

Sydney's Sustainable Housing & Integrated Transport Strategy

A 'Fast West Metro' + VHST to support affordable housing in the Bays Precinct & outer suburbs

Potential Stages:

1. *Reduce CBD bus congestion* immediately and cost-effectively by re-routing buses (instead of CBD & Eastern Suburbs light rail).¹
2. *Fast West Metro: CBD to Parramatta with branch to Epping & NWRL* (blue lines in map 1)
 - MartinPlace-Pyrmont/Barangaroo-Rozelle-TopRyde-WestRyde-UWS-Parramatta (Victoria Road),
 - Branch to Epping from West or Top Ryde delivers the Treasurer's commitment of NWRL trains direct to Sydney CBD (without passenger interchange).
or Rozelle to Five Dock-Strathfield-Olympic Park-UWS with branch to Epping from Strathfield.
 - CBD to Parramatta in under 20 minutes² (vs current 30-40 minutes) supports growth of Parramatta:
 - Parramatta practically merged with Sydney CBD (becoming effectively one employment centre)
 - high-value jobs close to western Sydney residents – reduces travel times & increases productivity
 - boosts demand & investment in more affordable housing in western Sydney ('closer' to jobs).¹
3. *Metro continues all-stops from Parramatta to Blacktown, Richmond & St Marys/Penrith*:
 - All stations every few minutes, yet *faster* than at present: Penrith/Blacktown to CBD ≈ 50/30 mins.³
 - Relieves key network capacity constraints of main-west corridor and harbour bridge.
4. Rapidly develop *affordable/social modular housing in the Bays Precinct & 'closer' western suburbs*.
5. Metro conversion of North Shore-Harbour Bridge-Inner West & Bankstown & Epping-Chatswood – made easier as new Epping-CBD metro provides an alternative path for diverted passengers (see p.7).
6. Convert Eastern Suburbs Railway to metro and potentially extend it to Randwick and Maroubra from Central or from Edgecliff or Bondi Junction. Expand metro to form an *Outer Sydney Orbital*.
7. *Badgerys Creek airport & Very High Speed Train* (VHST - black route in map 1) to new outer suburbs:
 - Parramatta is the primary Sydney station (further east will have congested road access and only gets you ≈ 5 minutes closer to Sydney CBD). VHST then goes north to Epping, Hornsby & Newcastle and south to Liverpool, Goulburn & Canberra.
 - Close and redevelop Bankstown airport.
 - Japanese maglev (600kph) funded / financed by land value uplift & vendor (at < 2% interest)⁴

Savings to Government over the next 10 years (indicative, after value-capture & farebox increases):

- Defer second rail harbour-crossing indefinitely (probably over 50 years), saving:
 - \$11bn less ≈ \$7bn net cost to Government for CBD-Ryde-Epping/Parramatta-Penrith metro ≈ **\$4bn**
- Defer Epping - Chatswood conversion - \$?m (& avoid extended closure & commuter disruption)
- Indefinitely defer CBD-eastern suburbs light rail: **\$2bn+**
- Avoid western line capacity upgrades: ≈ **\$2-3bn+** (ball park guesstimate).
Also avoids very disruptive line closures over many years (if there were no alternative new metro).
- Replace Parramatta-Epping/Macquarie Park - light rail with future VHST: **\$1bn+**
(also Fast West Metro provides a better outcome than light rail for Parramatta and western Sydney)
- Standard rail link to Badgerys Creek replaced with VHST: avoid \$?m
- Opportunity to downscale WestConnex (due to Fast West Metro relieving some west-east car demand).

Total avoided costs ≈ \$10bn (≈ est. 10-year funding gap for current plans/risks, even with electricity sale, noting bond investors look for sustainable finances over 10 years rather than the traditional 4-year budget).

¹ <https://sites.google.com/site/drdauidcthorp/transport/CBD-bus-rerouting> & /fast-cbd-parramatta-rail

² *Sydney Transport Review*, by Jim Steer (steer davies gleave) for NSW Treasury, February 2008

³ Delay per station with 120kph metro rail & fast acceleration & braking ≈ 1 min vs 2-3 mins with Sydney's double-deck trains, which are ≈ 60 mins to Wynyard from Penrith every 6 mins, or ≈ 90 mins on all-stops trains (typically every 20-40 mins).

⁴ A longer-term possibility could be Tesla/Elon Musk's Hyperloop, if successfully developed: <http://hyperlooptech.com/>

Funding/value capture and other benefits/support

- Vastly higher farebox revenues than the Chatswood to Bankstown Rapid Transit plan due to:
 - Higher mode share from a faster and more frequent & reliable service along the high-demand corridor of western Sydney to CBD
 - Induced business trips between the CBD and Parramatta
 - Opportunity to charge premium fares for the major time savings between Parramatta and the CBD (which may start to bring general fares up closer to those charged in places like the UK).
- Reduced operating costs as metro operations displace Sydney Trains
- Potential Commonwealth funding linked to Badgerys Creek airport.⁵
 - CEO of Infrastructure Australia should support it.
- Expect strong support from the Committee for Sydney & Sydney Business Chamber.
- Expect strong support from commentators such as Alan Kohler,⁶ the Daily Telegraph and western Sydney residents for a strategy that improves housing affordability and the economic productivity of western Sydney residents (in contrast to current official infrastructure plans, which will reinforce economic activity and housing cost pressures in the congested east and detract limited funds from other public services).
- Avoids growing opposition to the disruption & congestion that CBD-east suburbs light rail will cause.
- Superannuation funds may invest, given poor economic prospects in other sectors at present and especially if supported by tax and regulatory reform. A more flexible and customer-focussed superannuation industry could provide lower risk finance (requiring lower returns) with dividends replaced by public-transport fare discounts.⁷ This would exploit theories of efficient ‘Ramsey pricing’ as applied to existing loyalty-pricing or 2-part price structures in telecommunications & other utilities.⁸

Value capture / development opportunities

- NSW Government may benefit directly from increased values of past land/property acquisitions for the NW Metro, CBD Metro and possibly light rail and other acquisitions over recent years.
- Redevelopment at stations:
 - St James & Museum (hotels / apartments on top overlooking Hyde Park)
 - Demolish the Cahill Expressway and Circular Quay station and redevelop ferry terminals (divert ferries to Barangaroo where possible)
 - Town Hall, Wynyard & Central to Eveleigh (no new lines but stations & above-rail redevelopment facilitated by passenger diversion to new metro going to Martin Place, St James & Museum)
 - Parramatta station (move existing station underground and add VHST station)
 - Barangaroo/Pymont, Bays Precinct, Rozelle (Tigers Club & Bridge Hotel), UWS and other new stations along the new metro route (Top Ryde & possibly Five Dock, Strathfield & Olympic Park, depending on the route chosen) & stations west of Parramatta with improved metro rail services.
 - Liverpool and Bankstown (with VHST and Badgerys Creek airport).
- Auction increased Floor-Space-Ratio (FSR) limits in centres with enhanced rail access:
 - Sydney CBD and Parramatta especially could contribute significantly to the cost of the metro stations & line.
 - Allow relevant local councils to sell increased FSRs; require them to meet social/affordable housing targets or pay a levy into a *Social & Affordable Housing Fund*. NSW Government (FACS) to determine client eligibility criteria for social housing and *clearer / tighter & consistent criteria for “affordable housing”* (focussed on those most in need).

⁵ Financial Review 29 May 2015 suggests the Greens may strike a deal with Abbot to raise petrol tax and divert some funds to State public transport projects.

⁶ www.businessspectator.com.au/article/2015/2/23/infrastructure/australias-train-nowhere

⁷ <https://sites.google.com/site/drdauidthorp/superannuation>

⁸ <https://sites.google.com/site/drdauidthorp/transport/sydney-overground>

Parramatta, Olympic Park and VHST route

The route option from CBD to Parramatta via Five Dock serves Strathfield and Olympic Park before connecting to the University of Western Sydney (UWS), but requires more stations and a longer (more expensive) branch to get to Epping (via West Ryde or Top Ryde). If the northern (Victoria Road) route is used instead, then Olympic Park could potentially be connected to Parramatta by light rail or a dedicated bus lane, but the \$1bn cost of the planned light rail line⁹ should just about cover the cost of the extra stations and tunnel for the metro route via Olympic Park, which would deliver a much better service.

The southern route via Five Dock & Strathfield should still manage Sydney CBD to Parramatta in about 20 minutes or less, especially during the critical *off-peak* business times from the major new commercial developments in Barangaroo (these trips are critical for supporting business development in Parramatta). From Barangaroo there will be five intermediate stations before Parramatta, with two of them – Rozelle and Five Dock – likely to have a relatively small dwell delay in the off-peak.

There are various options to be investigated for metro and VHST stations at or near Parramatta, which includes the opportunity to move the existing Parramatta station underground, and hence open up the city's civic space.¹⁰

VHST route and rationale

The purpose of VHST is not to compete with Melbourne-Sydney-Brisbane flights, or to deliver people to Sydney CBD. The primary purpose of VHST, at least for the first 10-20 years, is to connect cheap land (for more affordable housing) to jobs in Sydney, and thereby facilitate continued growth (in population, but more importantly, in productivity due to increased agglomeration benefits).

For a realistic VHST project, it is necessary to have initial, relatively small stages that are economically viable in their own right, which must avoid excessive tunnelling to Sydney CBD (as was unfortunately, and perhaps deliberately assumed in the Commonwealth's 'phase 2 report' on High Speed Rail).¹¹ This can be achieved by connecting into Parramatta – the centre of Greater Sydney – and connecting Parramatta more quickly to Sydney CBD via the new metro. This approach is then also consistent with the metro rail objective of growing high-value jobs in Parramatta, closer to the majority of the population in western Sydney.

The *indicative* VHST route in map 1 connects to Parramatta through Hornsby, Epping and Liverpool,¹² and takes a dog-leg from Liverpool to Badgerys Creek airport. Improving the rail service to/from Liverpool is desirable in order to promote its long-term role as Greater Sydney's third regional city. However, alternative routes could include a VHST from Parramatta directly to Badgerys Creek, or via Blacktown, or to Liverpool and directly south, with interchange required to get to Badgerys Creek. The proposed continuous, dog-leg route to Liverpool and then Badgerys Creek is based on the following reasoning in relation to prospective VHST and airport demand:

- The wealthiest people in Sydney are likely to continue to live in inner / east / northern Sydney, work in top jobs in Sydney CBD/North Sydney and go to Kingsford Smith Airport (often by taxi). They are not the primary target market for the Fast West Metro, Badgerys Creek and VHST.
- Badgerys Creek and the VHST will serve lower-wealth households and businesses, who may currently live and work in outer suburbs or centres such as Parramatta, Macquarie Park, Westmead and perhaps Sydney CBD fringes (or a different, more affordable city). There are a few sub-markets in this category:

⁹ <http://www.dailytelegraph.com.au/news/sydney-olympic-park-light-rail-project-promises-long-overdue-linking-up-of-infrastructure/story-fni0cx4q-1227387417064>

¹⁰ Parramatta options are at <https://www.facebook.com/groups/FROGSDiscussion/>
Contact david.adams@strategex.com.au & russ.lunney@internode.on.net

¹¹ 10000friends.org.au/reports/Docs/197/Response%20to%20Feds%20Phase%202%20Report%2022%20May%202013.pdf

¹² Note Epping and Liverpool may be restrictive to build 300m platforms for VHS trains, so passengers wishing to disembark at these stations may be warned to board the front of the train, whilst the back end stays in tunnel at these stations.

- i. People living in western Sydney wanting to work in Sydney CBD. For those people living within access to relevant stations, the new Fast West Metro to Sydney CBD, along with possible interchange to/from the VHST, will substantially reduce their commute time.
- ii. People wanting to live and work in western Sydney. Decisions on where to locate relevant businesses will be made by owners / managers who need to tightly manage costs, yet be in an accessible place for their many employees living in western Sydney whilst still having good access to an airport and Sydney CBD (to trade with existing businesses there and to attract potential eastern suburb employees). For them, the new Fast West Metro linking Parramatta to Sydney CBD and the VHST linking to Badgerys Creek, will make Parramatta an attractive business location. Over time, these businesses will form an increasing share of the total market as a growing Parramatta develops its own agglomeration economic benefits.
- iii. People wanting to further reduce their living costs (or choose a different lifestyle) will be able to move to cheaper housing further along the VHST line (e.g. Hornsby, Newcastle, Goulburn, Canberra) and still get quickly to work in Parramatta or Badgerys Creek (for business or leisure).
- iv. People living in South-West Sydney will fly from Badgerys Creek but tend to access it by car.

For the second and especially third categories of demand above, a direct link from Parramatta to Badgerys Creek without interchange (via the VHST dog-leg) is valuable if flight customers have heavy baggage (as opposed to having to interchange at Liverpool from VHST to another train to Badgerys Creek if the VHST went directly south from Liverpool). Given a relatively long total journey (including flight time), the delay from a dog-leg VHST route from Liverpool to Badgerys Creek will be inconsequential (and likewise, the impact on VHST costs, relative to total VHST length, will also be minimal).

Similar arguments apply for people wanting to travel by VHST from, say, Newcastle to Canberra. Moreover, for international flights from Badgerys Creek, a direct VHST will enable customs and baggage check-in to be done at distant VHST stations (e.g. Newcastle), with seamless bag transfer from VHST to a plane at Badgerys Creek airport.

Finally, to the extent that there is some potential demand from cost-conscious people in Sydney CBD wanting to fly from Badgerys Creek, the alternative of a regular Sydney Trains service (even with a faster metro service to Bankstown) will be far too slow, because of the delays from stopping at so many stations, and/or the need for multiple interchanges (e.g. metro to Parramatta, change to VHST to Liverpool, then change for Sydney Trains to Badgerys Creek). These customers would simply go to Kingsford Smith. But for the budget-conscious flyer in or near Sydney CBD, one change at Parramatta from the Fast West Metro, then VHST to Badgerys Creek may be tolerable.

Nevertheless, it should be emphasised that the VHST route proposed in this paper is highly indicative and just one of many options that should be assessed with comprehensive transport and economic analysis before committing to any one option. This includes consideration of routes via Blacktown, and the proposed SWRL extension¹³ and Outer Sydney Orbital metro rail system.¹⁴

Finally, it may be noted that once Badgerys Creek airport opens, there is the opportunity to close & redevelop Bankstown airport – with Bankstown instead connected to other commercial centres by the VHST and by a faster and more frequent service on the existing rail line (converted to metro operations).

¹³ <http://www.transport.nsw.gov.au/projects-swrl-extension-corridor-preservation>

¹⁴ <http://www.transport.nsw.gov.au/projects-oso-corridor>

Rozelle to CBD and eastern suburbs (maps 2 & 3)

Rozelle

Rozelle Tigers / Balmain Leagues club / “Rozelle Village” was the previously proposed site of the Rozelle metro station. It has land that is currently at minimal value, due to community / Council opposition to development and the consequential risk faced by prospective developers. This maximises the potential uplift if Government owns land there and then announces a rail station and approval for higher density. Full economic analysis of options should be used to determine whether these benefits plus the relatively small transport benefits (given Rozelle’s proximity to the CBD and the reduced bus congestion available from re-routing – see maps 2 & 3) outweigh the cost of a station and the extra dwell delay (increasing the travel time to Parramatta and reducing the agglomeration benefits between Sydney CBD and Parramatta).

A high-level footbridge from a redeveloped (6+ storeys?) *Bridge Hotel* (currently in poor condition) to a redeveloped Tigers / Rozelle Village (i.e. no stairs, access via public express lift &/or escalators each side), would facilitate transfer of bus passengers from Drummoyne and Gladesville to the metro (see map 2).¹⁵

CBD, Pyrmont & Bays Precinct (with affordable housing)

- Connect the Bays Precinct by cable car from new high buildings (≈20 storeys?) to Pyrmont Star Casino & light rail – subject to being fully privately financed and funded by unregulated fares (since walking is a reasonable alternative over the short distances involved of about 1-1.5km).¹⁶
- Quickly install affordable, medium-density modular housing (which can be erected in about a week). High-quality 3-bedroom, 2-bathroom modular homes (≈100m²) stacked up to 5 storeys could be installed for about \$200k, with optional sustainable water systems and integrated solar power (reducing or even avoiding new electricity grid infrastructure costs by using stand-alone Tesla batteries).¹⁷ On-site manufacturing in the Bays Precinct of complete housing and integrated utility systems could significantly reduce costs and environmental impacts.
 - Carbon credits may help fund such housing when Australia inevitably restores a pragmatic carbon trading scheme based on the prior NSW Greenhouse Gas Abatement Scheme (GGAS) – which is conceptually similar to (and preceded) the UK’s former approach and other schemes promoted by Frontier Economics (Danny Price) & Malcolm Turnbull, and even (less efficiently) the current Australian Government’s ‘Direct Action’ plan.¹⁸
 - As noted above, value capture levies could be used to fund affordable homes and although these modular homes are designed to last 50 years, they could be replaced with high density apartments after a decade, say, and moved elsewhere (e.g. to relocate tenants during redevelopment of social housing estates).
- Develop high-density housing in the Bays Precinct and potentially increase public transport capacity with ferries and light rail (if economically viable).

No need for new CBD rail lines or stations

Sydney CBD, from Liverpool Street (at the south end of Hyde Park) to Circular Quay is a small area of only about 1 x 2 km (about a 20 minute walk top to bottom), and is blessed with 6 stations and 4 pairs of rail lines. There is no shortage of capacity if these assets were fully utilised with the efficiency of modern “metro rail” systems.

As indicated in the tables below, single-deck metros operating at 30 trains per hour (tph) can comfortably carry 50% more passengers than current Sydney Trains (with the potential to more than double capacity with crush loadings through short inner-city sections). There is also plenty of spare station capacity – the combined PM peak entries at the four platforms of St James + Museum and Martin Place + Circular Quay

¹⁵ This would be similar to the original Tiger’s development proposal and would address serious pedestrian safety issues at the current crossing there, as well as avoid increased ‘green time’ that would be required for substantially more pedestrians (which would congest Victoria Road traffic flows). Since the Bridge Hotel is so aptly named, the footbridge could be called “Thorp-bridge” or “Bridge-thorp”, since it goes to “Rozelle Village” and Thorp is a Viking name that means “Little Village”!

¹⁶ Note this cable-car proposal would be substantially shorter and cheaper than that proposed at: www.harbourskylink.com

¹⁷ www.tektum.com.au

¹⁸ <https://sites.google.com/site/drdauidcthorp/energy-greenhouse>

are only one third and two thirds respectively of that at Wynyard. Town Hall has 50% more platforms than Wynyard, but only 18% more peak passengers.

Currently, severe congestion is generally limited to only the PM peak hour at two of the 18 CBD platforms: platform 2 at Town Hall and platform 3 at Wynyard (for trains from North Sydney).¹⁹ Actual current double-deck peak train operations are typically 17-19 tph compared to a timetable and near-term target of 19-20 and an ambitious ultimate goal of 24 tph (23 tph may be more realistic).²⁰ The City Circle currently only has 30 tph operating on *two* tracks entering the CBD (14 entering at Town Hall, 16 via Museum); i.e. half of what metro on two tracks could deliver.²⁰

Train system ²¹	Pax / train	Seats / train	Trains / hr	Pax / hr	Seats / hr
Sydney Trains double deck	1,200	890	20	24,000	17,800
Single deck – high seating	1,200	600	30	36,000	18,000
Single deck – maximum	2,000	400	30	60,000	12,000

Stations (with no. of platforms)	Peak entries (3-4:30pm) in 2011-12
Town Hall (6)	39,000
Wynyard (4)	33,000
Martin Place + Circular Quay (4)	20,000
St James + Museum (4)	10,000

Strategy for increasing CBD rail capacity

In 2012, Interfleet UK (for INSW) proposed one possible train operations plan that would use single-deck metro trains and other strategies to increase capacity by 55% over 15 years, using predominantly existing track and station infrastructure.²⁰ Simplifying current complex service patterns is a key part of the solution.

Another strategy proposed by the late Barry Garnham and supported by others,^{22,23} is to break the City Circle and initially operate one part of it as a higher capacity metro. Trains coming into Wynyard platform 6 from Town Hall on the current City Circle tracks would return at Wynyard (from platform 4).²⁴ This also enables Circular Quay station and the Cahill Expressway to be demolished, thus allowing this prime public/tourist area to be opened up to the harbour views.

Generally, the preferred strategy is to operate all lines at 30 tph, and accept increased standing over short distances (e.g. < 20 minutes) before investing heavily in new multi-billion dollar infrastructure.²²

Map 2 in this paper proposes to connect the new fast-west metro to a broken City Circle at Martin Place (probably) & St James, continuing then to Museum and Central, and potentially being extended from there to the eastern suburbs.²⁵ It could also connect at Martin Place to the Eastern Suburbs Railway (converted to a franchised metro²⁶) and then be extended to Randwick & Maroubra – either from Bondi Junction¹⁹ or at a branch from Edgecliff.²⁷ The metro would probably not connect directly to Wynyard as it will be a

¹⁹ INSW 2012 SIS report chapter 8: http://www.infrastructure.nsw.gov.au/media/16985/sis_report_section8.0_print.pdf

²⁰ www.infrastructure.nsw.gov.au/media/16718/interfleet_summary.pdf

²¹ Double-deck assumes a nominal capacity of 1200 people with seating in line with Waratah train specifications. Planned frequency of 20 tph across the harbour bridge from Sydney's Rail Future; Single-deck 'high seating' capacity could have 500-600 seats (Source: Halcrow 2011); single deck would be based on standard international design with 3 doors per side. 'Maximum' single deck sourced from MTR for Transport for NSW.

²² Communication with Simon Lane, former CEO of CityRail and Singapore metro

²³ www.10000friends.org.au/reports/Docs/162/Why%20Fast%20Metro%20to%20West%20Dec%202010.pdf

²⁴ with a turn-back in the tunnels just north of Wynyard or a cross-over prior to platform 4 (making platform 6 redundant).

²⁵ The approach presented in this paper is a preferred, least-cost solution, if proven to be feasible after detailed planning & analysis. Other more expensive options can be considered, e.g. as per the original Rozelle-CBD metro proposal.

²⁶ Facilitated by building the Maldon-Dombarton Link to take freight off the Illawarra line.

²⁷ Further details from Russel Lunney: russ.lunney@internode.on.net

long way below it after tunnelling under Darling Harbour, making a station at Wynyard very expensive (interchange to Wynyard trains could instead be assisted through pedestrian tunnels, as described below).

A possible plan to redevelop CBD stations and convert services to high capacity metro could be as follows:

- **Reduce CBD bus congestion** immediately by re-routing buses (see maps 2 & 3),²⁸ complemented by use of high-capacity, articulated buses²⁹ (preferably rapid-charge hybrid-electric, for quiet and clean CBD operation³⁰) and broader bus network reform to provide a frequent “anytime, anywhere” ‘Sydney Overground’ service.⁸ This strategy could also include changes to bus pricing/ticketing systems to reduce CBD boarding delays, and broader reform of road and car parking prices, particularly for Sydney motorways and the cross-city tunnel, to reduce car demand in the CBD.
- **Build the Fast West Metro**, with tunnels from Parramatta and Epping to Sydney CBD (& potentially also to Blacktown). Construction access to the new CBD tunnel and Martin Place & St James stations would be possible by demolishing 12 Castlereagh St (Government-owned building on a site originally planned to become a CBD Metro station).
- **Redevelop St James and Museum stations** (with hotels / apartments on top overlooking Hyde Park) one at a time (passengers can be diverted to the open station given their current very low utilisation), then connect the new metro into Martin Place (probably) and St. James.
- Fast West Metro replaces current Western Line services.³¹ This will facilitate reconfiguration of tracks entering the CBD, **redevelopment of Town Hall and Wynyard stations** and **the Central to Eveleigh urban development area**, and upgrade of the Western Line (with lower costs and delays than if working on a ‘live’ line operating at full capacity).
- Convert to metro the 30tph trains from Liverpool and SW Sydney (including Inner West and Bankstown services) that currently go round the City Circle, and run these over the harbour bridge and up the North Shore line.²² (Conversion facilitated by patronage diversion to Epping & Metro to CBD.) Some Fast West or NW Metro services may then continue from Central to Waterloo/Green Square, Kingsford Smith Airport and SW Sydney.
- Trains from Hornsby to Central via Epping will terminate at Central or Wynyard (once a turn-back is built). They could continue as double-deck or be converted to metro along with Epping-Chatswood.
- Demolish Circular Quay station and the Cahill Expressway.
- Convert the Eastern Suburbs Railway to metro and potentially extend it to Randwick & Maroubra (and perhaps, eventually, to Bondi Beach).

How long until a second harbour crossing is needed?

The need for major new CBD infrastructure can be triggered by demand from the south or north.

Currently, on the 4 lines entering the CBD from the south & west (Western line, 2 x City Circle & the ESR), Sydney Trains only operates about 60tph into the north CBD beyond Central.²⁰ With all lines eventually converted to metro operation, this could double the total trains into the CBD (4 x 30tph = 120tph), thus *comfortably doubling seating capacity and tripling total capacity* (2 x 36/24 = 3; refer tables above). Capacity could potentially then be further increased by a factor of 1.67 (=60/36) if less seating and maximum (crush) loading conditions are tolerated over short distances from the CBD, thus *increasing capacity five-fold* vs the current capability (3 x 1.67 = 5).

From the north there is less spare capacity, but with greater community constraints on development than western Sydney, the rate of demand growth will be less, especially as the new Fast West Metro will take many people from NW Sydney. Starting with 19 tph (including 8 from Epping),²⁰ the number of trains can be increased by 58% to 30tph, and with high standing loads (over short distances) the *total capacity could increase by about a factor of four* (= 1.58 x 60/24).

²⁸ <https://sites.google.com/site/drddavidthorp/transport/CBD-bus-rerouting>; Sussex St. bus terminal plan by Russel Lunney.

²⁹ e.g. The Mercedes-Benz CapaCity has a capacity of 193 passengers, with 42 seats (fully low-floor, 20m bus with four double-width step-free entrances, single-articulated with two steered axles giving 23m turning circle).

³⁰ <http://www.opbrid.com/index.php>

³¹ Double-deck Blue Mountains trains could terminate at Central or at St Marys with interchange to the Fast West Metro.

Eventually (after many decades of CBD demand growth) the second harbour crossing could be built, and possibly be extended to northern beaches (subject to increasing housing densities there). The current forecast growth in CBD rail demand is about 50% over the next 20-25 years, or 1.5-2.0% p.a.,²⁰ but this may be reduced if some ‘peak of the peak’ demand were shifted to the shoulders through a tighter, 1-hour peak pricing window,³² and/or if Sydney CBD employment growth is moderated by the increased attraction of Parramatta resulting from the Fast West Metro (giving improved connection to Sydney CBD businesses), especially in the long term if a VHST brings employees into Parramatta from new outer suburbs (Newcastle, Goulburn, Canberra). On the other hand, improved metro rail and bus services and increasing road congestion may push total public transport demand growth higher than current forecasts.

The table below shows how many years it would take before the CBD rail system reached capacity (i.e. increased by a factor of 4 or 5), depending on the annual demand growth rate. A second harbour crossing seems unlikely to be needed for more than 50 years, but by then there may be better options available.³³

Annual growth	Years to reach 4 x capacity	Years to reach 5 x capacity
1.5%	93	108
2.0%	70	81
2.5%	56	65
3.0%	47	54

Access to/from & interchange between CBD stations

Because Sydney CBD is so small, there is no need for more stations to improve connectivity to employment locations, but interchange between train lines can be slow and inconvenient if it involves exiting & entering two stations, walking across surface streets and waiting to cross roads (especially in bad weather). However pedestrian tunnels can improve the experience, and some tunnels already exist from Town Hall to Pitt St. Mall and from Pitt St. to Wynyard and Barangaroo (via “Wynyard Walk” to near King St. Wharf 1). As map 2 shows, relatively little new pedestrian tunnels would be required to connect all CBD stations from Museum to Wynyard. If fitted with high-speed travelators (conveyor walkways, which can operate at 7-9 kph³⁴) walking times in these tunnels could be reduced by a factor of 2-3. The following table gives the approximate distance and walk time between selected CBD stations (the shorter of the distance range for Museum to Town Hall is by an almost direct-line tunnel):

Station pair	Distance	Walk time	Time with travelator
St. James to Martin Place	≈ 270 m	≈ 3 mins	≈ 1 min
Martin Place to Wynyard	≈ 630 m	≈ 7 mins	≈ 3 mins
St. James to Wynyard	≈ 900 m	≈ 10 mins	≈ 4 mins
Wynyard to King St. Wharf 1	≈ 430 m	≈ 5 mins	≈ 2 mins
St. James to Town Hall	≈ 800 m	≈ 9 mins	3-4 mins
Museum to Town Hall	400-500m	≈ 5 mins	2-3 mins

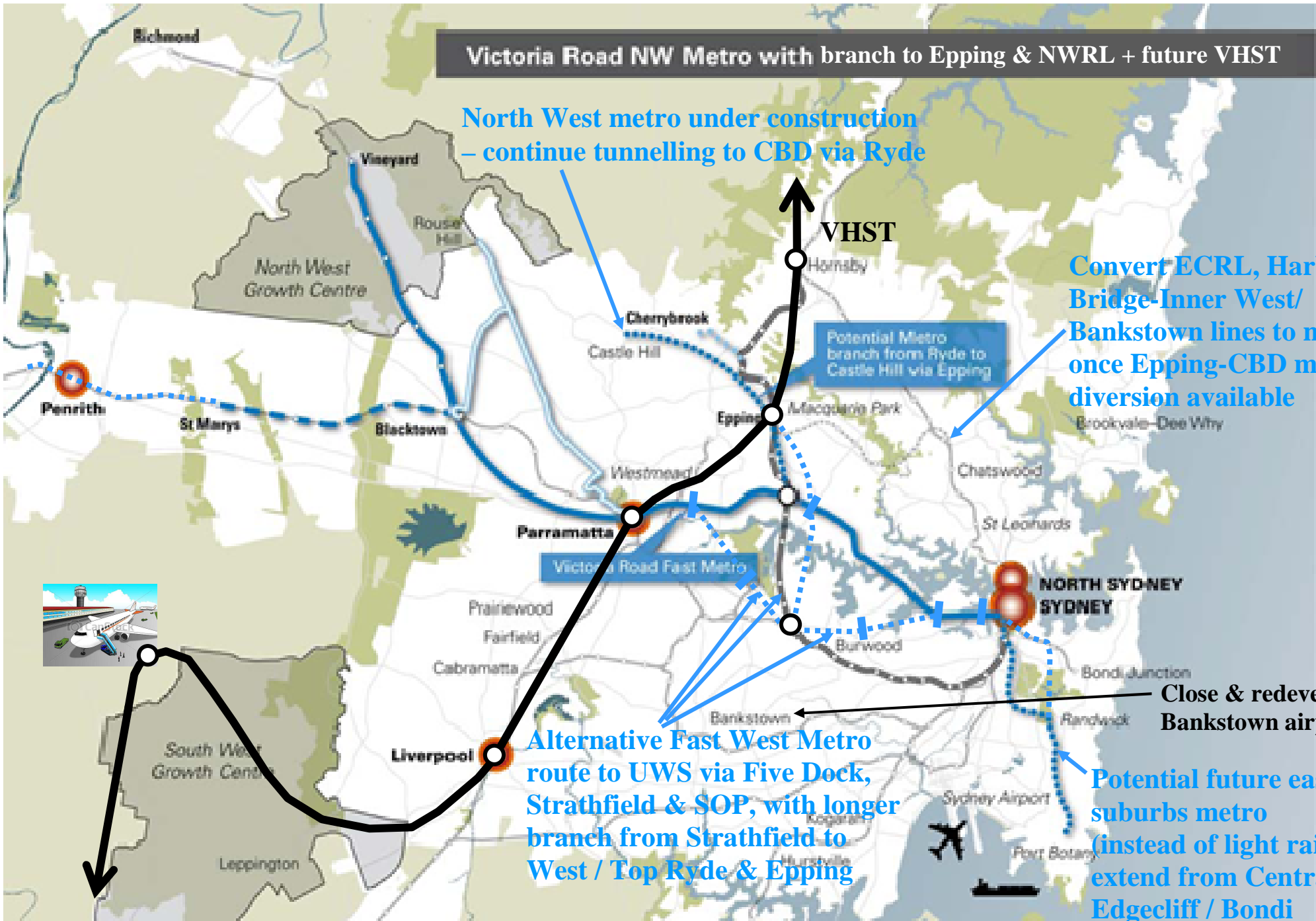
From near King St. Wharf 1, *a single station under Darling Harbour could be accessed via pedestrian tunnels from both Barangaroo and Pymont.*²⁷ This would avoid the cost of two stations at each location, and reduce the train delay from another station stop, which is important to ensure the metro can reach Parramatta faster (and thereby encourage businesses to establish there).

³² http://www.infrastructure.nsw.gov.au/media/16691/douglas_economics_insw_modelling_fares.pdf

³³ e.g. Tesla / Elon Musk’s Hyperloop, which could go from Sydney to Melbourne in 40 minutes www.news.com.au/travel/construction-on-billionaire-visionary-elon-musks-hyperloop-to-begin-in-california-next-year/story-e6frfq7r-1227244012466

³⁴ http://en.wikipedia.org/wiki/Moving_walkway

Victoria Road NW Metro with branch to Epping & NWRL + future VHST



**North West metro under construction
– continue tunnelling to CBD via Ryde**

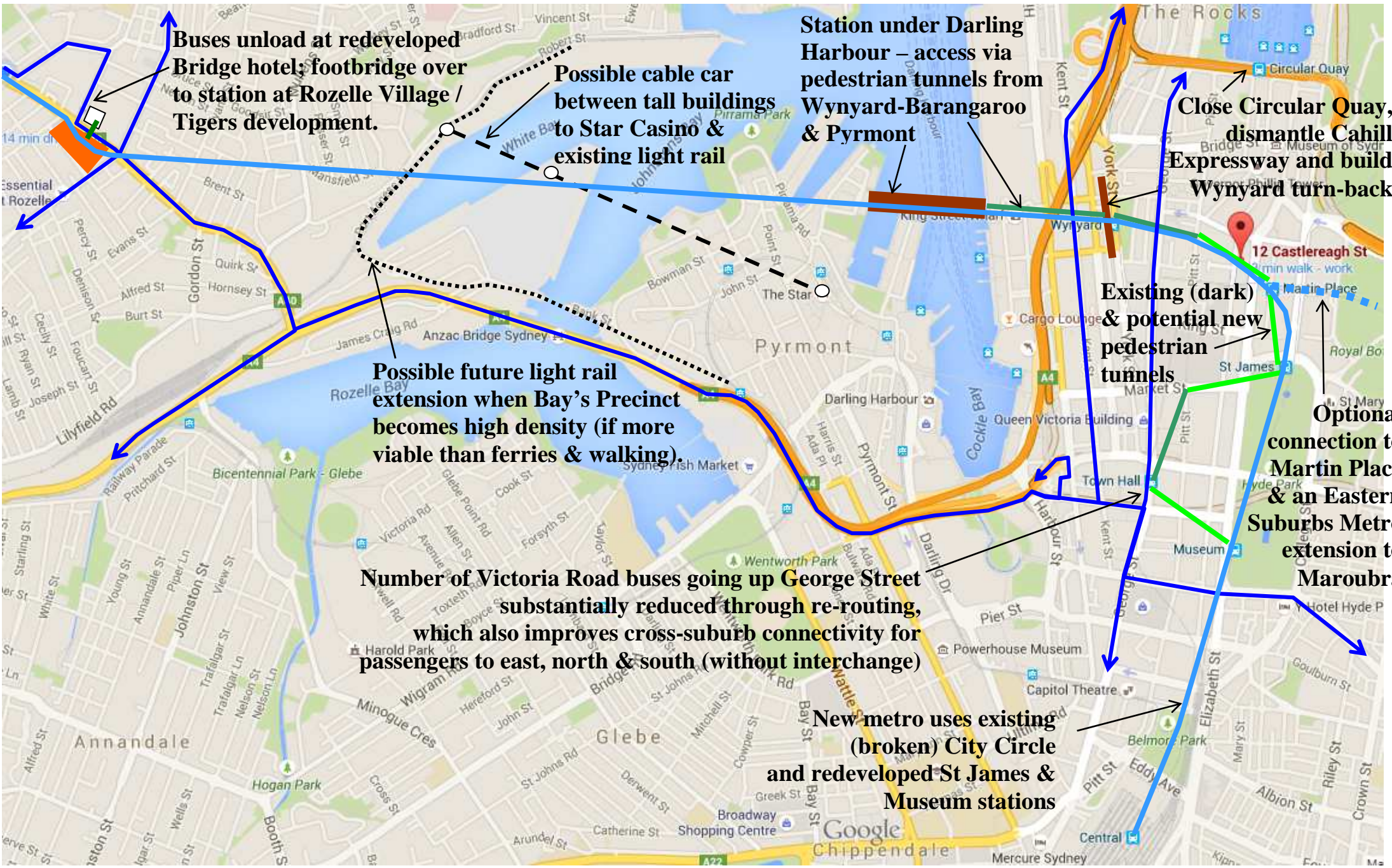
VHST

**Convert ECRL, Harbour Bridge-Inner West/
Bankstown lines to metro once Epping-CBD metro
diversion available**

**Alternative Fast West Metro
route to UWS via Five Dock,
Strathfield & SOP, with longer
branch from Strathfield to
West / Top Ryde & Epping**

**Close & redevelop
Bankstown airport**

**Potential future eastern
suburbs metro
(instead of light rail):
extend from Central, or
Edgecliff / Bondi
Junction**



Buses unload at redeveloped Bridge hotel, footbridge over to station at Rozelle Village / Tigers development.

Possible cable car between tall buildings to Star Casino & existing light rail

Station under Darling Harbour – access via pedestrian tunnels from Wynyard-Barangaroo & Pyrmont

Close Circular Quay, dismantle Cahill Expressway and build Wynyard turn-back

Possible future light rail extension when Bay's Precinct becomes high density (if more viable than ferries & walking).

Existing (dark) & potential new pedestrian tunnels

Optional connection to Martin Place & an Eastern Suburbs Metro extension to Maroubra

Number of Victoria Road buses going up George Street substantially reduced through re-routing, which also improves cross-suburb connectivity for passengers to east, north & south (without interchange)

New metro uses existing (broken) City Circle and redeveloped St James & Museum stations

