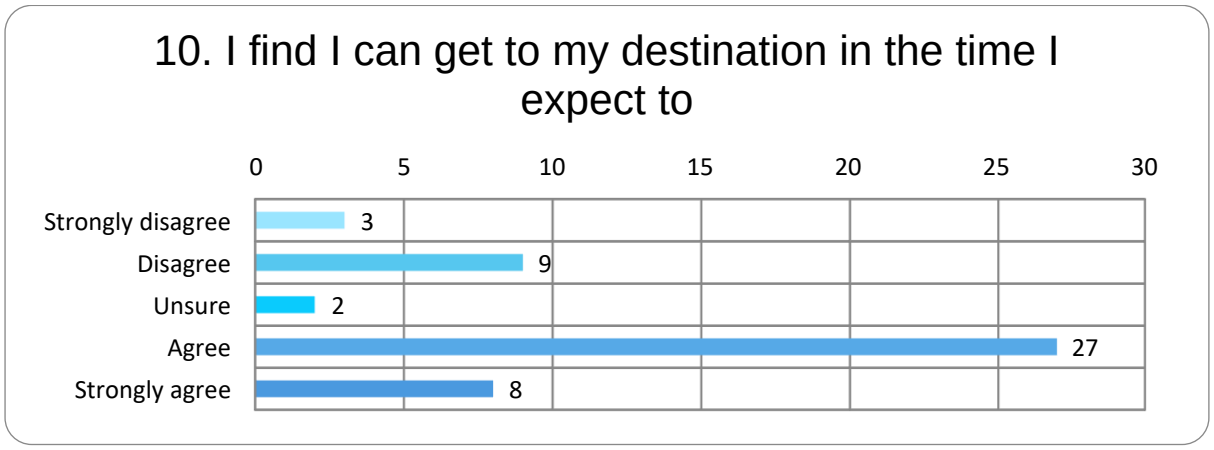

Quantity of Street Lighting
0
5
10
15
20
25
Strongly disagree
3
Disagree
14
Unsure
7
Agree
25
Strongly agree
1

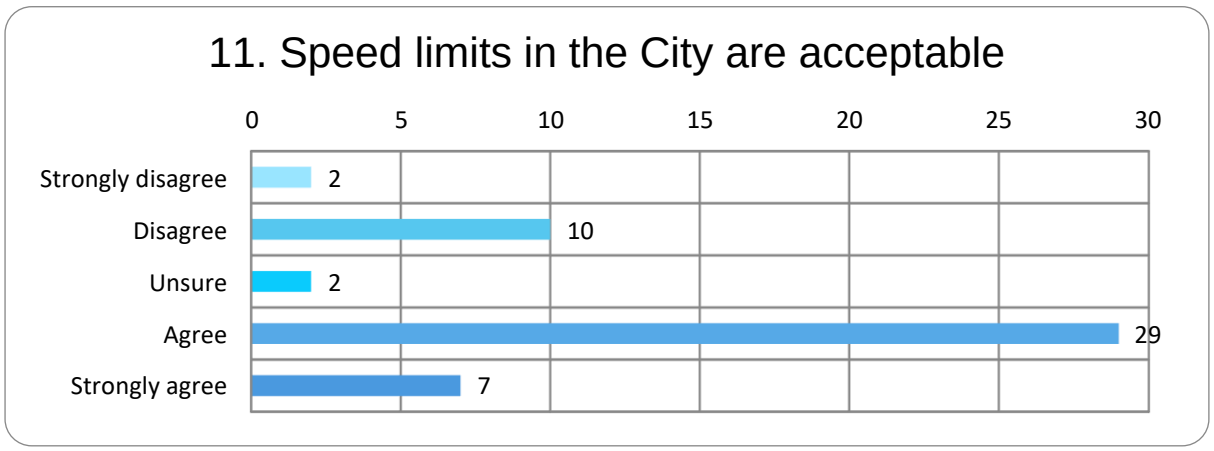

Quantity of Verge Landscaping
0
5
10
15
20
25
Strongly disagree
21
Disagree
14
Unsure
8
Agree
6
Strongly agree
1

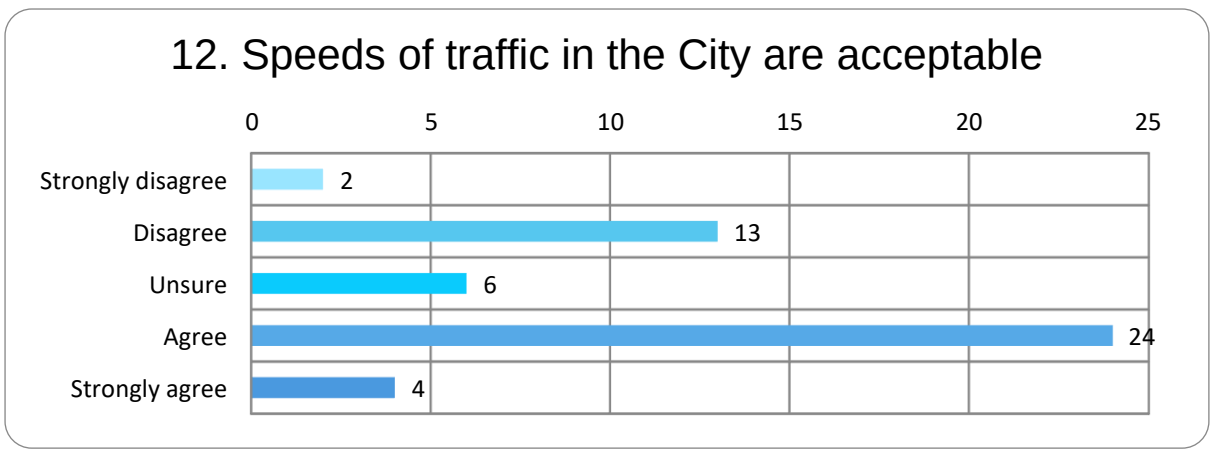

7. I experience difficulties seeing at intersections or corners when driving due to vegetation or other obstructions
0
5
10
15
20
Strongly disagree
3
Disagree
19
Unsure
3
Agree
19
Strongly agree
5

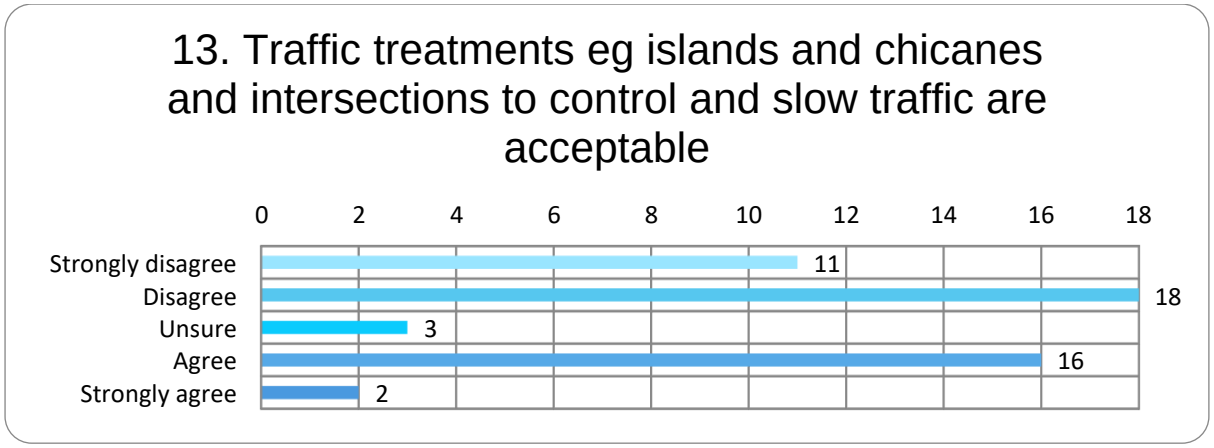

8. Roads have an acceptable level of lighting when driving at night
0
5
10
15
20
25
Strongly disagree
3
Disagree
15
Unsure
5
Agree
24
Strongly agree
3

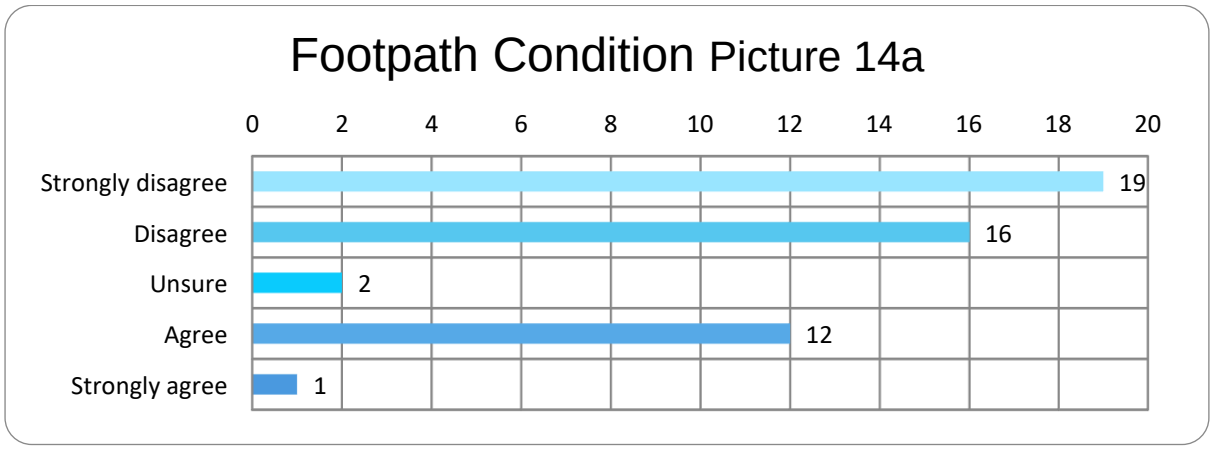

9. I experience traffic delays in the City of Kalamunda
0
5
10
15
20
25
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
6
23
4
13
4

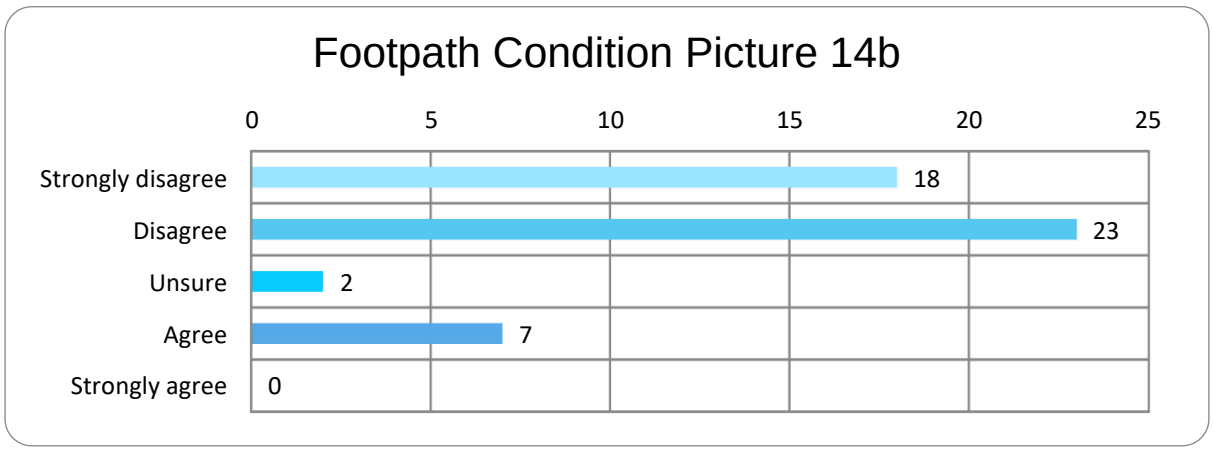

10. I find I can get to my destination in the time I expect to
0
5
10
15
20
25
30
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
3
9
2
27
8


11. Speed limits in the City are acceptable
0
5
10
15
20
25
30
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
2
10
2
29
7


12. Speeds of traffic in the City are acceptable
0
5
10
15
20
25
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
2
13
6
24
4


13. Traffic treatments eg islands and chicanes and intersections to control and slow traffic are acceptable
0
2
4
6
8
10
12
14
16
18
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
11
18
3
16
2


Footpath Condition Picture 14a
0
2
4
6
8
10
12
14
16
18
20
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
19
16
2
12
1


Footpath Condition Picture 14b
0
5
10
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20
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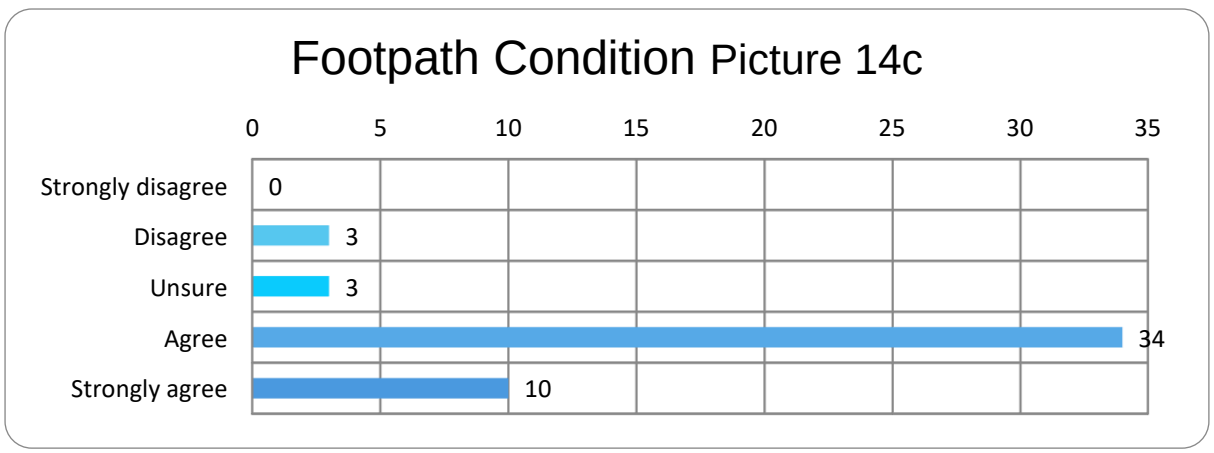
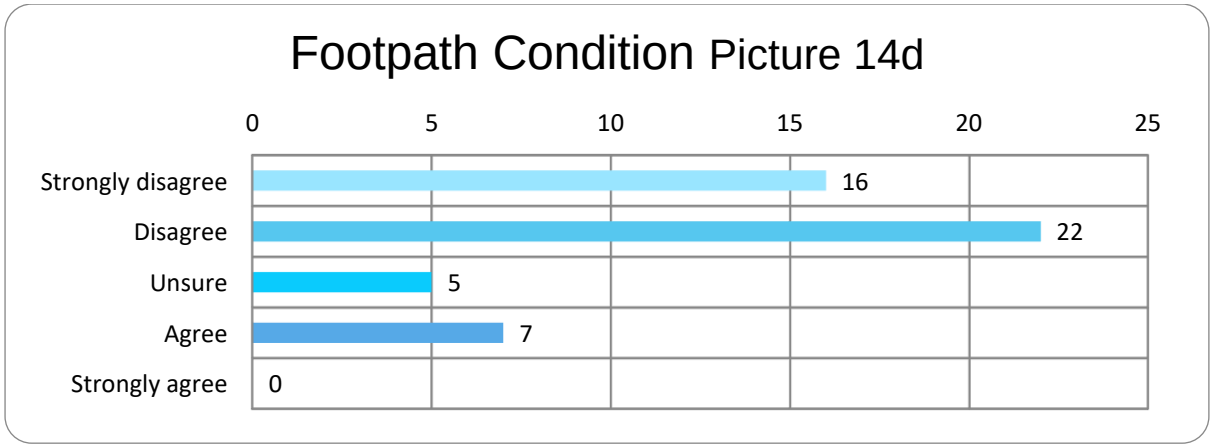
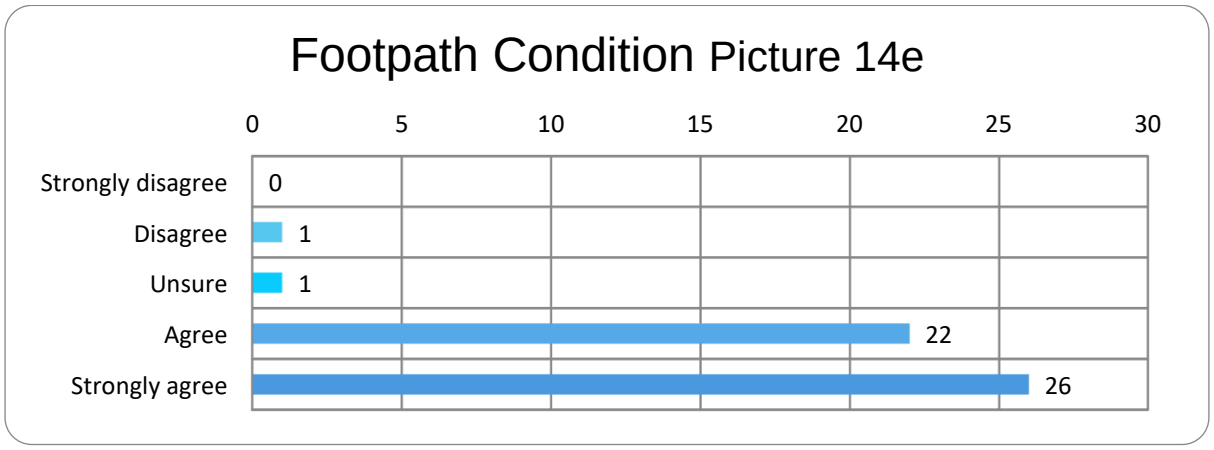
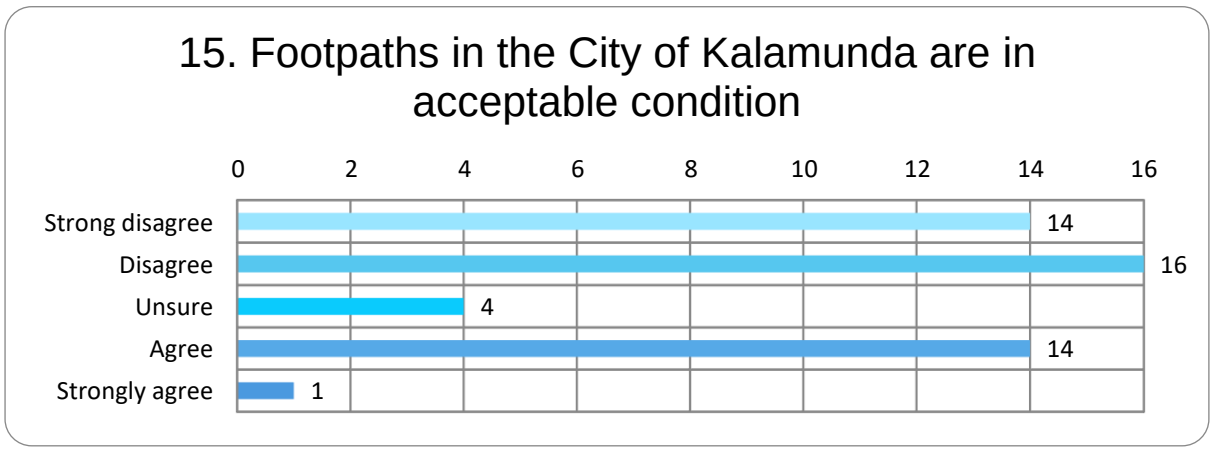
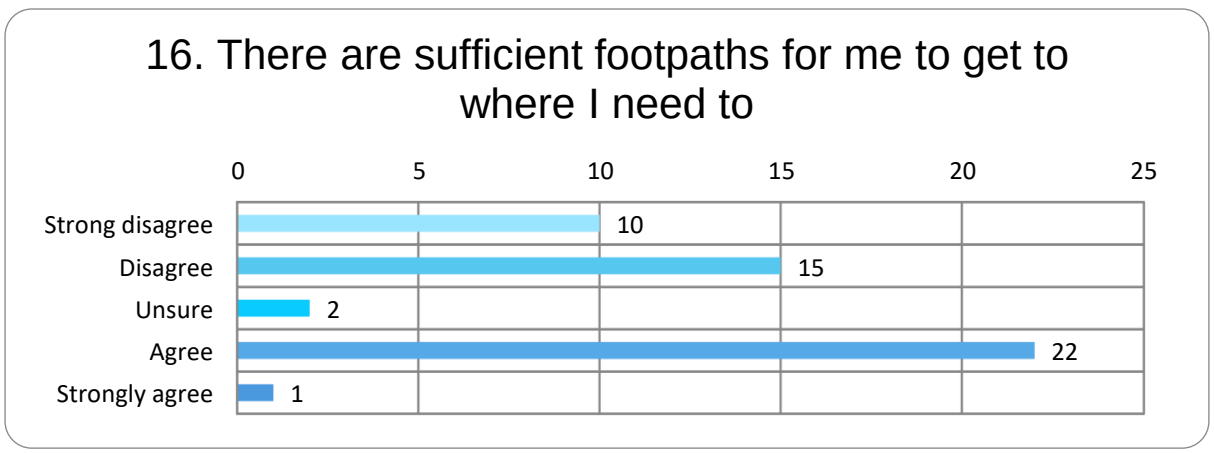
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
18
23
2
7
0


Footpath Condition Picture 14c
0
5
10
15
20
25
30
35
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
0
3
3
34
10

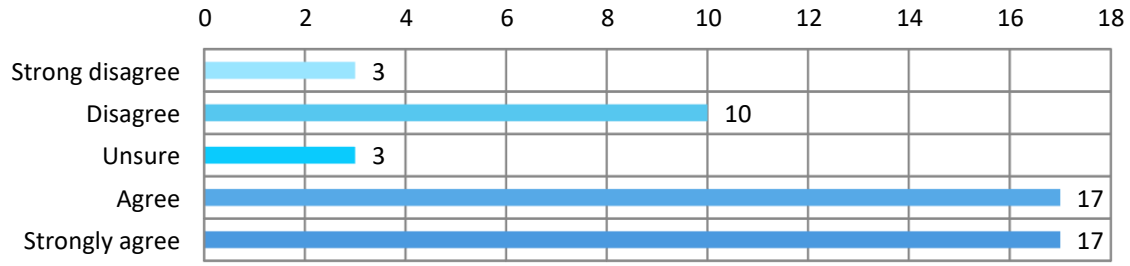

Footpath Condition Picture 14d
0
5
10
15
20
25
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
16
22
5
7
0


Footpath Condition Picture 14e
0
5
10
15
20
25
30
Strongly disagree
Disagree
Unsure
Agree
Strongly agree
0
1
1
22
26

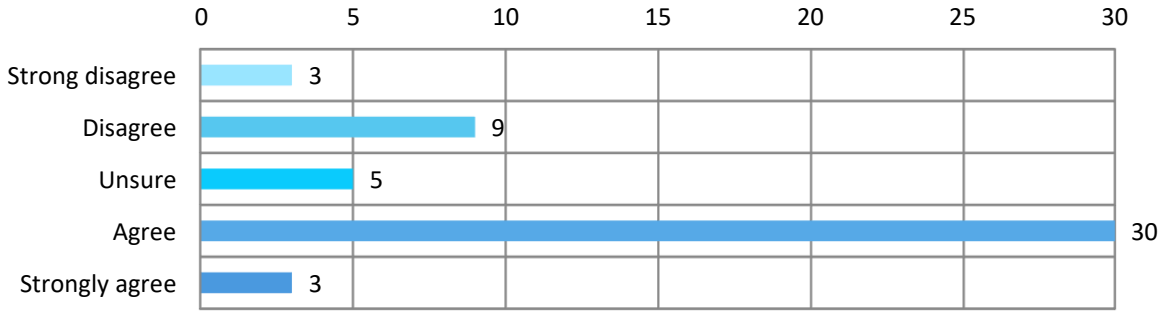

15. Footpaths in the City of Kalamunda are in acceptable condition
0
2
4
6
8
10
12
14
16
Strong disagree
Disagree
Unsure
Agree
Strongly agree
14
16
4
14
1


16. There are sufficient footpaths for me to get to where I need to
0
5
10
15
20
25
Strong disagree
Disagree
Unsure
Agree
Strongly agree
10
15
2
22
1

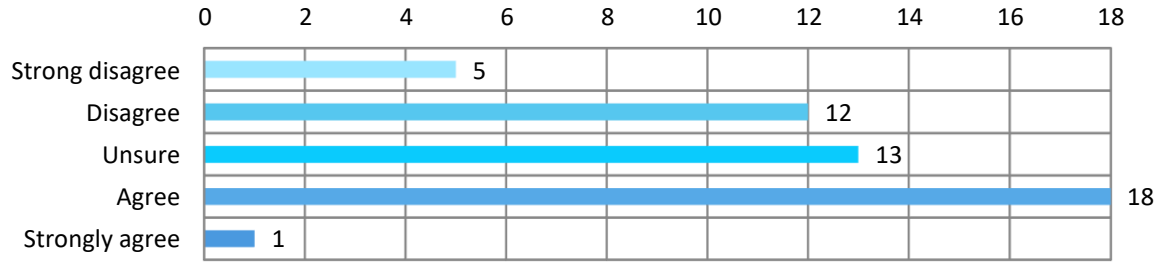
17. There are paths where I feel unsafe from slipping tripping or falling



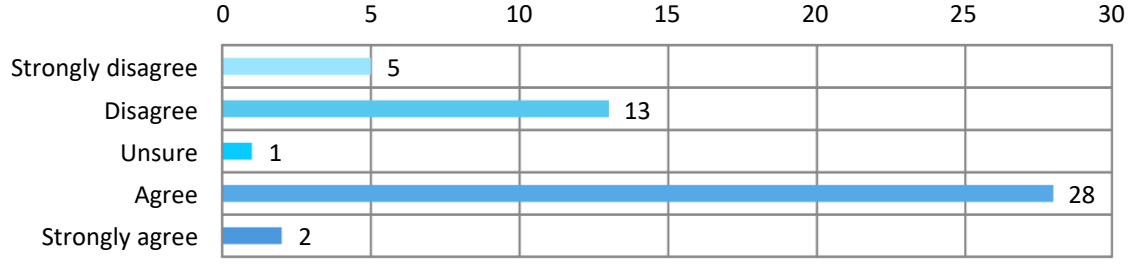
18. Footpath widths are acceptable



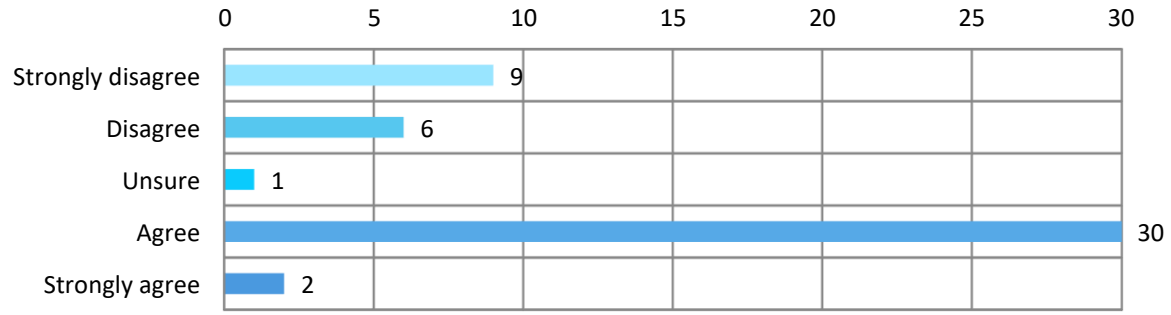
19. When walking, paths have an acceptable level of lighting



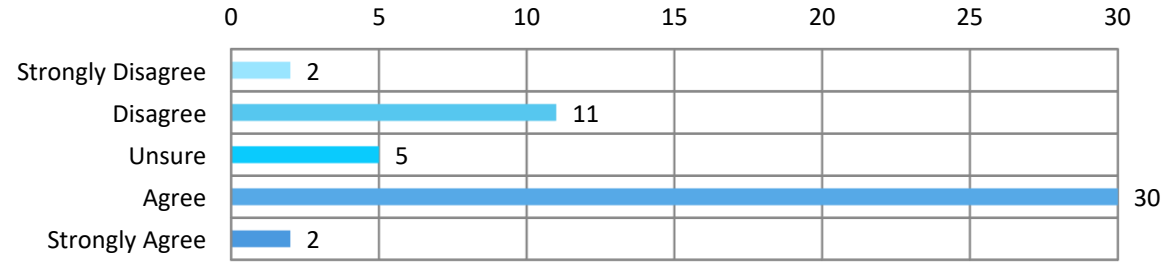
20. There are sufficient pedestrian ramps where I need to cross



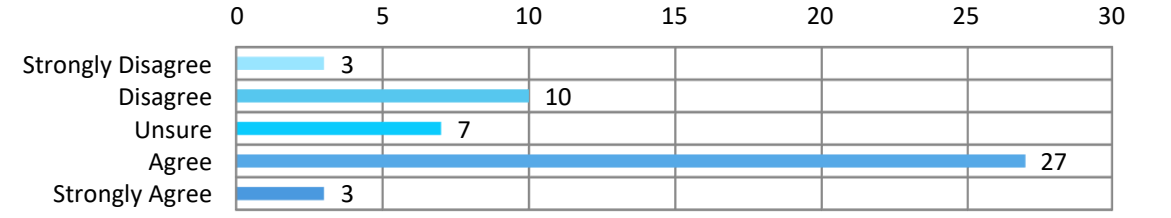
21. I am able to cross roads safely



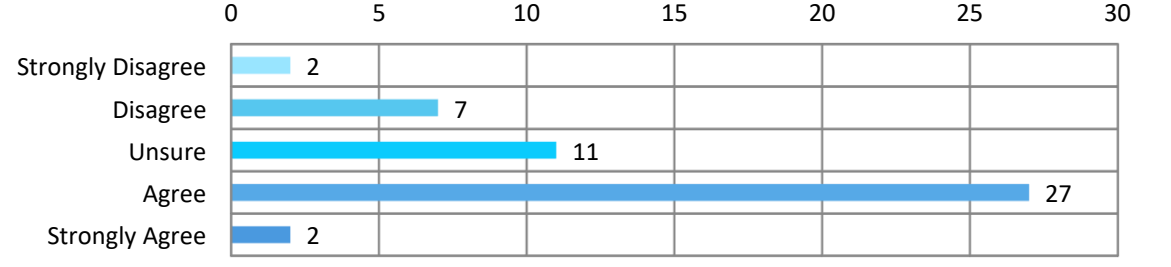
22. Drainage pits kerb and channels on the side of the road are working to an acceptable level



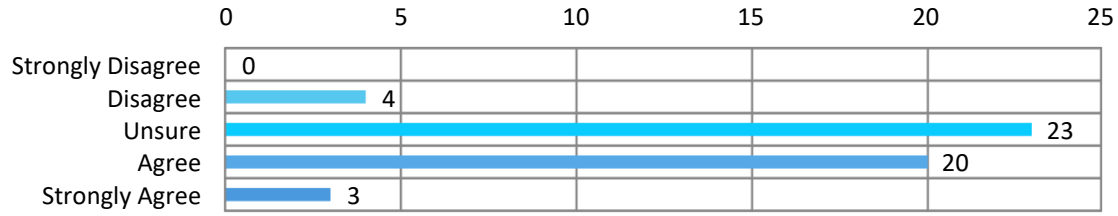
23. Stormwater drainage flows where it should (through drain pipes and along waterways and creeks)



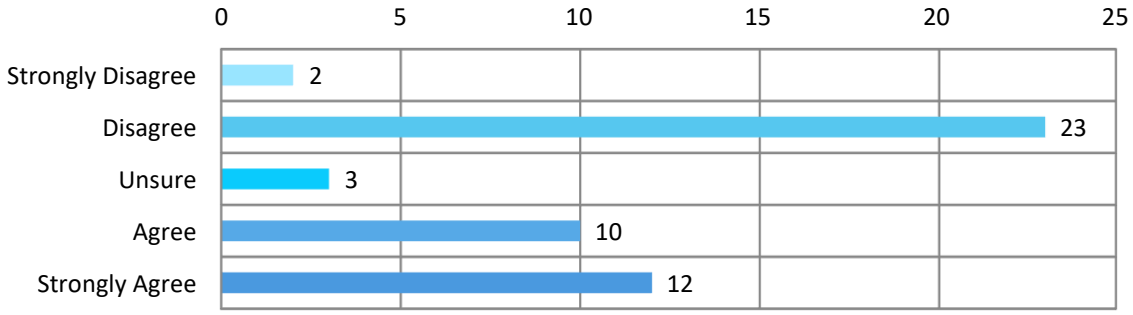
24. The amount of water running onto and through properties from storms is acceptable



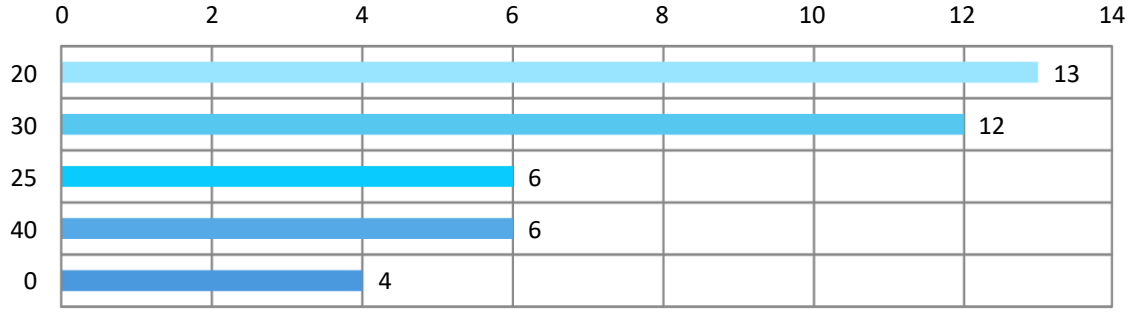
25. The quality of the water in the drainage system is acceptable for protecting the natural environment



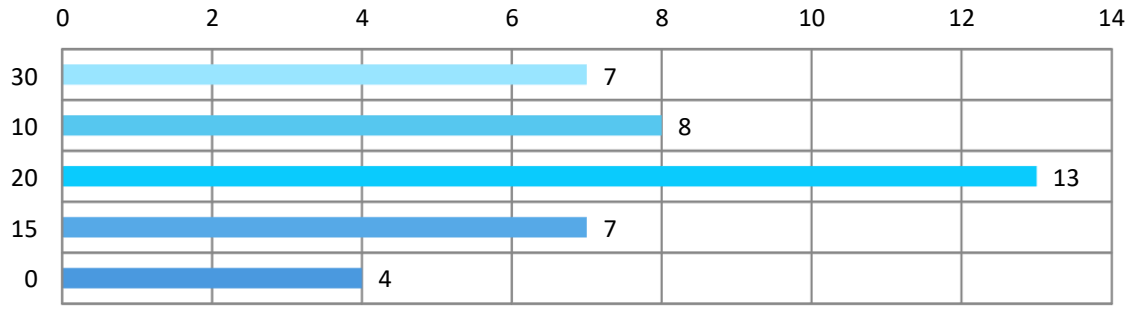
26. Mosquitos are a problem where I live

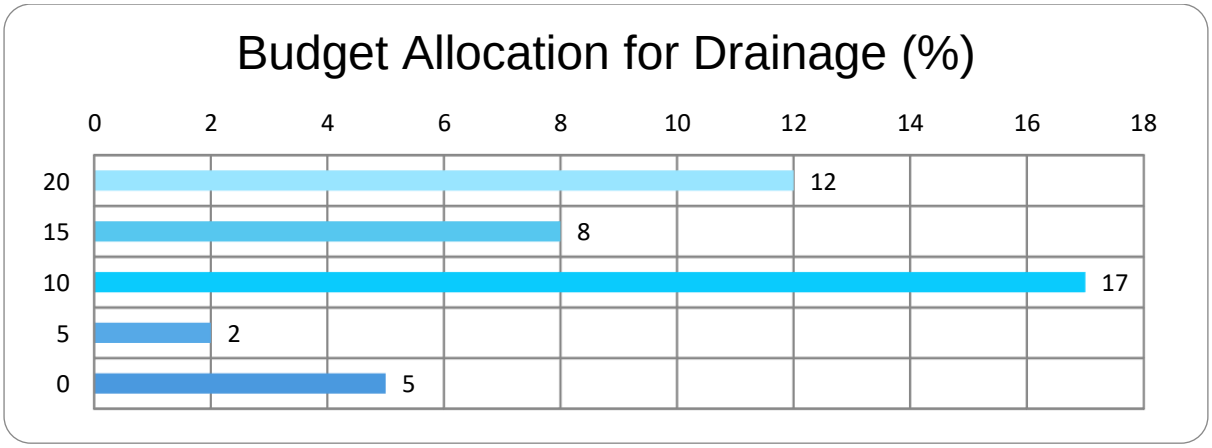


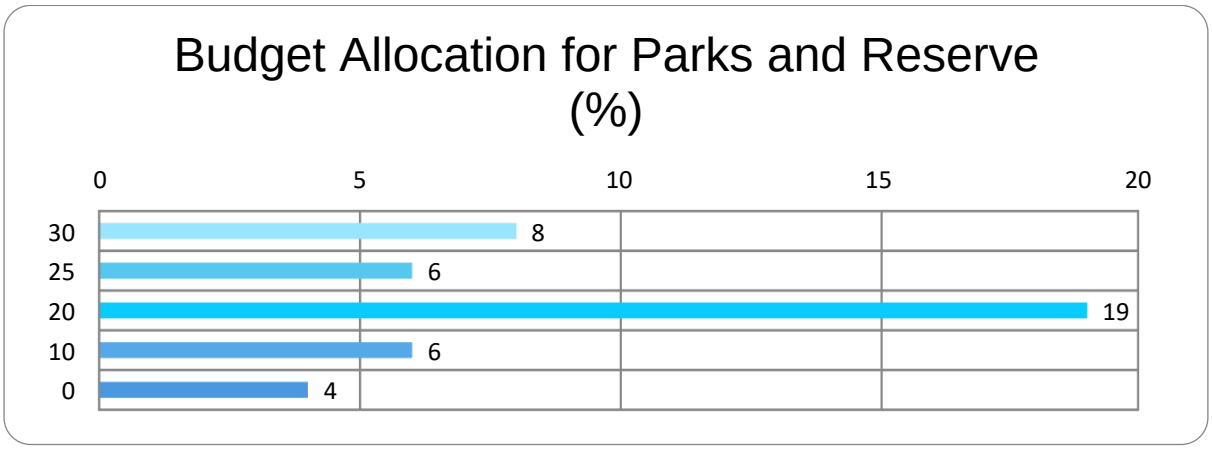
Budget Allocation for Roads (%)

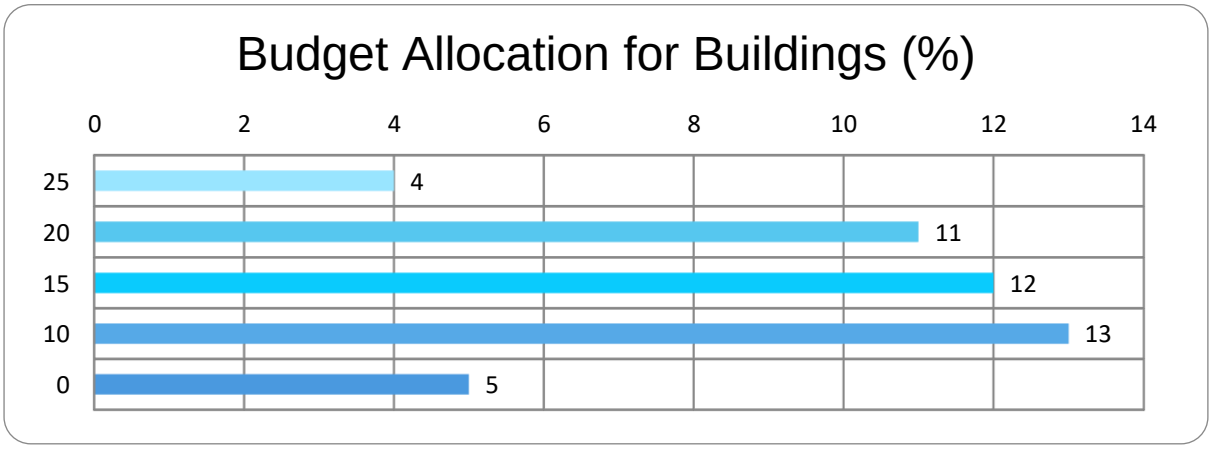


Budget Allocation for Footpaths (%)




Budget Allocation for Drainage (%)
0
2
4
6
8
10
12
14
16
18
20
15
10
5
0
12
8
17
2
5


Budget Allocation for Parks and Reserve (%)
0
5
10
15
20
30
25
20
10
0
8
6
19
6
4


Budget Allocation for Buildings (%)
0
2
4
6
8
10
12
14
25
20
15
10
0
4
11
12
13
5

M I N U T E S

Kalamunda Community Centre Community Reference Group
5:00pm, 6 December 2017
City of Kalamunda, Function Room, 2 Railway Road, Kalamunda

1.0 OPENING OF MEETING

1.1 Meeting Opened 5.01pm by Dennis Blair (Director Asset Services)
Opening and way forward

2.0 APPOINTMENT OF PRESIDING MEMBER

2.1 Michael Fernie was nominated to be the Presiding Member. As there was no further nominations, Michael Fernie was elected unopposed.

3.0 APPOINTMENT OF DEPUTY PRESIDING MEMBER

3.1 Two nominations were received for the position of Deputy Presiding Member, Ian Tarling and Russell Thom. A secret ballot was conducted, Ian Tarling received six votes and Russell Thom received six votes.

Both names were placed in a hat and the Presiding Member, Michael Fernie drew out Mr Tarling's name. Ian Tarling was declared the Deputy Presiding Member.

4.0 ATTENDANCE AND APOLOGIES

Reference Group Members

4.1

Cr Michael Fernie	Presiding Member
Ian Tarling	Deputy Presiding Member
Cr Margaret Thomas	
Ray Thompson	
Glynn Tomazin	
Carol Buckley	
June Butcher	
Russell Thom	
Rosemary Offer	
Cameron Watts	
Dennis Blair	Director Asset Services
Darren Jones	Manager Community Development

Apologies
Kris Nunn

Observers
Jim Sharpe

5.0 WELCOME AND INTRODUCTIONS

5.1 Round the room introduction of all members.

6.0 DISCLOSURE OF INTERESTS

6.1 Disclosure of Financial and Proximity Interests:

a) Members must disclose the nature of their interest in matters to be discussed at the meeting. (Section 5.65 of the *Local Government Act 1995)*

b) Employees must disclose the nature of their interest in reports or advice when giving the report or advice to the meeting. (Section 5.7 of the *Local Government Act 1995*)

Nil.

6.2 Disclosure of Interest Affecting Impartiality

a) Members and staff must disclose their interests in matters to be discussed at the meeting in respect of which the member or employee has given or will give advice.

Nil.

7.0 ITEMS FOR COMMUNITY REFERENCE GROUP CONSIDERATION – PRESIDING MEMBER

7.1 Terms of Reference

The Terms of Reference were noted by all Members without discussion.

Motion: Kalamunda Community Centre - Community Reference Group recommends to Council that the Terms of Reference be amended to include Deputy Community Representatives from each of the following stakeholders:

- Kalamunda Community Learning Centre
- Friends of Jorgensen Park
- Adjoining Neighbours to Jorgensen Park

7.2 Deputies for Specific Reference Groups

Nominations were taken from the floor for deputies for the Learning Centre, Friends of Jorgensen Park and Neighbours.

Motion: Kalamunda Community Centre - Community Reference Group recommends to Council that it appoints the following nominees as Deputy Community Representatives to the Kalamunda Community Centre - Community Reference Group:

- Kalamunda Community Learning Centre Deputy – David Storer
- Friends of Jorgensen Park – Joy McGilvray
- Neighbours – Jim Sharpe

7.3 Project Background presented by Dennis Blair

June 2014	Feasibility Study on options for KCLC – Jill Powell & Associates
October 2014	Workshop on options with support for new building
March 2016	Council requested: • review of Concept Plans • consideration in 2016/2017 for funding to enable detailed design • application to LotteryWest based on design
August 2016	$1m pledge from Federal Government subject to "value for money assessment" submission by 1 June 2017
August 2016	Jill Powell & Associates engaged by KCLC to undertake a review of the June 2014 Feasibility Study
December 2016	Council received the Feasibility Review and requested: • detailed designs and costs to be progressed • submission by 1 June 2017 to Department of Industry & Regional Development • include KCLC in State Advocacy Program • advice from Disability and Carers Advisory Committee
February 2017	Special Council Meeting which resolved to: • Confirmed Jorgensen Park (JP) as the site for redevelopment of KCLC. • Reaffirmed its decision of December 2016. • Recognised JP and buildings – Municipal Heritage Inventory. • Supported a number of actions relative to the Heritage classification: ➢ Photographic history of building ➢ Memory gathering project ➢ Public art and architectural design • Approved general location at eastern end of carpark. • Submit a minimum $1m grant application to LotteryWest. • Principle of commitment for other user groups to relocate. • Resolution not to be construed as a commitment to any future funding from Council.
May 2017	Special Council Meeting which resolved to: • Endorse JP Community Centre concept design site plan and floor plan (endorsed by KCLC). • Approved grant funding applications: ➢ Department of Industry & Regional Development - $1million ➢ LotteryWest - $2.5million • Request State Government to allocate $3million election pledge. • List $500,000 in draft 2017/2018 Capital Works Budget to detailed design, documentation and approvals.

July 2017	Council considered a report on a Community Reference Group (CRG) and resolved: • Formation of Kalamunda Community Centre – CRG • Terms of Reference • Advertise for community representatives • Nominations from: ➢ Kalamunda Community Learning Centre ➢ Friends of Jorgensen Park ➢ One representative from adjoining neighbours
October 2017	Council appointed the Community Representatives and expanded the number to nine. Councillor appointments: • Cr Michael Fernie • Cr Margaret Thomas

7.4 Funding update by Dennis Blair

Department of Infrastructure and Regional Development

- Minister has approved $1million
- Subject to Deed of Agreement
- Draft being finalised

LotteryWest

- Additional information provided since original submission
- Further details on partner funding by 21 January 2018
- Board Meeting in February 2018

State Government

- Awaiting confirmation of Election Pledge amount

Kalamunda Community Learning Centre

- $150,000 committed towards the project

City of Kalamunda

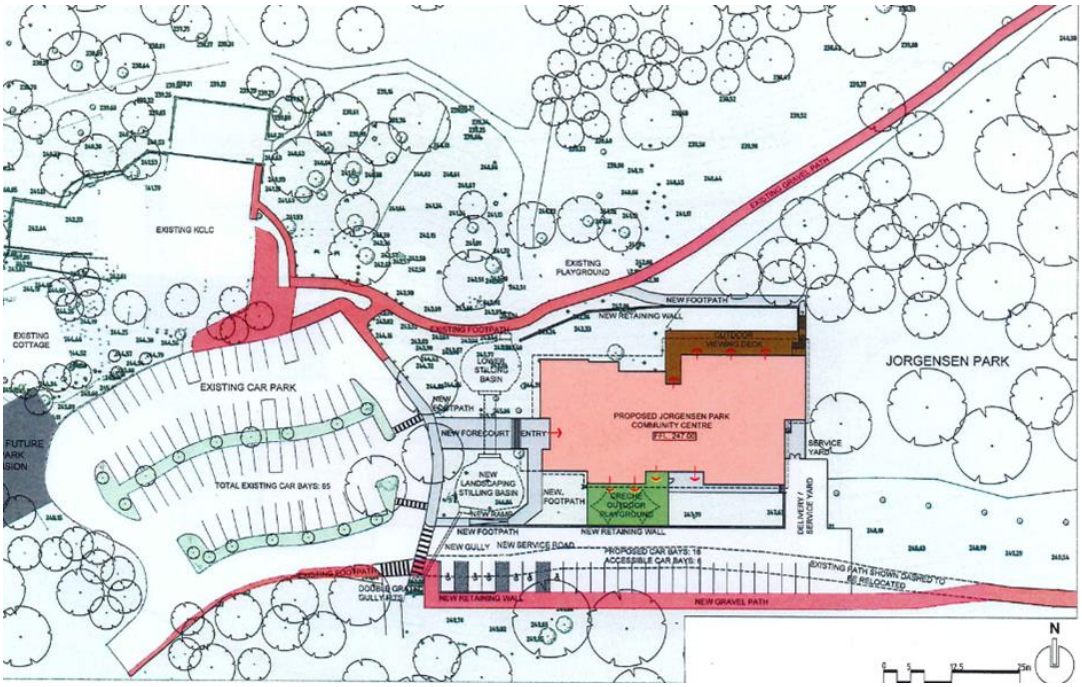
- An amount of $500,000 in 2017/2018 Buildings New Budget

7.5 Draft Timeline

- March 2018 – Confirmation of funding contributions
- May 2018 – Appointment of Architectural Consultancy Services and Quantity Surveyors
- October 2018 – Endorsement of Final Design by Council
- December 2018 – Award of contract for construction of KCC and associated infrastructure
- September 2019 – Completion of building works and associated infrastructure
- October 2019 – Building operational

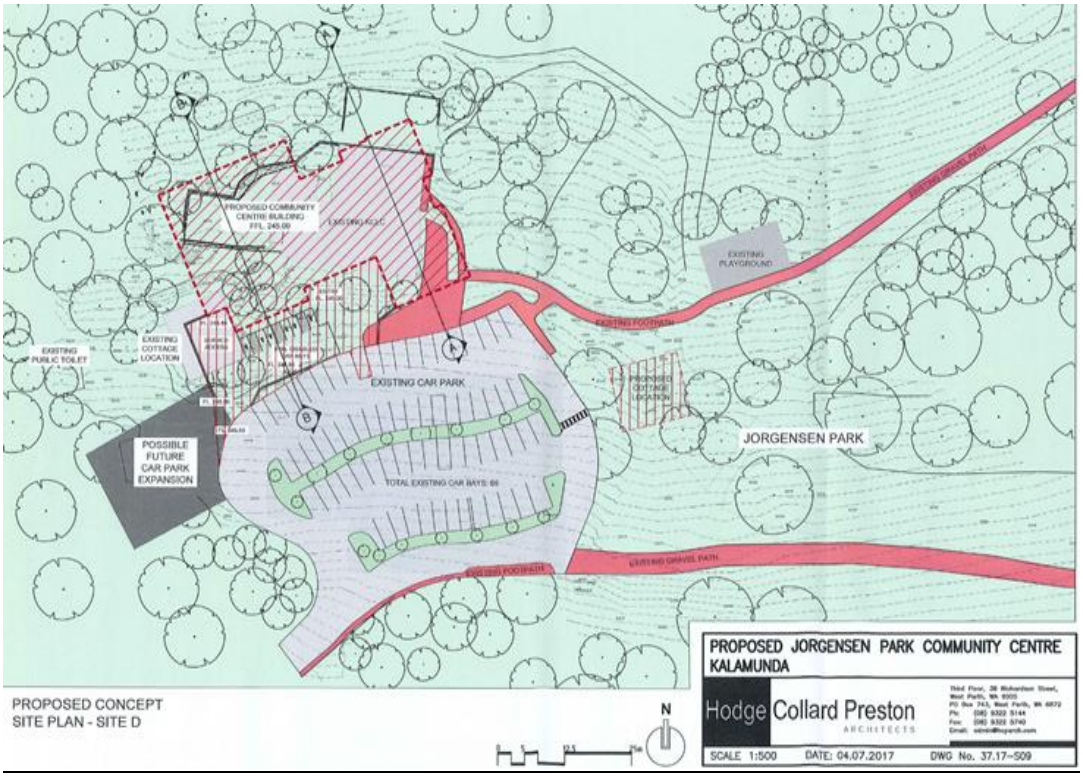
7.6 Location

Site Plan Endorsed 29 May 2017



Estimated Cost: $5,500,000

Alternative Site



Estimated Cost: $5,445,000
Includes: Demolition of existing KCLC and Relocation of Cottage

Motion: Kalamunda Community Centre - Community Reference Group recommends to Council that the location for the new Kalamunda Community Centre be on the site of the existing KCLC building.

It was recognised that this will require demolition of the existing building before construction of the new building and relocation of the Learning Centre activities during construction.

After some discussion, the motion was passed and carried unanimously.

7.7 Relocation of Jorgensen Cottage

It was advised that there may be a request for the Jorgensen Cottage to be relocated to another site on Jorgensen Park with the new Kalamunda Community Centre to be constructed on the site of the Kalamunda Community Learning Centre. This will be confirmed as part of the final design and documentation. In the meantime it is suggested that the Reference Group investigate alternative locations for consideration.

7.8 Transitional Locations

The Manager of Community Development advised discussions were underway with KCLC to allow them to operate from alternative facilities once the project commenced at no cost penalty.

8.0 GENERAL BUSINESS

- Rosemary Offer queried the role of the new Design Advisory Committee and it has been confirmed that the preliminary design can be referred for feedback and advice.
- Cameron Watts sought advice on expenditure to date on the project and it was indicated that approximately $30,000 had been expended on architectural services for the concept design/cost estimates and arborist report.
- June Butcher sough information on the usage of the Jorgensen Cottage and this was provided by Ian Tarling.

9.0 DATE OF NEXT MEETING

Date to be confirmed in January.

10.0 CLOSURE

Meeting closed at 6:35pm.

I confirm these Minutes to be a true and accuracy record of the proceedings of this meeting.

Signed: ……. Presiding Member

Dated this …….. Day of ……2017

M I N U T E S

Kalamunda Community Centre Community Reference Group
5:00pm, 9 May 2018
City of Kalamunda, Function Room, 2 Railway Road, Kalamunda

1.0 OPENING OF MEETING

Meeting opened at 5:04pm by Councillor Michael Fernie
Opening and way forward.

2.0 ATTENDANCE AND APOLOGIES

Reference Group Members

Cr Michael Fernie	Presiding Member
Ian Tarling	Deputy Presiding Member
Cr Margaret Thomas	
Glynn Tomazin	
Carol Buckley	
June Butcher	
Russell Thom	
Rosemary Offer	
Cameron Watts	
Kristine Nunn	
Dennis Blair	Director Asset Services
Darren Jones	Manager Community Development

Apologies
Ray Thompson

Observers
Jim Sharpe

3.0 CONFIRMATION OF MINUTES FROM PREVIOUS MEETING

The Members of the Community Reference Group Meeting held on 6 December 2017, as published and circulated, are confirmed as a true and accurate record of the proceedings.

Moved: Ian Tarling Seconded: June Butcher

4.0 DISCLOSURE OF INTERESTS

4.1 Disclosure of Financial and Proximity Interests:

a) Members must disclose the nature of their interest in matters to be discussed at the meeting. (Section 5.65 of the *Local Government Act 1995)*

DRAFT

b) Employees must disclose the nature of their interest in reports or advice when giving the report or advice to the meeting. (Section 5.7 of the *Local Government Act 1995*)

Nil.

4.2 **Disclosure of Interest Affecting Impartiality**

a) Members and staff must disclose their interests in matters to be discussed at the meeting in respect of which the member or employee has given or will give advice.

Nil.

5.0 ITEMS FOR COMMUNITY REFERENCE GROUP CONSIDERATION

5.1 **Matters Arising from Previous Meeting**

a) Amendment to Terms of Reference to include Deputy Community Representative

Dennis Blair confirmed the proposal will be reviewed by Council in the June Ordinary Council Meeting.

b) Appointment of nominees as Deputy Community Reference Group

Dennis Blair confirmed the proposal will be reviewed by Council in the June Ordinary Council Meeting.

c) Location of the new Kalamunda Community Centre

Dennis Blair confirmed the proposed location will be reviewed by Council in the June Ordinary Council Meeting.

d) Relocation of Jorgensen Cottage

Ian Tarling confirmed the cottage was donated in 1984 to the Learning Centre by the Davenport family. Ian noted there might be some components of the cottage that are historical and therefore might have planning restrictions.

Rosemary Offer suggested the cost of relocating the cottage would be significant and could be better spent upgrading the access into Jorgensen Park or the existing buildings. Rosemary also noted an asbestos warning sign adjacent to the cottage.

Councillor Michael Fernie suggested further investigation on the feasibility of relocating the cottage was necessary before a decision could be made.

Motion: Kalamunda Community Centre – Community Reference Group recommends that Administration undertake further review of the cost, condition and significance to maintain the Jorgensen Park Cottage and report back to the Reference Group.

Moved: Glynn Tomazin Seconded: Carol Buckley

All in favour.

5.2 **Funding of the Project**

a) Federal Government
Dennis Blair confirmed $1 million of funding from the Department of Industry and Regional Development was secured on 13 October 2017. The funding was committed subject to Deed of Agreement. A draft Agreement has been prepared, however has been put on hold until all funding has been secured.

b) Lotterywest
Dennis Blair confirmed up to $2.5 million of funding had been committed by Lotterywest on 10 April 2018. The funding was committed subject to the development of a Grant Acknowledgement Strategy and on the grounds that all project funding is secured.

c) Kalamunda Community Learning Centre
Dennis Blair confirmed $150,000 has been committed by the Kalamunda Community Learning Centre.

d) City of Kalamunda
Dennis Blair confirmed that the $500,000 of Municipal Funding approved in the 2017/2018 Budget has been recommended for carry forward to 2018/2019.

e) State Government
Dennis Blair confirmed that the Election Pledge of $3 million from the State Government was yet to be received. The City of Kalamunda is currently awaiting a formal response on the matter. A response may be received following announcement of the budget this week.

Motion: Kalamunda Community Centre – Community Reference Group will, pending the outcome of the state budget announcement, seek to meet with Member for Kalamunda, Matthew Hughes regarding the outstanding election pledge funding committed by the State Government.

Moved: Carol Buckley Seconded: Kris Nunn

All in favour.

6.0 GENERAL BUSINESS

Glynn Tomazin noted the good work of the Friends of Jorgensen Park to maintain and beautify the area.

Rosemary Offer noted that securing all funding was essential before further planning and details could be considered. Rosemary also queried what the plans for Jack Healey Centre were in place. Dennis confirmed that only high level discussions had taken place to date.

Councillor Michael Fernie suggested members create a vision of what they would like the new building to look like in preparation for the next meeting. This could include such things as the roof materials, walls, roof pitching, etc.

Ian Tarling proposed modular building consultant Emma Kallarn be invited to any upcoming presentations or that her material be circulated to the group members. Rosemary Offer also suggested a presentation from Wood Solutions on laminated timber construction. Dennis Blair confirmed it was best to wait on the outcome of the funding before engaging any external parties on the proposal.

Russell Thom queried whether usage statistics and demographics could be obtained. Darren Jones advised that some investigative work had already been carried out during the earlier stages. It was also confirmed that this information is a requirement of the detailed design process and therefore would be captured during the process.

Councillor Margaret Thomas noted that the intent with the new building was to construct is as quickly as possible and this should be a key consideration for the group members going forward.

7.0 DATE OF NEXT MEETING

Date to be confirmed in due course.

8.0 CLOSURE

Meeting closed at 6:02pm.

I confirm these Minutes to be a true and accurate record of the proceedings of this meeting.

Signed:…….. Presiding Member

Dated this …….. Day of …….. 2018

DRAFT

City of Kalamunda - Kalamunda Community Centre Community Reference Group

Terms of Reference

1. Name

The name of the Committee shall be Kalamunda Community Centre - Community Reference Group (Reference Group).

2. Objectives

2.1. To consider all matters relevant to the planning, location and design of the Kalamunda Community Centre (the Centre).

2.2 To provide advice, local knowledge and information to the City about local implications and opportunities for consideration during the planning and design of the Centre.

2.3 To liaise and consult, with individuals in the community and community groups that will assist in understanding local issues and concerns.

3. Strategic Alignment

Membership

3.1 The Reference Group shall consist of thirteen (13) members.

Elected Members:

- Two (2) Elected Members to be appointed by the Council.
- City Staff – two (2) staff representatives as follows:
  - Director Corporate and Community Services or nominated representative.
  - Director Asset Services or nominated representative.

Community Representatives:

One (1) representative and deputy from each of the following stakeholders:

- Kalamunda Community Learning Centre
- Friends of Jorgensen Park
- One representative from adjoining neighbours to Jorgensen Park

Six (6) representatives selected from nominations received from, but not restricted to the following:

- Residents Associations
- Community Groups
- Interested Residents

3.2 The Presiding Person shall be a City of Kalamunda Councillor and Deputy Presiding Person shall be appointed from the body of the Committee.

3.3 The CEO will appoint a non-voting staff member as the Secretary.

4. Terms of Membership

Members will be appointed by the Council until endorsement of the final design by Council.

5. Meetings

5.1 The Committee shall meet once every month, or as required.

5.2 A quorum shall be reached when at least one half plus 1 of the appointed members are present.

5.3 The Agenda and notice of meeting will be prepared and distributed not less than 7 days prior to each meeting.

5.4 It is important that Agenda items, along with any supporting papers are sent to the Secretary no later than 10 days prior to meeting. This allows time for members to consider the item and make an informed decision.

5.5 If there are no agenda items the Secretary in consultation with the Presiding Person will advise all members that the scheduled meeting is cancelled.

5.6 The Presiding Member is empowered to rule that any matter under consideration is to be referred, via the appropriate Committee, to Council for a decision.

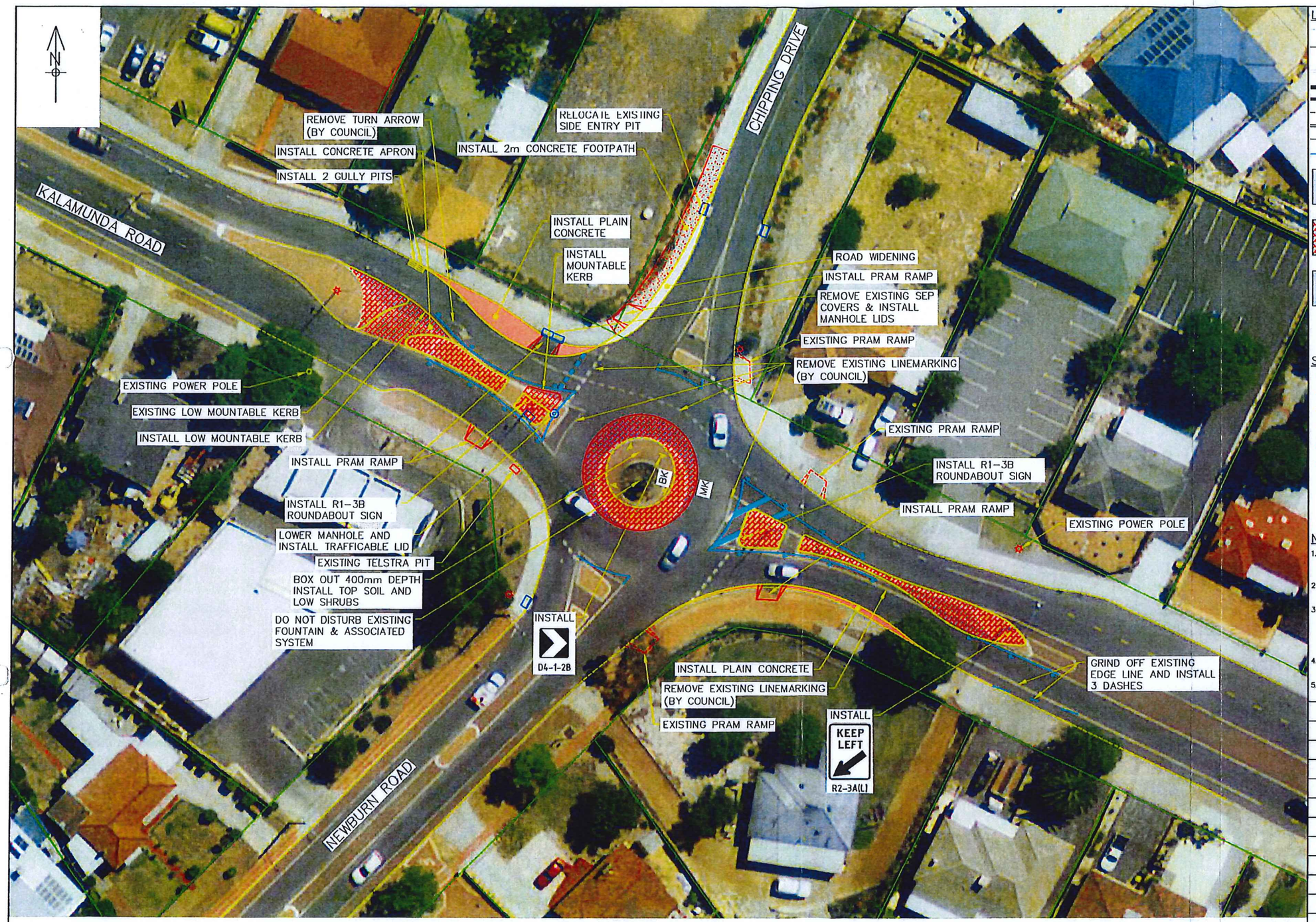
6. Minutes

6.1 The Secretary shall keep Minutes of all business transacted at all meetings and shall forward a copy of these Minutes to members within 10 days of each meeting.

6.2 The Minutes to be presented to Council as a Tabled Document.

7. Voting

7.1 Each appointed member present shall have one (1) vote. The Presiding Member will have a casting vote in the event of a tie.



PLAN
SCALE: 1:250

LEGEND:

- CADASTRAL BOUNDARY
- NEW SEMI MOUNTABLE KERBING (TYPE 3)
- EXISTING KERB REMAIN/REMOVE
- 300mm WIDE GIVE WAY LINE
- 300mm WIDE STOPLINE
- CONTINUITY LINE
- DOUBLE BARRIER LINE
- EXISTING LINEMARKING
- PROPOSED LINEMARKING
- NEW PAVEMENT CONSTRUCTION 150mm COMPACTED LIMESTONE SUBBASE 100mm COMPACTED ROCKBASE 30mm AC10 DENSE GRADED ASPHALT
- 75mm RED CONCRETE WITH BRICK PAVER PATTERN
- REMOVE REDUNDANT PAVEMENT AND BACKFILL WITH TOPSOIL. LANDSCAPE TO MATCH EXISTING
- EXISTING DRAINAGE SIDE ENTRY PIT
- EXISTING POWER POLE

SERVICES:

- WATER
- SEWER
- GAS
- ELECTRICITY
- TELSTRA
- TELSTRA – OPTIC FIBRE

NOTES:

1. SERVICES SHOWN IN APPROXIMATE LOCATIONS ONLY. REFER TO SERVICE AUTHORITY PLANS BEFORE COMMENCING WORKS.
2. ALL REINSTATEMENTS MATERIALS TO BE OF THE SAME TYPE PRIOR TO COMMENCEMENT OF WORKS.
3. SHEET ### REFERS TO SHIRE OF KALAMUNDA STANDARD DETAIL DRAWING NUMBER.
   - TRENCHES TO BE BACKFILLED TO SHEET 11/30
   - MANHOLE CONSTRUCTION TO SHEET 9/30
   - GULLY CONSTRUCTION TO SHEET 5/30.
4. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE STATED.
5. ALL NEW KERBS ARE OF SEMI-MOUNTABLE TYPE.

ROAD NAME	MRWA CODE
KALAMUNDA ROAD	1020001
NEWBURN ROAD	1020016
CHIPPING DRIVE	1021207

REFERENCE DRAWINGS / DOCUMENTS

NO.	DATE	REVISION	BY	CHKD	APPR	DATE
A	[illegible]	ISSUED FOR REVIEW	XX			XX/XX/XX

SURVEYED
BY XX
DATE XX/XX/XXXX
DATUM
PCG94

NOT TO BE USED FOR CONSTRUCTION UNTIL SIGNED APPROVED.
APPROVED .....
POSITION .....
DATE .....

DESIGNER TO COMPLETE		DATE
DESIGNED	SL/JB	18/06/15
DRAWN	JB	18/06/15
DRAFT CHECK	XX	XX/XX/XX
DESIGN ENGINEER	XX	XX/XX/XX

INFRASTRUCTURE SERVICES
JOB NO. XXX.XXXXX

Shire of Kalamunda

KALAMUNDA ROAD / CHIPPING DRIVE AND NEWBURN ROAD INTERSECTION UPGRADE CONCEPT LAYOUT PLAN

SCALE: AS SHOWN | A1 | DWG NO. 4086-001-001/A

PLOTTED Jul Batera, 7/2/2015 9:46:59 PM FILE: J:\3 MANAGER TECHNICAL OFFICE\1 DESIGN & DEVELOPMENT\1 PROJECTS\15-16_4086 KALAMUNDA RD, CHIPPING DRV AND NEWBURN RD\ADMIN & DESIGN\4086_002.DWG PRN ----

Intersection Upgrades:

Kalamunda Road/Newburn Road/Chipping Drive

Have your say!

The City has been awarded a $181,620 grant as part of the National Black Spot Program to improve the safety of the Kalamunda Road/Newburn Road/Chipping Drive intersection in High Wycombe.

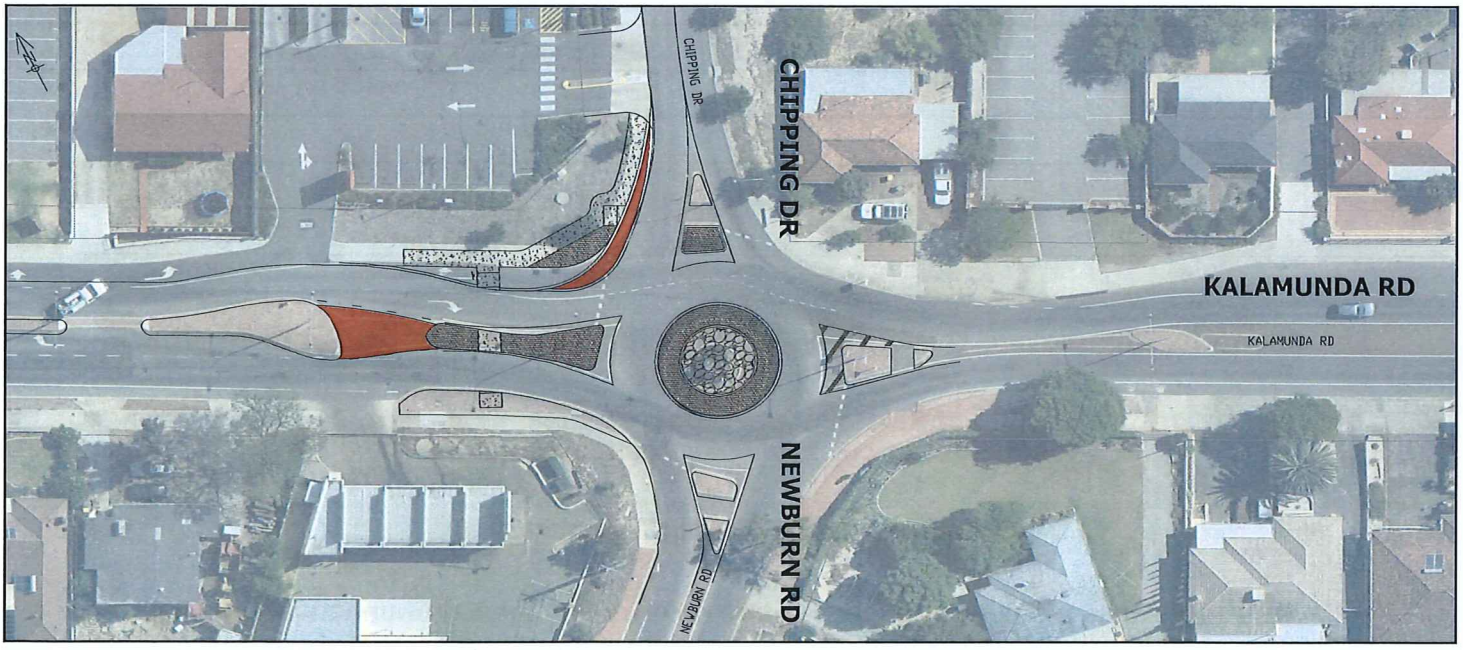
The funding covers works associated with improvements to the roundabout entry and exits, with a focus on improving entry deflection and hence reducing speed on approach to the roundabout.

The City wants your feedback on whether you would like to see these upgrades made to the intersection.

We kindly request you complete all parts of this survey, which should take about 2-5 minutes. If you have any questions about the survey, or would like any further information, please contact us at 9257 9999 or enquiries@kalamunda.wa.gov.au or visit our FAQ at engage.kalamunda.wa.gov.au.

1. Do you support the installation of the following safety upgrades at the Kalamunda Road/ Newburn Road/Chipping Drive intersection in High Wycombe?

Yes ☐
No ☐



Upgrades:

- Reconfiguration of Kalamunda Road western approach from two lanes (one designated left-turn/ through movement lane and one designated right-turn pocket) to one lane (one lane with all movements available);
- Modifications to raised median islands, kerb alignment and line marking on the Kalamunda Road western approach to the roundabout (i.e. the approach adjacent to Hungry Jacks) to provide improved entry deflection and hence reducing speed on the approach to the roundaout; and
- Improved line marking on all roundabout entries and exits that clearly delineates the traffic lane.

About You

Gender

☐ Male ☐ Female

In which suburb do you live?

☐ Wattle Grove
☐ Maida Vale
☐ Walliston
☐ Bickley
☐ High Wycombe
☐ Gooseberry Hill
☐ Piesse Brook
☐ Pickering Brook
☐ Hacketts Gully
☐ Canning Mills
☐ Paulls Valley
☐ Other_____
☐ Forrestfield
☐ Kalamunda
☐ Lesmurdie

What is your age bracket?

(Please tick all that apply)

☐ 15 years and under
☐ 16-25
☐ 26-35
☐ 36-45
☐ 46-55
☐ 56-65
☐ 66-75
☐ 76 +

Contact Details

Name: _____

Email:_____

Phone number:_____

Address:_____

_____

Please keep me informed on the progress of this project:

☐ Yes

☐ No

Any further comments?

_____

_____

_____

_____

_____

_____

Thank you for completing this survey. We look forward to receiving your feedback.

Return via post to the City of Kalamunda, PO Box 42, Kalamunda, WA, 6926, or to City Administration, 2 Railway Road, Kalamunda.

Comments close 5:00pm 27 March 2018

This survey can also be completed online @ www.engage.kalamunda.wa.gov.au

For further information please contact

E: enquiries@kalamunda.wa.gov.au

Phone: 9257 9999

city of kalamunda

www.kalamunda.wa.gov.au

82 Merrivale Road
Pickering Brook
WA 6076

11 April 2017

The CEO
Kalamunda Shire
2 Railway Rd
KALAMUNDA

Dear Rhonda,

I, as the present owner, need to apply to the Shire for appropriate access to Location 830 at what has traditionally been the address of this block at 221 Merrivale Rd. Pickering Brook. When this layout was originally designed the access seems to be via Merrivale Rd. exiting from Kingsmill Rd. However, this road has never been constructed.

A recent experience where a prospective buyer of this property was refused credit from the bank on the grounds that this block has no access other than across what is now National Park under Native Title, means that a more appropriate and formal access needs to be established.

From my, and the previous owners' initial inquiries to the Department of Parks and Wildlife, we were advised that an application could be made to Department of Land (DoL) for an easement from the southern end of the constructed Merrivale Rd. along a portion of the southern boundary of the block (See app 1).
After some 14 months of correspondence DoL now advise that because of Native Title issues this can't happen for at least 2 years and even then may not eventuate (see app 2).

DoL have given me two options, the former being a stop gap resolution only. The second option, and more appropriate, I feel, is for the Council to realign a portion of the unconstructed Merrivale Rd. to abut the southern boundary of the block. Because of the close location of the current residence the abutment should achieve at least a similar effect as the requested easement (app 1).

The reason for this is twofold, firstly all services e.g. address, power, phone can remain unchanged and secondly there is no need for any road construction as suitable gravel tracks already exist. I stress this point as my primary concern is for formal and practical access, not necessarily improvements in costly road construction.

Attached please find the salient case file correspondence.

I request the Council assists in what is, to me, a very important formality.

Regards

Gillian S Fantuz

cc Councillor M Fernie

82 Merrivale Road

Pickering Brook

W.A. 6076

20 Jan.2016

The CEO

Department of Lands

WEST PERTH 6873

Attention; Sean Browne (Metropolitan & Peel Region)

Dear Sir,

On behalf of the seller and purchaser we seek your approval of an appropriate easement to Canning Location 830 at 221 Merrivale Road Pickering Brook W.A.

This block has never had access other than through what is now National Park land. Although this has not been a problem in the past, a recent experience (refusal of a bank loan for the purchase of this property) would indicate that a statutory formalisation of appropriate access along the southern boundary is necessary.

Thank you for your consideration and we look forward to a favourable outcome.

Regards,

Signed: On behalf of Sellers

Sarah Hardman

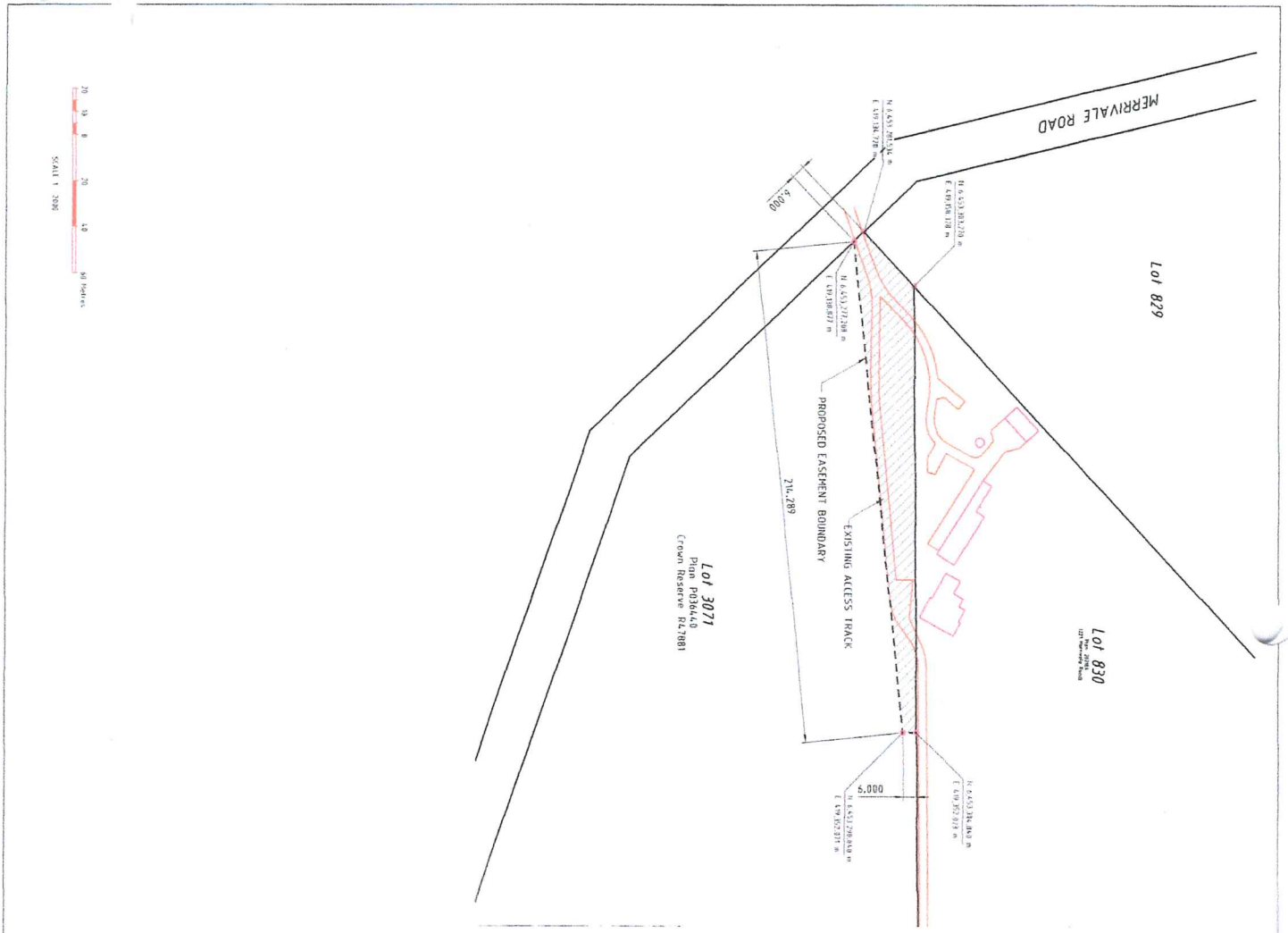
Sarah Hardman

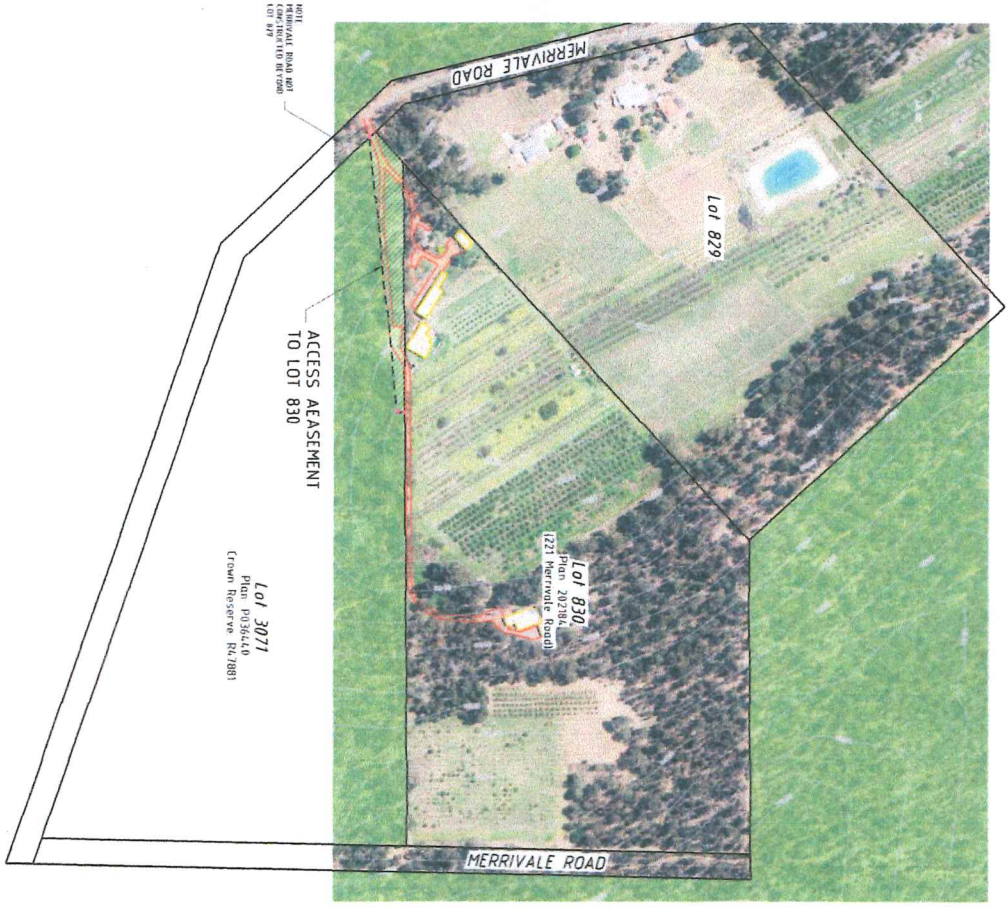
Enduring Power of Attorney for Joseph Hardman

Maurice Hall

Signed: On behalf of Buyer

Gillian Fantuz





LOCATION	LOT 830 221 MERRIVALE ROAD PICKERING BROOK W.A. 6076
BUILDING	LOT 830 ACCESS EASEMENT
EASEMENT PLAN	
DRAWN	PLF
DATE	14.01.16
DRG No.	G-001

APPENDIX 2

Chuah, Teong
to Sally Fantuz
cc Eidsvold, Jaimie

Tue, Mar 28 4:39 PM

Class A Reserve 47881 Merrivale Road

3 files attached Save all

Attach 2 Class A Res... .pdf 1.24 MB

Attach 3 Easement O... .pdf 1.46 MB

Attach 1 Smartplan... .pdf 358 KB

[Our ref: 50831-2004 Job No N/A]

Hi Gillian

Thank you for taking the time to speak with a couple of weeks ago.

In the first instance, I ask that you refer to the attached Smartplan graphic wherein to show your property in relation to Merrivale Road. The part of Merrivale Road hatched in red is understood to be unconstructed (not bitumised) which would have otherwise provided direct access to your property **(Attachment 1)**.

Merrivale Road is held under the care and control of the local government authority, being Shire of Kalamunda.

Class A Reserve 47881 is held for the purpose of 'National Park' vested pursuant to section 7(2) of the *Conservation and Land Management Act 1984*. The management body is the Conservation Commission of Western Australia, part of Department of Parks and Wildlife.

The Department of Lands (DoL) acknowledges that the Conservation Commission (Department of Park and Wildlife) has advised this Department that it supports the grant of an easement burdening a small portion of Class A Reserve 47881 (Korung National Park) for the purpose of access to your freehold property, being Lot 830 on Deposited Plan 202184, and otherwise known as 221 Merrivale Road in Pickering Brook.

Unfortunately Korung National Park is likely to be the subject of native title rights and interests of the Whadjuk People, which was accepted for registration on 26/6/2011. DoL on behalf of the State Government is unable grant an interest (ie. easement, disposal and grant lease etc.) over any part of Reserve 47881 without addressing native title rights and interests.

As I had briefly explained the State of Western Australia is currently in negotiation with six native title claimants group to surrender native title rights over the South West, which includes Reserve 47881. Once the agreement is finalised native title rights will be surrendered and this will allow DoL to arrange to formal access to your property via a section 144 Easement pursuant to the *Land Administration Act 1997* or to consider any other available options.

I had described two options available to you for further consideration. It is as follows;

-

Option 1

DoL is able to issue you a non-exclusive section 91 licence over that small portion of Reserve 47881 (currently being used as an informal access track to your property) for the purpose of "Access Only" to the

owner of Lot 830 on Deposited Plan for a term of 2 years. The grant of this licence will be subject to the Conservation Commission, Shire and Department of Mines and Petroleum advising no objections.

It is hoped that whilst in possession of a section 91 licence the State Government and the Native Title Claimants are able to reach an agreement for the South Western Settlement Agreement. If so, the licence will automatically terminate and DoL will then be in a better position to reconsider the grant of an easement or excise the subject portion from Class A Reserve 47881 (if feasible and subject to Conservation Commission's approval) in favour of Lot 830 DP 202184 in order to provide formal access to your property from the constructed part of Merrivale Road.

Option 2

This option involves the Conversation Commission first agreeing to excise the subject portion of land (currently providing Lot 830 with informal track access) to be excised from Reserve 47881. This is in addition to the Shire of Kalamunda also agreeing to resolve to dedicate pursuant to section 56 of the LAA the subject land as a public dedicated road. With regards to native title rights and interest, DoL can undertake a 24KA of the Native Title Act being a notification process only suppresses native title whilst the land is used for a public purpose as a road.

A case can be made to the Shire and the Conservation Commission to advise that because the unconstructed portion of Merrivale Road is not being used for its designated purpose it can be closed pursuant to section 58 of the LAA and subsequently included into Reserve 47881. This can be exchanged for the required subject portion of Reserve 47881, that currently provides you access, which can be dedicated as a road as per the paragraph above.

The proposal to grant an easement and/or excise from a Class A reserve requires ministerial and parliamentary approval. As such, I ask that you refer to the extract from DoL's Practice Manual regarding Class A Reserves and Class A Amendments (Major) wherein to provide you general information about Class A actions **(Attachment 2 and 3)**.

Both of these options requires the approval/comments from the Conservation Commission and the Shire which will need to be obtained before DoL can progress any further.

If you have any questions please ask me.

Regards

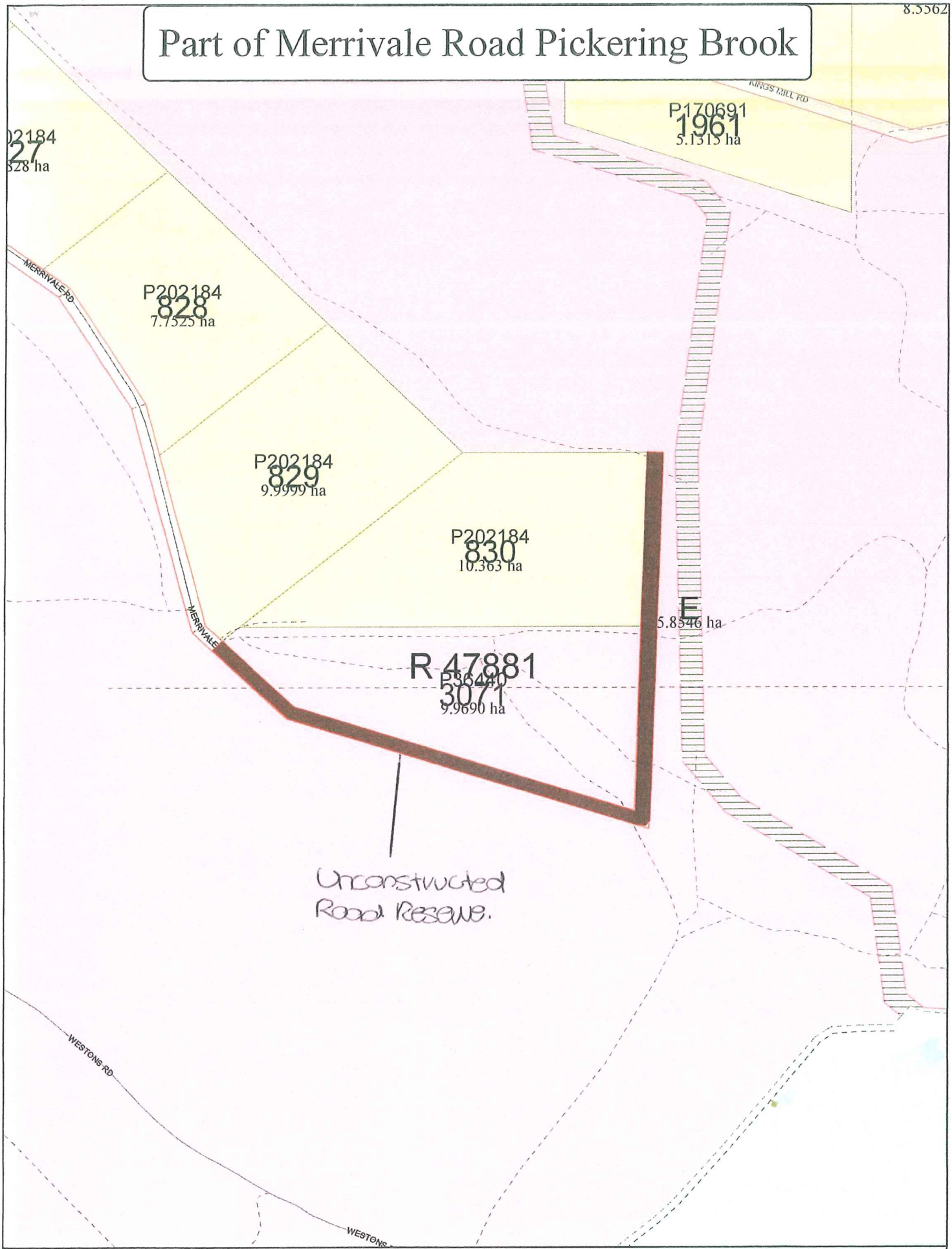
Teong Chuah | A/Assistant Manager | Case Management - Metropolitan and Peel
Department of Lands | Level 11, 140 William Street | Perth WA 6000
T (08) 6552 4781 | **F** (08) 6552 4417
E teong.chuah@lands.wa.gov.au | **W** www.lands.wa.gov.au

Government of **Western Australia**
Department of **Lands**

ARE YOU BUSHFIRE READY?
emergency.wa.gov.au

The Department of Lands has a new Post Office Box. PO Box 1221 West Perth WA 6872. Please update your records accordingly. Thank you

DISCLAIMER: The information contained in this email (including attachments) is intended only for the use of the person(s) to whom it is addressed as it may be confidential and contain legally privileged information. If you are not the intended recipient you are hereby notified that any perusal, use, distribution, copying or disclosure is strictly prohibited. If you have received this email in error, please immediately advise us by return email and delete the email document.



Scale : 1:6197 (Geographical)
MGA : SW=418854.0E,6452344.6N Zone 50 / NE=420086.8E,6454267.1N Zone 50
Lat/Long : 116°08'25.223", -32°03'43.990" / 116°09'12.809", -32°02'41.872" H 263mm by W 201mm

Printed : 15:24 Tue 28/Mar/2017
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Government of **Western Australia**
Department of Parks and Wildlife

Parks and Visitor Services
Policy and Planning Group, Land Unit

Your ref:
Our ref: 2010/004837
Enquiries: Anne Greig
Phone: (08) 9219 9790
Email: anne.greig@dpaw.wa.gov.au

Sarah Hardman
221 Merrivale Rd
Pickering Brook WA 6076

Dear Sarah

Access to 221 Merrivale Road, Pickering Brook (Lot 830 on Plan 202184) through Korung National Park (Reserve 47881)

The Department of Parks and Wildlife understands that you are in the process of selling 221 Merrivale Road and that you wish to confirm that the current access via Korung National Park to 221 Merrivale Road will be available to any future owner of this property.

Parks and Wildlife Perth Hills District has no objection to this continuing permissive access arrangement to 221 Merrivale Road subject to the following conditions:

1. that the future owner of 221 Merrivale Road confirm their intention, by writing to Parks and Wildlife's Perth Hills District Manager, to use this access route and their agreement to the conditions outlined in this letter;
2. that the only permitted access through Korung National Park will be via the existing track from Merrivale Road aligned alongside the neighbouring property at 211 Merrivale Road (Lot 829 on Plan 202184) to the southwest corner boundary of 221 Merrivale Road;
3. Parks and Wildlife accepts no liability for any accident, injury or claim for damages caused to any person, machinery, equipment or other thing using the firebreak or track to access 221 Merrivale Road; .
4. Parks and Wildlife provides no guarantee of the serviceability of the track;
5. any maintenance to the track, including road works and clearing of encroaching vegetation, to retain access or to ensure serviceability is to be paid for by the landowner of 221 Merrivale Road and only those works that have been approved in consultation and by agreement with Parks and Wildlife Perth Hills District are to be completed;
6. that the future owner of 221 Merrivale Road acknowledges the risk from natural disaster or wildfire / bushfire caused by living on a property with restricted vehicular access and that measures are taken to mitigate these risks. For example, considering and possibly implementing advise provided by the Fire and Emergency Services Authority of WA and the Shire of Kalamunda; and
7. Parks and Wildlife reserves the right to review or cancel this arrangement at any time to amend or realign access but will only do so in consultation with the owner of 221 Merrivale Road. The owner may apply for an easement or excision from class A Korung National Park to formalize access to the property.

The Perth Hills District is located at 275 Allen Road, Mundaring. Phone: 9290 6100. Email: mundaring@dpaw.wa.gov.au

Yours sincerely

Anne E. Greig
Land Services Officer

14 December 2015

Parks and Visitor Services Division:
17 Dick Perry Avenue, Technology Park, Kensington
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
www.dpaw.wa.gov.au

E-MAILED
4 JAN 16

Minister for Planning; Culture & the Arts
Government of Western Australia

Our Ref: 33-31524

Ms Sarah Hardman
221 Merrivale Road
PICKERING BROOK WA 6076

Dear Ms Hardman

221 MERRIVALE ROAD, PICKERING BROOK

Thank you for your email of 16 December 2015 regarding the above property.

I have noted the contents of the letter dated 14 December 2015 from the Department of Parks and Wildlife (DPaW). Officers of the Department of Planning have confirmed that the land through which you access your property is part of the Korung National Park (Reserve 47881).

Reserve 47881 is owned by the State and managed by DPaW. The formalisation of your access arrangements through the Reserve is therefore a matter which would need to be agreed with that Department. DPaW falls under the ministerial portfolio of the Minister for Environment, Hon Albert Jacob MLA.

While I am unable to assist in resolving your concerns, I have referred your email to Minister Jacob for his consideration.

I appreciate you raising this matter with me and trust the above information is of assistance.

Yours sincerely

JOHN DAY
MINISTER FOR PLANNING;
CULTURE AND THE ARTS

4 JAN 2016

11th Floor, 2 Havelock Street, West Perth, Western Australia 6005
Telephone: +61 8 6552 6200 Facsimile: +61 8 6552 6201 Email: Minister.Day@dpc.wa.gov.au

Hon Albert Jacob MLA
Minister for Environment; Heritage

Our Ref: 50-11811

Ms Sarah Hardman
221 Merrivale Road
PICKERING BROOK WA 6076

Dear Ms Hardman

I refer to your email dated 16 December 2015 requesting assistance in formalising access to your property in Pickering Brook. As the Minister responsible for the Environment portfolio, including matters relating to Crown land classified as class 'A' reserve such as Korung National Park, your email has been referred to me by Hon John Day MLA, Minister for Planning.

I am pleased to note from your correspondence that staff from the Department of Parks and Wildlife have been helpful in trying to assist you. I understand the Department provided you with an informal access agreement by way of letter, intended to be sufficient evidence to alleviate any concerns over access, which was unfortunately not accepted by the prospective buyer's bank.

I have asked Parks and Wildlife to seek approval from the Conservation Commission of Western Australia for the creation of an easement over the portion of Korung National Park that is used for access to your property. If endorsed by the Conservation Commission, the easement process can then be finalised by the Department of Lands. In accordance with the *Land Administration Act 1997,* this will require the matter to be laid before both Houses of Parliament by the Minister for Lands. I have copied the Minister for Lands, Hon Terry Redman MLA, into this letter to assist in this process.

I trust that in the interim this letter will be sufficient evidence of the intention to formalise legal access to your property.

Yours sincerely

Albert Jacob MLA
MINISTER FOR ENVIRONMENT; HERITAGE

cc: Hon Terry Redmond MLA, Minister for Lands
Hon John Day MLA, Minister for Planning

04 FEB 2016

12th Floor, Dumas House, 2 Havelock Street, West Perth Western Australia 6005
Phone: +61 8 6552 5800 Facsimile: +61 8 6552 5801
Email: Minister.Jacob@dpc.wa.gov.au

Government of **Western Australia**
Department of **Lands**

Our ref: 39-22563 160579
Enquiries: Jay Colton 6552 4589
jay.colton@lands.wa.gov.au

Ms Sarah Hardman
221 Merrivale Road
PICKERING BROOK WA 6076

Dear Ms Hardman

ACCESS EASEMENT OVER KORUNG NATIONAL PARK (RESERVE 47881) – PICKERING BROOK, SHIRE OF KALAMUNDA

I refer to the letter dated 4 February 2016 from the Hon Albert Jacob MLA, Minister for Environment; Heritage to you which was copied to the Hon Terry Redman MLA, Minister for Lands.

The Department of Parks and Wildlife has recently contacted this Department to bring attention to this matter. The Department's internal Assessment team is currently investigating the proposed grant of an 'access' easement over that portion of Korung National Park (Class A Reserve 47881) used as the access to your freehold Lot 830 on Deposited Plan 202184. This assessment will include an investigation into the history of the land and a determination of whether native title is extinguished.

It is my understanding that the Department of Parks and Wildlife and the Conservation Commission of WA have provided their support to the proposed easement.

As the proposed grant of an easement under section 144 of the *Land Administration Act 1997* (LAA) is through Crown land which is classified as a Class A reserve, the Minister for Lands must cause the proposal to be laid before each House of Parliament. This process will be conducted by the Department of Lands and as this will likely take some time to complete you can contact Jay Colton with any queries on 6552 4589 or jay.colton@lands.wa.gov.au. Jay's details can be passed on to any prospective purchaser if they wish to discuss the matter.

Yours sincerely

Cecelia Smith
Manager
Metropolitan and Peel Region

23 February 2016

Gordon Stephenson House, 140 William Street Perth Western Australia 6000 PO Box 1143 West Perth Western Australia 6872
Telephone (08) 6552 4400 Facsimile (08) 6552 4417 Freecall: 1800 735 784 (Country only)
Email: info@lands.wa.gov.au Website: www.lands.wa.gov.au
ABN: 68 565 723 484

82 Merrivale Rd.
Pickering Brook
W.A. 6076

14th December 2016

The Manager
Department of Lands
West Perth

Attention; Cecelia Smith

ACCESS EASEMENT OVER KORUNG NATIONAL PARK (RESERVE 47881) – PICKERING BROOK, SHIRE OF KALAMUNDA

Dear Cecelia,

I would like to draw your attention to our application for a statutory formalisation of appropriate access easement to our property at 221 Merrivale Road Pickering Brook dated 20th January 2016.

I have enclosed a copy of the map showing the proposed access easement and copies of the correspondence that took place 12 months ago.

I have sent an email and made several phone calls to Jay Colton to enquire as to the progress of this application but have never received a reply.

I appreciate that the process does take some time but I want to ensure that all is in order and that the application is in the system.

I look forward to hearing from you.

Yours sincerely

G D Fantuz

Gillian Fantuz

cc: Anne E Greig Land Service Officer, Department of Parks and Wildlife

4.6. RESERVE CLASSIFICATIONS

The *Land Act 1933* provided for reserves of Crown land to be classified as Class A, B or C reserve.

Under the LAA, there is only one classification for reserves – Class A reserves. All other reserves are simply known as "reserves". However existing Class "B" reserves are continued by the LAA's transitional provisions (see paragraph 4.6.2).

4.6.1. CLASS A RESERVES

4.6.1.1. INTRODUCTION

Class A reserves afford the greatest degree of protection for reserves of Crown land created under the LAA. The "A" classification is used solely to protect areas of high conservation or high community value.

As a matter of policy, Lands Division officers should take into consideration principles including but not limited to the following when proposing to classify Class A reserves:

- Where reserved land has special values warranting a very high level of protection,
- "A" classification should not be created without restraint, as the perceived value of such classifications may otherwise be degraded, and because of the substantial overheads involved in modifying such reserves;
- Reserves should not be given an "A" classification without reference to and agreement by the Department of Industry and Resources (DOIR) because of the constraints on accessing class "A" reserves for mining, resource development and other uses;
- Cabinet may direct "A" classification for specified reserves or a particular category of reserves;
- Regard must be had to the requirements of the *Native Title Act 1993* and associated policies, before proceeding with an "A" classification.

4.6.1.2. AMENDMENT OF CLASS A RESERVES

Under the *Land Act 1933*, class A reserves were, subject to certain actions under section 31(4) of that Act only amended by an Act of Parliament. Under the LAA, the process to amend Class A reserves has been modified.

As a general rule, with the exception of class A CALM reserves, amendments of Class A reserves under the LAA do not require an Act to be presented before both Houses of State Parliament.

Under the LAA, class A reserves can be amended in one of 2 ways:

- Where the amendments are of a minor nature, those amendments may be made by the Minister making a Ministerial order.

What constitutes a minor amendment is set out in section 42(3) of the LAA. Minor amendments include:

- adding Crown land to a class A reserve (Refer Form LAA - 1100– Order for Addition of Land to Class "A" Reserves);
- amending Class A reserves for the purpose of correcting unsurveyed boundaries provided that the area of the reserve is not reduced by more than 5%;
- excising 5% or one hectare, whichever is the lesser, of the area of a class A reserve for the purpose of public utility services;
- redescribing locations or lots or adjusting areas of locations or lots within a class A reserve provided that the external boundaries of the class A reserve do not change; and
- amalgamating 2 or more class A reserves having a similar purpose and the same management body (Refer Form LAA - 1097 – Amalgamation Order for Class "A" Reserves).

Please note, forms are to be completed by RDL staff only, however examples of completed forms are available on RDL's website (see State Land – Forms) for information purposes only).

- Where the amendments are <u>not</u> of a minor nature (that is. do not come within any of the above 5 types of amendments), the Minister can only amend a Class A reserve by tabling the proposal in both Houses of Parliament in accordance with section 43 of the LAA.

What constitutes a major amendment is set out in section 42(4) of the LAA. Major amendments include:

- reducing the areas of, or excising an area from, a class A reserve for a purpose other than the correction of unsurveyed boundaries or for public utility services – Section 42(4)(a);
- excising an area from a class A reserve for the purpose of creating a road - Section 42(4)(b);
- cancelling a class A reserve - Section 42(4)(c);
- changing the purpose of a class A reserve - Section 42(4)(c); or
- changing the classification of a class A reserve - Section 42(4)(c).

Under section 43, the proposal to amend a Class A reserve can only proceed where:

- a disallowance motion to the proposal is <u>not</u> made within 14 sitting days of either House of Parliament; or
- a disallowance motion is made within the 14 sitting days, debated and lost in 30 sitting days.

Where the disallowance motion is <u>not</u> debated within 30 sitting days, the proposal to amend the Class A reserve lapses and the process must be started all over again.

The number of sitting days for the tabling of a proposal to amend a Class A reserve can be counted across different sessions of Parliament and across different Parliaments – Section 43 (2) and (3) of the LAA.

Any amendment of a Class "A" reserve can only be made after the Minister has advertised his or her intention to make those amendments in a newspaper circulating throughout the State 30 days before making that order – Section 42(5) of the LAA.

Quality Assurance Procedures within RDL state, that Members of Parliament representing the region affected by the proposal from both houses are advised of the impending advertisement and tabling of the proposal.

Quality Assurance procedures also make reference to the preparation and submission for a correction to a submission tabled before Parliament.

4.6.2. CLASS B RESERVES

4.6.2.1. INTRODUCTION

Class "B" reserves were created under the *Land Act 1933*. Those class B reserves remaining under the *Land Act 1933* continue and remain so classified as if the *Land Act 1933* had not been repealed. Class B reserves cannot be created under the LAA.

4.6.2.2. CANCELLATION OF CLASS B RESERVES

Class B reserves can only be cancelled by the Governor by proclamation in accordance with section 31(2) of the *Land Act 1933* by order made under the LAA (see clause 14(6)(a) of schedule 2 of the LAA)

The Minister for Lands may continue to deal with Class "B" reserves created under the *Land Act 1933* provided that, should the reservation be required to be cancelled, the Minister must make an order under the LAA and also present a special report to both Houses of Parliament setting out the reasons for the cancellation and the purpose to which the land is intended to be used. The report must be made to both Houses of Parliament within 14 days from the date of cancellation, if Parliament is already in session, and if not, within 14 days after the commencement of the next session of Parliament: Section 31(2) of the *Land Act 1933*.

4.6.3. CLASS C RESERVES

Class C Reserves were created under the *Land Act 1933*. Class C Reserves cannot be created under the LAA.

4.9.1. EASEMENTS OVER CLASS A RESERVES

Policy 8.1.7 in the Government Land Policy Manual (please note this manual is not available on this website – please contact RDL's Lands Division, State Land Services for further information) deals with easements over Class A reserves.

Once a reserve has been classified as a Class A reserve for a particular purpose, the Minister can only grant an easement under section 144 of the LAA or permit the creation of an easement (under section 148 of the LAA) over a Class A reserve under section 44 of the LAA. An easement over a Class A reserve can only be granted where:

- the Minister advertises his or her intention to so act in a newspaper circulating throughout the State, and
- a proposal for the easement is laid before both Houses of Parliament in accordance with the procedure set out in section 43 of the LAA.

The Minister must advertise his or her intention in a State newspaper not less than 30 days before granting an easement or permitting the freehold owner of a Class A reserve to issue an easement. The advertisement must detail the reason for granting the easement and the purpose of the easement.

Under section 43, the easement can only proceed where:

- a disallowance motion to the proposal for the easement is not made within 14 sitting days of either House of Parliament; or
- a disallowance motion to the proposal for the easement is made within the 14 sitting days, debated and lost in 30 sitting days.

Where the disallowance motion is not debated within 30 sitting days, the proposal to grant the easement lapses and the process must be started all over again.

The number of sitting days for the tabling of a proposal to grant an easement over a Class A reserve can be counted across different sessions of Parliament and across different Parliaments: see section 43(2) and (3) of the LAA.

Easements over Class A reserves should be avoided, wherever possible. Use of existing roads or other 'corridors' through such reserves is to be encouraged. Where it is necessary to grant an easement through an A Class Reserve, the easement and the services it protects should constitute minimal interference with the reserve's values and use and enjoyment by the public.

The easement purpose should complement at least or be compatible with the purpose of the reserve. For example, a gas pipeline through a show ground reserve or an easement that requires substantial land clearing through a flora conservation reserve may not be appropriate. If such easements are essential, it will be necessary to ensure adequate conditions are contained in the easement document to provide protection and/or compatibility between the two purposes or to excise the area from the reserve.

The Manager of the relevant State Land Services region should ensure that any high-risk easement (eg. gas pipeline) through a Recreation or high public use reserve makes comprehensive provisions to safeguard users against danger (eg. encasing pipe in concrete) and the agreed Crown indemnity clause is used.

Where a Class A reserve is the subject of conditional tenure under section 75 of the LAA, and the landowner proposes to grant an easement using his powers under section 148 of the LAA, Registration Services should not accept such easement without first ensuring that 30 days' notice of intent has been published in the newspaper and approval on behalf of the Minister has been granted after tabling in Parliament.

No other transaction is permitted over a Class A reserve. If a particular transaction is essential over part of a Class A reserve, the land must first be excised from the Class A reserve and brought back to unallocated Crown land. The tabling process for excision of the land in section 43 of the LAA must be followed. See Paragraph 4.6.1.2 for details of this process.

Once the land becomes unallocated Crown land, the powers of the Minister under the LAA can apply.

4.9.2. TRANSACTIONS OVER RESERVES

Transactions under the LAA over reserved land are dependent upon whether or not the reserved land is managed or unmanaged.

4.9.2.1. TRANSACTIONS OVER MANAGED RESERVES

Where a reserve is classified for a specific purpose and placed under the care, control and management of a management body, the management body may deal with the reserved land subject to -

- the express powers granted to that management body in the Management Order; and
- the consent of the Minister for Lands under section 18 of the LAA.

It should be noted that section46 (3b) of the LAA provides that where a management order has been issued to a state government agency or a Minister, the consent of the Minister for Lands under section18 of the LAA to a dealing in that reserve is not required unless the management order specifically requires such consent. Section 18(8) (d) of the LAA also sets out some exceptions when prior ministerial approval under section 18 is not required.

4.9.2.2. POWERS OF LOCAL GOVERNMENT UNDER THE *PARKS & RESERVES ACT 1895*

Section 3.54 of the *Local Government Act 1995* empowers Local Governments to exercise certain powers for the purpose of controlling and managing reserves placed under their care, control and management by the *Land Act 1933* and, following its repeal, by the LAA.

Under this section of the *Local Government Act 1995*, Local Governments have certain powers under section 5(1) of the *Parks and Reserves Act 1895* to control and manage reserves, including the power to grant licences for

- the de-pasturing of animals on reserves; and
- the removal of any sand, gravel or other earth or mineral, and for cutting and removing wood.

With the exception of section 5 of the *Parks and Reserves Act 1895* as it relates to the exercise of certain management powers in relation to reserves by Local Government under the *Local Government Act 1995*, most of the management issues relating to reserves of Crown land are now covered by Part 4 of the LAA.

The powers exercised by Local Government over reserves under the *Local Government Act 1995* are statutory powers given to Local Government, and are in addition to the powers under the LAA. Licences prepared and entered into by Local Government (using the powers of a Board appointed under the *Parks and Reserves Act 1895*) are licences granted by Local Government under the *Parks and Reserves Act 1895*.

However, Officers within the Directorate should note that section 5(1a) of the *Parks and Reserves Act 1895* clearly provides that, unless the purpose of the reserve is the same as that

8.4.3. EASEMENTS OVER CLASS A RESERVES

Section 44 of the LAA requires that any proposal to grant an easement over a Class A reserve should be:

- advertised in a State-wide newspaper;
- no sooner than 30 days after advertisement, tabled in both Houses of Parliament.

Easements over Class A reserves should be avoided, wherever possible. Use of existing roads or other 'corridors' through such reserves is to be encouraged. Where it is necessary to grant an easement through an A Class Reserve, the easement and the services it protects should constitute minimal interference with the reserve's values and use and enjoyment by the public.

Where after careful consideration it has been agreed that an easement should be created over a Class A Reserve, the Lands Division is to arrange preparation and publication of newspaper advertisement 30 days prior to issuing or granting approval to an easement through a Class A Reserve. Notice for tabling in Parliament may be prepared at the same time. Newspaper advertisements must detail reason, purpose, extent and grantee of the proposed easement. Advertisement must also occur 30 days before action/approval to ensure that easement occurs.

State Land Services Managers of the Lands Division should ensure that any high-risk easement (for example, gas pipeline) through a Recreation or high public use reserve makes comprehensive provisions to safeguard users against danger (for example, encasing pipe in concrete) and the agreed Crown indemnity clause is used.

An LAA Easement cannot be granted over CALM Act Reserves for purposes inconsistent with the CALM Act. (*Note however, that the LAA may be amended to enable easements to be granted over CALM Act land for any purpose).*

Where a Class A reserve is the subject of conditional tenure under section 75 of the LAA, and the landowner proposes to grant an easement using his powers under section 148 of the LAA, Registration Services should not accept such easement without first ensuring that 30 days' notice of intent has been published in the newspaper and approval on behalf of the Minister has been granted after tabling in Parliament.

RDL Officers should relate to Policy 8.1.7 in the Government Land Policy Manual which relates to easements over Class A reserves

RECEIVED FRONT COUNTER
DATE 18/4/17 TIME 10.30am
RECEIVED BY Kristy O

C.E.O

KALAMUNDA SHIRE

2 RAILWAY RD.

KALAMUNDA.

W.A 6076



PLAN
SCALE 1:1500

INSET
SCALE 1:500

City of Kalamunda
ASSET SERVICES

MERRIVALE ROAD
ROAD RESERVE RATIONALIZATION
PICKERING BROOK

PLAN
1 OF 1

SCALE: 1:500 — SCALE IN METRES
SCALE: 1:1500 — SCALE IN METRES

No.	REVISION	BY	DATE	AUTH
0	ISSUED FOR USE	AG	24/01/18	

AS SHOWN

DATUM: AHD
GRID: PCG94

SURVEYED: ENGINEERING SURVEYOR /2018
DESIGNED: INFRASTRUCTURE DESIGN OFFICER /2018
DRAWN: A. GREGORY INFRASTRUCTURE DESIGN OFFICER 24/01/2018
CHECKED: L. PUDHOTA COORDINATOR PROJECT DESIGN 24/01/2018
AUTHORISED: MANAGER ASSET DELIVERY 24/01/2018
APPROVED: DIRECTOR ASSET SERVICES 24/1/2018
Discipline: CI
Structure Code: 420
JOB No. --

DRAWING-No. -SHEET /REVISION: 4253-01-01/0
ORIGINAL DRG. SIZE: A1

TABLE C

Local Government Checklist to close a Road (Dedicated Public Road)

ITEM	DOCUMENTS TO BE PROVIDED	ATTACHED
1	Report/Background information to Councillors before Council Meeting to close road	
2	Signed copy of Council Resolution to close road	
3	Copy of advertisement to close road	
4	Copies of any submissions and objections to advertisement	
5	Signed copy of Council motion and comments on submissions and objections	
6	Copies of correspondence to public utility service providers and other agencies confirming their agreement to the proposed closure • Water Corporation • Western Power • Alinta Gas • Telstra • Department of Industry and Resources • Dampier to Bunbury Natural Gas Pipeline (DPNGP) Land Access Minister • RDL (Statutory Planning)	
7	Sketch plan showing proposed allocation/sale of land in road to adjoining owners (to identify easements under either section 167 of the Planning and Development Act 2005 for drainage works, water, electricity or gas, if required or, under section 144 of the LAA)	

TABLE D

RDL Checklist to Dedicate a Road where the land is Reserved or Acquired for use by the Public as a Road under the Care, Control and Management of Local Government

ITEM	DOCUMENTS TO BE PROVIDED	ATTACHED
1	Signed and dated copy of Council resolution to request dedication of road	
2	Details of consultation process together with the number of objections and support plus comments including Local Government's comments on these submissions	
3	Indemnity in favour of the Minister for Lands against any claims for compensation and costs	
4	Copies of correspondence to public utility service providers and other agencies confirming their agreement to the proposed dedication. • Water Corporation • Western Power • Alinta Gas • Telstra • Department of Industry and Resources • Dampier to Bunbury Natural Gas Pipeline (DPNGP) Land Access Minister • RDL (Statutory Planning)	
5	Plan of survey, sketch plan or document to describe the dimensions of the road	
6	Written confirmation that the Local Government has complied with section 56(2) of the LAA	