23.3.2 O-Bahn Geometric Design Criteria

A review of the existing O-Bahn Design and guidelines, in particular *Austroads Guide to Road Design*, and *Austroads Guide to Road Tunnels*, has been undertaken to determine the concept geometric design criteria as detailed in the table below.

Table 30: O-Bahn Geometric Criteria

Criteria	Min / Max	Desirable
Design Speed - Busway	60 km/hr (min)	80 km/hr
Design Speed - Ramps	40 km/hr (Min)	60 km/hr
O-Bahn Bus Lane Width	2.6 m	-
Track Centres	3.3 m	3.4 m
Passenger Egress Walkway	0.9 m	1.2 m
Vertical Clearance within Tunnel (4.5m bus)	4.8 m	5.0 m
Maximum Grade - Ramps	10 %	5 %
Minimum Grade – within tunnel	0 %	0.3 %
Maximum Grade – within tunnel	6 %	3 %
Driver Reaction Time	1.5 sec	2.0 sec.
Deceleration – Bus	2.8 m / sec (d=0.29) (emergency)	1.5 m / sec (d=0.15) (comfort)
Drivers Eye Height	1.8 m	-
Object Height	0.2 m	-
Horizontal Curve	R = 270 m	R = 400 m
Horizontal Curve Transitions	Clothoid	-
Vertical acceleration	0.3 m/s^2	
Lateral acceleration	1.0 m/s^2	0.6 m/s^2
Rate of change - lateral acceleration (transitions)	0.3 m/s^2	-
Widening for Horizontal Sight Distance	As required AGRD	-
Superelevation	0 % min - 5 % max	3 % Max

23.3.3 O-Bahn Pavement Loading

The design of the guide way and pavement shall allow for the legal maximum axle load weight for buses.

Due to the O-Bahn guide way system the bus wheel path are confined to defined wheel paths, reducing “wander” within a pavement width and resulting in a more onerous repetitive loading. The assumed loading for single-decker buses is as follows:

- Vertical axle loading on running surface = 120 kN;
- Lateral load on guide kerb = 15 kN.

Details of the existing O-Bahn track design are included in the Appendices for information.

23.3.4 O-Bahn Pavement Type

O-Bahn pavements include a traditional pavement with a 180 mm up-stand kerb to provide the bus guidance. The pavement is required to be constructed to a high tolerance to ensure reduce ride and vibration issues and ensure safety and passenger comfort.

A number of options are available to construct a pavement suitable for use with the O-Bahn guide way System. The following pavement approaches to the guide way pavement could be considered:

- Longitudinal beam and sleeper (as per existing O-Bahn Track);
- Jointed reinforced pavement;
- Continuous Reinforced Concrete pavement CRCP (slipform); and
- Fibre reinforced concrete pavement.

Where a jointed pavement is utilised, pavement joints shall be placed to reduce ride and vibration issues, particularly for articulated buses. Where a slip form pavement is utilised, the slip-form technique shall ensure the guide way kerb is smooth, and without “corrugations” to ensure passenger comfort and meets the tight pavement tolerances.

The concept design for the O-Bahn has been based on utilising the existing guide way system, with an in situ slab and either a precast “track” or pre-cast kerb that will enable some adjustment over the life of the facility. Asphalt pavement is not recommended due to the tight pavement tolerances and maintenance issues.

A “full width” pavement between the guide way kerbs is proposed to reduce the access issues for emergency and maintenance vehicles within the tunnel that is currently experienced with the existing raised pre-cast track structure.

23.3.5 Entry / Exit Splays

The O-Bahn guide way system requires entry and exit splays to “funnel” the bus from a normal roadway into the guide way. Entry / exit splays shall be designed to smoothly transition into the guide way to maximise passenger comfort and be consistent with other parts of the existing O-Bahn Network.

23.4 Further Work

Further work on the Road design is currently being undertaken to further refine the concept design and project requirements as part of and during the public consultation process:

- Concept design development for East Terrace;
- Local access requirements along Hackney Road including treatment of the service road and location of u-turn facilities (in consultation with the City of Norwood Payneham and St Peters);
- Calibration of the Micro (Aimsun) modelling of the existing site and proposed works;
- Access across Hackney Road for pedestrians and cyclists;

- Landscaping of Hackney Road and integration with the Botanic Gardens including modifications to existing parking;
- Completion of concept road safety audit;
- Finalise design for Rundle Road; and
- Connection of shared paths and bicycle paths to existing and proposed parkland trails.

23.5 River Torrens Bridge

The Hackney Bridge was first known as the "Second Company Bridge" as the South Australia Company built it. It was built so that wheat farmers from the northern side could access the South Australian Company's flour mill which stood where the Hackney Hotel was later built. The current eastern bridge is the third at the same site; in 1845 "Prescott's Crossing" was built as a timber beam bridge, 1860 saw it replaced with a four span, trussed timber bridge and in December 1885 it was replaced with a 126-foot (38 m) long, 34-foot (10 m) wide truss arch bridge.

The two current structures include a steel truss arch bridge built in 1926 and a three span cantilevered structure with a drop in span commissioned in 1965.

23.5.1 Eastern Heritage Bridge

The eastern bridge is heritage listed and is not proposed to be modified. The risk of constructing adjacent to the bridge warrants careful consideration due to vibration issues.

23.5.2 Western Bridge

DPTI’s internal structural section completed a feasibility assessment to determine if the existing bridge can be modified to provide an additional lane for bus priority traffic over the River Torrens. Due to the nature of the bridge assessment and design modifications, DPTI’s internal structural section has been engaged to complete a detailed design for the proposed modifications to the existing bridge.

Environmental consideration and the resulting impacts the project has on the community are a key element of the development of the design and ultimate success of the project.

Whilst this report does not detail the environmental assessments associated with the project a brief summary of the environmental considerations is included as a background to the design development of the concept.

24 Construction staging and design

24.1 Overview

The detailed construction methods and staging will be finalised during the final design phase of the project by the Contractor selected to construct the project, in consultation with DPTI. This will consider all elements of the project such as the design, local access requirements, traffic management construction staging, utility service relocation and any potential impact on events. The integration of these components seeks to achieve a balance so that the works can be constructed with minimal impact and disruption in an efficient and safe manner.

To achieve this outcome various management plans are developed and implemented during the construction of the project. These include:

- Safety Management Plan;
- Environmental Management Plan;
- Traffic Management Plans;
- Construction Management Plans, taking into account all Park Lands events; and
- Quality Management Plans.

24.1.1 Construction Impact Modelling

During construction of the works a reduction in traffic lanes on the Inner Ring Route will result in a reduction in capacity. As congestion increase through the works, some drivers will take alternate routes, well in advance of the site to reduce their travel times and will re-route their journey around the site depending on the origin and destination of their journey.

The O-Bahn sub-network area Meso model has been initially reviewed to gain an understanding of the construction impacts. This model however has limitations and restrictions on route choices (alternative routes) and cannot capture the real traffic diversion in the up-streams (outside the model area). Therefore, the results from the modelling can be considered as conservative for a worst-case scenario.

Traffic impacts on Hackney Road during peak hours could be managed better by informing motorists well in advance (VMS, Media, etc). Further detailed assessments are to be undertaken separately by the DPTI project team for various construction staging options.

Further modelling of the construction impacts using the micro simulation model (Aimsun) is proposed during the detailed design stage following confirmation of the proposed construction technique for the tunnel and resulting restrictions to traffic.

24.2 Constructability and Design

A key consideration in the development of the concept design is the constructability of the concept and requirement to maintaining existing traffic flows (albeit with local capacity reductions) on the Inner Ring Route.

The proposed construction method for the tunnel is included in the typical cross-section concept design drawings. The traffic staging and construction workspace provisions are included in the concept design drawings staging plans.

The Construction method for the tunnel under the roadways will be investigated to minimise impacts to the Inner Ring Route and Park Lands Operations in consultation with the successful Contractor to find an optimal solution.

The alignment of the tunnel is located central to Hackney Road and Dequetteville Terrace. Whilst this creates a work zone central to the traffic with resulting challenges and constructability issues, the concept design has adopted this approach due to the following considerations:

- Avoid relocation of longitudinal services in the verge or Hackney Road and Dequetteville Terrace, in-particular the Telecommunications and high voltage overhead power line;
- Enable traffic to be retained on the Inner Ring Route through staging of the elements of excavation;
- Avoid the removal of significant trees on Hackney Road and potential impacts to the historical Adelaide University building;
- Reduce requirement to remove trees on the verge of Hackney Road and Dequetteville Terrace resulting from the tree route impacts; and
- Avoid impacting at-grade road cross-fall and drainage pits.

24.3 Busway Tunnel

A key element in the development of a concept design for the proposed O-Bahn bus tunnel is the clarification of the tunnel definition.

AS 4825 Tunnel Fire Safety, Clause 1.6.32 defines a tunnel as *“A substantially enclosed roadway or track-way greater than 80m in length”.* Clause 1.4 TUNNEL CLASSIFICATION, subclause (a) (i) states *“Long Tunnel (L) where the length is greater than 120m in the case of road and Bus tunnels and 250m in the cast of rail tunnel.”*

Austroads Guide to Road Tunnels Part 1, Clause 2.2 provides further commentary and guidance on the classification and considerations in the development of road tunnel designs.

The proposed O-Bahn bus tunnel concept is in excess of 250m. Therefore based on AS 4825, and the *Austroads Guide to Road Tunnels*, the concept design for the O-Bahn grade separation has been considered to be a Tunnel.

24.3.1 Busway Tunnel Features

The operation of the tunnel as a bus way for Adelaide Metro Buses only has different features to a general traffic tunnel including:

- Bus tunnels are generally two-way traffic, whereas road tunnels often have one-way traffic;
- Bus tunnels are not trafficked by general road traffic or hazardous goods;
- Bus tunnels are managed as part of an actively managed busway;
- Buses carry significantly more people per vehicle than private motor vehicles;
- Bus drivers are trained prior to operating within the tunnel environment;
- Bus drivers are trained in emergency procedures;
- Bus passengers may not be familiar with the tunnel environment as they are passengers and not drivers, and may not even perceive they are in a tunnel environment; and
- Based on a review of other bus tunnels, the buses operating within busway tunnels exhibit a better accident record than operating on the open road network, due to a combination of factors such as:
    - Bus drivers are generally more alert in the changed environment of the tunnel;
    - The absence of general traffic vehicles;
    - Absence of roadside obstacles;
    - Standard of design and construction within the tunnels is generally better than the historical urban road network design; and
    - The fire and life safety features that are incorporated in the busway tunnels.

Further detail regarding the Tunnel is provided regarding the following key points

- O-Bahn Guideway;
- Functional Safety and Operation; and
- Further Design Development.

24.4 Geotechnical Engineering

The O-Bahn City Access Project includes a number of elements that require detailed understanding of the sub-surface conditions. A number of geotechnical investigations have been completed during the concept design development, with further investigations programmed to continue to provide an understanding of the soil, groundwater and contamination along the proposed alignment.

Further detail regarding the Geotechnical Engineering will be provided regarding the following key points:

- Soil Profile;

- Groundwater;
- Environmental Aspects;
- Contamination;
- Hackney Bridge investigations;
- Pavement investigations; and
- Other site investigations.

24.5 Structural Engineering

A number of options are available to create the structure for the O-Bahn Tunnel. The selected structural form of the tunnel will need to consider:

- Subsurface conditions;
- Existing services;
- Traffic management during construction;
- Cost and program;
- Construction and operational safety;
- Impact to adjacent environment during and post construction; and
- Impact to existing stakeholders, residents and buildings during construction.

A combination of top down construction and cut and cover is proposed for the O-Bahn City Access tunnel component, to balance impact to traffic during construction and cost.

DPTI note that other tunnelling methods including Tunnel Jacking and Canopy Tubes may be considered as an alternative method with benefits of potential reduced traffic delays to Hackney Road /North Terrace intersection. Further development of the cost and techniques of alternate methods is recommended during further design development.

Further detail regarding Structural Engineering will be provided regarding the following key points:

- Historical Profile;
- Groundwater and Soil Properties;
- Top Down construction;
- Cut and Cover construction;
- Tunnel Jacking;
- Bored (driven) tunnels;
- Fire and Life Safety Considerations; and
- O-Bahn Track.

24.6 Stormwater Drainage

A desktop of the drainage network has been undertaken to determine the impacts in the design and construction of the O-Bahn City Access Project

The review undertaken has been based on dial-before-you-dig, site survey and borehole investigation information completed by DPTI. Further work to depth and accurately locate the services is required to finalise the design.

Further detail regarding Stormwater Drainage will be provided regarding the following key points:

- Existing Stormwater Network;
- First Creek Culvert;
- Flood Plain Mapping;
- Tunnel Drainage;
- Stormwater Services Treatment; and
- Further Design Development.

24.7 Services

The concept design development for the O-Bahn City Access Project has included review of services initially based on dial-before-you-dig and site survey information completed by DPTI.

Design development for service relocation and protection works are currently in progress with the various service authorities. Where possible the concept design has avoided impacting services to minimise the costs and delays associated with relocating services, particularly considering the impact to the Inner Ring Route during construction.

Detailed investigations into the location of existing services within the Park Lands has not been undertaken to date due to Park Land access restrictions. DPTI will progress with these investigations as soon as possible. An Early Works program is being developed by DPTI for later in 2015 to ensure much of the service relocation works can be completed prior to contract award, minimising delays and disruptions to the overall works program.

Further detail regarding Services will be provided regarding the following key points:

- Sewer Services;
- Water;
- Electrical;
- Telecommunications; and
- Gas Services.

24.8 Access

24.8.1 Impacts

There will be obstructions to foot, bike, bus and motor vehicular traffic during construction which is likely to result in delays.

There will be some disruption to O-Bahn services and passengers during the construction phase of the project. Construction will be carefully planned to minimise the impact wherever possible and details will be communicated to passengers as they become available.

The majority of commercial businesses are along the eastern stretch of Hackney road and as such, access is not likely to be inhibited (construction is mainly occurring on the western side). Access impacts to the Adelaide Zoo and the Botanic Garden via Plane Tree Drive and Botanic Drive will be minimised during construction and access maintained whenever possible.

24.8.2 Alternatives and Mitigation Measures

Access to all sites throughout the construction process will be planned to minimise impacts on local businesses.

Alternate City access routes will be promoted during the construction phase through signage, community consultation, information services etc.

Notifications of access impacts to businesses and the community may also be provided by the project team as required.

25 Project Impact Report Conclusion

This Project Impact Report has been provided to inform the community and stakeholders about the current concept design for the O-Bahn City Access Project as of June, 2015. The Project Impact Report has been developed with consideration of community and stakeholder consultation and collaboration.

As project planning and concept design progresses the project team will continue to work with the community, stakeholders and multi-disciplinary areas to ensure the best overall project outcomes are achieved. Opportunities for the refinement and improvement to the project will be incorporated as the design progresses and during detailed design and construction phase of the project.

For further information about the O-Bahn City Access Project, please visit

http://www.infrastructure.sa.gov.au/public_transport_projects/o-bahn_city_access

Or contact the project team on:

P: 1300 443 198

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O-Bahn City Access Project

Department of Planning, Transport and Infrastructure

GPO Box 1533

Adelaide SA 5001

SECTION E
Appendices

26 Key Stakeholder Interaction

Following the announcement of the project by Minister for Transport and Infrastructure, and the briefing provided to the Adelaide City Council on 25th February, the project team engaged with the following stakeholders:

- Presentation to the Adelaide Park Lands Association on 26 February 2015;
- Meeting with Tandanya National Aboriginal Cultural Institute 27 February 2015;
- Meeting with St. Peters College on 2 March and 14 April 2015;
- Meeting with the Adelaide Zoo CEO and senior staff on 3 March 2015;
- Briefing of Norwood, Payneham and St. Peters Council CEO and senior staff on 4 March 2015;
- Presentation to Emergency Services Providers on 5 March 2015;
- Meeting with Transfield Services 26 February 2015;
- Meeting Torrens Transit 26 February 2015;
- Key stakeholder forum of key stakeholders (including Botanic Gardens, Zoos SA, Royal Zoological Society, St. Peters College, RAA, Bicycle Institute of SA, National Wine Centre, People for Public Transport, Adelaide Caravan Park, Beit Shalom Synagogue, City of Norwood, Payneham and St. Peters Council, Vailima Gardens Retirement Village, AusCare, Transfield Services, Romilly House Minicozzi Solicitors, Caltex Woolworths Petrol Station, Hurley Hotel Group) on 10 March 2015;
- Attendance at a board meeting of the People for Public Transport on 10 March 2015;
- Briefing of the DPTI's Accessibility Advisory Group on 11 March 2015;
- Meeting with Theo and Steve Maras and David Williams, President of the East End Coordination Group 13 March 2015;
- Presentation to Adelaide City Council customer service and event staff 16 March 2015;
- Meeting with Nic Minicozzi Solicitors on 16 March 2015;
- Meeting with the 3 day International Horse Trial Event organisers in Rymill Park on 20 March 2015;
- Attendance at the East End Trader and Residents forum on 23 March 2015;
- Presentation to the Vailima Retirement Village residents on 24 March 2015;
- Presentation to the Botanic Park Board on 24 March 2015;
- Presentation to the Beit-Shalom Synagogue Board on 25 March 2015;
- Presentation to the Norwood, Payneham and St. Peters Council Elected members on 25 March;
- Key stakeholder forum of event organisers / coordinators in Rundle Park, Rymill Park and Botanic Gardens (including Fringe, Schützenfest, Womad, Rymill Park Kiosk, Cheesefest, TourismSA, Asiafest, Tandanya Cultural Centre, Carnevale, Gluttony, Garden of Unearthly Delights, Tour Down Under, Adelaide City Council event staff, Botanic Gardens Event Coordinator (also representing Moonlight cinemas) on 27 March 2015;
- Presentation to Kaurna Indigenous representatives on 27 March 2015;

- Presentation to Ramindjeri Indigenous representatives on 27 March 2015;
- Meeting with business owners and tenants of Botanic Integrated Therapies 30 March 2015;
- Meeting with Womad Organisers on 7 April 2015;
- Presentation / meeting with the Hackney South Residents Group 8 April 2015;
- Meeting with Botanic Gardens Restaurant operator (Blanco Food and Events) 9 April 2015;
- Meeting with the RAA on 10 April 2015;
- Meeting with the Aboriginal Lands Trust on 14 April 2015;
- Meeting with Clipsal 500 Event organisers on 21 April 2015; and
- Meeting with Moonlight Cinema Event organisers on 29 April 2015.

27 O-Bahn Historical Context

27.1 The Background of the O-Bahn

When diesel buses replaced trams in the 1955-1958 period, they largely mirrored the same through-tram City routes. MTT buses from ANZAC Highway were also introduced into King William Street, but private buses still terminated on the outskirts of the CBD. Because buses had slower passenger loading times and had to access the kerb, bus stops were spaced further apart compared to the tram stops. Patronage on each route dropped as buses replaced the trams (unless the bus route was extended further out) although where suburban feeder buses to trams were replaced with through buses to the City, the new bus services were popular with the passengers who had previously been required to change.

Trolley buses were replaced with diesel buses in 1963 with routes remaining in Rundle Street until the Mall opened displacing the routes to Grenfell Street and North Terrace.

The 1960s and ‘70s saw the expansion of the outer suburbs, with an increase in private buses serving those suburbs and operating on a limited-stop basis into the City. Most bus services from the outer north east (today served by the O-Bahn), operated around a one-way loop inbound via North Terrace and King William Street and outbound via Flinders and Pulteney Streets. A smaller proportion ran along King William Street to and from Victoria Square, but were not allowed to pick up passengers in King William Street.

Increasing interest in public transport in the early 1970s saw the introduction of the Bee Line bus route in 1973, in an attempt to make access to the CBD as good for tram and train passengers as it was for MTT bus passengers. This service was some years later, supplemented by the City Loop bus route which was eventually withdrawn as a cost saving measure by one Government, and reinstated by another in the 1990s.

The year 1974 saw the takeover of the private buses by the State Government. The companies had found it increasingly difficult to make a profit as the Government would not permit a fare rise. To be viable, public transport needs to have good, even, all-day passenger loading.

In the late 1970s and 1980s, to ensure that bus passengers on the former private bus routes had equitable access to the CBD, compared to that of parking stations users, the old private bus routes were through-linked. This occurred mainly from east to west along North Terrace or from south west to north west along Grote, Wakefield and Pulteney Streets and North Terrace (west).

The mid 1980s saw the opening of the world longest O-Bahn system, and the diversion of many north eastern bus routes along that new busway. It was decided that all O-Bahn bus routes would use Grenfell and Currie Streets as that was considered the best City bus street after King William Street, which was already carrying the largest number of buses.

The new City bus routes for O-Bahn services, which passed through the central area, undoubtedly contributed to the 70% increase in patronage on those bus routes which occurred over the next few years.

The decision to route all O-Bahn services through Currie and Grenfell Streets required major alterations and expansion of bus stop spaces along these streets, with bus stops for each route pushed further apart. Peak-only bus stops for O-Bahn services were also introduced so that bus stops could be used for parking and loading at other times of the day. The re-spacing of long-established bus stops resulted in many complaints, especially from elderly people.

The mid 1980s also saw the major introduction of articulated buses. Bus stops along King William Street were spaced even further apart to allow for this and other service improvements.

27.1.1 The 1990s

In the early 1990s the very long bus routes from outer southern suburbs were extended from Flinders Street along King William Street to Government House. The commencement of bus service tendering in the mid 1990s resulted in the need to “de-link” a number of bus routes – mainly those between northern and southern suburbs, due to a requirement of the Passenger Transport Act. For a few years a greater number of buses traversed King William Street (with a few more in Grenfell Street) as the bus routes had to overlap in the CBD to provide good City passenger access. The City of Adelaide had to provide additional layover space at several points around the City and objected to the greater number of buses using City streets without carrying additional patrons.

To avoid bus volumes in King William Street becoming too great, one bus route which had used Grote and King William Streets and North Terrace (east), was switched to Currie, Grenfell and Pulteney Streets and North Terrace. In 2000 the limitations on through-movement in the Passenger Transport Act were overcome and bus services were re-allocated to operators which were able to operate through-City services. The bus route mentioned above was relocated back into King William and Grote Streets and its patronage immediately increased.

27.1.2 Since 2000 – total private operation of buses but under Government contract

Since 2000 all buses have been operated by private companies under contract with the State Government. Many changes have been made to the linking of bus routes in the City, to improve the balance of bus movements, to provide improved access into the CBD and to the Royal Adelaide Hospital (RAH), to adjust bus numbers at peak times in various streets and to remove some difficult right turns. An example of a change was one bus route that was removed from running east-west along North Terrace to run instead along Currie and Grenfell Streets. Its patronage increased by 15%. The long establishment of many bus route linkings and the streets used by those bus routes means that passenger travel patterns are often built up on the basis of those routes.

27.1.3 Splitting the O-Bahn routes

A significant bus route change affecting the O-Bahn was the redirection of some O-Bahn bus routes along North Terrace and King William Street to Victoria Square and beyond, partly to reduce bus volumes in Currie and Grenfell Streets, but also to provide access to a greater part of the City for residents of the north eastern suburbs.

In the PM peak some 21% of outbound O-Bahn buses travel via King William Street and NorthTerrace, with 79% using Currie and Grenfell Streets (2009). These North Terrace buses have to use Grenfell Street at night because passengers are attracted to the greater frequency of O-Bahn buses in Grenfell Street. When the North Terrace services were introduced many passengers would not use these buses at night.

28 Community and Business Profile: Additional Information

28.1.1 O-Bahn User Catchment Land Use Review

Analysis of land uses within the O-Bahn user catchment revealed that it is predominantly residential, particularly within close proximity to the O-Bahn corridor and interchanges (Figure 84). Commercial and non-residential uses typically envelope the arterial road corridors, as well as forming suburban activity centres. Notable non-residential parcels include Westfield Tea Tree Plaza at the Modbury O-Bahn terminus, Hope Valley Reservoir and the River Torrens Linear Park. The general land use typology shifts intrinsically to a peri-urban/rural function as it approaches the Adelaide Hills face in the east.

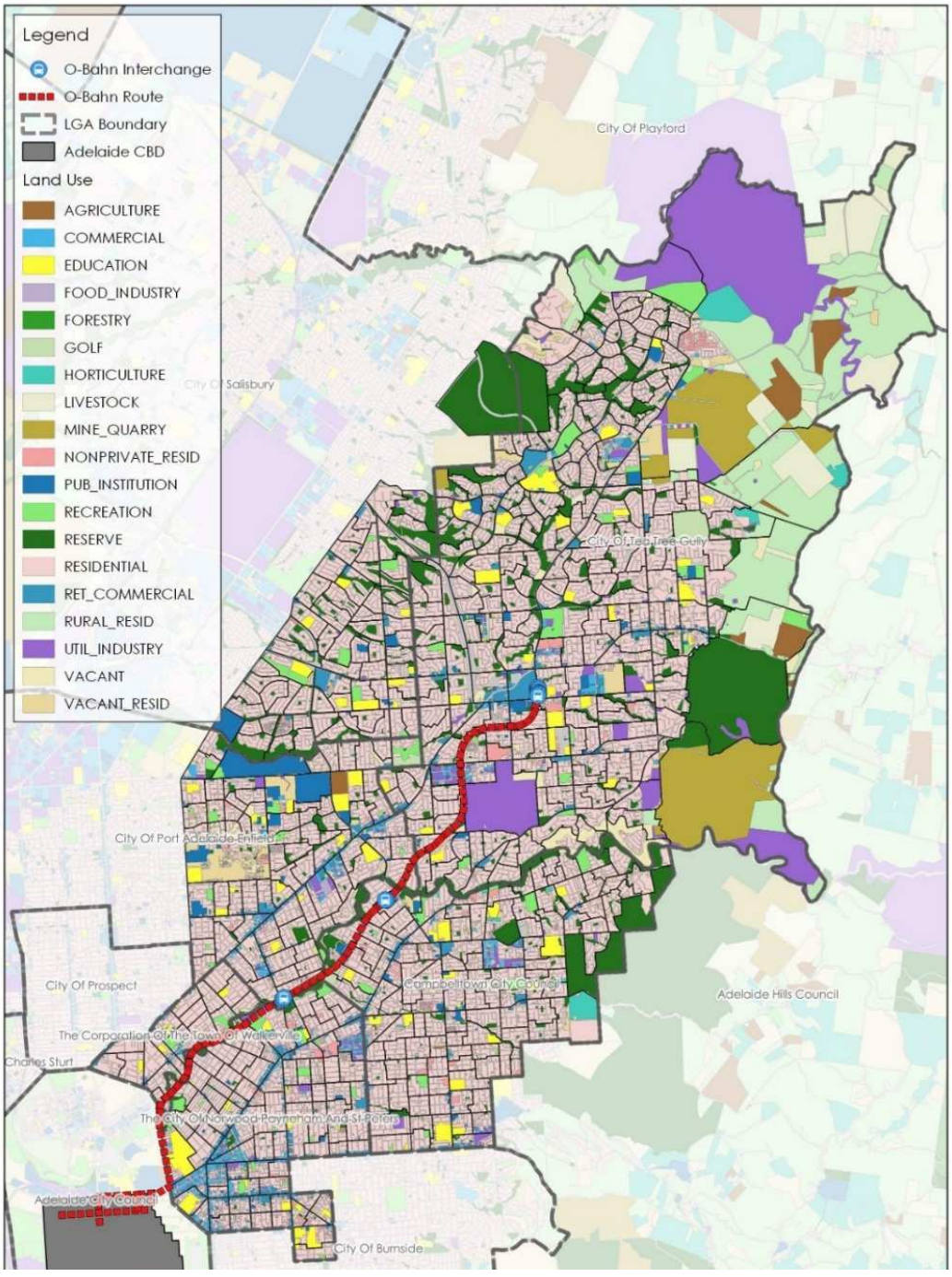

Figure 84: Land use description map of the O-Bahn user catchment area.

28.1.2 Demographic Profile of the O-Bahn catchment

A community profile for the O-Bahn user catchment area was undertaken, comprising analysis of Australian Bureau of Statistics (ABS) Census data from 2011. For the purpose of this profile, Census data at the SA1 (smallest) level was aggregated to align with the broader O-Bahn user catchment area defined in Figure 16. The following sections of this chapter reflect and assess the demographic data at this level. A high-level demographic summary of the catchment has been provided in Table 31 table below.

Key observations resulting from this demographic study include:

- A community population largely of adults, slightly older than the Greater Adelaide average;
- A densely populated region;
- Above average income (combined);
- Below average unemployment rate (combined), with some sub-regions significantly higher or lower than average;
- Above average car ownership;
- A generally well-educated community (combined);
- A significantly high proportion of people who commute to work by bus; and
- Above average number of university students.

It is acknowledged that this community is diverse and that residents engage with a variety of people, businesses and services both within and outside of the catchment area. Within the context of this project, two distinct user groups were identified to assess at a finer level given their O-Bahn patronage potential, that being City commuters and tertiary education students.

Table 31: Summary of the demographic characteristics of the O-Bahn user catchment area.

Local Government Area	Population	Population Density (ppl/ha)	Median Age	Median Salary	Unemployed	University Qualified	No Cars
City of Campbelltown	47,607	19.55	41	$847	5.2%	20.9%	8.8%
City of Norwood, Payneham and St Peters	34,385	22.69	39	$970	5.2%	32.3%	13.1%
City of Tea Tree Gully	93,777	9.84	40	$867	4.7%	14.1%	5.2%
Town of Walkerville	7040	19.72	44	$1,105	4.4%	33.7%	8.7%
City of Port Adelaide Enfield (East)	33,473	19.45	37	$852	7.1%	18.9%	10.8%
City of Salisbury (South-East)	27,047	17.38	39	$806	6.5%	9.6%	5.5%
O-Bahn User Catchment	**243,329**	**18.11**	**40**	**$908**	**5.52%**	**21.6%**	**8.68%**

Local Government Area	Population	Population Density (ppl/ha)	Median Age	Median Salary	Unemployed	University Qualified	No Cars
Greater Adelaide	*1,214,662*	*3.73*	*39*	*$857*	*5.9%*	*18.2%*	*9.2%*

28.2 Travel demand

Travel demand for the O-Bahn City Access Project is driver by the O-Bahn catchment, and predominantly generates travel into the City. The City of Adelaide supports a heavily car dependent metropolitan workforce (see Figure 85). This is largely driven by relatively affordable (compared to other cities) and plentiful car parking (70,000) compared to other cities. For example, Adelaide's is up to 300% cheaper and has 300% more parks per 1000 employees when compared to Sydney.

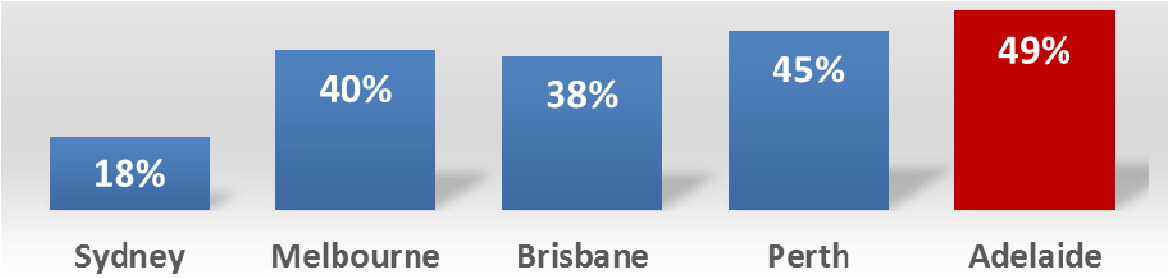

Figure 85: Percentage of City workers who travel by car to work, ABS census 2011

The largest congestion impact comes from the 120,000 workers who converge on the City every day, about 60,000 of whom commute by car. About three quarters of the 88,000 City students travel to the City during the morning period on buses, by bike or on foot[2]. Efficiently being able to get people in and out of the City is paramount for a growing City economy, and is one of the driving considerations for the O-Bahn City Access Project.

28.3 City Workers

Commuting to work is the predominant reason people use public transport. This can be attributed to a number of factors, such as the financial costs associated with driving and parking a vehicle, time spent in peak commuter traffic, stress, access to a car and so on. This reasoning is typically amplified as the distance between employment opportunities and homes increases. As a general rule, this suggests that the further people live from their place of work, their potential to rely on public transport increases.

A study endorsed by the Department of Planning, Transport and Infrastructure suggests that transport costs form a significant ongoing cost for households, particularly those on the urban fringe (InfraPlan 2013, p. 30).

'… inner City living (middle ring) where either one car or no car is required, and where the journey to work trip is assumed to be met by public transport by at least one householder, expenditure could be up to

[2] City User Population Research, 2012-2013, ACC, 57% of students take public transport a week and 53% cycle or walk once a week

$200,000 lower over 20 years [than households on the urban periphery] (or just over $10,000 in savings per annum)'.

Efficient public transport services between already established urban peripheries, as well as to and from economic and social opportunities are fundamental facets to sustainable and equitable development.

By improving O-Bahn bus service reliability, travel times and overall competiveness against private vehicle travel, the already above average percentages of people travelling between the city and the north-eastern suburbs will likely continue. As the research shows, this would also likely facilitate a reduction in housing stress, social inequities and environmental impacts, while increasing household economic potential. Table 32 presents the fifteen local government areas (LGAs) with the highest number of employees who live within the O-Bahn user catchment. Intrinsically, the highest number of workers commute to the Adelaide LGA, which comprises the central business district (CBD) and the suburb of North Adelaide. Significant numbers of catchment residents are also commuting to Port Adelaide Enfield, Tea Tree Gully, Salisbury and Norwood Payneham and St Peters. It is important to acknowledge this table not only reflects those leaving the catchment for work, but also those remaining.

Table 32: The top 15 LGAs to which workers from the O-Bahn User Catchment commute

Rank	Local Government Area	Workers from O-Bahn user catchment	% of resident labour force
1	Adelaide	25,040	21.1%
2	Port Adelaide Enfield	13,932	11.7%
3	Tea Tree Gully	12,843	10.8%
4	Salisbury	11,068	9.3%
5	Norwood Payneham and St Peters	9,533	8.0%
6	Campbelltown	5,986	5.0%
7	West Torrens	5,507	4.6%
8	Charles Sturt	4,593	3.9%
9	Playford	3,513	3.0%
10	Burnside	3,382	2.9%
11	Unley	2,638	2.2%
12	Mitcham	1,410	1.2%
13	Prospect	1,287	1.1%
14	Walkerville	1,005	0.8%
15	Marion	860	0.7%
Total labour force of O-Bahn catchment		**118,580**	**100%**

28.3.1 Bus Commuters

As City-bound workers form the largest share of commuters from the catchment, it is therefore likely that they form a significant share of O-Bahn users.

As O-Bahn bus services continue along routes at either end of the busway, the catchment is significantly greater than that of traditional static transit interchanges. Perhaps unsurprisingly, this is reflected in the above average share of bus commuters for each of the LGAs within the user catchment as depicted in Table 33.

Since the 2006 Census, these LGAs have experienced an equal-to or above average uptake in bus patronage. The only exception is Walkerville, which although experienced slight decline remains significantly higher than the Greater Adelaide average.

Table 33: Change in travel to work by bus (wider metro area) between 2006-2011 Census years

Local Government Area	2011 Census	2006 Census	Change
City of Port Adelaide Enfield (East)	12.4%	10.1%	+2.3%
Norwood, Payneham and St Peters	10.8%	9.5%	+1.3%
City of Campbelltown	9.9%	9.8%	+0.1%
City of Tea Tree Gully	9.8%	9.4%	+0.4%
Town of Walkerville	7.9%	8.2%	-0.3%
City of Salisbury (South-East)	7.8%	7.5%	+0.3%
O-Bahn User Catchment	**9.8%**	**9.1%**	**+0.7%**
Greater Adelaide	*5.9%*	*5.8%*	*+0.1%*

28.3.2 Catchment users

Recognising the projected growth for Adelaide's northern and eastern regions it is likely that their bus patronage rates will remain above average and continue to increase at a rate greater than that of the Greater Adelaide benchmark.

Bus commuter data from the 2011 Census has been refined and analysed spatially using a GIS model to show 'how many' and 'where' City workers are coming from within the O-Bahn user catchment. The output is presented as Figure 86 and specifically illustrates the percentage of City workers living within each of the smallest Census collection districts (SA1) commuting to Adelaide's CBD by bus. This map shows a high bus patronage for workers into the City from the suburbs north of the Tea Tree Gully interchange. Conversely, workers travelling to the CBD by car are lower in these suburbs.

Although the exact route of the bus journeys cannot be extracted from the available data, it shows that a high proportion of CBD workers living within the O-Bahn user catchment are indeed commuting by bus, with an average of 31.3%, compared to the Greater Adelaide benchmark rate of 22.7%.

It is estimated that 18% of the O-Bahn catchment City workers equating to 4,500 residents (north eastern suburbs) use the system every morning to get to their place of work (assuming these are 'regular' ticket users). This suggests that another 13% of bus users (3,300 residents) use other bus services from within the catchment to access City jobs or are not included in the public transport count as workers given they may fall under the category of concession fares even though they work in the City (part or full time).

The remaining 69% (17,300 workers) are primarily dependent on private motor vehicles to access jobs in the City. The travel time reliability of the O-Bahn is likely to attract new trips from the pool of existing drivers (who have to contend with increasing traffic congestion on the ring route and more expensive costs of travel including parking) but also new users of the system seeking employment in the City (latent effect).

This analysis also demonstrates the principle of increased public transport reliance as the distance between the concentration of CBD employment opportunities and outer-residences increases. It may also demonstrate that travel times by O-Bahn from outer areas is competitive with car travel and catchment areas are aligned with bus services.

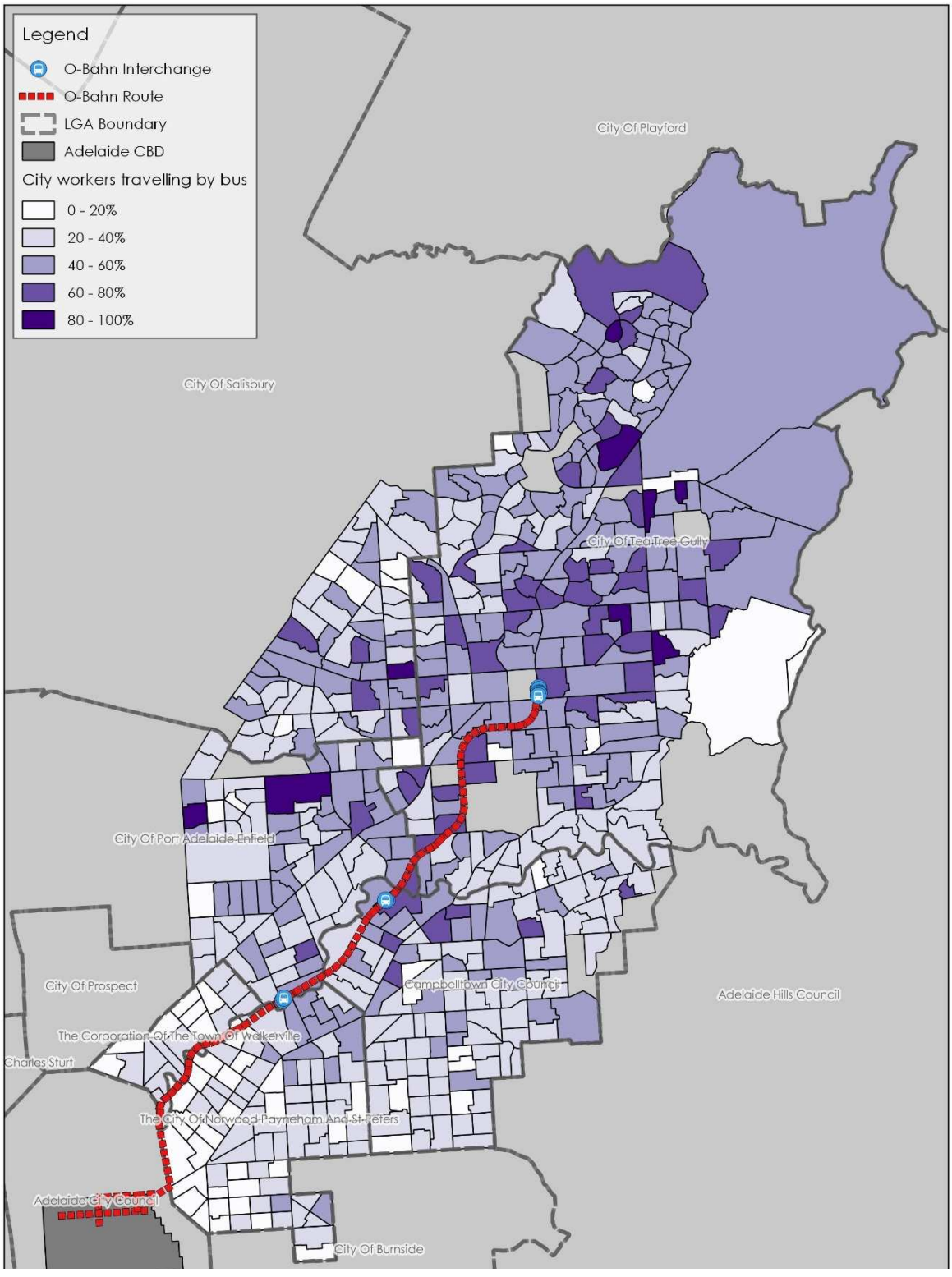

Figure 86: Percent of resident City workers travelling to the Adelaide CBD by bus.

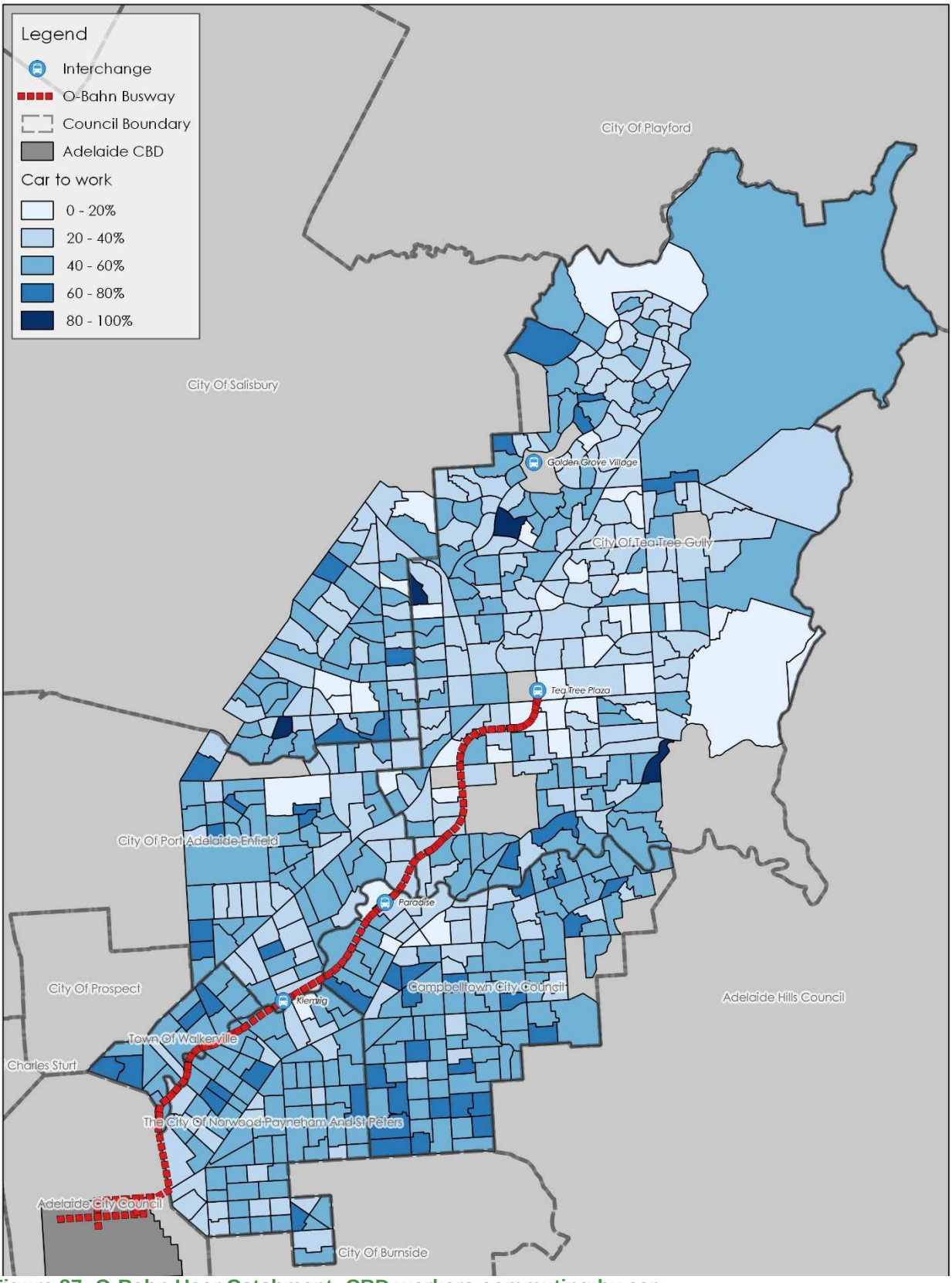

Figure 87: O-Bahn User Catchment: CBD workers commuting by car

28.3.3 Socio-Economic Indexes for the O-Bahn Catchment

The Socio-Economic Indexes for Areas (SEIFA) is an amalgamation of data compiled by the ABS that ranks areas in Australia according to relative socio-economic advantage and disadvantage. It is a commonly applied assessment instrument used to identify a community's socio-economic standing, based on a number of ABS Census variables (including: employment status, level of education and income). The most frequently assessed SEIFA index is the *Index of Relative Socio-Economic Disadvantage*, which includes the broadest range of social disadvantage indicators and summarises a range of information about the economic and social conditions of people and households within an area (geographies at SA1 level).

The SEIFA data for the O-Bahn user catchment has been spatially represented in Figure 88. This analysis shows that socio-economic disadvantage relative to the catchment is most prominent within a central band that runs north-south primarily through the LGAs of Salisbury, Port Adelaide Enfield and Campbelltown. Interestingly, north of the O-Bahn Busway terminus at Tea Tree Plaza the relative level of disadvantage decreases. As outlined, this is a multifaceted result stemming from, but not limited to an increasingly professional and higher paid resident workforce, better connected households and more educated individuals.

It has been established that most workers from the catchment are commuting to the Adelaide CBD, where there are generally more professional and higher paid jobs, as well as tertiary education opportunities and services. When assessing this SEIFA data against method of travel to work in the CBD (Figure 86 and Figure 87), it shows that this northern Tea Tree Gully area are mostly bus commuters, thus establishing a correlation between increased accessibility to the CBD and socio-economic advantage.

Therefore, it is apparent that the O-Bahn Busway is facilitating the efficient commute of a growing number of people working in the Adelaide CBD, encouraging the uptake of public transport, while alleviating some socio-economic disadvantage within the north-eastern suburbs, particularly areas further from the CBD, such as Golden Grove, Modbury Heights and Surrey Downs. With the improved service reliability resulting from the O-Bahn City Access Project, the communities within its catchment are likely to benefit as access to city-centric business, services and opportunities are improved.

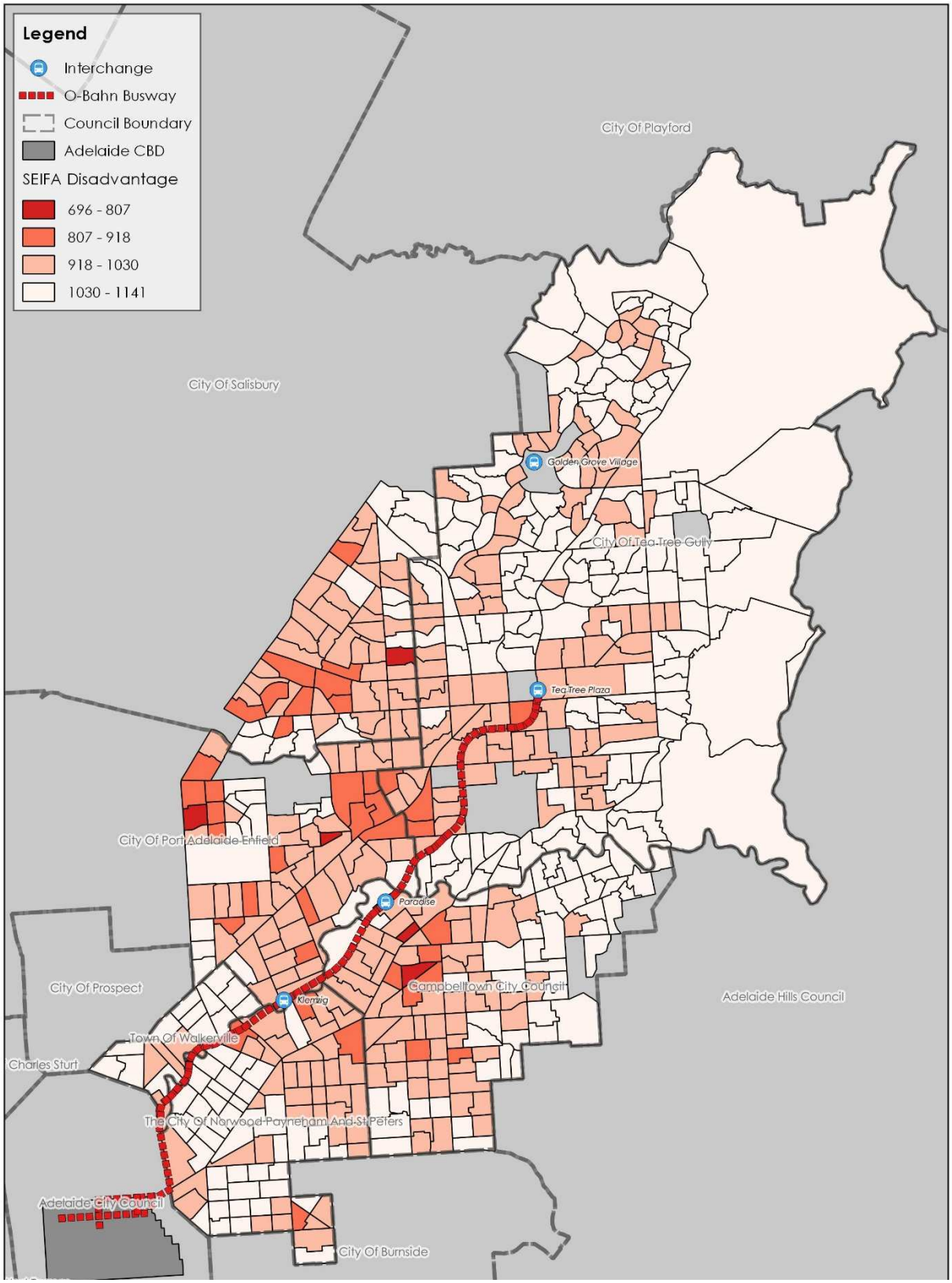

Figure 88: O-Bahn Catchment Index of relative socio-economic disadvantage (SEIFA index – darker shades represent greater socio-economic disadvantage) greyed areas not included in catchment

28.3.4 City Destination of Workers

Perhaps the most noticeable correlation between public transport/car parking demand drivers is with the location and intensity of CBD workers. The locations that have very high worker/ employment clusters are also well serviced by public transport and commercial off-street parking (Figure 89).

- **Employment in the City**. The number of jobs in the City grew from 108,000 in 2006 to 118,200 in 2011 (Adelaide City Census Of Land Use and Employment 2011) and is currently estimated at around 130,000. In employment terms, the City's economy grew faster than the State economy during 1991 - 2009 (1.3% p.a. vs. 1.1% p.a.);
- **Office based sectors and service sectors**. The main sectors in terms of numbers of employment are public and administrative services (21%), health and community services (14%) and professional, scientific and technical services (11 %). Employment in manufacturing, wholesale trade and transport and storage have fallen (Adelaide City Census of Land Use and Employment 2011);
- **Forecast growth in small businesses.** 83% of the City's businesses are defines as small business (employing less than 20 people). Over the next 20 years, growth in micro and small business is forecast to be strong, followed by growth in medium and large businesses (Blandy, 2008);
- **The City is central within the metropolitan area**. The central location provides access to the broadest possible workforce, this reinforced by being the hub of the public transport system, by being in proximity to major research institutions and within a 10 minute drive of Adelaide Airport;
- **Major offices have expanded the CBD southwards.** Between 2005 and 2011, large scale offices have been approved in the heart of the CBD, and extending the CBD southwards around Flinders/Franklin Streets, Victoria Square/Tarndanyannga and King William Street south These have been green star rated buildings attracting premium tenants and rents and this trend is likely to continue. Examples include Aurora, Santos, City Central, SA Water, Federal Court, and 400 King William. Extensive small scale office development has occurred throughout the City over the last five years;
- **In 2011, there were 12359 vacant premises in the City, with 780 vacant office premises and 221 vacant retail premises.** The vacancies provide the opportunity for business to establish, and provide easy access to other businesses and are centrally located within the metropolitan area (which can translate into benefits in terms of selling services and products and to access workers);
- **Office demand is influenced by many factors.** The 30-Year Plan for Greater Adelaide forecasts an increase in 50,000 workers in the City over the next 30 years, estimated to need an additional 25,000 square metres of office space to be added each year. However, demand for office space is influenced by the broader economy, and technological changes presenting opportunities and challenges, such as smaller offices, working from home and increasing casual employment;
- **The State Government is a major office customer.** The State Government occupies around 25% of City office space and is seeking more efficient use of floorspace (employees/sqm) whilst also seeking to increase building sustainability.

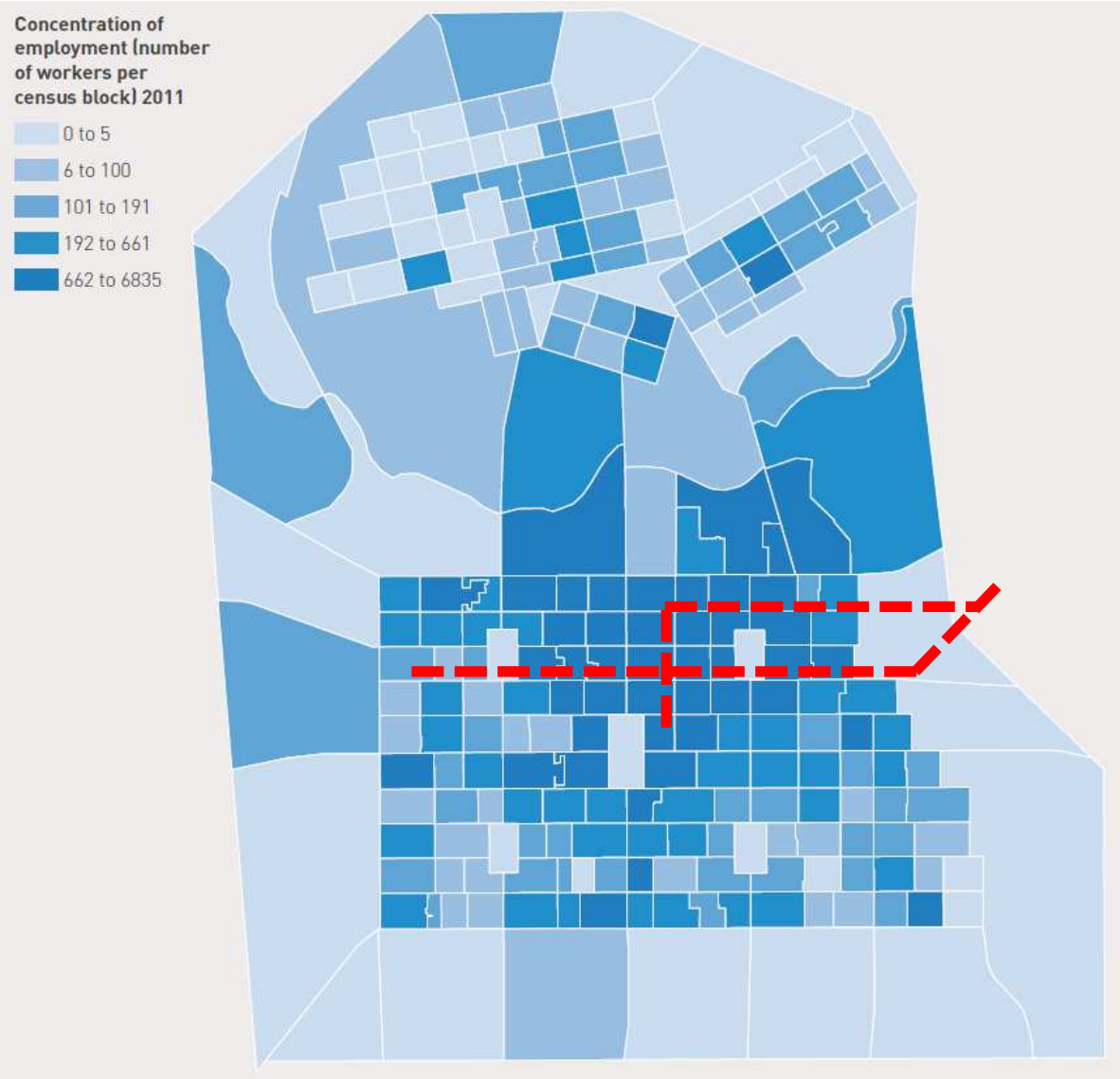

Figure 89: Employment Survey block analysis by Adelaide City Council (ACC2011 Land Use Employment Report).

The analysis indicates that the distribution of most job locations are located between North terrace and Victoria square (Flinders Street), within walking distance of O-Bahn services. The largest concentration of jobs is near King William Street where most services cross including Grenfell Street served by the proposed O-Bahn City Access Project.

28.4 City Residents

The residential clusters within the CBD are more dispersed than other land uses. The south-eastern and south-western sections of the CBD are often referred to as the 'residential' sections of the CBD, and are characterised by low/medium density housing. However the more intense clusters of residential populations are dispersed throughout the City and are generally located at the periphery of the CBD in the East-End, North Terrace, West Terrace and South Terrace (Figure 90).

Only 22,000 residents live in the City of Adelaide and while a significant 42% walk or cycle to work, many travel to work by car a few City blocks away. The City residents also comprise workers, students and a large proportion of retired population who have been attracted to the City lifestyle.

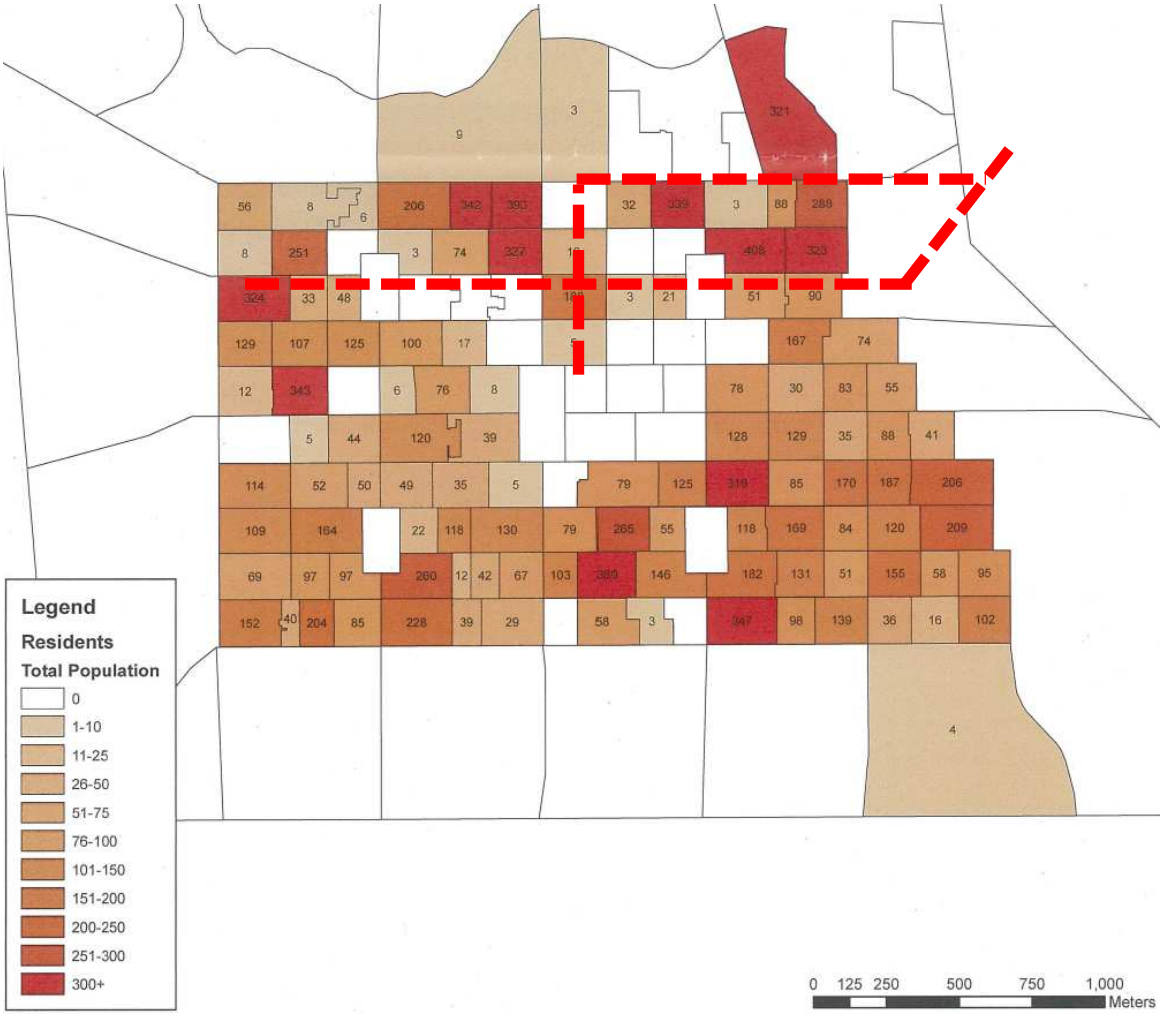

Figure 90: The location of City residents, survey block analysis by ACC (Draft).

The East End has a high concentration of residents compared to other parts of the City and therefore represent a higher proportion of people that might be impacted by projects and changes located along on the eastern edge of the Park Lands. A closer examination of the traffic impact of the O-Bahn City Access Project, compared with the location of residents (as a result of this project) on the East End indicates most residents will improve from the changes (see Section 15.4).

28.5 University Students

The other key demographic group identified within the O-Bahn user catchment are university students. Although available data is limited in revealing exactly where resident students are travelling to for their studies, assumptions can be made given that three of South Australia's four major universities are centred within the Adelaide CBD. These are:

- Adelaide University (North Terrace campus);
- University of South Australia (City East and City West campuses); and
- Carnegie Mellon University Australia (Victoria Square campus).

It is noted that subsidiary campuses for the University of South Australia are located at Mawson Lakes and Magill, and Adelaide University's at Roseworthy, Thebarton and Urrbrae.

Although Flinders University's main campus is located south in Bedford Park, the current 'G40' bus service connects it directly with the north-eastern suburbs via the O-Bahn corridor.

Table 34 below interprets 2011 Census data to show the percentage of the O-Bahn user catchment population attending university by their LGA. The innermost council of Norwood Payneham and St Peters has the highest number, which is perhaps unsurprising given the low car ownership rate and higher density. Overall, the catchment average is slightly above the Greater Adelaide benchmark.

Table 34: Percent of the population currently studying at university.

Local Government Area	University Students
Norwood, Payneham and St Peters	9.3%
Town of Walkerville	7.6%
City of Campbelltown	5.7%
City of Port Adelaide Enfield (East)	5.3%
City of Tea Tree Gully	3.9%
City of Salisbury (South-East)	3.3%
O-Bahn User Catchment	**5.6%**
Greater Adelaide	*5.1%*

A GIS model was used to display this information at the SA1 level, showing where concentrations of university students are living within the catchment. In addition, data counts supplied by the Adelaide City Council were also included to show the number of students attending the CBD campuses. The output of this model is shown in Figure 91.

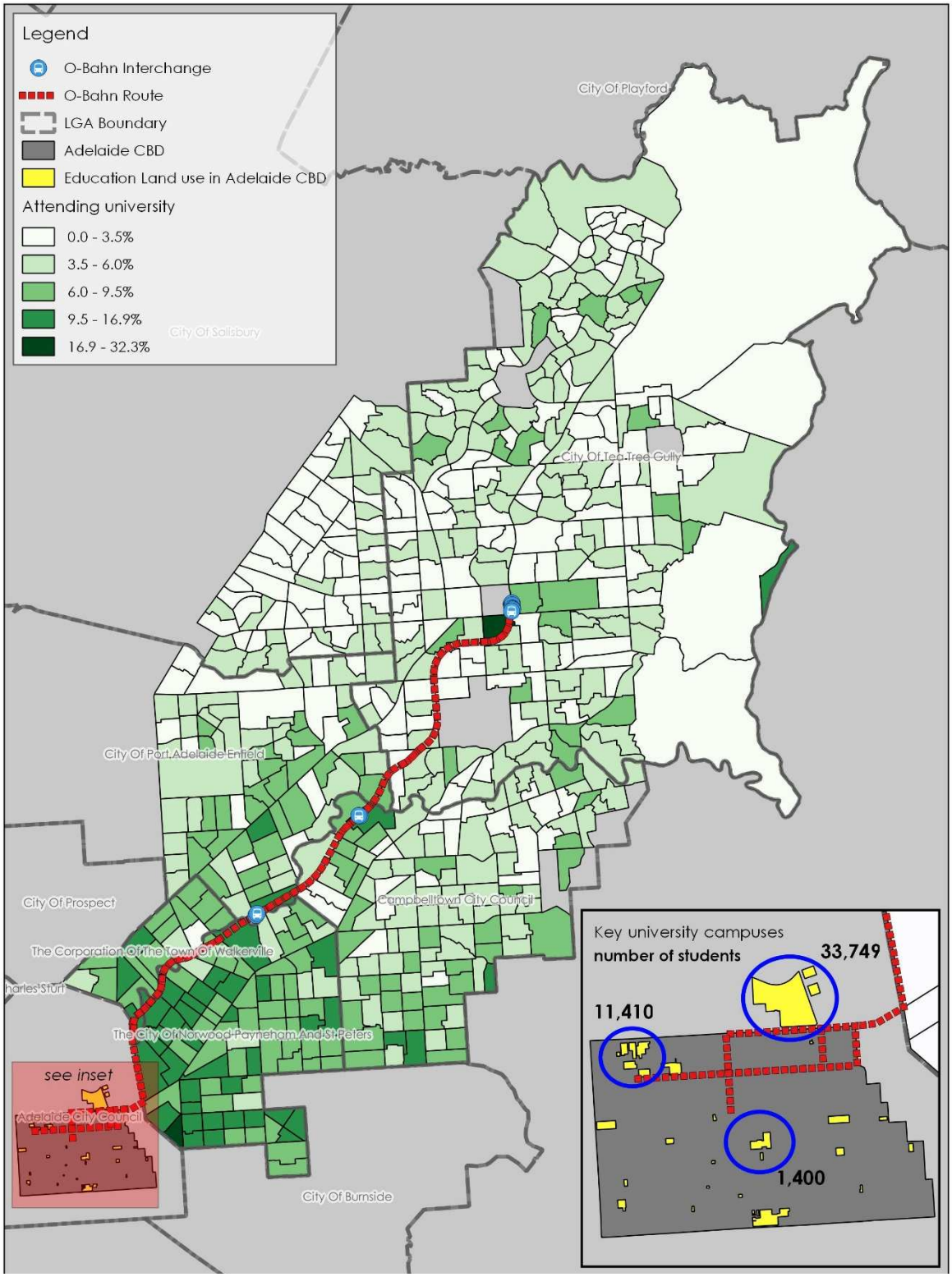

Figure 91: Percent of the population currently attending university.

Similar to that of workers, the further a student is from their campus, the greater their transport costs impact on an already restricted budget. However, the student demographic sustain unique connections to transport reliance that require consideration within the scope of this project. These include:

- generally reduced access to a private vehicle;
- increased insurance costs for drivers generally under 25 years of age; and
- international exchange students who often completely rely on public transport.

Therefore, an increase in service delivery to those living within the catchment, as well as those travelling to the area for work or study as a result of the project is a positive outcome. As the region's primary rapid transit link, it is essential that the needs of the current community are met and that the network is 'future-proofed' for anticipated growth.

28.5.1 City Student Destinations

Student populations within the CBD are heavily clustered around the University campus' of Adelaide University and University of South Australia (East and West Campus), as well as the major schools (such as Adelaide High, CBC and Pulteney Grammar). The highest concentration of students in the CBD is the Adelaide University/UniSA East (Figure 92).

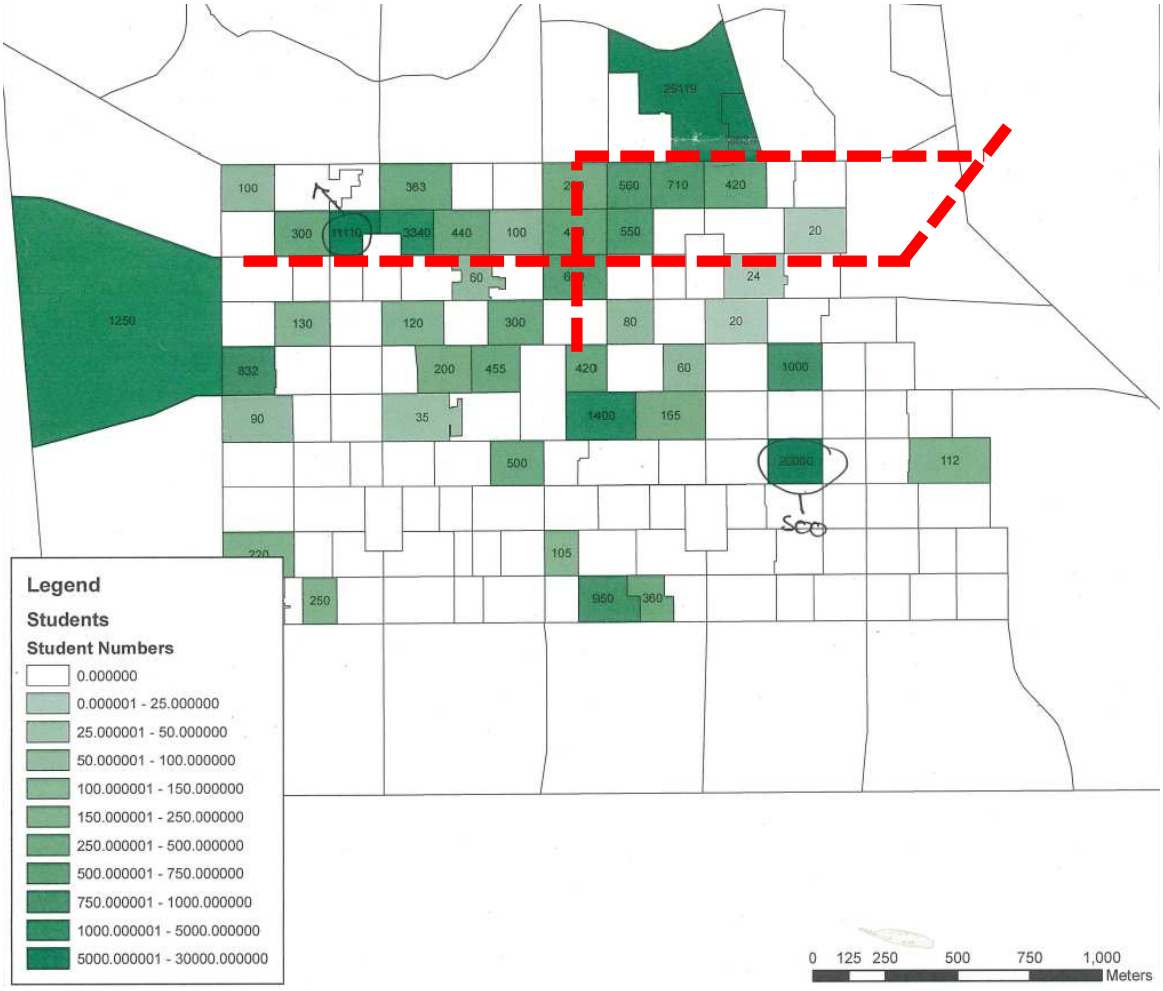

Figure 92: Location of City students, survey block analysis by ACC (Draft).

- **The City has experienced significant growth in students**. Students enrolled in City educational/vocational institutions and schools grew from 59,000 in 2004 to 90,792 in 2009. Since 2001, there has been an additional 15,000 international students enrolled in the City (total of 24,425 in 2009/10, being 72% of international student enrolments in SA).
- **Higher education providers have grown and diversified.** The City has approximately 212 education and training businesses, employing 9,500 (2008 Land Use Survey), and has both diversified and grown over the last 5 years. Adelaide University and the University of SA both have long term plans for growth and major capital investment. Flinders University has established a presence in the City that it is expected to grow over time.
- **City schools are in demand**. The educational offer of the schools sector in the City is of a high quality with public primary and secondary schools at capacity and private schools experiencing high enrolments and increased demand necessitating waiting lists and capital programs. The CBD's pre-eminence as an employment hub will drive further demand for increased school enrolment – both public and private - in and near the City. Hence, the capacity of all schools in and near the CBD affects the ability of the CBD to grow worker numbers.
- **Specific accommodation for students has grown**. Student Colleges in North Adelaide are at capacity and when counted with managed student housing (such as IPAD and Urbanest), around 3,000 – 4,000 students are accommodated in specific student housing.
- **Council has a strong and ongoing commitment to growing City education.** This is reflected in supporting the State Government's institutional attraction initiatives to position Adelaide in the marketplace as a university city, and in targeted initiatives to increase the number of students studying and living in the City, growing existing education providers attracting new quality providers and fostering education investment.
- **Limited Accommodation Supply**. In a housing market with low rental capacity, demand for affordable housing associated with significant numbers of students studying in the City remains a challenge.
- **Limited data**. Better data is needed to understand the level, impacts and effects on the learning and living experience of students in the private rental/apartment market in order to mitigate the risks and constraints to growth and improving the living conditions of students as tenants.
- **Policy Updating**. The Development Plan needs clarification in order to better promote the development of quality student housing that is affordable and provides a quality living and learning environment.

About 11% of students representing 1200 secondary and primary students per day use the O-Bahn system to attend schools in the City or along the Hackney Corridor, not accounting for other concession holders that will also include tertiary students (up to 4,000). The demographic distribution (inner suburbs) suggests that many of the students who attend class at the University of Adelaide (east campus) arrive by other bus services that nevertheless may benefit from the Hackney Road bus lanes and improved capacity on North Terrace given that 55% of non-direct buses will be removed.

28.6 The Royal Adelaide Hospital

As at January 2014, the Royal Adelaide Hospital (RAH) operated in the order of 650 beds (inclusive of inpatient and day patient beds) and a range of consulting, medical, health and other associated services.

The 2011 Census data (see Figure 93) indicated that there were 6,339 workers in the current RAH precinct of which 5,233 where on site on the day of Census. The current RAH site is well serviced by public transport, with access to a number of bus services via three bus stops at the North Terrace boundary and an additional bus stop on Frome Road, at the western boundary. Visitors/patients who park in the multi-story car park pay commercial rates as set by the private operator. However, of the 5,233 that were on site of the day of the census only 1,210 caught the bus and of these passengers 238 were from Tea Tree Gully or about one fifth of all bus users.

From analysis that was undertaken in 2010 on RAH workers:

- 30% Admin Workers (Day) – these workers tend to work 9am to 5 pm, Monday to Friday;
- 70% are shift workers:
  - 51% Group 1
    - 40% AM
    - 40% PM
    - 20% Night
  - 16% Group 2
    - 90% AM
    - 10% Night
  - 3% Group 3
    - 75% PM
    - 25% Night
    -

The analysis indicates that the majority of workers who drive to the RAH every day live in the southern, western and northern suburbs. The relocation of the RAH is to its new site is likely to promote more bus use from these locations given these will be more direct and not have to travel through congested sections of the City. This also implies that traffic on North Terrace through the East End of workers who access car parking is likely to decrease.

The following observations can be made when comparing the demographic analysis with the boarding data:

- The data indicates that 3,250 either drove or were a passenger in a private vehicle. This represents 62% of Journey to Work travel, which is a higher percentage of workers dependent on private vehicles than the 49% average of all CBD workers;
- The RAH has a highly car dependent workforce relying on on-site and east end car parks and less so on public transport. Only about 350 arrive every day by bus from the north eastern catchment, nevertheless representing about one quarter of RAH bus users but less than 10% of all workers that use the O-Bahn;

- About 420 RAH workers drive to work from the north eastern catchment, which is only marginally higher than bus users from the same area. The other 2,800 workers primarily arrive by car from other parts of the metropolitan area, primarily from western, northern and southern suburbs;
- The relocation of the RAH will likely reduce the traffic and parking demand within the East End precinct, freeing capacity of the road network and parking spaces.

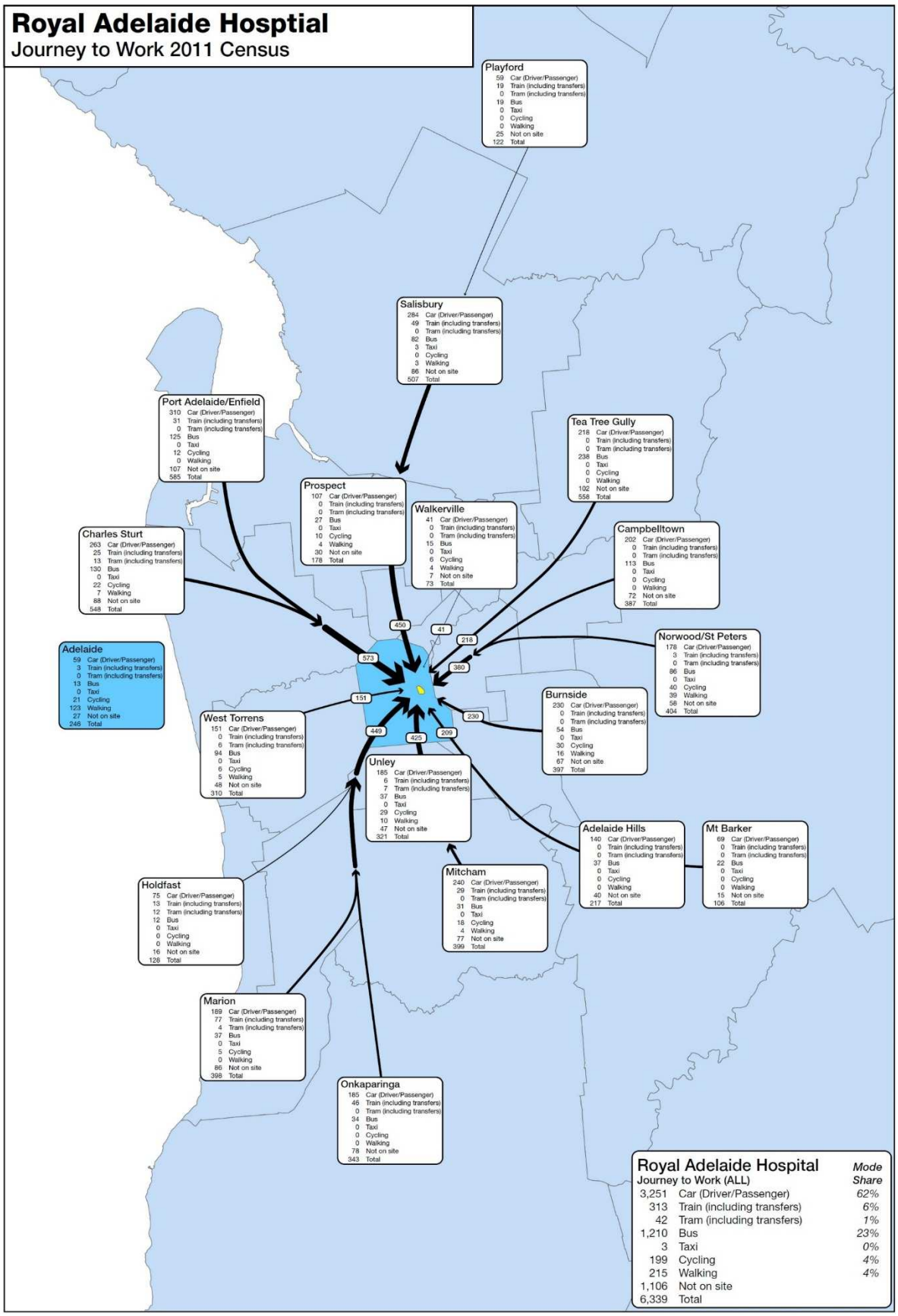

Figure 93: 2011 Journey to Work patterns of RAH employees

29 Business profile and the City economy

This section profiles the community and businesses within the Adelaide CBD. The CBD forms the convergence point of all O-Bahn bus services. The 'East-End', which is broadly defined by East Terrace, North Terrace, Pulteney Street and Grenfell Street is intersected by a number of O-Bahn bus routes. As depicted in Figure 94, the primary land uses within the immediate vicinity of O-Bahn routes are commercial, retail (Rundle Mall and Rundle Street), residential, education (Adelaide University and University of South Australia), public institution (Royal Adelaide Hospital) and some utilities mostly made up of multi-storey car parks. There are also a number of bus stops within the immediate vicinity that will see a shift in patronage as some of the bus services are realigned from North Terrace to Grenfell Street under the current project scope. Therefore, the main focus of this section is to profile Adelaide's East-End.

29.1 Retail

Retail in the City is diverse. Retail comprises food, specialist and bulk categories, with examples being supermarkets, clothing and furniture retail. City retail is a significant attractor and attracts visitors from State-wide, metropolitan and local levels. Rundle Mall is focussed on specialist retailing and the Central Market focussed around food, both being different attractors at the highest level and primarily serving the central suburbs of Adelaide, and City workers and residents. Rundle Street, Gouger Street, the West End, and O'Connell, Melbourne and Hutt Streets play both a destination role for wider Adelaide and a role for City residents.

City retail is influenced by economic conditions. Nationally, growth has occurred in the food, café, restaurant, and takeaway sectors, with more subdued growth in other retail sectors (JLL 2011). A sector of the market is seeking luxury goods, diversifying the top end of the market. The bottom end of the market remains resilient, with the middle weaker (Colliers 2011). Internet based retail presents both opportunities and challenges, with City specialist retail facing strong competition from online trading fuelled by a high dollar value.

Enhancing City retail and Rundle Mall. The 30 Year Plan for Greater Adelaide envisages the City's retail primacy to be reinforced with high-quality speciality retail, and for the inner/middle suburbs to have an additional 150,000 people over the next 30 years, this being located in the Mall's primary catchment. Within this context, Rundle Mall recently underwent a redevelopment to attract and take advantage of this growth.

Build on the City's retail diversity. The overall challenge is to grow and diversify the different retail/mainstreet precincts within the City whilst presenting the City as a holistic attraction in order to maximise benefit from planned increases in population in the inner/middle suburbs.

Adapting building stock. Specialist retailing formats require particular building forms that current City building stock is not always suited to.

29.2 City Users and Spend

People visit the Adelaide City Council area for a broad range of reasons, whether it be employment, shopping, education, entertainment/leisure, visiting residents or personal business. Each of these visitation purposes has a different economic benefit to the City. Understanding why, how and where people visit the City assists in understanding the economic impact of the O-Bahn City Access Project.

29.2.1 Why People Visit the City

The City User Population Research (Adelaide City Council, 2013) provides a good overview of who and how people are using the City and determined that "*of those people on street, one quarter (26%) are shopping, 23% are in the City for work purposes, 11% are meeting friends and 10% are in the City for personal business*." On weekdays, workers account for a large proportion of visits, followed by shopping and study.

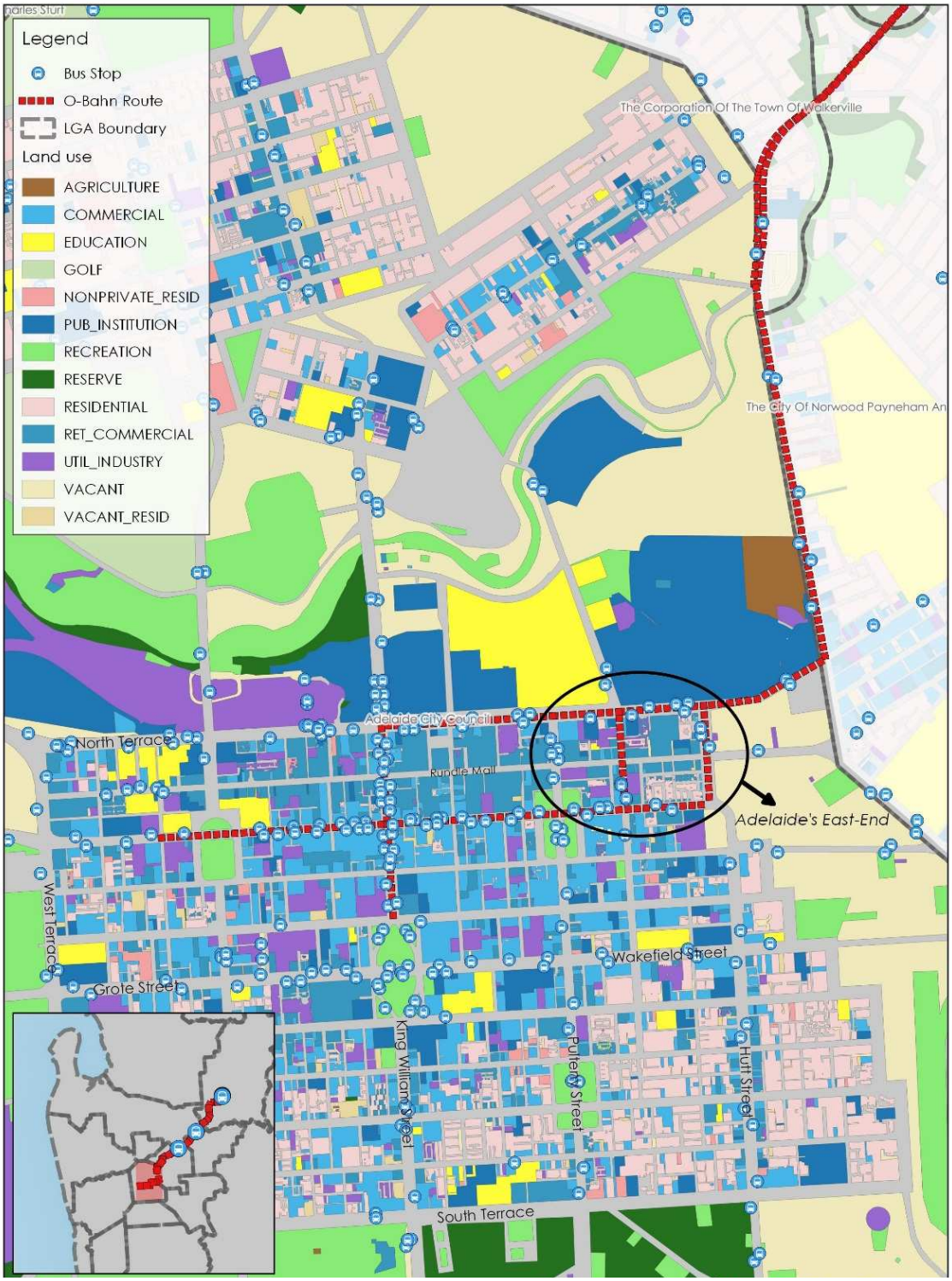

Figure 94: Land use description map of the Adelaide central business district.

Figure 95: City users purpose: *City User Population Research* (ACC, 2013)

29.2.2 Average Spend

The City User Population Research (Adelaide City Council, 2013) has determined that "*average spend per visit to the City is variable. However, those who are neither working nor studying (typically shoppers) spend the most per visit, followed by workers and students.The average spend by a City user is $95 for shoppers, $41 for workers and $32 for students*". Given that workers account for 32% and shoppers 21% of the weekday City users, the total weekday spend by workers is effectively increased, however less than the total spend genereated by shoppers.

29.2.3 Where City Users Are Coming From

A majority of City-users come from the City centre and the inner suburbs (13% and 53% respecitvely). This represents a catchment that has greater options for alternative forms of transport into the City, including walking, cycling and public transport. Inner suburbs of Adelaide refer to all suburbs located approximately within a 12km radius from Adelaide's CBD, while suburbs beyond this within the Adelaide Metropolitan area are considered outer suburbs.

Figure 96: Origin of City users, *City User Population Research* (ACC, 2013)

The O-Bahn extends beyond the inner suburbs and into the outer-suburbs (East Terrace to Tea Tree Plaza is approximately 15.5km) therefore this project is effectively improves access for the relatively low outer suburbs catchment of the north-eastern suburbs.

29.2.4 How People Visit the City

Concern for some of the stakeholders relates to the removal of car parks along Rundle Road, and its economic impact, however a majority of those who visit the City do so by means other than by car, with 39% of people using public transport. The O-Bahn City Access project will improve the efficiency for public transport users from the north-eastern suburbs (O-Bahn users) accessing the City.

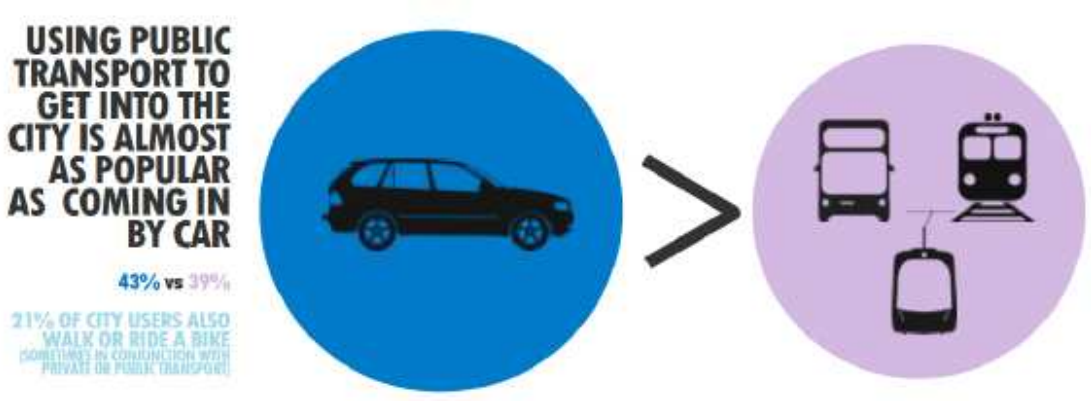

Figure 97: Accessing the City, *City User Population Research* (ACC, 2013).

29.2.5 Bus Users Reason to Visit

According to the 2013 survey by Adelaide City Council (Figure 95) the major purposes for being in the City were shopping (32%), work (21%) and study (12%). The major trip purposes, 'shopping' and 'work', are almost reversed for bus passengers and the general populace, with work being the main purpose for bus passengers and shopping being the main purpose for all respondents. 'Study' is also a main purpose for bus passengers.

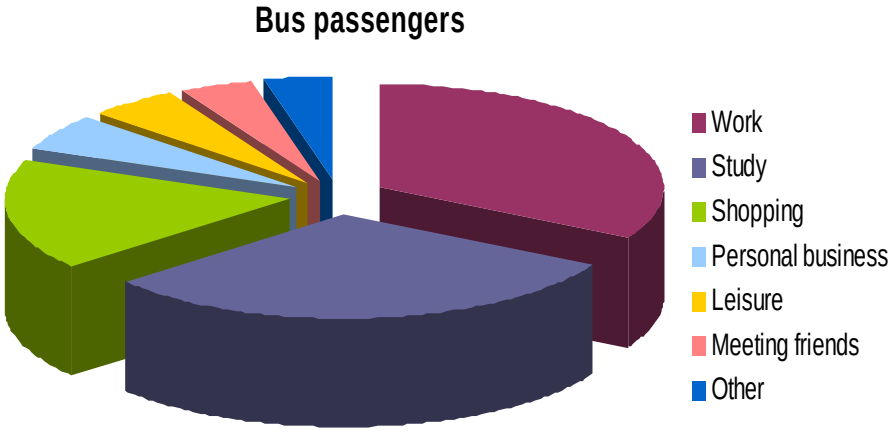

Figure 98: Purpose for bus travel

These factors contribute to making public transport less sustainable due to the heavily peaked nature of work and to some extent, student travel. The public transport system has plenty of capacity at off-peak times to cater for significant patronage increases at minimum cost.

It is most important that shopping and other non-peak trip purposes (including study in the case of tertiary students) are increased for public transport.

It is therefore essential that public transport serves the retail part of the City, i.e. Rundle Mall, and the major student destinations north of North Terrace. Increasing patronage from this part of the City will provide good all-day patronage, helping to sustain a more effective public transport system. Major competition to public transport today is from private cars in the form of cheap short term parking. Another major consideration is proximity of public transport stops to main trip attractors (i.e. popular shopping, work and study destinations).

Where there is a high-frequency service like the O-Bahn it is sometimes possible to provide different inner-City routes to widen the areas served – as has been done with the O-Bahn. It is not possible to do this with lower frequency routes. Experience has shown that users are very sensitive to the convenience of their public transport route to their destination. Moving buses from one street to locations further away from the major destinations can have a dramatic impact on patronage. Any revision to bus routes should be coupled with a review of car parking strategies.

The average weekday City spend by workers is half of the average shopper and for students it is one third. However, given that worker and students account for four times the number of visitors to the City compared to shoppers their combined retail effect is far greater than that of visitors who visit for shopping alone. This includes O-Bahn bus users and in that sense impacting on the viability of services also impacts on retail trade and after work restaurant trade. Parking for retail shopping and restaurant visitors serves a relatively smaller niche of the City economy compared to parking and bus services for workers and students who collectively spend more while in the City.

29.3 Leisure and Events

Cafes/restaurants are growing. From 1991 to 2006, employment in the retail trade reduced by 2% whereas from 1991 to 2009, employment in restaurants, cafes and accommodation increased by 63% (ABS in Blandy 2008 and 2010).

The City has a growing night economy. The night economy is those activities that never close (such as hospitals, police and emergency services), or that close after 10pm (restaurants, hotels, night clubs, theatre and car parks). The night economy increased by 15% from 2006 – 2008 and was dominated by health and community services (57% of jobs).

The night economy is in entertainment areas and hospitals. The night economy is focussed in employment at the City's six major hospitals and in and around night life precincts (Riverbank, Hindley, Gouger, Rundle Street, O'Connell and Melbourne Streets). With the Royal Adelaide Hospital relocating to the west of the City by 2017, this has implications in terms of fostering demand for a greater mix of uses in the North West and a replacement of retail and restaurant drivers in the East End precinct.

29.3.1 Restaurants and Cafes

Traffic generation of restaurants/cafes can vary substantially, dependent on the characteristics of the offering. However the clusters of cafes/restaurants will average out the generation of individual offerings. The clustering of café/restaurant seats generally align with Rundle Street, Gouger Street, Hutt Street and Hindley Streets, and also correlate with car parking and public transport. Locations with high concentration of café/restaurant seats also have a correlation with (or are adjacent to) locations with high employment concentrations. The East End precinct has a significant bar and restaurant offering (approximately 7500 seats) and is dependent on both student and workers visiting the precinct after their usual activities, as well as "outside" visitors who primarily use the on and off street parking in the precinct. See also section 9 and 10 on car parking changes along Rundle Road and East terrace.

Figure 99 : Restaurant chairs by survey block (ACC, 2015 Draft) activities.

29.4 The Role of the O-Bahn and Public Transport on the Economy

One of the primary aims of the O-Bahn City Access Project is to create a more efficient and less congested transport network, therefore improving accessibility and movements for all transport types including cars seeking to park in the East-End.

Economic impact arising from the O-Bahn City Access Project was raised by some stakeholders during the consultation period. Although the project will generate jobs and supporting activities over the course of its construction, it is the resulting design, access and urban design that requires consideration to ensure that economic benefits accrue from the project now and into the future. The main impact will be felt once it is completed, leading to “flow on” social and economic benefits (including improved transport network efficiency): these benefits are not solely a result of the investment into the project, but of the improved potential for transport and land use integration, urban design improvements and precinct enhancement.

The crucial planning challenge is to arrive at an optimal spatial organisation of activities and a well-balanced transport network linking these activities in an efficient and sustainable way. Land use and transport planning are highly related by nature and finding the right balance will be an ongoing task in the East End and related precincts given the access arrangements to land uses that will result. However the current land use (and economic generators) within close proximity to the O-Bahn City Access Project are not expected to change as a result of the project.

The distribution of land uses, such as residential, retail or commercial, over the urban area determines the locations of human activities such as living, working, shopping, education or leisure.

- The distribution of human activities in space requires spatial interactions or trips in the transport system to overcome the distance between the locations of activities (e.g. within the Adelaide City Council and between the north-eastern suburbs serviced by the O-Bahn and other land uses such as adjacent employment and residential areas)
- The distribution of infrastructure in the transport system creates opportunities for spatial interactions and can be measured as accessibility (e.g. the travel time savings present by tunnelling the bus movements, intersection capacity and precinct accessibility).

The major theoretical approaches to explain this two-way interaction of land use and transport in metropolitan areas include technical theories (urban mobility systems), economic theories (cities as markets) and social theories (society and urban space). The results of these theories of land-use transport interaction in terms of expected impacts of essential factors such neighbourhood and urban design, location, city size, accessibility, travel cost and time.

29.5 North East suburbs – Counter Flow Opportunities

The project will have a number of specific benefits to the City of Tea Tree Gully. These benefits include

- Improved access to employment in Adelaide’s central business district (CBD) for employed residents, where 8,146 or 16.8% of our employed residents travel to for work (2011 census).
- Improved access to educational institutions such as universities and TAFE facilities for the 5,900 of residents currently attending these institutions (2011 census), noting that the many are accessed from O-Bahn bus routes.

- Improved access to the Adelaide CBD for shopping, eating out and meeting friends for TTG's 98,378 residents, noting that 44% of trips to the CBD are for these reasons (Adelaide City Council, 2013).
- A potential reduction of future congestion on key arterial roads that connect TTG to the CBD, in particular North East Road and Lower North East Road as a result of expected increases in public transport use resulting from reduced travel time and improved convenience.
- Environmental benefits (e.g. vehicle emissions and noise) resulting from a reduction in private car use due to reduced travel times and improved convenience.
- Economic and social benefits, particularly for the Modbury Precinct, by positioning TTG as a more desirable place to live and work due its rapid transit connection to the Adelaide CBD (reducing travel time between Modbury and the CBD to less than 15 minutes).
- A benefit to local businesses and our force through improved public transport access to employment locations within our Council area (particularly the Modbury Precinct), noting that 8,463 people travel from other local government areas to work in the City of TTG, and that there are over 4,000 jobs located in close proximity to the Modbury O-Bahn Interchange as well as key services, education and medical facilities.
- Social and economic benefits for our residents by improving the liveability of the City of TTG and the personal wellbeing of residents by reducing commute times to the CBD and improving living costs by making public transport a more viable transport option.

Appreciating what social infrastructure, services and businesses are within the study area is essential to understanding the social and economic climate. While the O-Bahn user catchment area is predominantly residential (refer Figure 84), a profile of the employment sectors was undertaken to summarise the key employment industries and to determine whether a smaller counter flow of City residents or day time workers could use the O-Bahn for trip purposes. The business profile has been summarised and presented in Figure 100, with the five largest industries in order as follows:

- retail trade (16.9%);
- health care and social assistance (15.2%);
- manufacturing (10.4%);
- education and training (10.0%); and
- construction (7.4%).

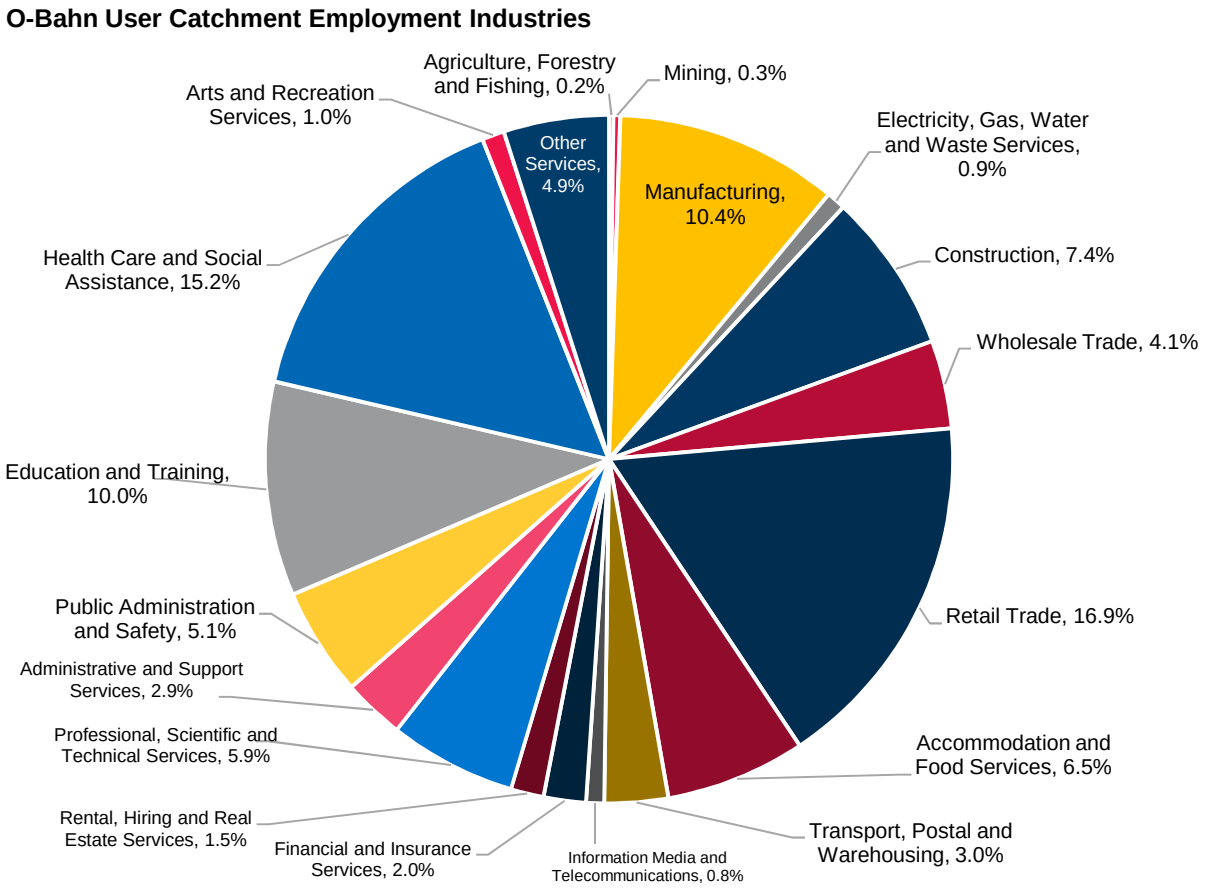

Figure 100: Industry share of the O-Bahn user catchment employment sector.

Within the catchment, existing economic activity is distributed predominantly along arterial roads, including: North-East Road, Payneham Road and Grand Junction Road, which form service 'spines', as well as major and direct access corridors. Westfield Tea Tree Plaza, located in Modbury at the O-Bahn terminus is a regional-scale shopping centre with around 245 shops and services. The shopping centre provides around 4,500 car parks with a designated O-Bahn park'n'ride facility linked with the Modbury interchange.

It is acknowledged that the physical landscape and distribution of land uses within the user catchment will remain unchanged as a direct result of project works, including those directly adjacent to the Hackney Road section. However, it is crucial that access to, from and across Hackney Road is not prevented at the local level, nor future enhancements precluded, with it continuing to form a key segment of the Inner Ring Route.

The breakdown indicates that education and training, white collar administrative services and health care opportunities located along the corridor and in particular at Tea Tree Plaza/Gully, could over time attract employment trips from Adelaide City Council residents (as the City grows) given this complements the demographics of City dwellers. It is not uncommon for a person/spouse to elect to work in a different location to a City centre because they prefer the lifestyle living choices a City offers. This has not been researched in any detail but could develop into a latent effect of the project given that satellite regions connected by high speed and reliable public transport facilities have been shown to spur two way business exchange and journey to work travel in many interstate and overseas jurisdictions.

29.5.1 Population Projections Enquiry System

The Population Projections Enquiry System (PPES) gives online access to the current age-sex population projections released by the State Government by statistical local area (SLA) (DPTI 2011). The O-Bahn user catchment is covered broadly by eleven SLAs in the table below These population projections therefore illustrate the potential growth of the general area in a broad context, not specifically the project area. The table below demonstrates that over the next 20 years a reasonable growth is expected in the catchment, which could contribute to a natural growth in O-Bahn services as road congestion increases.

Table 35: PPES population projections for each SLA within the O-Bahn user catchment

LGA	SLA	Resident population at 30th June				
		2006	2011	2016	2021	2026
Tea Tree Gully	Hills	12,225	12,719	13,476	14,334	15,178
	North	27,975	28,215	28,733	29,043	29,298
	Central	26,024	26,633	27,229	27,909	28,554
	South	33,098	33,933	35,616	37,156	38,627
	Total	99,322	101500	105054	108442	111657
Campbelltown	East	27,944	29,285	30,486	31,194	31,729
	West	19,856	21,200	22,073	22,316	22,248
	Total	47800	50485	52559	53510	53977
Norwood Payneham and St Peters	East	16,625	17,173	17,330	17,242	17,039
	West	18,649	19,353	19,818	20,176	20,500
	Total	35,274	36,526	37,148	37,418	37,539
Walkerville	(All)	7,242	7,397	7,621	7,916	8,199
Port Adelaide Enfield	East	32,157	35,737	38,732	40,194	40,909
Salisbury	South-East	36,038	37,951	38,704	39,219	39,662
Total	-	257,833	269,596	279,818	286,699	291,943

These projections are based on the South Australian Cabinet approved medium series of South Australian Statistical Division projections, released in January 2011.

30 Traffic and Passenger Demand: Additional Details

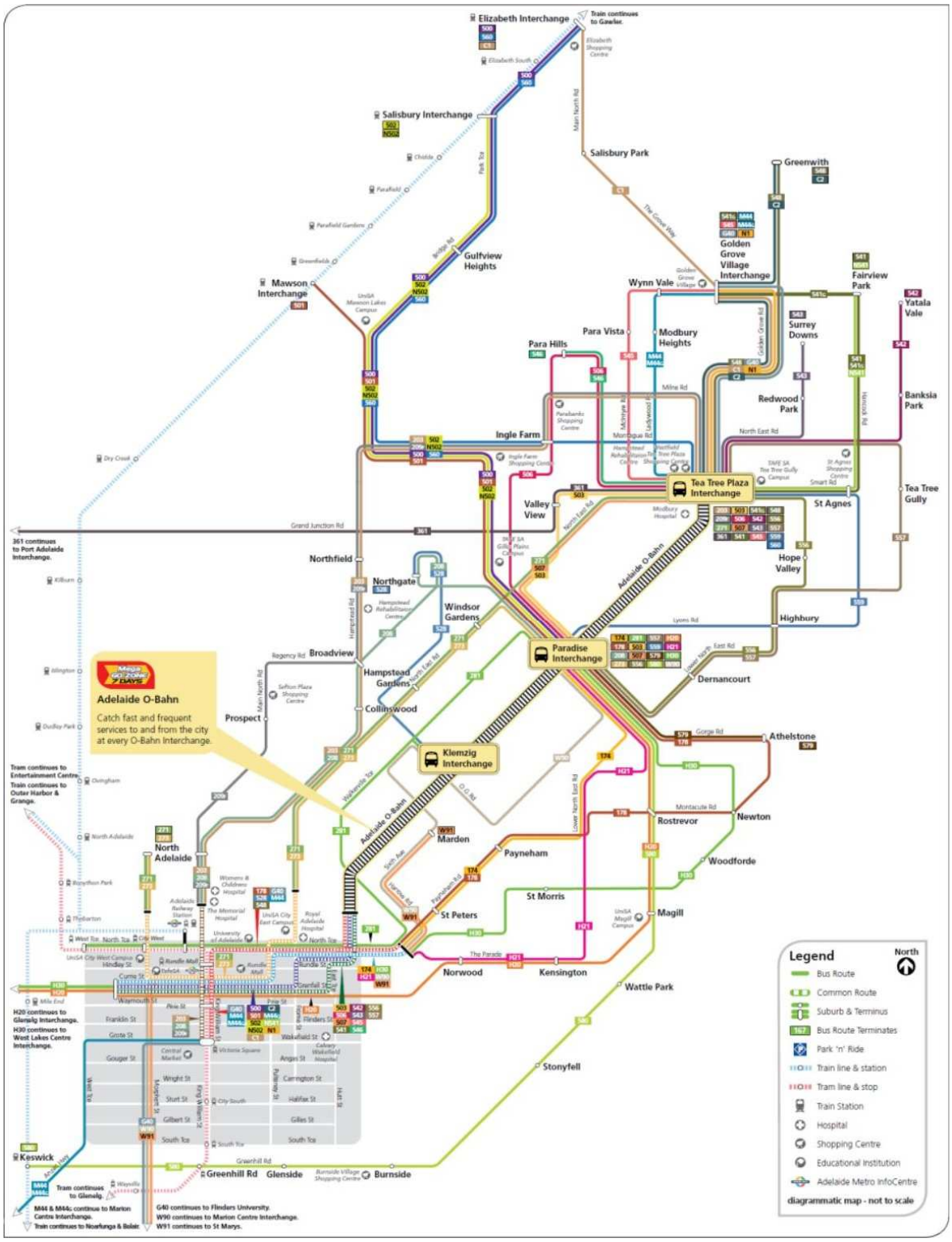

Figure 101: Schematic of all O-Bahn bus services and interchange connections including non-City bound services

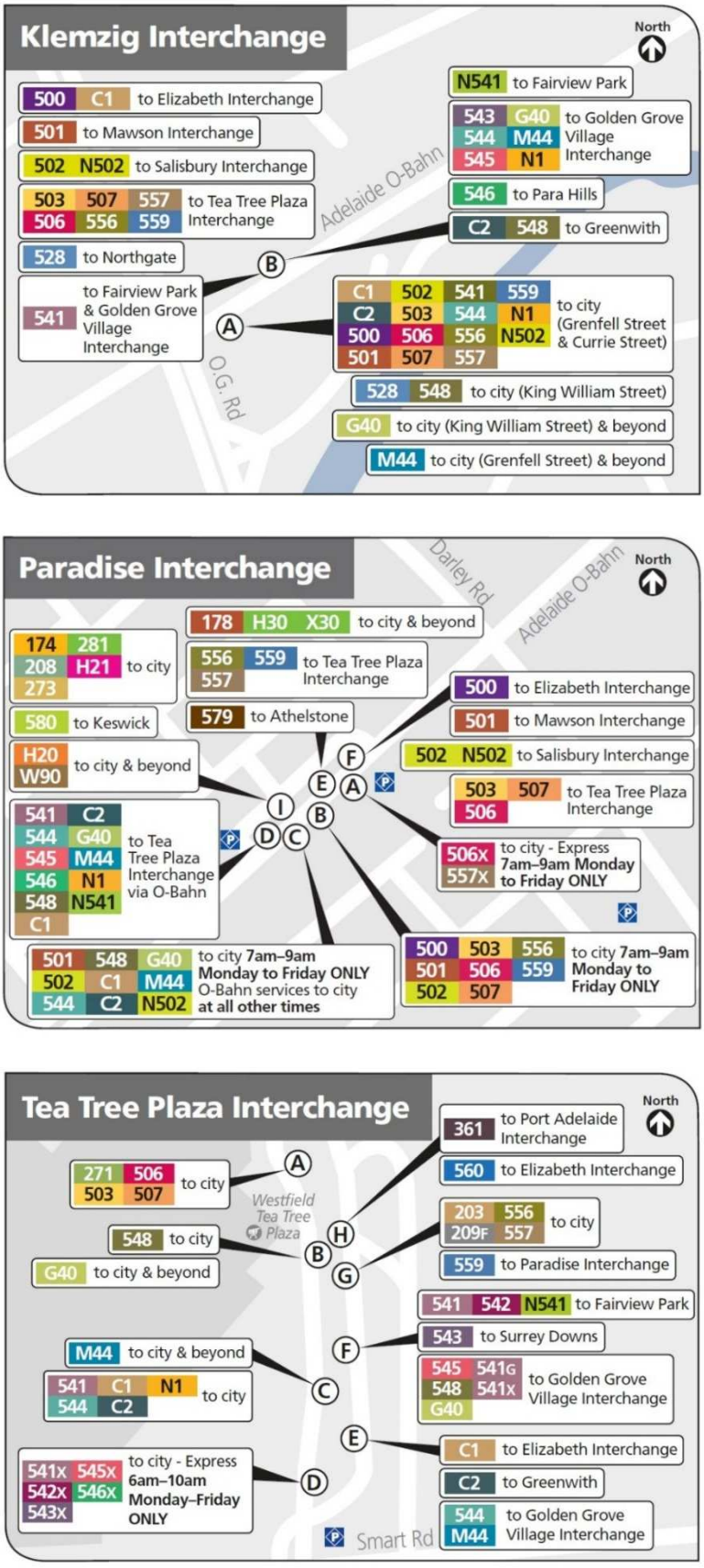

Figure 102: Services and connections provided by the three interchanges.

30.1.1 The Currie Street and Grenfell Street Corridor

The Currie Street - Grenfell Streets route is still considered the most appropriate corridor for east-west bus services in the Adelaide CBD, including those buses linking with the O-Bahn. ACC previously defined the role for Currie / Grenfell Streets in the *City Strategies – Integrated Movement Strategy* report as follows:

- To act as a major public transport and pedestrian access corridor for the core of the City, but continue to meet the requirements of local traffic related to commercial, retail and car parking facilities;
- To provide a safe and accessible pedestrian environment linking Rundle Mall and Hindley Street to the adjacent office precincts and provide a high level of pedestrian amenity

This corridor provides the best pedestrian access to the major destinations in the Adelaide CBD (refer Figure 103) including:

- the major retail precinct in Rundle Mall;
- major office employment precinct south of Currie/Grenfell Streets;
- the popular entertainment precinct in Hindley Street;
- the cultural precinct and the Royal Adelaide Hospital in North Terrace.

Following completion of the O-Bahn City Access Project, the majority of O-Bahn services will be re-routed along the proposed tunnel alignment to take advantage of the improved travel time to, from and within the CBD for bus passengers. North Terrace will continue to be a key destination and generator of public transport trips. The impact on existing Grenfell Street operation will be negligible, and along with Currie Street will continue to operate as per current conditions.

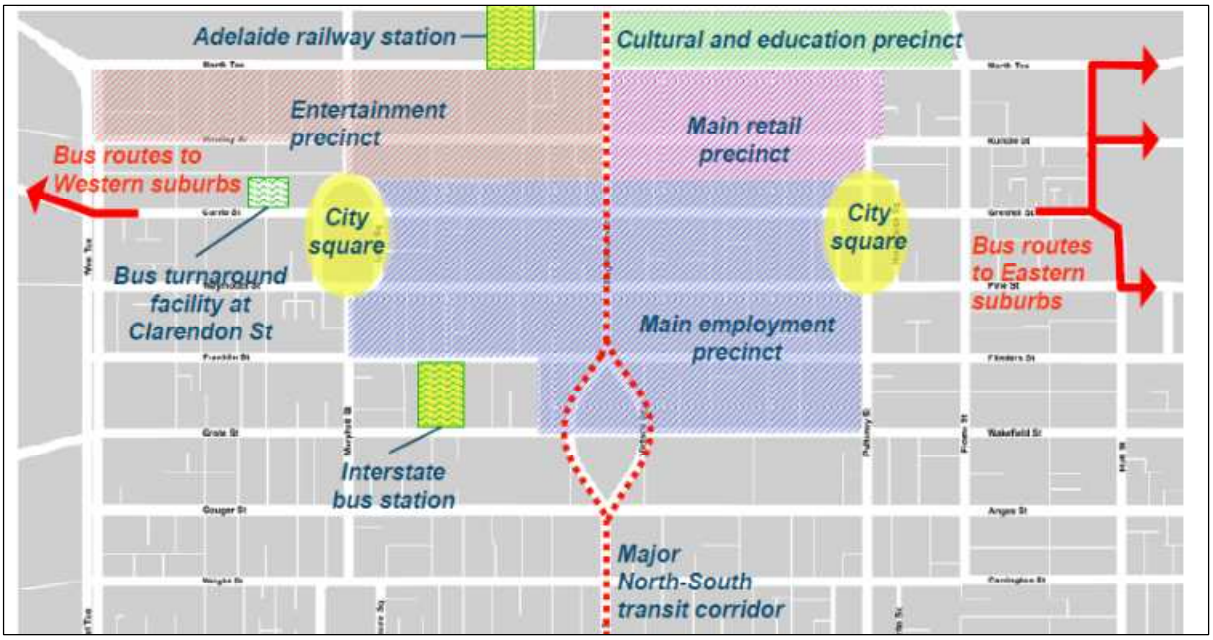

Figure 103: Currie/Grenfell Street as the main east-west corridor for the O-Bahn and key destinations.

The Adelaide Metro Passenger Information Centre is located at the northwest corner of King William/Currie Streets where passengers can conveniently purchase tickets, ask questions of customer service staff and obtain timetables and maps of the system.

The major trip purposes, 'shopping' and 'work', are almost reversed for bus passengers and the general populace, with work being the main purpose for bus passengers and shopping being the main purpose for all respondents. 'Study' is also a main purpose for bus passengers.

These factors contribute to making public transport less sustainable due to the heavily peaked nature of work and to some extent, student travel. The public transport system has plenty of capacity at off-peak times to cater for significant patronage increases at minimum cost.

A major factor in the need for public transport to be heavily subsidised is the imbalance between patronage at peak and off peak times. With services being heavily peaked to cater for work journeys, many vehicles and drivers are used only at peak times.

The following graphs show boarding data published in 2010 for eastbound services in Grenfell Street. While the absolute figures may have changed, the proportional values are expected to be similar to current activity.

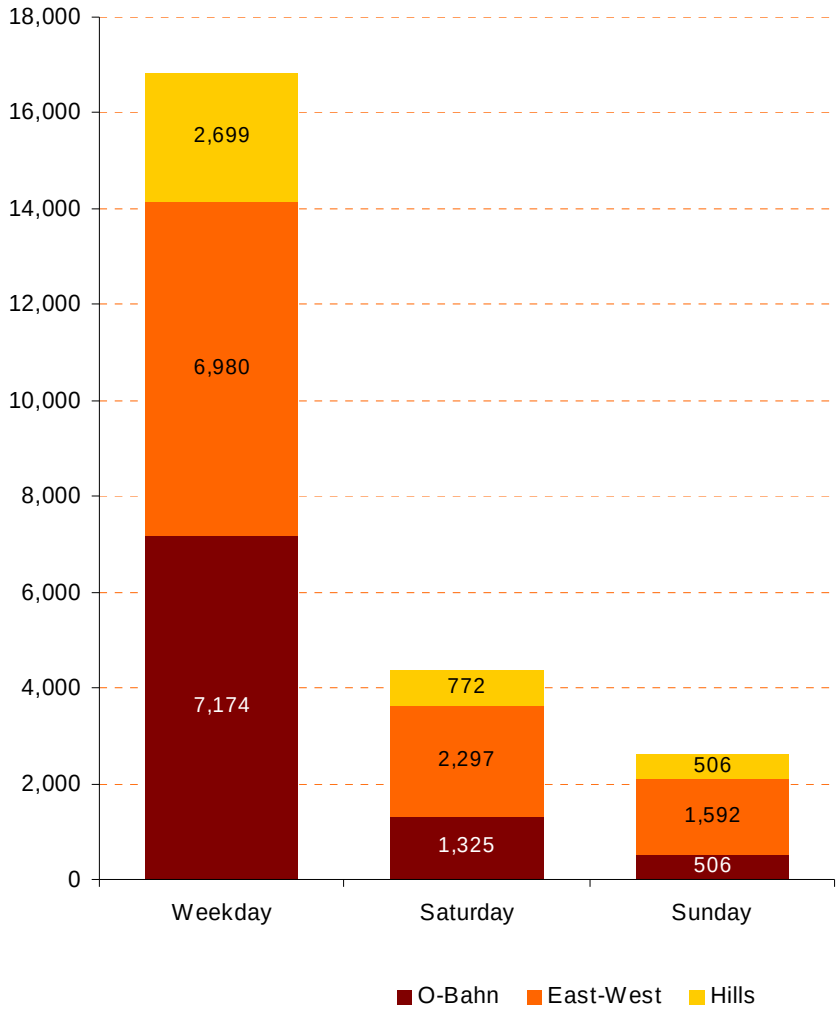

Figure 104: Average daily boardings at eastbound bus stops in Currie / Grenfell Streets (excluding North Terrace boardings)

Some of the busiest street segments for buses on any weekday in the Adelaide CBD include Currie/Grenfell Streets between Light and Hindmarsh Squares (2027 bus movements) and North terrace across from the RAH (2127 bus movements) - see Figure 105. Approximately only 26% of the Grenfell Street buses use the O-Bahn track yet carry nearly half of the passengers along this corridor. This also shows that Currie/Grenfell Streets are an important east-west corridor for more than just O-Bahn services. Most of the buses that use this street are the east-west bus routes that are through-linked to service both the eastern and western suburbs more efficiently, rather than with separate CBD-terminating services. The other group of bus routes that operate in this street provide services to and from the Adelaide Hills via Hutt Street or Pulteney Street and Glen Osmond Road.

The busiest segment is North Terrace between Frome Street and East Terrace comprising of about 2,127 two-way bus movements on a weekday with 17% being O-Bahn services. The second busiest street for buses is King William Street between North Terrace and Victoria Square where over 2,070 two-way daily bus movements occur with 10% of these buses using some section of the O-Bahn corridor via North Terrace. Note that the number of buses in King William Street and Currie/Grenfell Streets are almost the same on both sides of the intersection of King William Street and Currie/Grenfell Streets because no buses make any turns at this location.

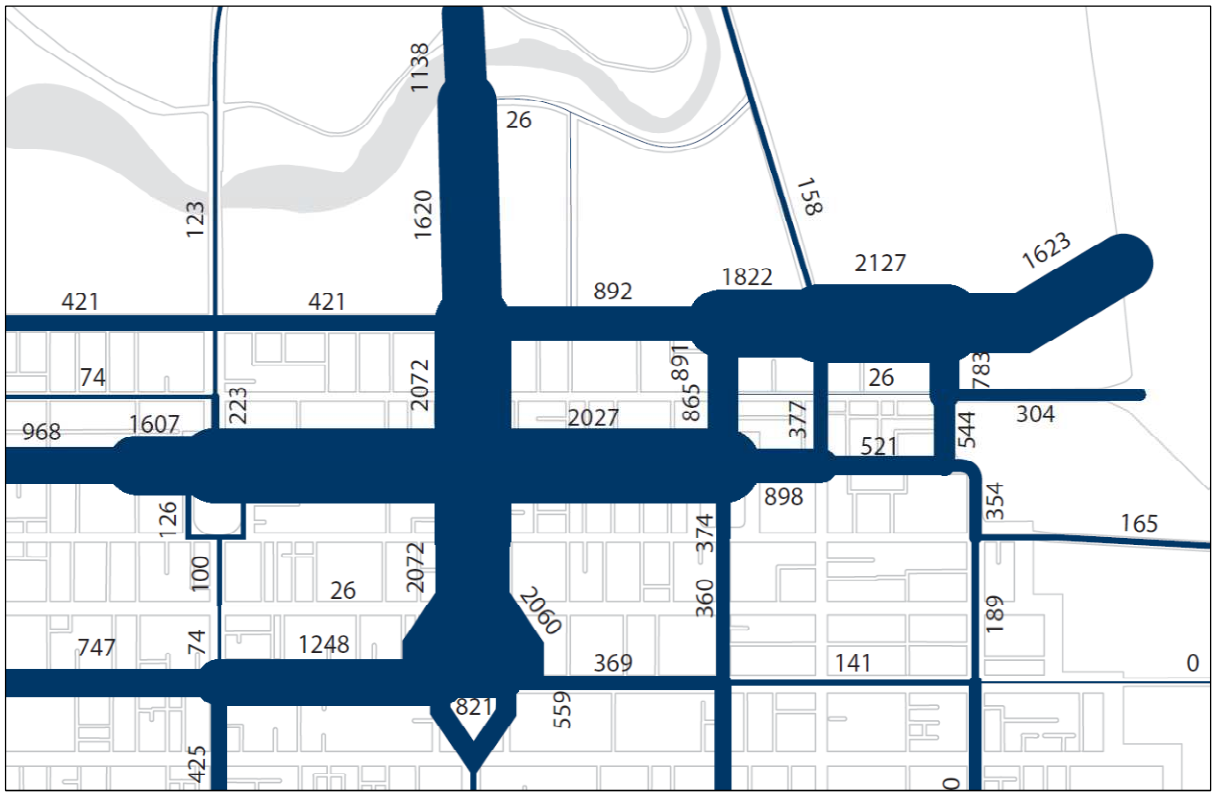

Figure 105: inset of the number of daily bus services per City route in the central CBD area (2012), based on current contracts

30.1.2 Travel Time Reports

A number of Travel Time assessments have been undertaken for this project, including:

- Report prepared by AECOM which took a small sample of trips undertaken by staff and timed sectors between Grenfell Street and Klemzig Interchange in February 2015;
- DPTI assessment of collated GPS data from all non-express O-Bahn services between Klemzig and Grenfell Street over a 23-day period in August 2014; and
- Mott MacDonald report which modelled future travel times using AIMSUN software to determine the travel time impacts of various project cases.

All reports focussed on the segments from Klemzig Interchange to Grenfell Street. The part of the trip beyond Klemzig is undertaken on a dedicated busway to Tea Tree Plaza (Modbury) Interchange and not subject to significant delays caused by interaction with other traffic. Travel times on this portion of the journey are predictable and reliable. Timetabled trip times show a journey time of 9 minutes in both directions at all times except for the PM peak where outbound trips are timetabled at 10 minutes. It is understood that O-Bahn services are regularly meeting or ahead of these published timetable times.

For the purposes of assessment, the journey between Klemzig Interchange and the City has been broken into two segments:

- Klemzig to Hackney Road, Stop 2;
- Hackney Road Stop 2 to Grenfell Street (first stops accessed).

Stop 2 lies approximately 300m north of the Botanic Road intersection on the eastern (inbound) side of Hackney Road. During the peak period O-Bahn buses do not service this stop in order to facilitate the right turn at Botanic Road. To determine trip times to this stop for services that were not recorded as stopping here, DPTI applied a formula that determines the average speed for the service over the full length of the Klemzig Interchange to Grenfell Street journey and applies a proportional time to this segment of the trip. Errors in this calculation are most likely to manifest as a penalty to the Klemzig Interchange to Hackney Road, Stop 2 segment of the journey due to the higher travel speed achieved on the busway.

Table 36: Timetabled average trip times for O-Bahn journey segments (derived from Adelaide Metro published timetable data)

Start and Stop Destination	Average	Min.	Max.
Klemzig Interchange to Grenfell St	11:10	08:00	13:00
Klemzig Interchange to Hackney Road	05:57	05:00	07:00
Hackney Road to Grenfell St	04:58	03:00	06:00

Table 37: Travel time comparisons from DPTI GPS data assessment

Trip Segment	Distance (km)		Average time (mins)	Minimum time	Maximum time	Average Speed (km/h)
Tea Tree Plaza Interchange to Klemzig	8.5 (approx.)	AM Peak	9	(timetable information only)		100km/h posted speed limit between interchanges
		PM Peak	10			
Klemzig to Hackney Road Stop 2	4.76 (approx. 3.5km on busway)	AM Peak (Inbound)	5:24	3:42	9:52	53.0
		PM Peak (outbound)	5:09	3:48	**16.17**	52.7
Hackney Road Stop 2 to Grenfell Street	1.45	AM Peak (Inbound)	5:57	2:11	10:32	14.6
		PM Peak (outbound)	8:11	4:44	**20:44**	**10.6**

30.1.3 Klemzig Interchange to Hackney Road, Stop 2:

This is a journey of 4.76km with approximately 3.5km of that on the busway. The final portion of the trip is on Hackney Road with buses sharing the road with other traffic. This section includes the Bundeys Road intersection.

Summarised results show that there is a relatively low level of variation (standard deviation of 42 seconds or 14% of average trip time) due to the large proportion of the trip being on the dedicated busway. Figure 107 shows the distribution of recorded trips using on-board GPS receivers. It shows that the journey times vary by up to 50% of the average travel time at all times of day with the greatest variability in the PM Peak period. Where colour density is greatest, journey time reliability is best. The afternoon peak period shows the broadest distribution of recorded journey times indicating poor reliability of journey time.

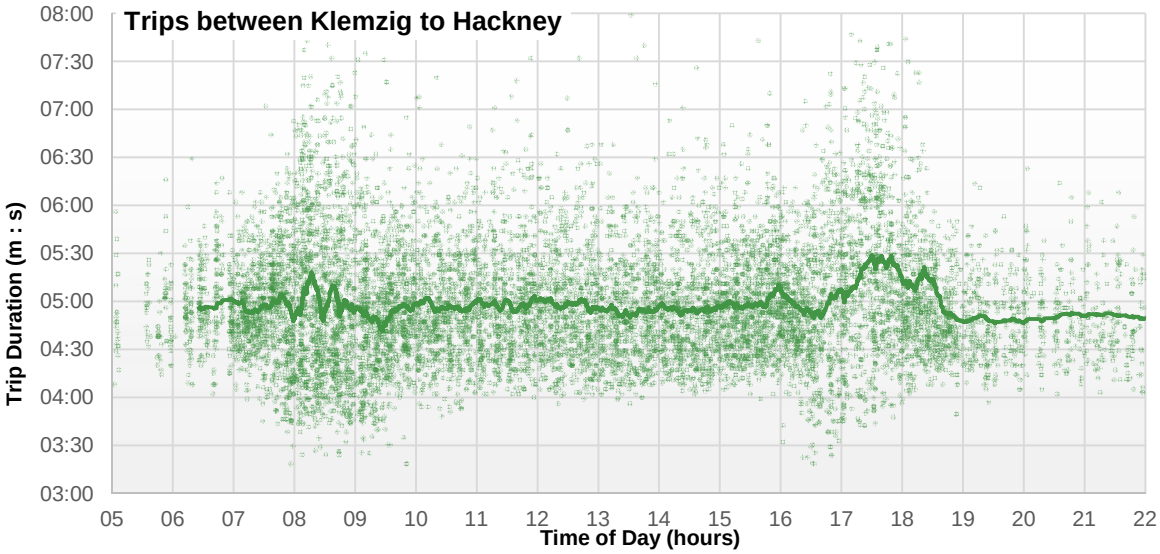

Figure 106: Klemzig Interchange to Hackney Road: Trip times across Time of Day (DPTI)

The average calculated speed for this journey segment is 57km/h. Average recorded trip time is 55sec faster than average timetabled time. Outbound journey time during the PM peak is on average 23 sec slower than daily recorded average.

Reliability of bus services is interpreted and perceived in many ways depending on the perspective (passenger, service operator, traffic planner) and the parameters used to define reliability. A general definition suggests that reliability is the invariability of service attributes which influence the decision of travellers and transportation providers (Abkowitz, 1978).

30.1.4 Hackney Road, Stop 2 and Grenfell Street:

This journey of 1.45 km uses public roads including Botanic Road, East Terrace or North Terrace / Frome Street and Grenfell Street. Kerb side bus lanes operate between 7am and 7pm, Monday to Friday on Botanic Road, North Terrace, East Terrace and Grenfell Street. The Hackney Road / Botanic Road intersection features a bus-only right turn lane but this intersection is considered to be operating at or above capacity during the peak periods under existing conditions leading to extended delays for buses. Routes accessing Grenfell Street via East terrace have the option to use Dequetteville Terrace and Rundle Road instead of Botanic Road between Hackney Road and East Terrace. This route choice is up to driver discretion and traffic counts show is more commonly used in the outbound direction than inbound.

A summary of results from the DPTI report shows that for this journey section of 1.45km length, the calculated average speed is 14.4km/h. The average recorded trip time for this segment is 6 minutes, 2seconds which is 1minute 4 seconds slower than the timetabled average of 4:58 minutes. The average afternoon outbound trip is shown to be 2 minutes 21seconds slower than average morning inbound trip time of 5 minutes 50 seconds.

The maximum recorded travel time for this segment was 20 minutes 44 seconds (PM Peak outbound) and the minimum 2 minutes 4 seconds (off-peak inbound), a total variation of 18 minutes 39 seconds and standard variation in travel time of 1min 33 seconds or 25% of the average travel time.

Using the 95th percentile approach to calculate the reliability buffer time for the inbound AM Peak trip would equate to 6 minutes 54 seconds and for the outbound PM Peak, 7 minutes 35 seconds.

"This shows the consistency of the travel times of services in the section throughout the day, and that the afternoon delays experienced for trips between Klemzig Interchange and Grenfell Street are caused in the Hackney Road to Grenfell Street section." (Department of Planning, Transport and Infrastructure, 2014)

The following Figure 107 is a graph of travel times for recorded trips between Hackney Road, Stop 2 and Grenfell Street from the DPTI Report. It shows that the inbound morning trips exhibit greater reliability of service travel time compared to the afternoon peak period. This is demonstrated by the closer clustering of recorded travel times resulting in greater density of colour.

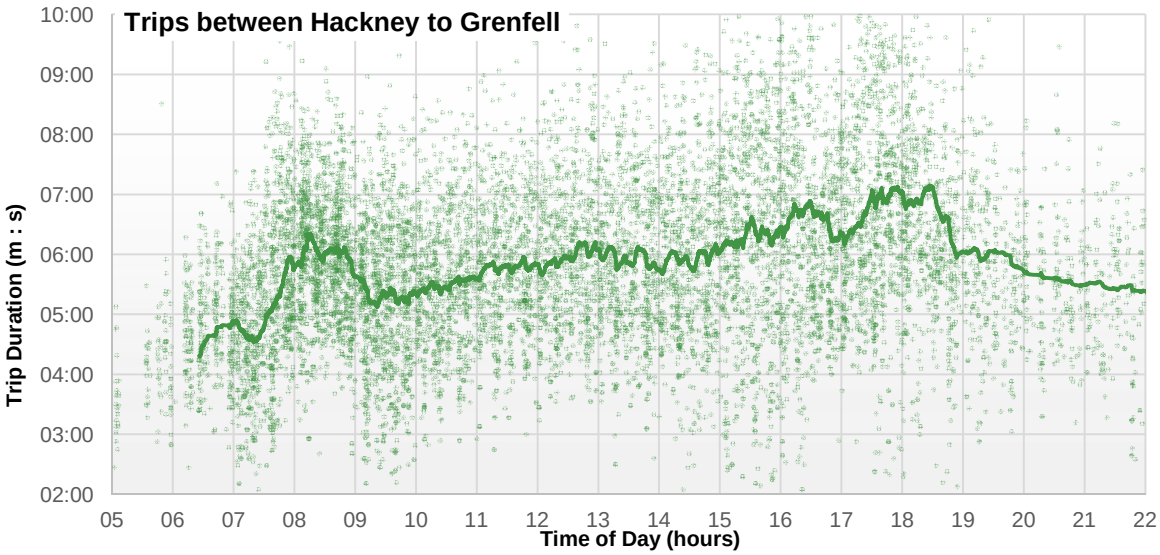

Figure 107: Hackney Road and Grenfell Street: Trip times across Time of Day (DPTI)

The large variation in travel times show the scope of improvement possible if buses are provided with a protected route that eliminates delays caused by congestion and traffic signals. More importantly, it creates conditions where public transport operators are able to ensure reliability of service and journey time, providing confidence to commuters that their bus will arrive at their destination at the promised time. This reliability and predictability of service delivery has been shown to lead to greater passenger numbers which is the ultimate goal of the project.

30.1.5 Segment Comparison

If the segments were redrawn to separate the portion on the O-Bahn track (approximately 3.5km from Klemzig Interchange) and on-road portions (approximately 2.7km). The full O-Bahn track trip from Tea Tree Plaza is approximately 12km, with two interchanges, takes approximately 13:30 to 15 minutes depending on the time of day and direction of travel according to timetable information. The remainder

of the journey into Grenfell Street is shown, from collected data, to take on average 7:45 but in some cases may be up to 25 minutes. From this breakdown it is clear that the time savings in the City end of the journey may be modest but the reliability of service is the more significant gain to commuters and service providers.

This assessment also shows that the sources of delay are in the areas where buses share the road with other vehicles and are affected by congestion on the roadway and at intersections. Despite the provision of protected bus lanes from the approach to the Botanic Road intersection, buses continue to be negatively affected by traffic congestion and resultant limitations to movement.

"The O-Bahn corridor between Gilberton and the City of Adelaide has limited measures to protect public transport services from the effects of road congestion, affecting journey times and timetable reliability. Delays currently experienced on the on-road section of the O-Bahn will increase with the increased number of buses and services which are proposed to operate along the O-Bahn corridor over the next decade. The Hackney Road/Botanic Road and Rundle Road/Dequetteville Terrace intersections on the Inner Ring Route are at, or are approaching capacity and will increasingly constrain bus movements." (Department of Planning, Transport and Infrastructure, 2014)

Projected travel times for the project case produced by Mott MacDonald through the application of AIMSUN models show a travel time saving of around three minutes in the 2016 case (179 seconds in AM Peak and 201 seconds in PM Peak) and of four to four and a half minutes in the 2021 case (236 seconds in AM Peak and 267 seconds in PM Peak). The model compares future performance with the Do Minimum case where all future Grenfell Street O-Bahn services are re-routed from Botanic Road to Rundle Road, directing services via East Terrace and eliminating Frome Street movements.

The AIMSUN modelling included detailed intersection analysis to evaluate Do Nothing and Do Minimum cases and for various project cases where buses are moving at grade through intersections. The AIMSUN model also used traffic generators as determined by the MASTEM model for Greater Adelaide. The model output shows general improvements to intersection performance across the study area due to the separation of bus movements from general traffic.

Importantly the travel time and speed comparisons for O-Bahn services are relatively unchanged from 2016 to 2021 under the project case whereas growth in general traffic numbers has negative impacts on intersection delay times under the same project conditions. Therefore if buses were to remain on the surface roads, delays would increase even further and journey time reliability would continue to deteriorate.

Travel time comparisons of all project cases show that projects with extended tunnels under East Terrace provide the shortest travel times, particularly for inbound services but that the project case assessed here is the best performing of all other project cases.

PM Peak O-Bahn Bus Travel

The surveys show that travel time variability on the O-Bahn is very poor at the City end. The 1.45 km leg from Grenfell Street to Bus Stop 2 on Hackney Road can take up to 20 minutes in the PM Peak. Also the Hackney to Klemzig leg (less than 5 km) can take up to 16 minutes in the PM peak, however it takes an average of 9 minutes to travel 8.5 km between the Klemzig and Tea Tree Plaza interchanges.

Therefore, it can take almost twice as long to travel the 1.45 km City leg from Grenfell Street to Hackney Road as it takes to travel the 12 km of the O-Bahn track.

This travel time variability is why both the Hackney Road bus lanes as well as the City end tunnel of the O-Bahn Project are critically important.

By providing bus lanes and tunnels buses will experience reduced travel times due to the elimination of intersection wait times but more significantly will not be affected by other traffic and associated congestion. Bus travel times therefore, as for the 12km of dedicated busway, will become independent of all other road users and will be free to travel at pre-determined speeds for the length of the trip, achieving more rapid travel and highly predictable service delivery.

A travel time reduction of 4 minutes and reliability buffer reduction of 3 minutes has been calculated by DPTI personnel to give an overall reduction of 7 minutes.

30.2 Daily Traffic Patterns

Twenty routes that cross the Park Lands cater for around 220,000 vehicle trips every day that move in and out of the City. Analysis shows3 that up to a quarter of these vehicle trips on some links (55,000 cars) are 'through' traffic that use the City as a convenient short cut. This adds to unwanted congestion on City streets.

As noted in Section 7.3, traffic volumes on key roads within the project area and of the existing O-Bahn bus route are:

- Hackney Road: 44,600 vehicles per day (vpd) and 5% commercial vehicle percentage (cv%);
- North Terrace (west of East Terrace): 29,700 vpd and 5cv%;
- Botanic Road: 33,700 vpd and 7.5cv%;
- Rundle Road: 14,500 vpd and 5.5cv%;
- East Terrace (north of existing Rundle Rd): 16,800 vpd and 7cv%;
- East Terrace (south of existing Rundle Rd): 20,500 vpd and 5.5cv%;
- Grenfell Streer: 14,700 vpd and 8.5cv%; and
- Frome Road (south of North Terrace): 14,100 vpd and 5cv%.

30.2.1 Origin – Destination Study using Bluetooth technology

Bluetooth sensors have the ability to detect devices emitting a Bluetooth signal. Each Bluetooth emitting device has its own unique Bluetooth signature which is useful for traffic flow data analysis. For the purpose of the traffic flow analysis, Bluetooth sensors, as are indicated as red dots in Figure 108 are positioned at various intersections in and around the Adelaide CBD. The data provided by DPTI revealed the traffic circulating the points highlighted. Entrance points to the City were recorded

[3] Based on PB Blu Trips Origin and Destination Survey for Victoria Square project

through North Terrace/Botanic Road, Rundle Road, Bartels Road, and Wakefield Road as shown at sensor points 74, 72, 154 and 4503.Through a process of elimination, the percentage of traffic travelling through the City during their morning commute was calculated as a percentage of total vehicles entering the City. This final value excludes vehicles which may have been involved in a 'drop off' scenario, i.e. making a U turn in the City and returning to their origin, as well as vehicles which have passed through the data points and continued along the Inner Ring Route.

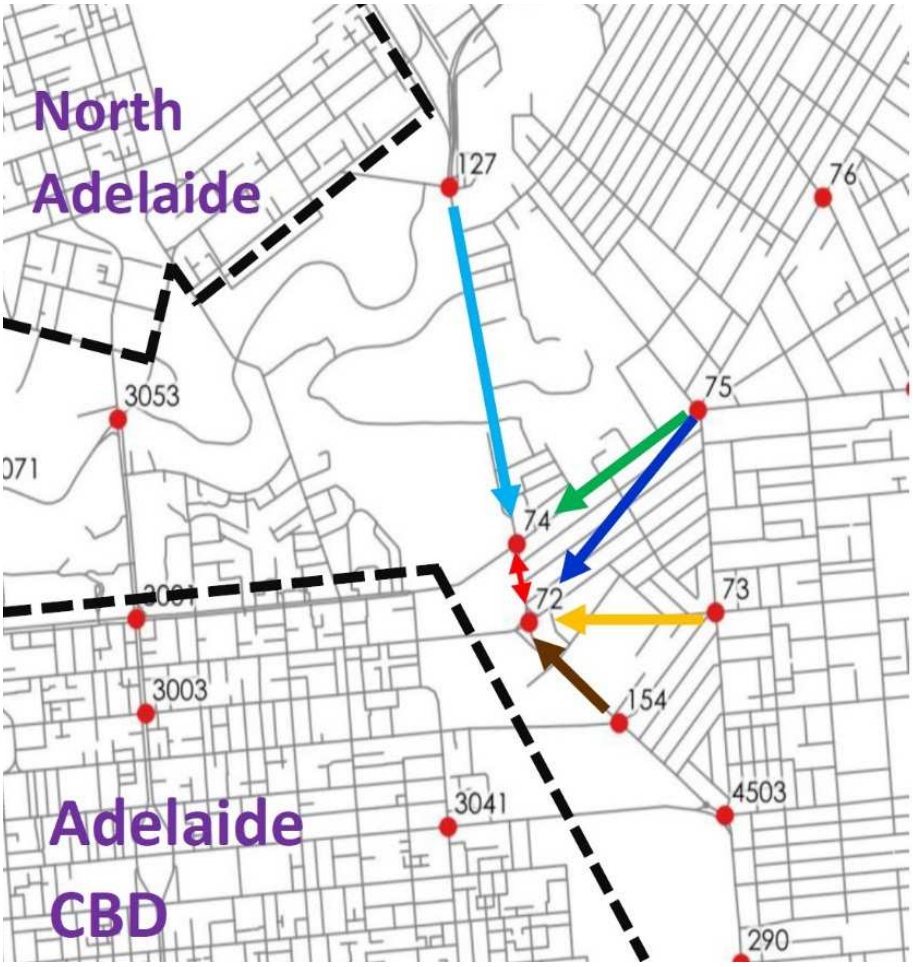

Figure 108: Bluetooth Detector Locations

The values expressed are considered to be only a sample size of the traffic that passes through a detector, and are represented as the total number of devices which have been detected. This system may not guarantee precisely one Bluetooth device per vehicle. Additionally, a noteworthy point is to consider a bus carrying fifty commuters with Bluetooth active mobile phones, these devices will be detected as 50 individual Bluetooth signatures, however, for the purpose of the data analysis, one Bluetooth device has been assumed to equate to one vehicle.

Result are described as follows:

- Inner Ring Route - The total number of Bluetooth devices that travel through the categorized link and continue around the City via the Inner Ring Route;
- Eastern Suburbs - The total number of Bluetooth devices that have travelled through the categorized link and then continued into the Eastern Suburbs (perhaps a 'drop off' scenario); and

- City and 'Through' traffic - The total number of Bluetooth devices identified entering the City as a destination or using it as a through-route to the southern, western and northern suburbs (exiting the City cordon within a certain timeframe).

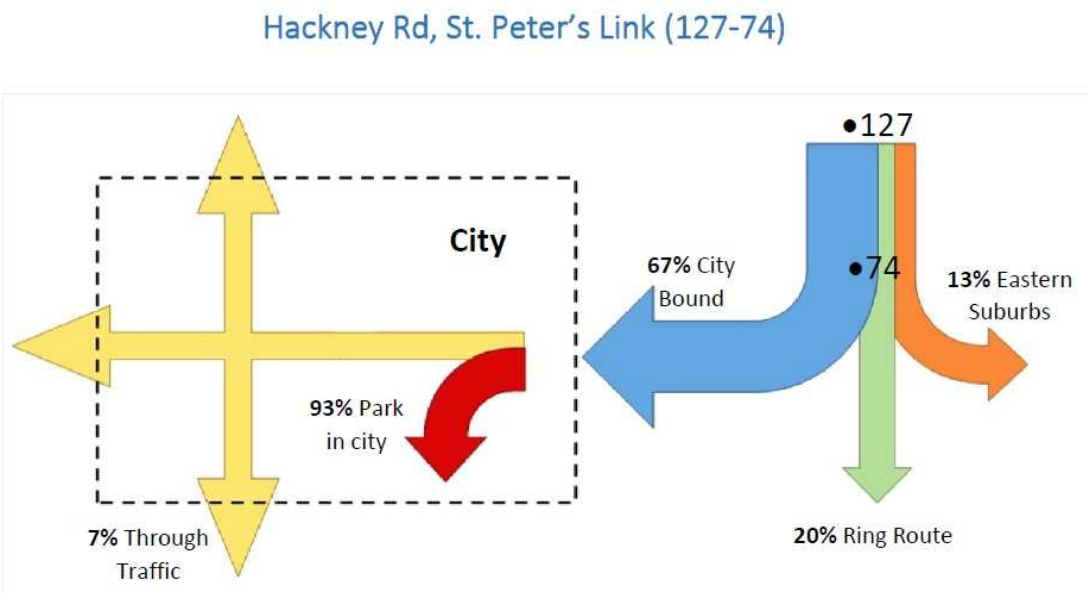

Figure 109: Hackney Road, St Peters AM Origin-Destination survey

The Hackney Road approach during the AM peak was found to cater for a high proportion of City destination trips (67%) while also performing a ring route function (20%). Of the traffic that turns off into the City a significant proportion of traffic parks in the City or has short term business to undertake. This suggests that the role of the Hackney Road corridor is one of delivering both passengers and cars efficient during the morning peak. The O-Bahn City Access project is in that regard critical in effectively delivering this end.

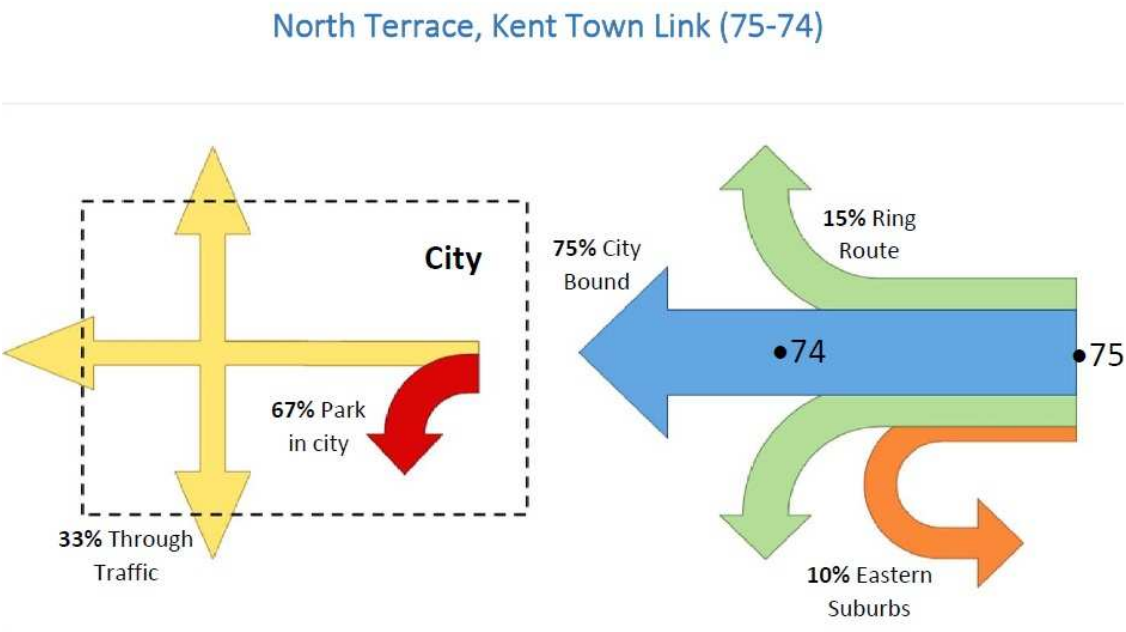

Figure 110: North Terrace, Kent Town AM Origin-Destination Study

The North Terrace approach during the AM peak was found to cater for the highest City bound component compared to other eastern suburban roads, However, a significant 33% of this traffic uses the City as a convenient 'through' route congesting the east-west traffic network, especially Botanic Road/North Terrace. This traffic should use the ring route however constraints at both the North Terrace / Hackney Road intersection and Bundeys Road intersection limits the ring route diversion to only 15%. The O-Bahn City Access project will increase some capacity at these intersections, which may in turn attract more through traffic.

Rundle Street, Kent Town (75-72) & The Parade, Norwood Links (73-72)

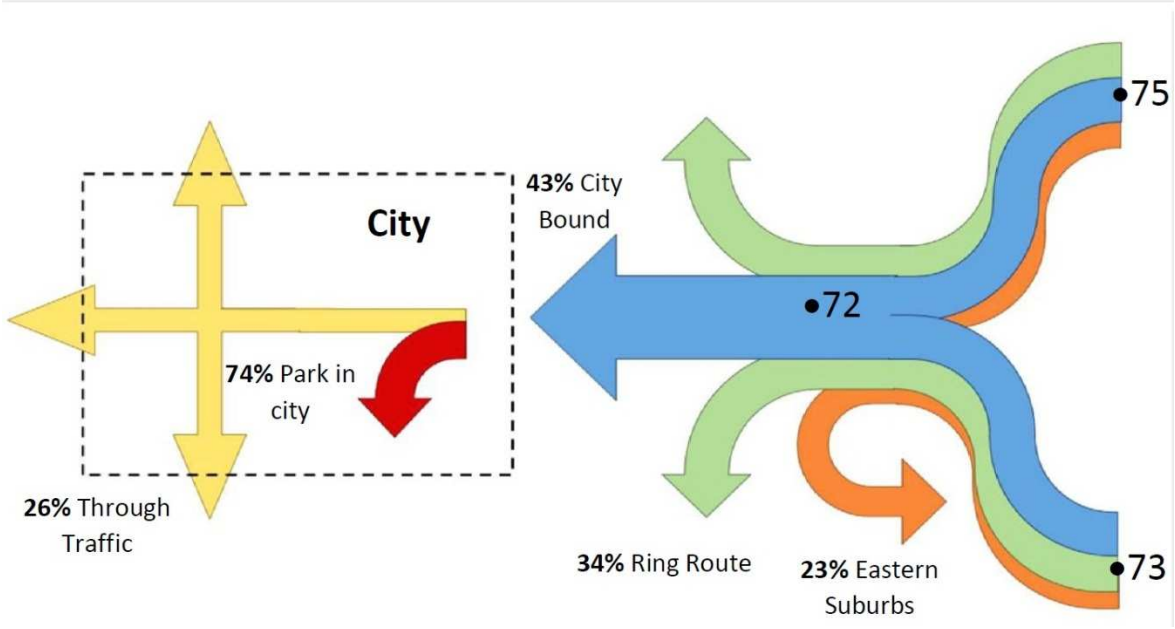

Figure 111: Rundle Street, Kent Town AM Origin and Destination Study

The Rundle Street approach during the AM peak was found to cater for a relatively low proportion of City destination trips (43%) while also performing a stronger ring route function (34%). However, a significant 26% of the City bound traffic that has crossed the Park Lands also uses the City as a convenient 'through' route congesting the east-west traffic network, especially Grenfell Street is conveying far too much traffic that would otherwise use the ring road. Given the proportion of ring route users is high from this approach it is suggested that right turn constraints at the North Terrace / Hackney Road intersection may be driving up the diversion to the Rundle Street right turn approach i.e. North Terrace and Rundle Street are acting as a 'couplet' system.

Of the traffic that turns off into the City 74% of traffic parks in the City or has short term business to undertake. This suggests that the role of the new Access Road may diminish in traffic over time as competition for this road space (buses) increases or unwanted traffic is diverted onto the ring route as capacity improves.

30.3 Traffic Forecast and Modelling of the East End Network

30.3.1 Strategic Model (MASTEM)

The Metropolitan Adelaide Strategic Transport Model (MASTEM) has been utilised as the foundation for further detailed modelling for origin and destination analysis and changes to travel patterns including changes in land use and future projected traffic and public transport patronage growth.

The traffic demand of the 'base case' (representing current conditions) was calibrated against May 2014 count data for key intersections, as well as the latest available manual turning counts to estimate turn flows for shared lanes.

30.3.2 Microscopic Model (AIMSUN)

AIMSUN micro-scopic simulation modelling software application was utilised in the assessment and comparisons of the options, and benefits as part of the detailed planning process prior to the selection of a preferred project alignment.

The AM peak hour is considered the most critical. The AIMSUN model was calibrated to generally reflect car, bus and truck movement counts that have been observed. The turn volumes can be inconsistent with on the ground counts given these are often collected on different days and times of the year. The outputs are now internally consistent and have been applied by traffic analysts to compare before and after project cases.

30.4 Model development process

The following steps were undertaken prior to the development of the Aimsun micro-simulation model which was used for the detailed assessment of the final proposed layout:

- Initial traffic flows were obtained from the Adelaide MASTEM model;
- Traffic volumes were used as input for an Aimsun meso-scopic simulation model which covered the major road network across the Adelaide metropolitan area;
- A subarea of the model was created, focussing on the project area to ease calibration and validation of the simulation. The subarea model scope was limited by the following roads:
    - West: Pultney Street, Frome Road
    - North: intersection of North East Road / Stephen Terrace / Northcote Terrace / Nottage Terrace
    - East: Payneham Road, Fullarton Road
    - South: Wakefield Street

The model was calibrated and validated to match existing conditions. Detector data from key intersections was obtained, analysed and used to calibrate the origin/destination (O/D) matrices to match flow patterns along key sections.

Figure 112 below shows the model extent of the meso-scopic subarea model.

30.4.1 SCATS Data

The vehicle release profile for the AM and PM peak modelling periods have been based on Sydney Co-ordinated Traffic Signal System 'SCATS' data and manual turn count data at various locations within the study area. Average 15 minute peak flow factors were determined based on the data. For all modelled scenarios, a 2.5 hour model period subdivided into 15 minute intervals was used for both AM peak and PM peak periods.

30.4.2 SIDRA

During the assessment of options, a SIDRA intersection analysis was completed to assist in the concept design of the intersections and understanding of the impacts to the intersection resulting from reduction of lanes during construction at the following intersections:

- TS074 – Hackney Road / North Terrace / Dequetteville Terrace / Botanic Road; and
- TS072 – Dequetteville Terrace / Rundle Street / Dequetteville Terrace / Rundle Road.

Please note that TS072 shows better results in SIDRA than what the actual operation of the intersection is showing. This is due to the fact that northbound traffic queues back from Traffic Signal TS074 and therefore traffic cannot cross Traffic Signal TS072. SIDRA is not showing this fact due to the isolated analysis of each intersection.

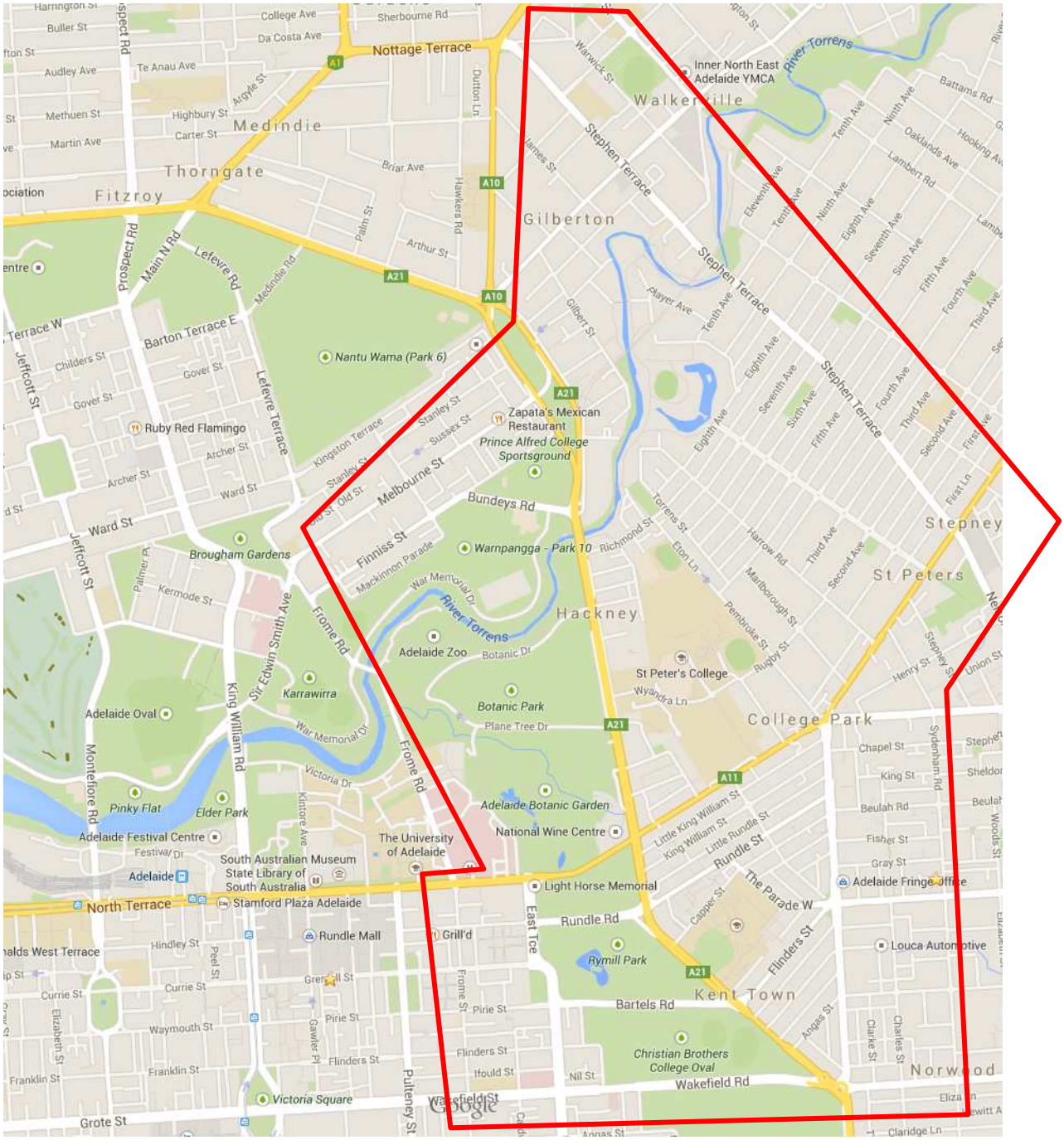

Figure 112: Model extent of subarea for meso-scopic simulation (Google Maps)

Following the calibration and validation of the base case model, multiple options were modelled in meso-scopic simulations to assess benefits and disbenefits. The results indicated that the currently proposed design will show the best benefits for both public transport and general traffic in the area. Further micro-scopic assessment was therefore based on this option.

A smaller subarea was defined to complete the micro-scopic simulation. This step was required to include detailed signal operation parameters and to determine detailed geometric requirements of the design (e.g. lengths of turning lanes).

Traffic flow patterns were obtained from the previous model area, meaning that volume flows along the edges of this smaller subarea were matching the calibrated traffic flows of the bigger subarea.

The extent of the smaller sub-area for the micro-simulation is shown in Figure 113 below.

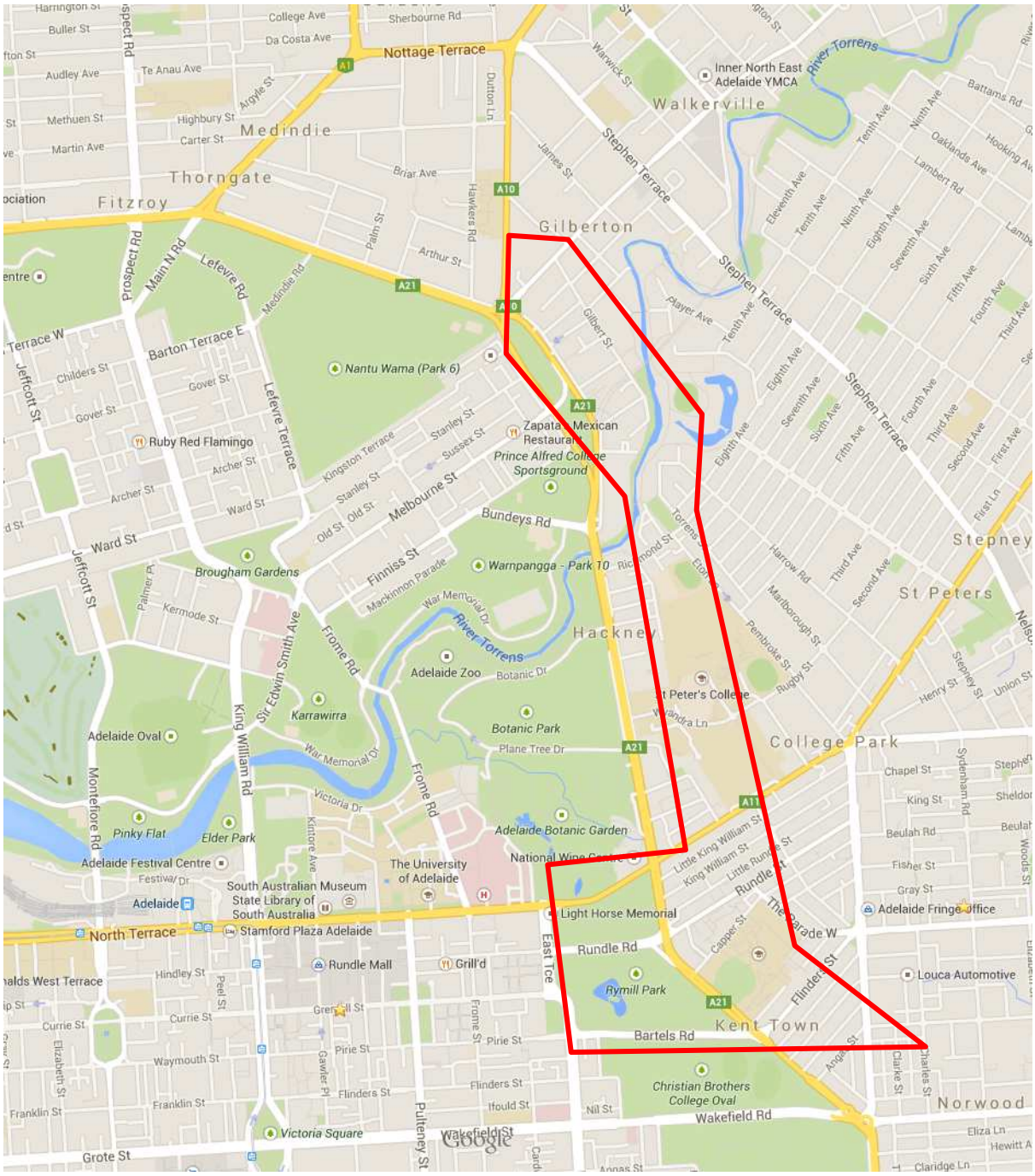

Figure 113: Model extent of subarea for micro-scopic simulation (Google Maps)

30.5 Base Case Calibration and Validation

The traffic demand was calibrated against May 2014 detector count data for key intersections, as well as the latest available manual turning counts to estimate turn flows for shared lanes. Additionally, CCTV footage of key intersections was analysed to determine extents of existing queues during the peak hour periods.

Aimsun micro-simulation outputs were validated against Bluetooth travel time information (where applicable). At the time, the following intersections along the Inner Ring Route were fitted with Bluetooth receivers at the following Traffic Signals (TS) numbers:

- TS030 – Northcote Terrace / Walkerville Terrace / Park Terrace / Mann Road / Robe Terrace
- TS127 – Hackney Road / Park Terrace / Bundeys Road
- TS074 – Hackney Road / North Terrace / Dequetteville Terrace / Botanic Road
- TS072 – Dequetteville Terrace / Rundle Street / Rundle Road

31 Urban Development and Planning

The current development potential of the O-Bahn City Access Project area is governed by a suite of documents and plans ranging from the State to local government levels. This chapter reviews these documents to assess the current urban condition, zoning, land use and planning conditions of the project area. The project is required to deliver an integrated land use and transport project outcome, and will help achieve a number of objectives in key national, state, regional and local planning strategies. The O-Bahn City Access Project is likely to act as a catalyst for changes to the existing zoning regime to more closely align with the 30-Year Plan, and deliver an integrated transport and land use solution.

31.1 Development and Planning Legislative Requirements

The *Development Act 1993* (the Act) and *Development Regulations 2008* (the Regulations) are the primary statutory instruments controlling development activities in South Australia. Activities deemed to be 'development' include building work, the sub-division of land, those that may affect heritage places and significant trees as well as Crown Development activities. The Act regulates land management and the design and construction of buildings. It also makes provision for maintaining and conserving land and buildings, where appropriate.

It is not anticipated that any development approvals will be required for the proposed road works, as the Development Act does not apply to the construction of roads on land that has been acquired under the Highways Act 1926 (except in relation to significant trees and State Heritage places). Other legislative and approval processes are outlined in Section 3.7 'Approvals'.

Section 22 and Section 23 of the Act refer to the State 'Planning Strategy' and local Council 'Development Plans', to instruct and guide the vision for desirable development State-wide, regionally and locally. The 30-Year Plan for Greater Adelaide is the relevant volume of the State's planning strategy for the O-Bahn City Access Project development area. The Development Plan of each Council contains local planning policies in the form of council wide zone, precinct and policy area provisions. The project area covers three local government areas: the City of Adelaide, the City of Norwood Payneham and St Peters and the Corporation of the Town of Walkerville. Development plans are intended to provide detailed criteria against which development applications are assessed, but also provide character statements which govern the appropriateness of adjacent or surrounding land uses.

The following documents were reviewed and inform this Urban Development and Planning chapter:

- 30 Year Plan for Greater Adelaide;
- Adelaide (City) Development Plan consolidated 2 April 2015;
- Norwood Payneham and St Peters (City) Development Plan consolidated 31 October 2013; and
- Walkerville Council Development Plan consolidated 28 August 2014.

31.2 Zoning and Land Use

The O-Bahn City Access project area comprises a unique blend of land uses and zoning requirements. The residential areas within close or immediate vicinity consist of the City's East-End, Hackney, Kent Town and Gilberton. The area also has significant institutional, commercial and recreational land uses including the Adelaide Botanic Garden, Botanic Park, National Wine Centre, Prince Alfred College Sportsground, Rundle Park/Kadlitpinna, Rymill Park/Mullawirraburka, St Peter's College and the City's East-End commercial district.

31.2.1 Zoning, Precincts and Policy Areas

Zoning within the area is under the jurisdiction of the City of Adelaide, the City of Norwood Payneham and St Peters and the Corporation of the Town of Walkerville, each having a Development Plan which contains local planning policies with council wide, zone and policy area provisions. A map showing the zones is proved as Figure 114, with the specific Policy Areas shown in Figure 115. Upon review, neither Council has designated Precincts within the immediate Project Area.

City of Adelaide

The City of Adelaide consists of the western edge of the project's Hackney Road section and the entire Park Lands area. The Development Plan identifies the following zones, precincts and policy areas:

- Park Lands Zone; and
- Capital City Zone.

The City of Adelaide Development Plan further identifies the River Torrens East, Botanic Park, Rundle and Rymill Parks and the Main Street Policy Areas. Those Policy Areas within the Park Lands Zone prescribe additional detail with respect to the land use, built form, planting character, landscape and access. The Main Street Policy Area envelopes Rundle Street and relates predominantly to specific development provisions and is fully detailed within the Development Plan.

City of Norwood Payneham and St Peters

The City of Norwood Payneham and St Peters bounds the east side of Hackney Road. The Development Plan identifies the following adjacent zones:

- Urban Corridor;
- Local Commercial;
- Special Uses;
- Residential Historic (Conservation);
- Residential 2 (St Peters); and
- Residential 3N.

Within the immediate vicinity of the project corridor, the City of Norwood Payneham and St Peters also comprises the Hackney South, Boulevard and High Street Policy Areas, which prescribe finer-detail provisions additional to that of the overlayed zones and are detailed within the Development Plan.

Corporation of the Town of Walkerville

The Walkerville Council borders the north-eastern side of Hackney Road, where the O-Bahn busway meets Hackney Road. The Development Plan identifies the following adjacent zones:

- Residential; and
- Residential Character.

The Walkerville Development Plan also prescribes the Gilberton Medium Density and Gilberton South Policy Areas, which establish specific principles over development control and can be sought in the Council's Development Plan.

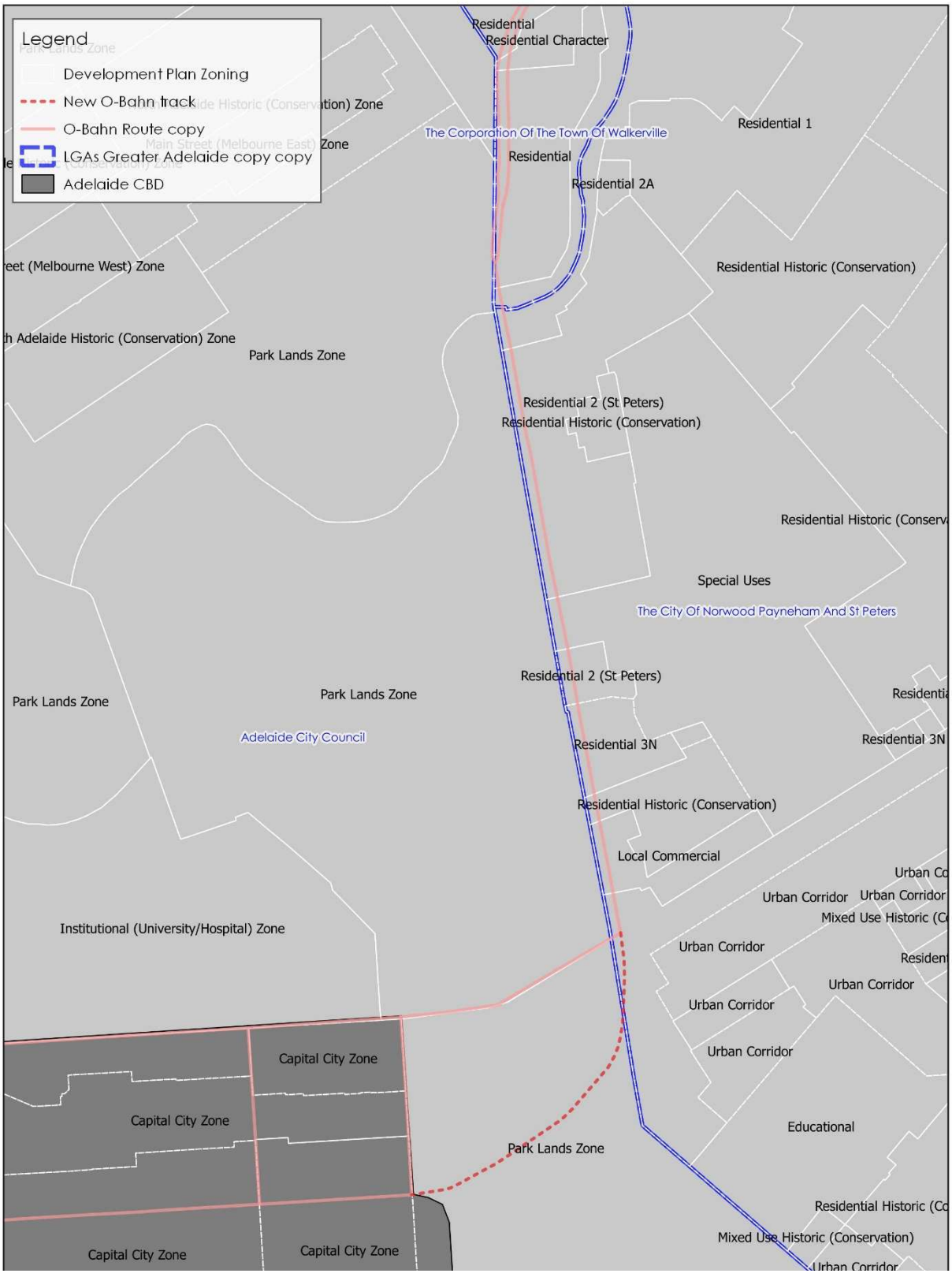

Figure 114: Development Plan Zones.

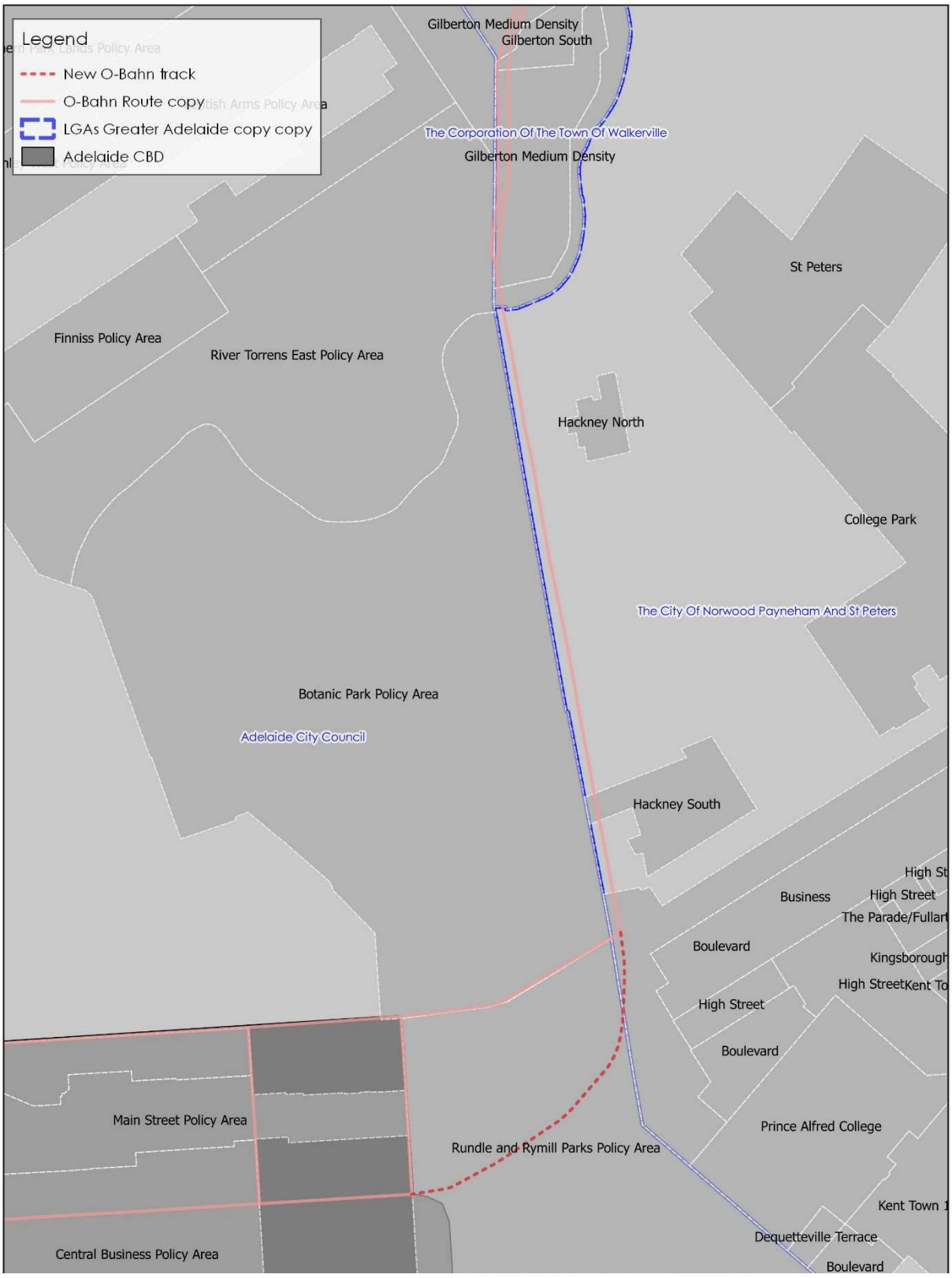

Figure 115: Development Plan Policy Areas

32 References

- DPLG 2010, *The 30 Year Plan for Greater Adelaide*, Government of South Australia, Adelaide.
- DPLG 2010, *Housing and Employment Land Supply Program Report 2010*, Government of South Australia, Adelaide.
- DPTI 2011, *Statistical Local Area Projections 2006-2026*, Government of South Australia, Adelaide, viewed 30 November 2014, < https://www.sa.gov.au/topics/housing-property-and-land/building-and-development/land-supply-and-planning-system/planning-data-for-research-and-mapping/population-and-demographics/population-projections#title0>.
- InfraPlan 2013, *Urban Infill Vs. Greenfield Development: a review of economic benefits and costs for Adelaide*, Department of Planning, Transport and Infrastructure (SA Government), Adelaide, accessed 16 April 2015, <http://dpti.sa.gov.au/__data/assets/pdf_file/0009/123210/InfraPlan_Report_Infill_versus_Greenfield_Development_Adelaide_-_Final_report.pdf>.