

# The Future Inner Sydney Light Rail Network

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## Abstract

The Inner West Light Rail extension to Dulwich Hill will effectively double the length of the existing line, provide access to numerous significant urban renewal sites along the route and provide greatly improved opportunities for interchange at the Lewisham and Dulwich Hill stations on the Heavy Rail network. The paper also examines other proposed Inner Sydney Light Rail routes and their patronage catchments and the practical feasibility of shared on-street running of Light Rail vehicles under mixed traffic conditions close to the Sydney CBD, on streets where existing commercial and residential property access requirements need to be maintained. The paper summarises the current patronage of the system and how this can be improved by increased train capacity and better fare integration in the future. The future effectiveness of Light Rail lines in Inner Sydney will also potentially be limited by the interactions with other traffic and the physical availability of trains and stabling locations. The potential future passenger comfort and urban amenity benefit of Light Rail vehicles replacing buses on the major surface streets of the Sydney CBD is nevertheless a highly desirable future attribute which will ultimately form a major part of the future justification for the current system extensions and proposed new routes.

Note\*: The paper represents the views of the authors and is not based on any official Arup study

## 1. The Existing Line

### 1.1 History of Development

The existing Inner West Light Rail line in Sydney has been operating since 1997. This line primarily operates over its own dedicated right of way, which was formerly an Inner City – port access goods line, with only a short section of on-street running for the terminating loop at Central Railway Station in the Haymarket precinct of the Sydney CBD.

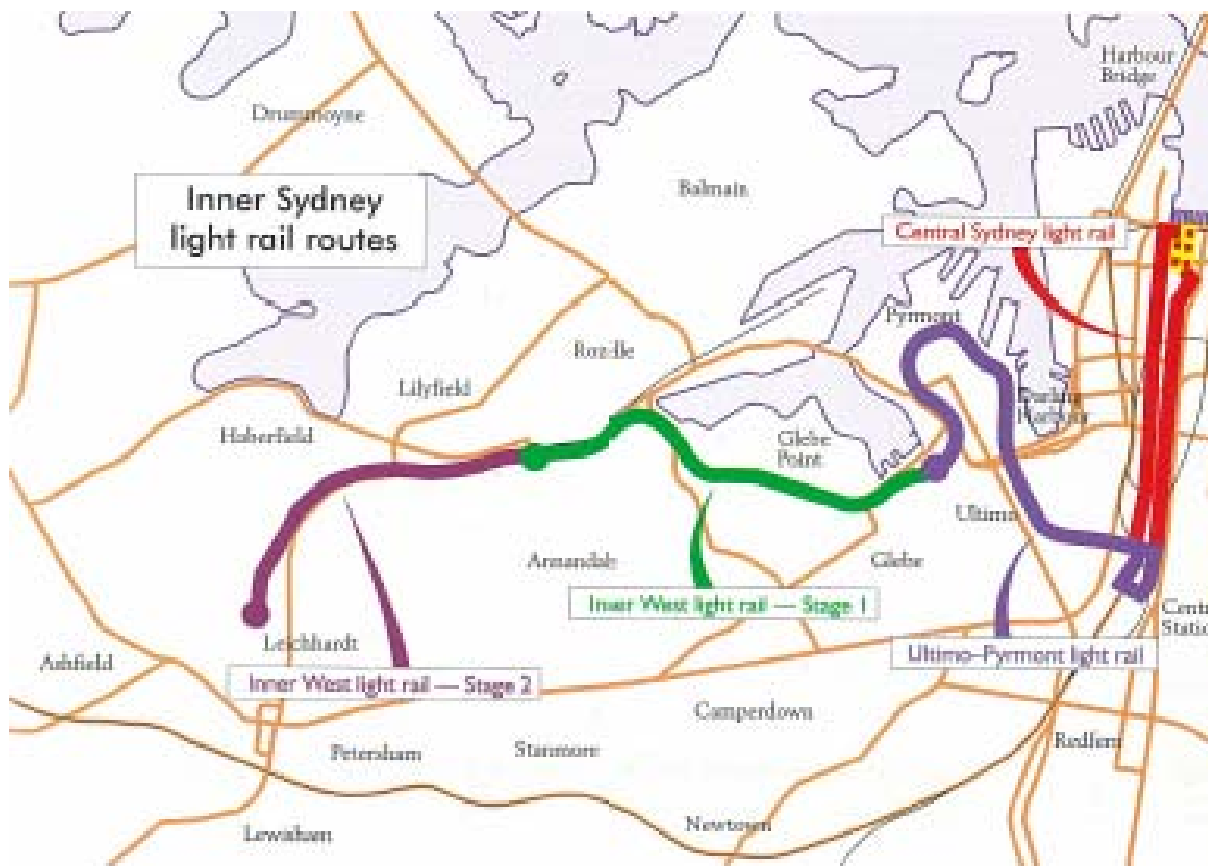
The history of the development of this line and its potential extensions, represents the first significant step towards the re-introduction of Light Rail as a significant public transport mode in Inner Sydney, subsequent to the formal closure of Sydney's last operating tram lines in 1961. The chronology is as follows.

- 1993-4 Ultimo-Pyrmont section planning studies undertaken
- 1995 Ultimo-Pyrmont construction commenced (Better Cities Funding)
- 1996 First proposal for CBD Light Rail extension identified in "Accessible City" (City of Sydney 1996)
- 1997 ( August ) Ultimo-Pyrmont operations commenced ( Private Sector Operator )
- 1998 Planning studies completed for Glebe and Lilyfield extension
- 1999 Construction of Lilyfield extension ( NSW Government Funding )
- 2000 ( August ) Lilyfield extension operations commenced ( Private Sector Operator )
- 2003-4 First planning studies and EIA Report completed for CBD extension ( Pitt and Castlereagh Streets )

- 2005-6 First plan for CBD extension deferred until improved CBD traffic operating conditions occur following opening of the Cross City Tunnel Motorway
- 2006 Revised Plan for CBD Light Rail extension proposed by City of Sydney via Castlereagh Street only ( City of Sydney, 2006 )
- 2007 Hickson Road Options Study ( 6 route options ) undertaken by City of Sydney for CBD extension ( City of Sydney, 2007 )
- 2007/8 Planning Studies for Inner West Light Rail extension deferred due to “NW Metro Project” which required use of the line for construction spoil transport
- 2009 Joint Planning Studies for Inner West Light Rail extension to Dulwich Hill commenced by City of Sydney and Transport NSW following abandonment of the Sydney Western Metro and CBD-Rozelle Metro Projects
- 2010 Planning Studies exhibited for Inner West Light Rail extension to Dulwich Hill, (GHD,2010), (Transport NSW,2010)
- Late 2010 Additional planning studies commenced for CBD Light Rail Extensions via either George Street and/or Hickson Road in conjunction with “CBD Access Plan” study

The Sydney CBD and Inner West Light Rail extensions were first publicly proposed by the City of Sydney in its planning strategy document, Accessible City ( City of Sydney, 1996 ), as illustrated by the map in Figure 1, below.

**Figure 1: Original City of Sydney Proposal for Light Rail Extensions in 1996**



The existing Inner West Light Rail services are privately operated until 2028 when control is due to revert to the NSW Government. Construction tenders for the 5.6 km extension to Dulwich Hill are due to be awarded later this year and trains are due to be operational by either late 2012 or early 2013. For future residential and commercial developments along the

route west of Glebe towards Lilyfield and Dulwich Hill, reliable access to a convenient and affordable Light Rail system is likely to significantly reduce car ownership and usage, which will also create better street environments in the vicinity of these future developments.

## 1.2 Population Catchments

The “Inner City & East” Sub-region is not one of the defined areas of the NSW Government’s recent planning strategies. However it is effectively the primary population catchment area of the existing system and the future potential Light Rail lines which have been identified. This region is defined by the ABS as comprising the City of Sydney council area and the following six directly adjoining local government areas of Inner Sydney.

- Leichhardt, Marrickville, Botany, Randwick, Waverley and Woollahra

The City of Sydney and these six adjoining local government areas are all currently experiencing strong population growth, generally above the average population growth rate for the Sydney Region of +1.7% per annum, as summarised by the Year 2006-2009 trend of the estimated resident population (ERP) for these areas. Within the “Inner City & East” Sub-region, the highest annual population growth rates ( +2.5% on average ) have actually occurred in the City of Sydney LGA itself, for which the ABS provides data as four separate Statistical Local Areas ( Inner, East, South and West ), Table 1.

**Table 1: Sydney Region and Inner City & East Population Growth Trends 2006-2009**

Locality	ERP 2006	ERP 2009	3 year growth	% growth p.a.
City of Sydney(Inner)	22,733	25,090	2,357	+3.5%
City of Sydney(East)	49,815	52,015	2,200	+1.5%
City of Sydney(South)	52,420	57,006	4,586	+2.9%
City of Sydney(West)	40,628	43,809	3,181	+2.6%
<b>City of Sydney</b>	<b>165,596</b>	<b>177,920</b>	<b>12,324</b>	<b>+2.5%</b>
Leichhardt	51,554	54,525	2,971	+1.9%
Marrickville	75,546	78,271	2,725	+1.2%
Botany	37,680	39,664	1,984	+1.8%
<b>Other Inner Sydney</b>	<b>164,780</b>	<b>172,460</b>	<b>7,680</b>	<b>+1.5%</b>
Randwick	126,108	131,714	5,606	+1.5%
Waverley	64,684	68,316	3,632	+1.9%
Woollahra	53,317	55,228	1,911	+1.2%
<b>Eastern Suburbs</b>	<b>244,109</b>	<b>255,258</b>	<b>11,149</b>	<b>+1.5%</b>
<b>Inner City &amp; East</b>	<b>574,485</b>	<b>605,638</b>	<b>31,153</b>	<b>+1.8%</b>
<b>Sydney Region</b>	<b>4,281,988</b>	<b>4,504,469</b>	<b>222,481</b>	<b>+1.7%</b>

Source ABS, 2011

The Light Rail route railway line infrastructure, west from Lilyfield to Dulwich Hill is significantly underutilised currently, as the line has no longer been used by any freight trains to the Rozelle Goods Yard since 2008.

There are also numerous locations where future urban consolidation and urban renewal type redevelopments can occur along the route of the line between Glebe and Dulwich Hill, to

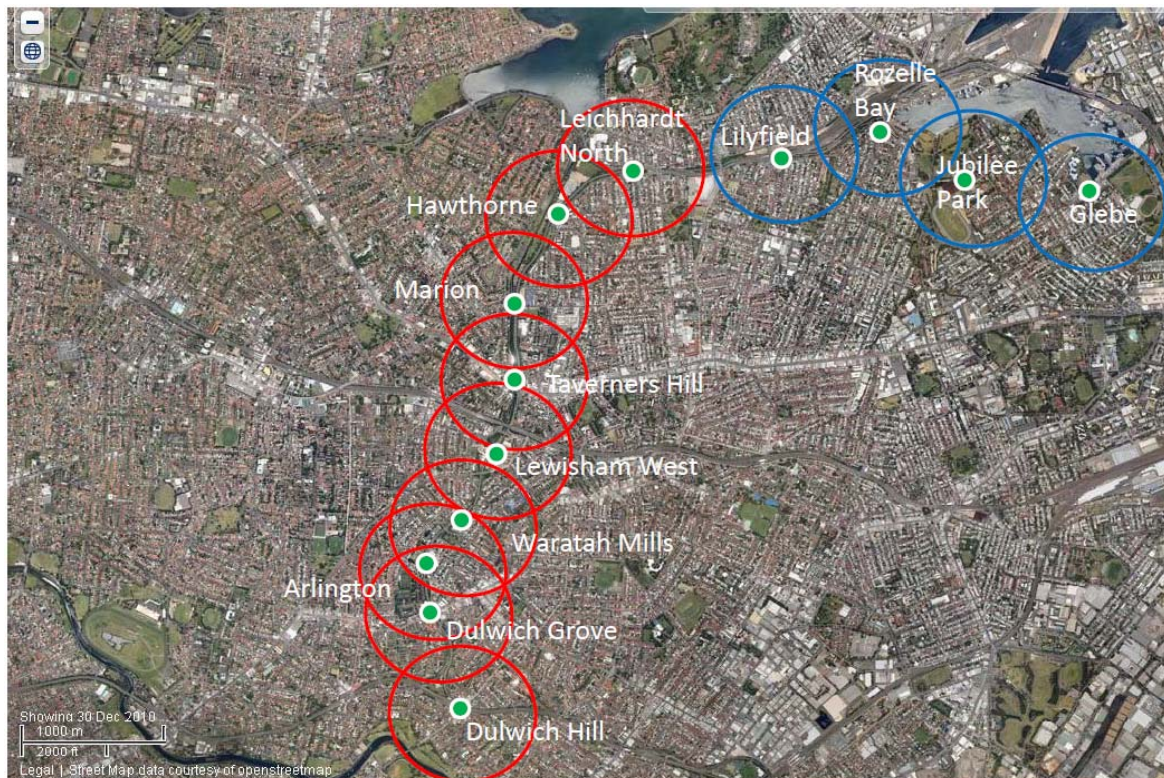


support the continuing high population growth demand in the Inner City areas of Sydney. Significant opportunities for future residential, commercial and mixed use site redevelopments exist within the primary station walking distance catchments ( 500 metre radius nominally ) of virtually all the future proposed Light Rail stations.

This urban consolidation will take advantage of the existing underutilised railway line corridor infrastructure and also contribute to the increased future sustainability of commuter and other transport usage in this part of Sydney.

The outer four existing stations of the existing line at Glebe, Jubilee Park, Rozelle Bay and Lilyfield have a relatively high average station spacing of 700-800 metres on average. However, the nine proposed new stations of the extension to Dulwich Hill will have a much closer average spacing of 500 metres or less typically, providing a much denser coverage of the overall 1 kilometre wide Light Rail corridor catchment, as shown by Figure 2 below.

**Figure 2: Existing and Proposed Station Locations on the Lilyfield to Dulwich Hill extension**



The high population growth rate and strong demand for urban consolidation in Inner Sydney has been recognised in all the NSW Government's metropolitan planning strategies since 2004. It was first proposed in that year, ( DIPNR, 2004 ) that over 50% of all new dwellings in the Sydney Region should be constructed by urban consolidation and urban renewal within the East Central and West Central sub regions of Sydney, as shown by the map in Figure 3.

The continuing strong "Inner City" population growth rates over the past 3 years, as shown in Table 1, indicate that despite the high cost of housing in the "Inner Sydney" and "East" sub-regions, increasing numbers of people are still choosing to live in the suburbs which are close to the Sydney CBD, including the Sydney CBD itself. There are many reasons for this including the proximity to high earning capacity jobs, easy access to the wide range of community, cultural and recreational facilities which are located in the Sydney CBD and a growing desire by many persons to live more sustainable lifestyles with reduced time spent commuting and less car dependent travel.

More investment in high quality urban public transport is now both necessary and justifiable to support the continuing high population growth in the Inner City areas. Although travel time

is an important influence on a person's choice of travel mode, the consensus of international research now shows that system reliability is a far more significant influence. The potential future advantages of a "reliable" Light Rail system over other modes of transport (e.g. buses) serving this region of Sydney have been summarised by (Currie, 2009) as follows:

**Figure 3: Proposed Distribution of New Dwellings in the Year 2004 DIPNR Urban Consolidation Strategy for Sydney**



- Research shows that weighted trip time is considered about 10% less for light rail travel compared to bus.
- Light rail stations have more amenities and are easier for passengers to locate than bus stops.
- Rail lines are easier to comprehend compared to "spaghetti-shaped" bus networks. According to urban theorist Kevin Lynch, such systems have higher 'imageability'.
- A rail line is more comfortable than an uneven bus ride.
- Traffic congestion makes buses more unreliable than light rail.
- Light rail is perceived as faster whereas bus is generally more influenced by other traffic on the road.
- Bus routes are unreliable and subject to change from political pressure whereas light rail routes essentially remain unchanged once implemented.
- A light rail network builds more confidence to local traders and residents as they are generally unalterable. New businesses and residents are more likely to relocate to the area. This creates an increase in local land and property values.
- Light rail is safer for cyclists and pedestrians as compared with the unpredictable movement of buses
- The impact on the street environment – in terms of noise, air quality and safety – is far less for light rail than buses

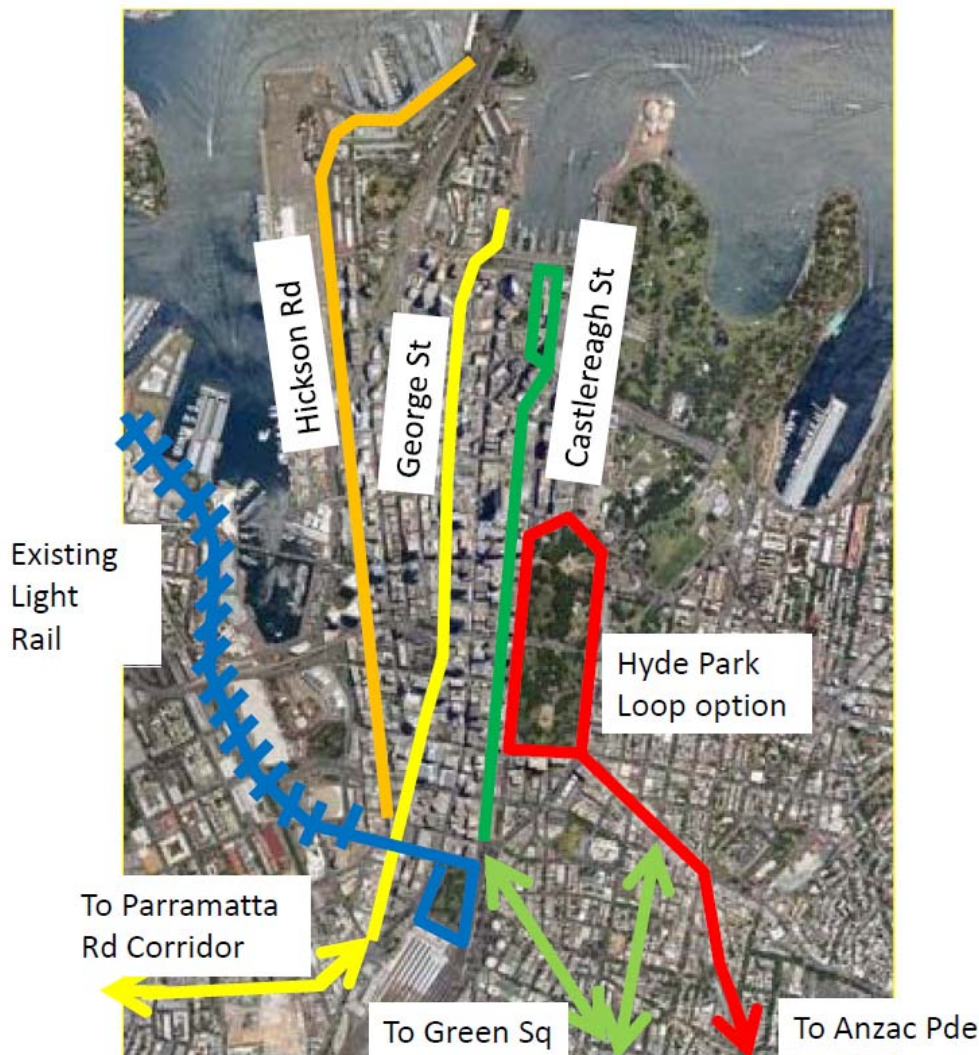


These travel mode choice factors will all be important factors in the future development and justification of a longer term network of four Inner City Light Rail routes, all of which have been identified and/or are currently under investigation in a series of recent studies by the City of Sydney and other NSW Government transport planning agencies, namely:

- The Inner West Light Rail extension from Lilyfield to Dulwich Hill, linked to a potential CBD extension, via either George Street or Hickson Road or Castlereagh Street
- A future Sydney CBD to Green Square ( and potentially Mascot) Light Rail route to operate on-street, through the Suburbs of Surry Hills, Redfern and Victoria Park
- An Anzac Parade Corridor Light Rail route, connecting the Sydney CBD with Kensington, Kingsford, the University of NSW at Randwick and potentially further extensions to Coogee and/or Maroubra
- A potential future Parramatta Road and Broadway Light Rail route, which would effectively be an outer extension of the George Street route through the Sydney CBD

The four potential Inner City Light Rail routes, and their likely approach and travel routes within the actual Sydney CBD are illustrated by the map in Figure 4.

**Figure 4: Future Network of Potential Light Rail Routes within the Sydney CBD**



In a recent newspaper article (SMH, 2011- March), the potential construction of a Parramatta Road Light Rail route has now been publicly linked with the simultaneous construction of the M4 East Motorway Tunnel, which would then potentially reduce the current need for

Parramatta Road to also function as a major arterial traffic route serving the western approaches to the Sydney CBD.

However, as there is only limited additional road traffic capacity available leading onto the Anzac Bridge to carry additional traffic from the M4 East Motorway Route towards the Sydney CBD, the M4 East Motorway Tunnel may in practice have little effect in providing any significant commuter traffic relief to Parramatta Road on the most heavily trafficked ‘Inner City’ sections of the route near Broadway.

## 2. Capacity of the Light Rail Vehicles and Network

The existing Inner West Light Rail services generally operate every 10-15 minutes on Sunday to Thursday (6am to 11pm) and Fri & Sat (6am to midnight). During the actual weekday morning and afternoon peak commuter periods ( 8-9 am and 5-6 pm ) the service frequency is increased to provide trains every 9-10 minutes in the peak direction.

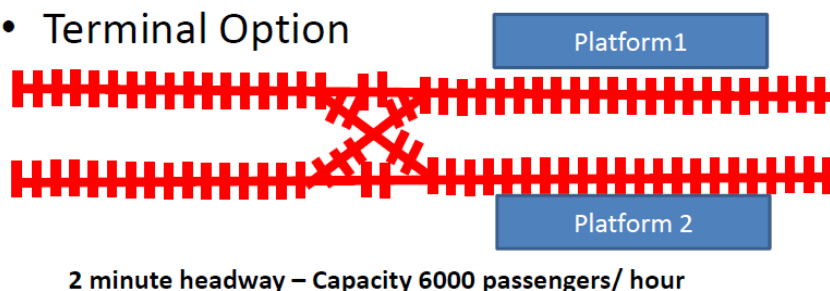
Each train/tram unit has an overall capacity of approximately 200 persons with 74 seats. The current peak hour system capacity level is approximately 1,200 passengers per hour in the peak direction. The current peak hour, peak direction, system passenger loading level is approximately 50% of the total system capacity (seated + standing passengers), such that most passengers who want to sit down can do so. Other types of tram units can provide even greater total passenger capacity, up to 230 or 270 persons. However, these types of vehicles are normally low-floor vehicle, of a type more suitable for systems that have exclusive on-street operation.

The overall peak hour passenger capacity of the system on any existing or future Light Rail line is determined by the vehicle headway. The peak hour peak direction vehicle headway on any line is ultimately determined by the type of turnaround facility at the City end of the route. This can vary between approximately 2 minutes per vehicle to 1 minute per vehicle (peak direction capacity 6,000 to 12,000 passengers per hour), depending on whether a terminating platform or turning loop is available, as summarised by the plan in Figure 5.

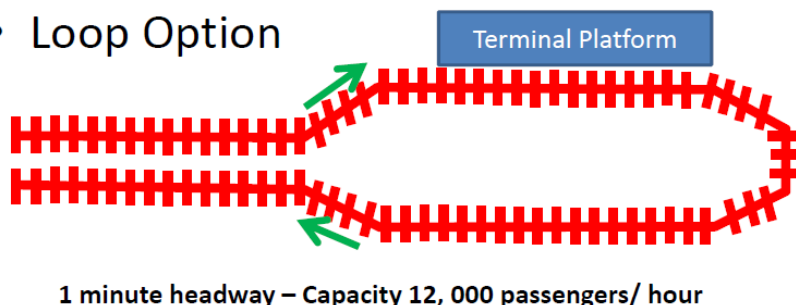
**Figure 5: Future Light Rail Route Terminal Turnaround Options**

### Terminal Turnaround Options

- Terminal Option



- Loop Option



### **3. Fare Structure**

#### **3.1 Existing Inner West Light Rail Fare Structure**

The single Light Rail journey fare is currently \$3.40 for a single zone journey and \$4.40 for a two zone journey. The system currently has two zones which comprise the following stations.

- Zone 1 = Central to Pyrmont Bay
- Zone 2 = Pyrmont Bay to Lilyfield

Discount fares are available for multi trip travel.

From the system opening until 27 June 2011 the Light Rail fare system was not integrated with the ticketing of Sydney's other public transport systems. Historically this has inhibited the use of the system for multi modal travel. The dual fare "penalty" makes regular commuting relatively expensive where other public or privately operated modes of public transport had to be used in Sydney. The lack of a formal timetable for the Light Rail system has also made journey planning more difficult for the Light Rail system passengers and effectively prevents any formal measurement of the level of service which is being provided by the system to its customers in terms of either journey time or on-time running.

These two constraints are however 'soft infrastructure' issues which can relatively quickly be addressed by improved system operations in the future.

Fully integrated ticketing of the Light Rail services with Sydney's other major public transport modes (Heavy Rail, Bus and Ferry) and the publication of a formal timetable would definitely improve the usability and attractiveness of services for passengers on both the existing Light Rail system and the potential future system extensions.

#### **3.2 Future Sydney Zonal Fare Structure and Integrated Ticketing**

In April 2010, the MyZone fare structure was introduced to rationalise fares and ticketing across the virtually the entire Sydney public transport system including all Heavy Rail lines, Sydney Ferries routes and public and private bus routes, but excluding the two Sydney Airport stations, the Lilyfield Light Rail Line and the privately operated ferries which currently operate some services in Sydney Harbour, Port Hacking (Cronulla to Bundeena) and Pittwater.

Fully integrated ticketing of all public transport systems throughout the Sydney Region by means of a single travel card (similar to the London Oystercard, but called Pearl probably) is also now proposed but not scheduled to be introduced before the year 2014 at the earliest.

The current NSW government has made a commitment to include the Inner Sydney Light Rail network in the future integrated public transport ticketing scheme for Sydney. As part of this commitment, on the 27 June 2011, it was announced that from that date all the daily, weekly, monthly, quarterly and yearly MyMulti tickets which cover the bus rail and ferry networks in Sydney, would also be valid on the Light Rail services. Anecdotally, this has already led to increased patronage on the existing services but no formal comparative patronage survey data is yet available.

### **4. Future Additional Development Projections and Patronage Catchments**

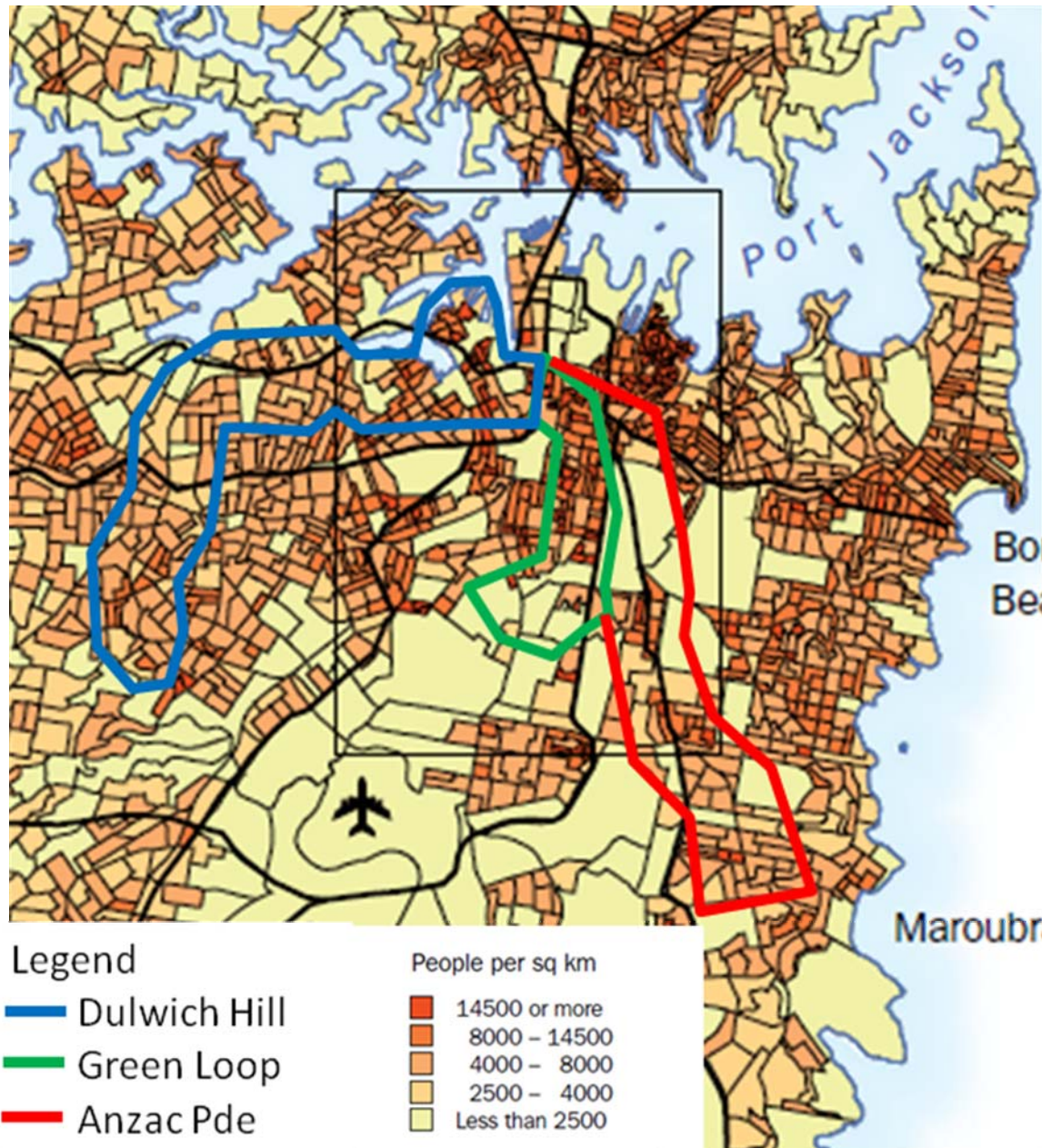
The existing population density along the route corridors of the Inner West Light Rail line, its proposed extension to Dulwich Hill and two other proposed Inner Suburban route extensions



to Green Square and the University of NSW via Anzac Parade is relatively high, as illustrated by the map in Figure 6.

The high existing population density along these three routes in itself sufficient to justify the introduction/reintroduction of Light Rail/Tram operations to these route corridors when supported by the major institutional land uses served, ie The University of NSW at Randwick.

**Figure 6: High Existing Population Density along Light Rail Corridor Routes**



The NSW Government has produced in 2005 and 2010, a series of future urban planning “Metropolitan Strategy” documents, which have identified detailed future population growth and urban consolidation “Dwellings Growth” strategy targets for a series of sub regions containing all the existing local government areas of Sydney.

The December 2005 Metropolitan Strategy for Sydney, for which all the associated sub-regional strategies were completed during 2007 and 2008, recommended the following 27 year future urban consolidation dwellings growth targets from 2004 to 2031, for the seven local government areas within the “Inner City & East” sub-region of Sydney.

- City of Sydney, +55,000 dwellings
- Leichhardt, +2,000 dwellings
- Marrickville, +4,150 dwellings
- Botany, +6,500 dwellings
- Randwick, +8,400 dwellings
- Waverley, +2,200 dwellings
- Woollahra, +2,900 dwellings

Under the most recent Metropolitan Strategy update which was released in 2010, the future “sub-regional” dwellings growth targets were revised upwards but the targets for individual local government areas, other than the City of Sydney were not updated. The latest revised sub regional dwellings growth targets ( NSW Government, 2010) are as follows;

- City of Sydney LGA sub-region target; +55,000 increased to +63,000 dwellings
- East sub-region target ( 4 LGA's) +20,000 increased to +25,800 dwellings
- Inner West sub-region target ( 5 LGA's) +30,000 increased to +37,300 dwellings
- South sub-region target ( 6 LGA's ) +35,000 increased to +52,900 dwellings

In the latest review, the City of Sydney LGA dwellings growth target, which was already high, has been increased by a further 15%. The dwellings growth targets for the three sub-regions which contain the other six identified “Inner City” LGA's were also increased by +36% on average. However the new dwellings growth targets now apply to a 30 year growth period from 2006 to 2036, rather than the previous 27 year growth period.

However, as these Inner City local government areas have all experienced relatively high rates of population growth during 2006 to 2009, the future year 2036 population and dwellings growth targets of the latest Metropolitan Strategy,(NSW Government, 2010) will all probably be achieved much earlier than the year 2036.

## **5. The Development Potential of Additional Light Rail Routes**

### **5.1 Inner West Light Rail Extension to Dulwich Hill**

Under the previous NSW Government's Metropolitan Transport Plan, published in 2010, ten year funding guarantees were provided for the two proposed extensions of the Light Rail system, namely;

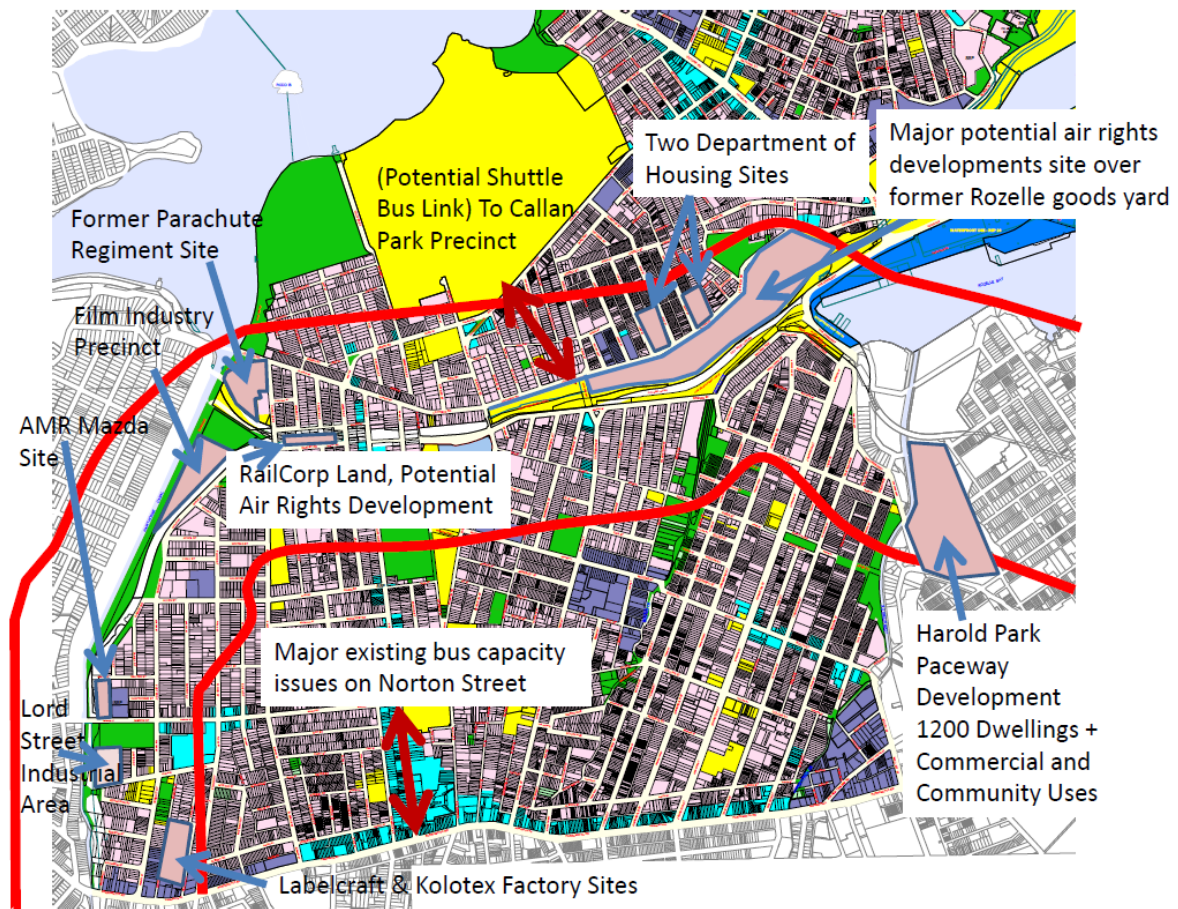
- The Inner West Light Rail extension from Lilyfield to Dulwich Hill
- Potential CBD extensions of the Inner West Light Rail, via either George Street or Hickson Road

These outer and inner extensions will allow the Inner West Light Rail system to provide better access to parts of the CBD with high employment concentrations (City of Sydney, 2006) and correspondingly increase the patronage demand for Light Rail services within the Inner West sub-region of Sydney.

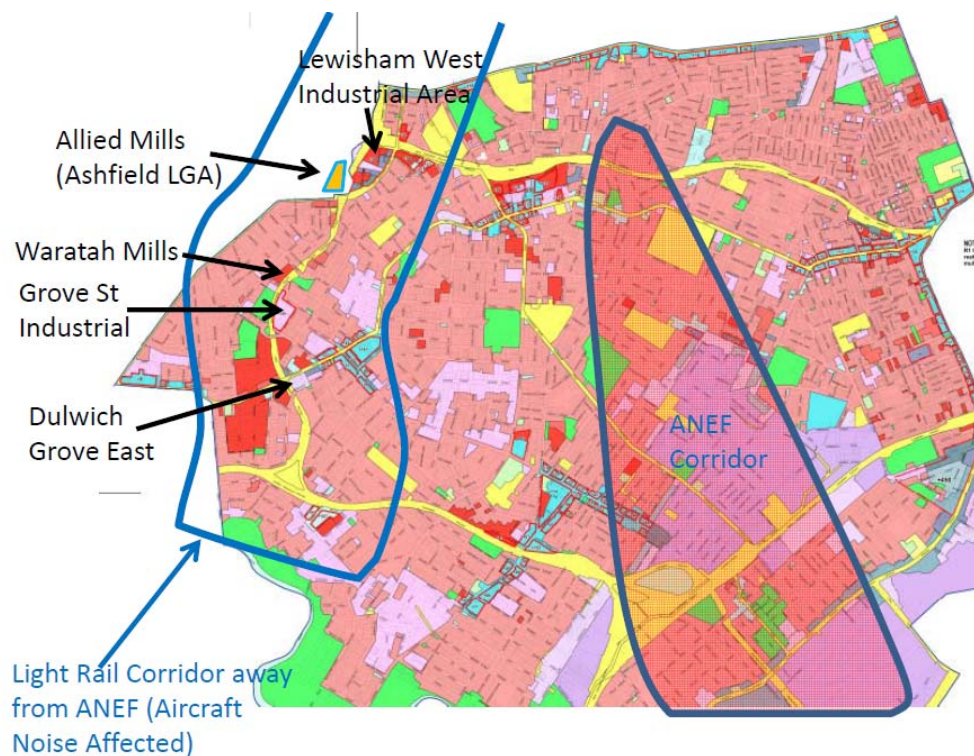
The Inner West Light Rail extension to Dulwich Hill, passes through areas of the Leichhardt and Marrickville LGAs where the existing population catchments are well established, the existing housing stock in many areas is aging and the future population growth potential in the areas adjoining the Light Rail corridor is considerable, with numerous potential development sites present as illustrated by the maps in Figure 7 and Figure 8.



**Figure 7: Potential Redevelopment Sites Adjoining the Light Rail Corridor in Leichhardt**



**Figure 8: Potential Redevelopment Sites Adjoining the Light Rail Corridor in Marrickville**



The Leichhardt LGA map in Figure 7 also does not include the proposed “Balmain Tigers” leagues club site redevelopment on Victoria Road, which is outside the primary walking distance catchment of the Light Rail line corridor. However, this site alone could potentially provide over 2,000 new dwellings, which is sufficient to meet the entire future 30 year urban consolidation “dwellings growth” scenario for the Leichhardt LGA.

Within the Marrickville LGA, the Light Rail line corridor is suitably located well to the west of the Aircraft Noise Affected (ANEF zone), Figure 8, where future residential development is not recommended.

## **5.2 Other Inner Sydney Potential Light Rail Extensions**

The proposed Inner West light Rail extension to Dulwich Hill is only one of many potential Light Rail route extensions which have been identified for the Inner areas of Sydney. In previous independent studies ( Prescott, 2008 ) and The 30 year Public Transport Plan for Sydney, ( Glazebrook, 2009 ) up to 9 potential new Light Rail routes for the Inner City areas of Sydney, which would serve numerous potential new urban development and urban renewal precincts throughout the Inner City extending as far south, east and west as Botany, Burwood and Bondi Beach.

### **5.2 Central CBD Extensions via George Street and/or Hickson Road**

Following the agreement of a “Memorandum of Understanding” between the City of Sydney Council and the NSW Government in September 2010, two new studies were commissioned in late 2010 to further investigate these route options for the Central CBD Light Rail extension. However, as the timing of these two studies effectively spanned the “caretaker government” period prior to the March 2011 NSW State Election, neither study was able to produce any public report or recommendation prior to the NSW State Election in March 2011.

Nevertheless, the formal public commitment of the NSW Government and the City of Sydney Council to the CBD Light Rail extension remains as stated in the “Ten Year Funding Guarantee” in the Metropolitan Transport Plan ( NSW Government, 2010). The City of Sydney Council have also publicly committed \$180 million of Council funding towards the street reconstruction works which will be required for the route along George Street ( SMH, 2011 - May ).

In the Central CBD currently buses and cars still dominate the mix of mobility options and the street environment. However by introducing new transit options that reinforce the quality of the street environment, the overall CBD urban environment can be improved – in terms of improved visual quality, and also reduced air quality, pedestrian safety, noise and amenity impacts - leading to richer work and play experiences and higher quality of life for the CBD workforce, residents and visitors, including the large numbers of international tourists who visit Sydney each year.

The real opportunity of Light Rail within the core streets of the Sydney CBD is the opportunity it presents to “revision” the central city area, as illustrated by the pair of existing and future streetscape images in Figure 9 and Figure 10. Quiet, clean trams will offer quieter more liveable streets, smoother more comfortable travel, more space for pedestrians and cyclists, and an attractive place for young people to live/work/play. Such a re-visioned city area will permit Sydney to compete better in the league ladder of World Cities. There is very real competition from other cities in Australia and overseas financial hubs such as Singapore and Hong Kong to be the pre-eminent cities in the Asia- Pacific Region, acting as magnets for world industry, finance and culture.



**Figure 9: Existing Sydney CBD Streetscape – George Street north of Bathurst Street**



**Figure 10: Future Sydney CBD Streetscape – George Street north of Bathurst Street**



Source: Arup – 2030 Revisioning Sydney Streetscape Project for the City of Sydney

Sydney's high on -going ranking as a World City is by no means assured. Light Rail gives the additional certainty of "rail means commitment" for future central city area transport access and amenity improvements for real estate developers, retailers and other businesses.

### **5.3 The Green Square – Green Loop Light Rail Corridor**

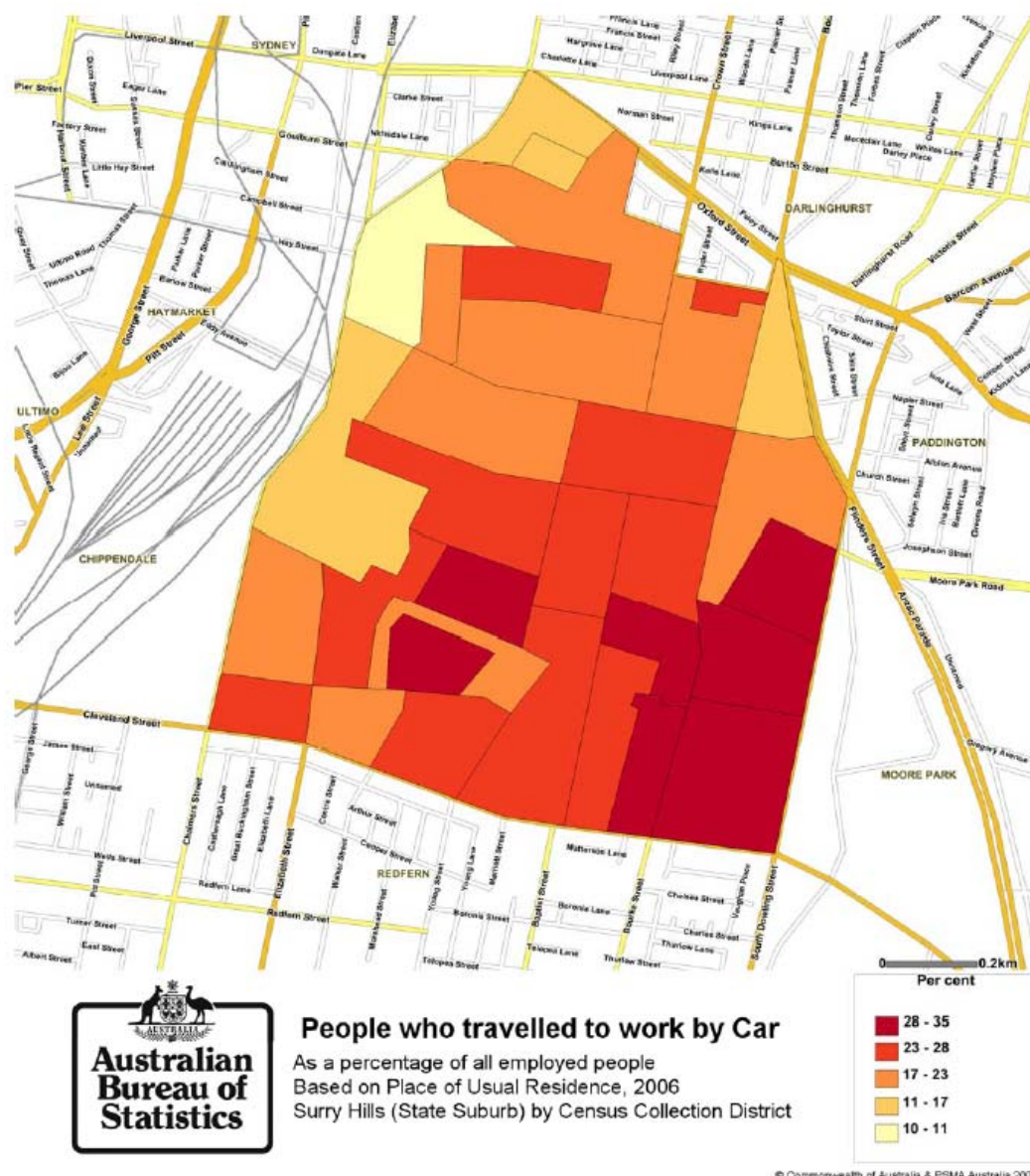
On the proposed Green Square, Green Loop light rail route, Botany Road, Bourke Street, Crown Street, and O'Dea Avenue all previously carried tram services on the 'Botany via Railway Square Network'. Returning Light Rail to these streets would be a 'restorative' move, providing a mode of transit sympathetic to the street environment.

The Crown Street and Bourke Street corridors through Surry Hills currently have comparatively high levels of car driver journey to work travel usage, with increasing

remoteness ( over 800-1000 metres typically ) from the nearest railway station at Central, as shown by the map in Figure 11.

This high car usage would be addressed by the Green Loop Light Rail proposal. Existing bus services in these areas are not sufficiently frequent or attractive enough to stop people using cars in these areas currently. Green Square is intended to be an emblematic urban development within Sydney, with a total of 10,000 new residential dwellings at Green Square and Victoria Park and more additional dwellings are proposed in the other urban renewal precincts of Redfern, Waterloo and Surry Hills/ Darlinghurst to the north ( up to 5,000 additional new residential dwellings potentially ) acting as prototypes for new sustainable developments elsewhere.

**Figure 11: Trend in Increasing Journey to Work Car travel with increasing distance from rail**



A reliable light rail system is likely to significantly reduce the Central City area car usage, as well as creating a better street environment for other non motorised transport system users. Light Rail extensions for Inner Sydney should provide high levels of comfort, reliability and frequency, such that they become a genuine alternative to private car use for all travellers.

The Green Loop transit system will provide opportunities to showcase new technologies in urban informatics and passenger information systems for the new trains.

Also, as the City of Sydney ( South ) sector of the LGA, will be responsible for providing a large proportion of the overall future City of Sydney dwellings growth target of +63,000 dwellings, in areas such as Redfern, Waterloo, Victoria Park and Green Square, public transport system improvements will be essential along the route of the proposed Green Loop light rail system.

Over the past ten years, the Green Square urban renewal precinct has been relatively slow to gain development momentum and badly needs the stimulus to development which a new Light Rail system through the area can provide, in particular for the urban renewal redevelopment sites in the eastern part of the Green Square-Victoria Park area which are substantially outside the 800-1000 metre walking distance catchment of any railway station.

#### **5.4 The Anzac Parade Light Rail Corridor**

On numerous occasions, throughout the past 20 years future proposals for restoration of the Light Rail tram service corridor connection the Sydney CBD with the Randwick area, via Anzac Parade, have been put forward for consideration by the NSW Government. The major proponents behind many of these schemes have been the group Ecotransit, the Randwick City Council and the University of NSW, which is now the only major University in Sydney whose major campus is not connected to either a light or heavy rail network.

The limitations of space in this paper prevent giving any detailed descriptions of the potential corridor patronage and other related benefits of the future Light Rail operations along this route. These benefits have however been recently addressed in other ATRF papers eg ( Norley, 2010 ). Also, the future reintroduction of Light Rail style tram services to the Anzac Parade corridor will be greatly facilitated by the former wide tramway reservation which still exists along the majority of the length of this route.

### **6. Future Light Rail Network Design and Operational Issues**

#### **6.1 On street running operations in mixed traffic**

Rail and Bus will continue to be the ubiquitous public transport modes in Greater Sydney for many decades, evolving to include cleaner green powered train sets and hybrid, clean fuel or electric buses, albeit supported by light rail and ferries, taxis, walking and cycling. The future constraints of Light Rail system operations for on street with other transit modes and other road users can be acknowledged as being, but not limited to:

- Ensuring the safety of pedestrians and transit users
- Ensuring accessible and inclusive transit
- Minimising potential disruption to essential vehicular access
- Minimising disruption to bus services
- Provision for systems control and power, including robustness against power blackout, breakdown etc
- Measures to address track blockage
- Minimising disruption to taxi ranks
- Optimum traffic signal co-ordination
- Consideration to be given to the clearances for overhead centenary wiring
- Measures to address loss of flexibility of routing parades and special events through city streets, eg Anzac Day marches, triathlons.

Any existing road, which is proposed to be converted to a future light rail route, must have at least four traffic lanes currently so that the minimum property access requirements can be maintained by means of a combined vehicle access/ parking lane for private properties, except where routes are adjacent to public parkland or frontage vehicular access was not required if adjacent property lots could provide alternative vehicular servicing access.

## **6.2 Vehicle Stabling**

Due to the shortages of suitable land in close proximity to Green Square and the Sydney CBD, all potential bus or tram storage sites on government-owned land should be identified in the vicinity of proposed Light Rail routes. Potential future bus or tram storage sites should also be investigated in the Inner West at the former Rozelle Goods Yard alongside the existing Inner West light rail line.

The former Rozelle Goods yard, which is located adjacent to the Light Rail network at Lilyfield, was identified during 2007/8 as the preferred future train stabling location for trains for the Sydney Metro project which is now deferred indefinitely. The alternative use of at least part of this site for future stabling of additional Light Rail vehicles to support future extensions of Sydney's Light Rail Network, should now be given serious consideration.

Another potential means of reducing the future Light Rail transit vehicle stabling requirements is to operate the service "24/7", thereby keeping a proportion of the vehicles either operational or parked at the outer end of the network throughout the night time and off-peak periods.

## **6.3 Passenger Interchange between routes**

As it will be difficult to achieve direct physical interchange of passengers between the proposed Light Rail routes, without requiring Light Rail services from the four different CBD approach routes to cross over or share tracks within the street of the Central CBD, north of Central station in the Sydney CBD, this is not recommended.

Such physical intersection or combination of two Light Rail routes will significantly reduce the potential peak operating frequency of both the Light Rail routes which are combined in this manner. However some physical interconnection of routes will be desirable for off peak movements or transfers of rolling stock between systems, eg along Hay Street in the vicinity of Central Station and via a tunnel at the northern end of George Street and Hickson Road. The best practical means of achieving future passenger interchange between the four key Light Rail routes within the Sydney CBD, will be by means of a wide east west "pedestrian tunnel" style concourse, enabling the Rail interchange passengers to easily cross the streets between each route in a weather protected environment, as shown in Figure 12.

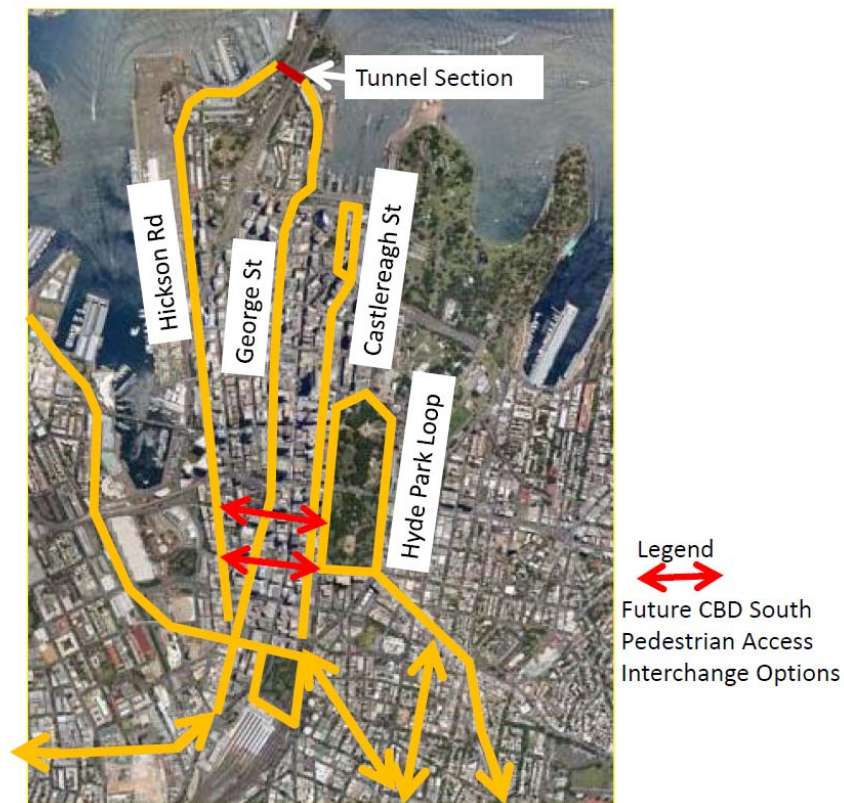
## **6.4 Other Related Bus and Rail Network Interchange Improvements**

In the longer term, the future practicality and viability of the potential network of four Light Rail route routes connecting Inner Sydney suburbs with the Sydney CBD will be enhanced if measures can be found to reduce the existing high numbers of buses entering the Sydney CBD via the Anzac Parade and Parramatta Road routes at peak periods. In the morning peak hour over 1000 buses now enter the Sydney CBD ( SMH, 2011 – March ), approximately 300 via the Harbour Bridge and 700 via other routes.

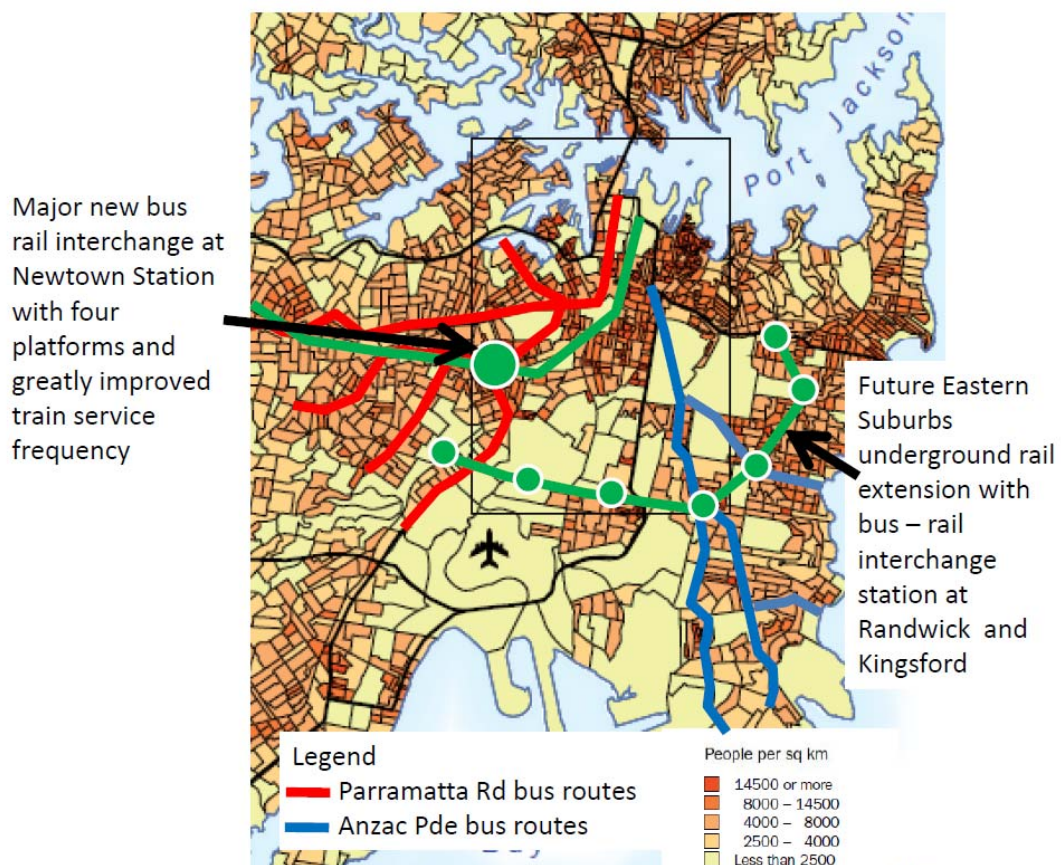
Future reductions in CBD bus numbers are critical to achieving the improved street environment and urban amenity benefits which are needed in the major north- south streets of the Sydney CBD. In the longer term, this objective will also be assisted by constructing major new bus-rail interchange stations on the Heavy Rail network, by means of an underground extension of the Eastern Suburbs Railway, with new stations at Randwick and Kingsford and constructing a new four platform railway station with a major bus-rail interchange for the King Street bus routes at Newton, as shown by the map in Figure 13.



**Figure 12: Future Light Rail Pedestrian Interchange Tunnel Locations in the Sydney CBD**



**Figure 13: Potential Future Bus-Rail Interchange Improvements for Inner Sydney**



Newtown is a high population density “potential major transit hub” railway station in the Inner West sub-region of Sydney, but the current transit access and bus-rail interchange function is severely compromised by the poor capacity of the existing railway station, which has only 2 platforms and only about 10 percent of all the railway trains which pass through the station actually stop there currently. Any passengers who wish to transfer from buses to rail at Newtown face potentially long waiting times currently, not to mention the fare penalty caused by the lack of an integrated zonal fare structure for all bus and rail travel in Sydney. This can however be resolved by a new purpose designed bus-rail interchange stations and the new integrated ticketing system for Sydney, which will eventually remove all the fare penalties and other disincentives for bus-rail interchange travel in Sydney.

## 7. Summary and Conclusions

The Inner West Light Rail extension to Dulwich Hill is a relatively low cost public transport system improvement, which the NSW Government is expected to proceed with by signing construction contracts later this year for operations to commence in Late 2012 or Early 2013.

Further potential extensions include three Inner City routes approaching the Sydney CBD via Parramatta Road, Oxford Street and Surry Hills ( Crown Street or Devonshire Street ) and four north south routes within the actual Sydney CBD via Elizabeth Street, Castlereagh Street, George Street and Sussex Street – Hickson Road.

The three Inner City routes, via Parramatta Road, Oxford Street and Crown Street all follow former tramway routes and there should be no technical difficulties with re-introducing Light Rail style tramway operations to these routes. Similarly the four CBD routes ( with the exception of Sussex Street – Hickson Road ) are also former tramway routes that can be easily retrofitted to re-introduce Light Rail style tramway operations.

In order to maximise the future system vehicle and passenger capacity, the four inner city routes and the four CBD route should all be matched so that actual Light Rail vehicles are not required to cross each other’s travel paths, similar to the proposed Rail Clearways operating system for Sydney’s heavy rail network.

Also in order to maximise the future system vehicle and passenger capacity, each incoming route will require a loop turnaround at the CBD end of the route.

For optimum passenger interchange between the four routes of the “ultimate” light rail network, a new East-West underground pedestrian concourse will need to be constructed underneath the roadways of either Bathurst or Liverpool Streets in the Southern Sydney CBD, extending from Elizabeth Street in the East to Sussex Street in the West.

The future Oxford Street Light Rail route should be extended via Anzac Parade to serve the University of NSW which is now the only major University in Sydney that does not have access to the Rail Network.

The Inner City & East Sub Region of Sydney has higher population growth rates than the Sydney average, which are occurring despite all the new housing development being limited to either flats or townhouses as there is no vacant available land for the construction of detached houses in this area of Sydney.

The future Inner City and CBD Light Rail improvements are needed to provide additional public transport capacity to serve a number of important urban renewal precincts and also to improve the overall street environment of the key north south streets of the Sydney CBD which are adversely affected by noise and air pollution impacts from bus operations currently.

In the longer term future potential major bus-rail interchange stations at Newtown, Randwick and Kingsford ( the latter two requiring an extension of the Eastern Suburbs railway ) will also potentially play an important role in reducing the need for future bus traffic from these routes

to travel all the way into the Sydney CBD, as rail interchange will provide faster journeys to and from the CBD potentially and also more improved interchange opportunities with the rest of the Sydney Rail Network.

Progress is being made with the introduction of Fully Integrated Ticketing and Fare integration between all of Sydney's public transport systems, most recently with the extension on 27 June 2011 of the validity of all Sydney's MyMulti daily, weekly, monthly, quarterly and yearly travelpass tickets to be also valid on the Light Rail services.

## References

- ABS, 2011 National Regional Profile data for Inner Sydney LGA's and SLA's
- City of Sydney, 1996, *Accessible City*, An Integrated Transport Strategy for Central Sydney
- City of Sydney, 2006, Review of Patronage and Revenue for the Castlereagh Street Light Rail Route, report by Glazebrook & Associates, May 2006
- City of Sydney, 2007, Sydney Light Rail Hickson Road Options Report – Final Draft, report by Hyder Consulting, February 2007
- Currie, 2009, BITRE Colloquium, Canberra 18-19 June 2009, Monash Institute of Transport Studies, presentation by Professor Graham Currie
- DIPNR, 2004, Media Release, *Keeping communities in a growing city*, 13 December 2004
- GHD, 2010, Sydney Light Rail Inner West Extension Study, Final Study, July 2010.
- NSW Government, 2010, Metropolitan Transport Plan, *Connecting The City of Cities*
- Norley, 2010, Light-Rail: the semi-metro concept, paper of the 33<sup>rd</sup> Australasian Transport Research Forum, Canberra, 2010, by Kym Norley.
- Prescott, 2008, *A Practical Scheme for Light Rail Extensions in Inner Sydney*, article in Transit Australia, vol 63, no 11, November 2008
- SMH, 2011- March, *Boulevard of dreams comes with a hidden cost*, Sydney Morning Herald article, 2 March 2011
- SMH, 2011- May, *Keating lashes muesli-chewer Barangaroo Inquiry*, Sydney Morning Herald article, 6 May 2011
- Transport NSW, 2010, Sydney Light Rail Extension – Stage1- Inner West Extension, Environmental Assessment, report prepared by Parsons Brinkerhof, October 2010.