Fastrack Australia

AN IMPLEMENTATION PLAN FOR HIGH SPEED RAIL IN THE SYDNEY-MELBOURNE CORRIDOR

The staged implementation of high speed rail can power the growth of Australia and its economy. Countries around the world have typically upgraded existing conventional rail networks with high speed rail to increase connectivity that promotes regional growth and economic development.

This paper examines the Sydney-Melbourne corridor to develop an approach that progressively unlocks regional economic benefits through the staged implementation of sections of high speed track along with the rollout of new rolling stock.

Appropriate governance arrangements need to be put in place and coordination with other regional development initiatives are essential to maximise the benefits.

The "Wentworth Deviation" between Sydney and Mittagong, and the section of high speed rail out of Canberra are considered the best starting points for the upgrades to rail infrastructure. They will produce immediate benefits, and can become the foundation for a national rail network across Australia's south east.

Dr. Garry Glazebrook

Dr. Ross Lowrey

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HIGH SPEED RAIL IS ESSENTIAL FOR AUSTRALIA'S FUTURE

Previous attempts to justify high speed railways in Australia have focused on shifting passengers from air and road travel onto rail, particularly between Brisbane, Sydney and Melbourne. These have failed to produce a viable business case due to the very high cost of implementing high speed rail over large distances, along with benefits (passenger numbers) that only start kicking in when the full line has been implemented. This results in payback periods of over 50 years, which is too long even for long-term government investment. As a result, the widespread opinion is that Australia's major cities are too far apart and its population density is too low to justify the investment in high speed rail.

REMOVE CRIPPLING ASSUMPTIONS

Our approach is based on two principles that take a wider view of the economics of high speed rail, and its role in connecting communities. These principles rectify two key assumptions that have crippled the business case for high speed rail.

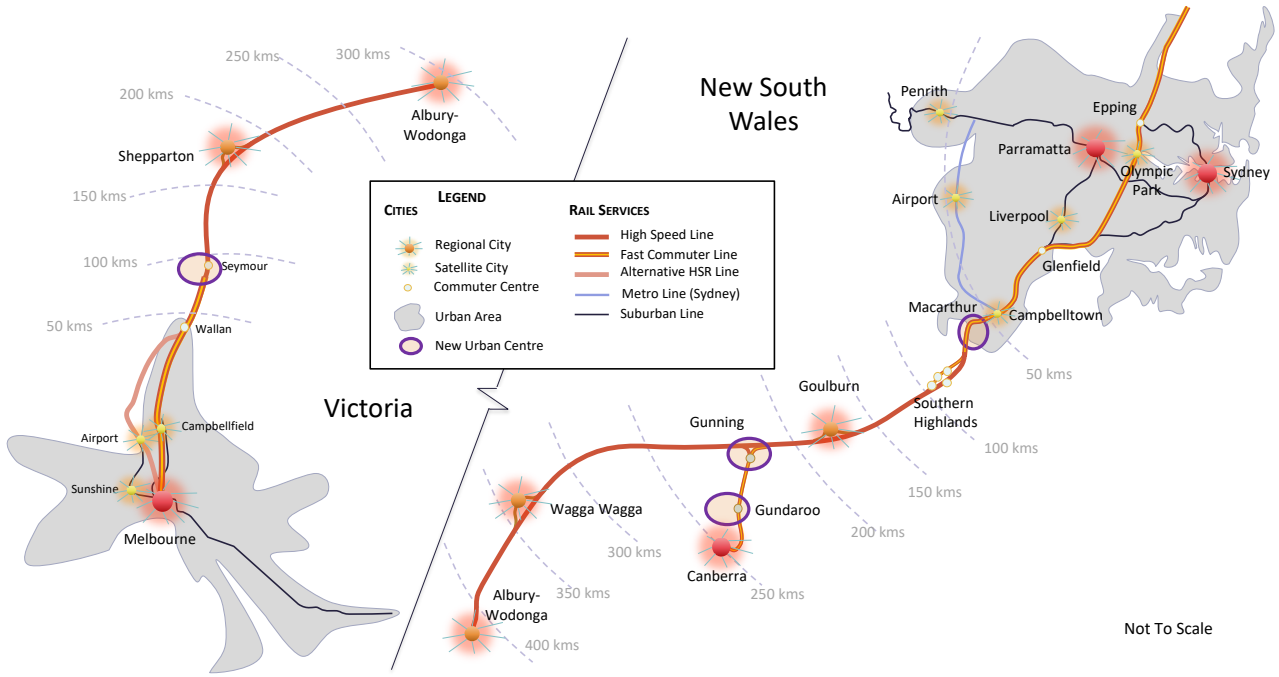
The first principle is that high speed rail is a key **enabler of regional economic growth**, not just an alternative to air and road transport. Since the early 2000s, there has been increasing evidence that faster rail connections increase the economic activity between cities, resulting in population shifts and regional economic growth. As a result, there has been a dramatic growth in high speed rail lines implemented since about 2010, especially by developing countries seeking to boost their economic growth (such as Morocco, Turkey, Laos, India and Indonesia)

The second principle is that high speed rail needs to be considered as **an upgrade to the existing rail network**, and not as a separate standalone system. Faster connections are needed to places where people live, which are largely dictated by the existing rail network. Therefore faster connections must supplement and enhance the mix of services including long distance and local passenger services, as well as bulk, container and fast freight services. High traveller demand will justify the separation of high speed and conventional lines, such as between capital cities. But other lines should not be ignored. Spur lines carrying all types of services including faster passenger trains need to be considered (even if the average speed is less than genuine high speed passenger services).

STAGE IMPLEMENTATION FOR MAXIMUM BENEFIT

Based on these principles, the primary objective of implementing high speed rail between Sydney, Canberra and Melbourne is to create stronger economic connections between these capital cities and the regional cities in the corridor.

Creating economic connections by shrinking the distance between regional cities



One significance of removing the previous assumptions is that high speed rail can be implemented in stages, progressively connecting regional cities along the line (in the same way that the national highway network continues to be rolled out, progressively linking more regional cities with dual carriage highways). This enables the benefits to be accrued as each section of the line opens. This in turn means that each section can be managed as a separate project with its own business case, which progressively accumulate for the full high speed line.

The new approach to implementing high speed rail between Sydney and Melbourne is based on:

- Progressively upgrading the existing line with new sections of high speed capable main line parallel to the existing line.
- Introducing innovative new high speed passenger and fast freight trains. These would operate on both the new high speed sections (where available) and the existing main line (where new sections were not yet available).
- Progressively expanding and accelerating both passenger and freight services, as new sections of high speed line are commissioned.
- Introducing very fast trains (top speeds above 250 km/h) only when the first full corridor is completed and electrified (Sydney – Canberra). However all new high speed sections would be designed from the outset to accommodate these trains.
- Continuing to operate local passenger and slower industrial freight trains on the existing main line. This would enable continued provision of passenger service to existing stations in intermediate cities, as well as freight service to industrial sidings and yards between Sydney and Melbourne.

START NOW

The timing of the proposed high speed rail network will depend on the availability of finance, growth rates in population and the economy, future technology developments, the need to decarbonise Australia's transport sector, and other factors. However, it should be possible to complete the Sydney – Melbourne corridor between 2022 and 2050, and the Sydney – Brisbane corridor between 2030 and 2060.

Stage 1 of the Sydney – Melbourne plan (the Wentworth Deviation to straighten the alignment between Macarthur and Mittagong) is recommended as the logical place to start. Provided there was a sense of urgency, construction of the new rail infrastructure could commence as soon as 2024-5, and be completed by 2028-30. This provides time for the acquisition of the complementary rollingstock and other steps required to launch new services.

Considerable investigation of this part of the corridor has already been undertaken. However, planned urban development in the vicinity of Picton threatens to create difficulties, unless the corridor is protected without further delay.

The important issue is to make a start with concrete "no regrets" investments which can demonstrate a pathway forward. This is how many countries have implemented high speed rail and reaped the benefits. It should not be beyond Australia's imagination or capability.

RECOMMENDATIONS

The High Speed Rail Authority:

- Immediately start the planning for the staged introduction of high speed rail in the Sydney – Melbourne corridor as outlined in this report.
- Accelerate the necessary corridor protection measures needed to ensure rail access into the capital cities, particularly the entry into Sydney from the South-West. This is essential if high speed services between Sydney and Melbourne and also between Sydney and Wollongong are to become a reality.
- Continue to examine the Sydney – Newcastle corridor. Previously identified as the highest priority for investment, it should proceed when sufficient funds are available. However, meaningful investment in this corridor is likely to involve a tunnel from Sydney (probably Olympic Park) to the Central Coast (probably Gosford). When funded, this project could proceed in parallel with the proposed Stage 1 of the Sydney – Melbourne corridor.

FASTER RAIL CONNECTIONS PROMOTE GROWTH

PROMOTE REGIONAL CITY GROWTH

Implementing faster connections to regional cities will increase regional settlement. More people will be attracted to them for better liveability and lifestyle compared with Australia's capital cities (particularly Sydney and Melbourne).

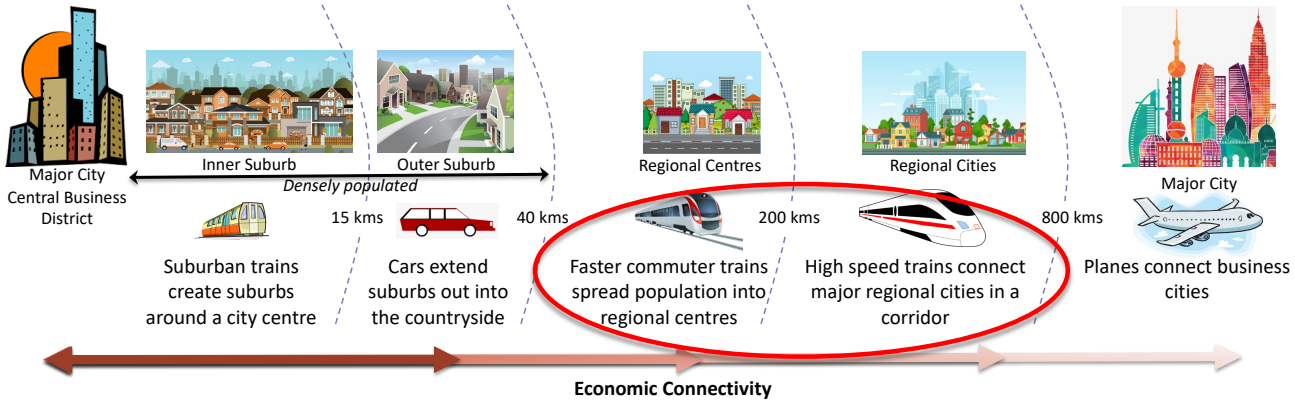
Australia is one of the most urbanised, or strictly speaking suburbanised, countries on earth. This has led to Australia being one of the wealthiest countries in the world with one of the highest standards of living. But we are now facing growing problems of congestion and housing affordability in our capital cities, and growing disparities in educational, health and other opportunities between urban and regional Australia.

These trends have continued, and indeed accelerated, in recent decades, with the growing global dominance of "world cities". In Australia's case, Sydney and Melbourne and even Brisbane are now linked in many ways more closely to the world economy than to our own national economy. Paradoxically, the rapid growth of communications technology, which some thought would lead to the decline of major cities, has reinforced this trend.

As a result, our largest cities have generally increased their share of national population, while smaller cities and towns have in many cases grown very slowly or not at all, despite Australia's overall high population growth rate.

This has led many to seek a better way. Can we divert the predicted growth of our population out of our major cities and into regional cities? Clearly this will reduce the problems of congestion and housing affordability in our major cities. But is it achievable?

Rolling out faster train services will accelerate the growth of regional cities



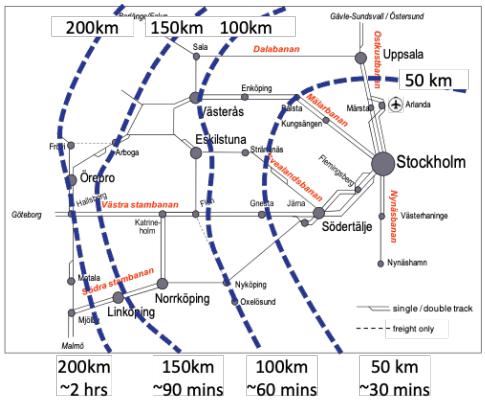
Faster rail connections promote regional growth and development along the corridors they serve. If Australia wants to divert its population growth into regional cities, then it must invest in faster rail services to connect regional cities to their nearest capital cities.

In 2013, AECOM[1] looked at the broader impact of high speed rail on regional development when its High Speed Rail study for the Australian Government. It found that the implementation of high speed rail would substantially improve accessibility for the regional centres that it serves, providing the opportunity for increased regional economic development. However the emerging international evidence at that time was insufficient to support the inclusion of regional benefits in its economic assessment.

Since then, more reliable evidence has been obtained, initially from China, and subsequently from other countries across the world. The World Bank[2] has observed that high speed rail in China has triggered significant agglomeration benefits, increased

[1] AECOM (2013), High Speed Rail Study Phase 2 Report
[2] World Bank (2019): China's High speed Rail Development

tourism to regional attractions, and has been instrumental in re-distributing jobs along the HSR rail corridors in China. More recent studies have confirmed that implementing faster rail lines has boosted regional economies and reduced the economic disparities between regions.



Stockholm has distributed its population growth with fast regional commuter rail

Observed regional impacts:

- Immediate increase in passengers from regional cities
- Strong population and jobs growth in the larger cities
- Station and precinct redevelopment follows
- Central location and local public transport is critical

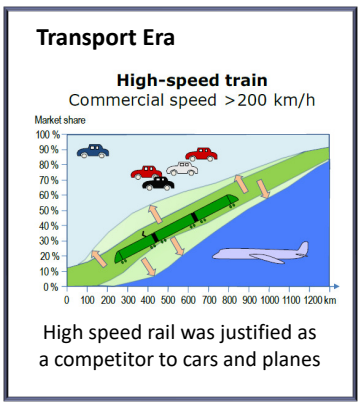
*Source: Bayley (2012), Master Thesis - Regional development via high-speed rail

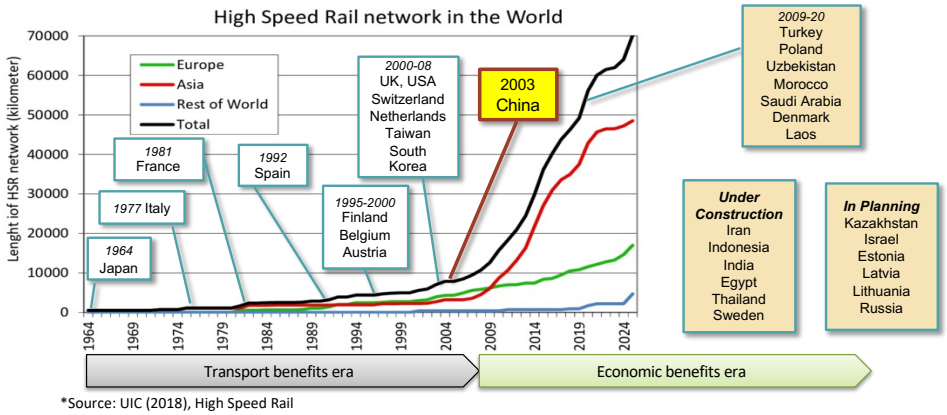
This effect has been observed on a small scale in Victoria. Cities like Geelong, Ballarat, Macedon Ranges and Bendigo saw increased growth when faster rail services were introduced by the Regional Fast Rail project in 2005, compared with cities like Shepparton, La Trobe and Wangaratta that did not get faster services. Cities within 150 kilometres of central Melbourne on the project corridors showed average growth rates of about 2% population, and up to 3% – compared with the average growth rate of 1.5% per annum for all regional cities in Victoria. On the other hand, other cities, and those between 150 kilometres and 250 kilometres from central Melbourne, had growth rates about 0% to 1% per annum. Similarly, total employment growth in the project cities outperformed other regional cities often by a factor of two and sometimes three. Plus growth in jobs associated with knowledge-based industries was much stronger for the project cities than other cities.

CREATE AN INTEGRATED ECONOMIC MEGAREGION

Implementing a fast rail network connecting the capital and regional cities in the south east of Australia will create a megaregion with a stronger, integrated economy better able to compete in international markets.

Since 2010, high speed rail has been implemented to stimulate regional economic development





*Source: UIC (2018), High Speed Rail

The OECD says that faster rail services are essential to grow the population and economies of regional cities. It says that transport infrastructure must be provided as part of an integrated approach to regional development[3]. Similarly, the UN Cities Alliance

[3] OECD (2009): Policy Brief: How Regions Grow

says that connectivity within systems of secondary cities is crucial to lifting the performance, prosperity, and development of regions and nations across the world[4].

Cities are becoming increasingly interlinked and dependent upon each other to boost trade, investment and local economic development. Systems of secondary cities are exerting a greater influence upon the economic development of nations and larger geographic regions. This is why megaregions are increasingly becoming the focus for planning and co-ordination of economic development and settlement policy.

The Cities Alliance argues that governments should support the development of systems of cities. A secondary city's performance is largely shaped by the level, quality and global orientation of its connectivity with other cities. Therefore, strengthening a city's connections supports the development of the local regional economy by facilitating the trade of goods and services within regional and international value chains.

Economic modelling by NIEIR[5] shows that implementation of faster rail connections in Victoria will lead to a 5% increase economic activity. This study confirms that growth in a 'system of cities' outperforms growth concentrated in a single megacity (Melbourne), primarily because urban sprawl creates a drag on economic growth in the megacity.

Source: SGS Economics and Planning, 2019.

SGS Economics [6] argues that creating an Australian Eastern Seaboard Megaregion would enable Australia to respond to growing global competition and managing a growing population. A megaregion is a set of cities integrated with each other and their surrounding hinterlands, where labour and capital can be moved around at a very low cost.

Forming a south east Australia megaregion will boost our economic productivity and innovative capacity, and enable us to better-compete in international markets. It would allow population dispersion to relieve our congested cities, help regional activation, improve housing affordability, reduce inequality, promote economic growth and job creation, and improve liveability.

The economic benefits of regionalisation in Australia will only be achieved if regional cities are well-connected, particularly to the capital cities in each state. Attracting people and businesses to regional cities is very dependent on the city's accessibility to the larger population and markets in capital cities.

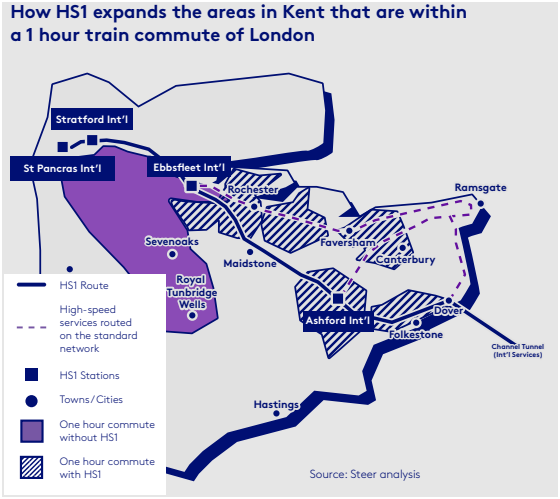
INCREASE CONNECTIVITY

As the economic connectivity between regional cities grows, there will be more demand for people to commute to work in major cities, for tourists to access regional attractions, and for business travel to sites in the region. In addition, there will be more demand for local travel for shopping, access to services and gatherings.

High speed lines increase economic activity at intermediate stops along the line, stimulating growth in population and services, making them more attractive places to live. In turn, this creates demand for local and long-distance travel services, particularly commuting services to the main centres on the line. A well-developed "feeder" network extends the benefits into the surrounding area, becoming an important factor for local development within regional areas.

[4] Cities Alliance (2019), Connecting Systems of Secondary Cities, UNOPS
[5] NIEIR (2020), National Institute of Economic and Industry Research: Economic impact assessment of fast regional rail on Victoria.
[6] SGS Economics & Planning (2020), Reimagining Australia's South-East: Prepared for The Committee for Melbourne

This effect was best exemplified when the new direct high speed line was opened for Eurostar services between London and the channel tunnel in the UK. The new high speed line allowed faster commuter trains to operate into regional cities within Kent (called domestic high speed services). This drew the Kent economy into the greater London economy, driving increased demand for commuting, tourist and business travel into Kent.



The Kent economy has grown after HS1 increased access to London

Domestic high speed services divert off the HS1 to provide fast commuter services into London

Passenger journeys nearly doubled in 6 years

- Increased commuters due to increasing employment
- More visitors because of the high speed service
- Growing market for business trips into Kent
- Increased investment and housing has followed

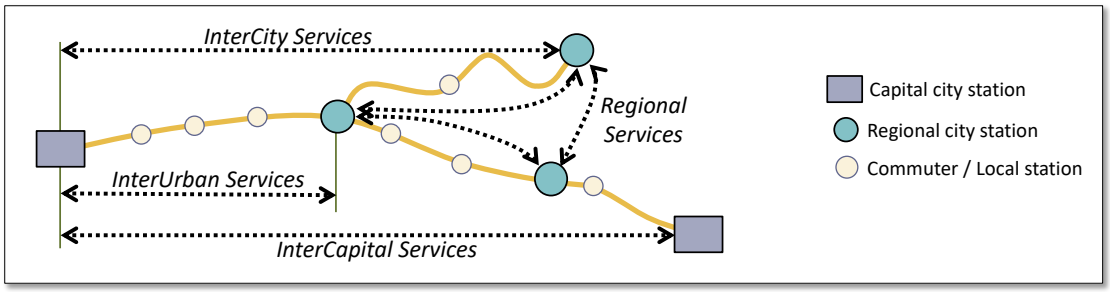
*Source: Steer (2019), Delivering for Kent: The Economic impact of HS1

Note that "commuting" does not necessarily mean the old pattern of five days a week commuting into the office. As demonstrated by post-COVID experience, it is much more likely to mean less frequent commuting by people living in regional cities to offices in the major capitals. Faster connections will allow the regional workforce to spend more time (and money) in their regional cities. This will be attractive to many people currently forced to live in the capital cities because of where their jobs are located.

In addition, the availability of high speed lines in Europe is also stimulating a return to longer distance fast (but not very fast) overnight train travel, with people arriving in their destination in the morning, fresh for business or pleasure activities. These services utilise the high speed lines which are otherwise underutilised at night.

It can therefore be predicted that demand for new types of rail passenger services will emerge:

Growing demand for new types of passenger service



SERVICE	DEMAND
InterUrban	Fast commuter services to a capital city from nearby regional cities and intermediate centres
Local	Local services stopping at intermediate towns between regional cities
InterRegional	Long distance services between regional cities stopping at intermediate regional centres
InterCity	Fast long distance services between a capital city and regional cities beyond the commuter belt
InterCapital	High speed services between capital cities with stops only at large intermediate regional cities

Internationally it is now recognised that high speed rail dominates travel over distances between 150 km and 800 km (up to four hours travel time), where it has clear advantages over car and air travel. It then competes with air travel for distances up to about 1200 km, after which air travel dominates. Significantly reducing the need for air travel will reduce the demand for additional airports, for example in Melbourne and Brisbane.

It is expected that high speed rail has the potential to dominate regional travel demand in Australia. The majority of regional cities are more than 150kms from a capital city, and many are more than 150kms from their nearest regional city. If faster rail connections were available, then it is highly likely that rail will become the preferred travel option to regional cities, especially for these longer trips. This will reduce the need to upgrade highways, which are currently the only viable option for most of these trips currently.

Therefore the rollout of high speed rail should be planned with this eventuality in mind. This suggests that high speed rail should supplement the existing conventional rail network. It should be rolled out in stages that progressively connect regional cities with faster services to capital cities, in much the same way as the national road network has been upgraded with multi-lane dual carriage motorways.

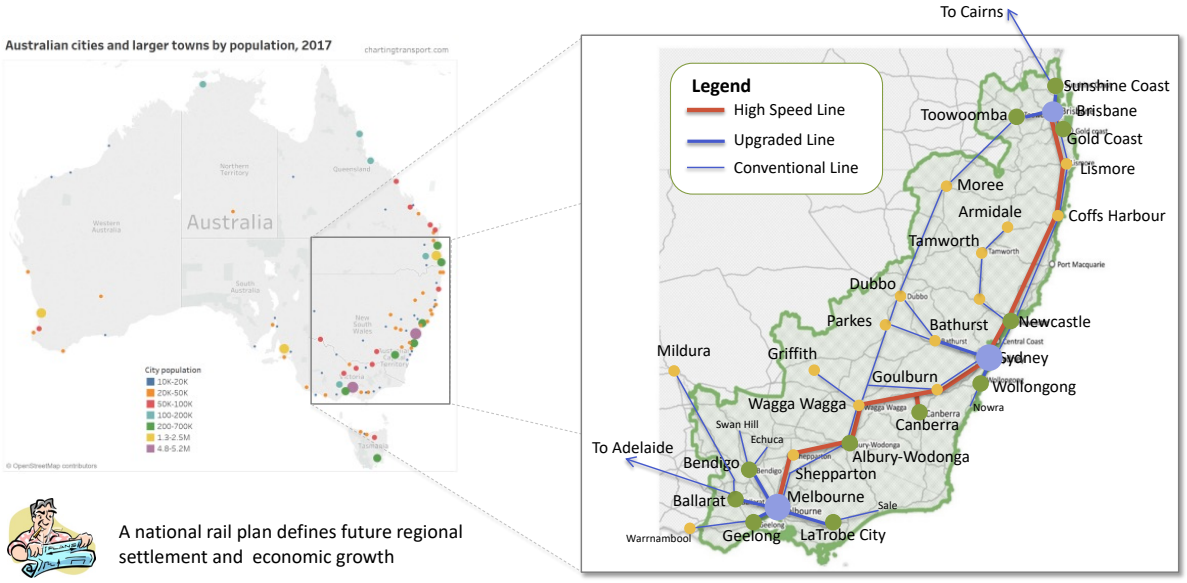
UPGRADE THE EXISTING RAIL NETWORK

High speed rail needs to be considered as an extension of the existing rail network, and not as a separate standalone system. High speed rail supplements travel services where there is sufficient demand, which is typically dictated by a settlement pattern that was driven by the existing rail network. Therefore, where possible, countries integrate high speed rail into their existing rail networks to provide faster and a broader range of services to their existing set of services.

BUILD ON THE EXISTING SETTLEMENT PATTERN

The most expedient way of boosting the population and economies of regional areas is to build on the existing settlement pattern. Much of this settlement has largely occurred as a result of the rail networks created in the 19th century. This means that faster rail connections should be implemented to supplement and enhance the existing rail network.

Build on the existing settlement pattern by enhancing the existing rail network



A national rail plan defines future regional settlement and economic growth

The ultimate goal has to be to link every regional and capital city into a national rail network that provides effective passenger and freight services to each city. This can be achieved by implementing a high speed line between Brisbane, Sydney and Melbourne to form the backbone of a faster passenger network. This faster network should be extended to major regional cities surrounding Brisbane, Sydney and Melbourne by upgrading the existing lines for faster passenger rail services. Other regional cities should be connected by conventional lines that support both passenger and freight services. These can be upgraded to support higher speeds for passenger services where practical.

This approach contrasts with the previous concept for a high speed rail in Australia, which was for a completely separate, stand-alone, passenger-only line, electrified throughout and cleared for speeds up to 350 km/h.

Instead, implementation of high speed rail should be approached as an upgrade to the existing conventional freight and passenger network. Initially short sections between regional centres should be implemented to support faster passenger services, especially where hilly terrain currently means slow, circuitous routes, and where sufficient demand exists. Over time these sections of track will be connected to form a dual carriageway of double-tracked lines, one primarily for faster passenger services that can be progressively upgraded to support very fast passenger services – a truly "high speed" line.

Eventually it will create an integrated rail network consisting of:

- New, separate high speed lines between Brisbane-Sydney-Melbourne, with high speed links to Canberra, the Gold Coast and Wollongong. These would handle high speed passenger inter-capital and inter-regional passenger trains, as well as fast freight trains which would operate mainly at night.
- The existing slower-speed conventional rail lines between Brisbane-Sydney and Sydney-Melbourne, used primarily for heavy freight trains and regional passenger trains;
- Mixed passenger and freight lines to connect regional cities away from the main corridor, such as to the Hunter Valley, Toowoomba, Ballarat, Bendigo, Griffith etc;
- Dedicated freight lines for the bulk carriage of goods and material to terminals or ports; and
- Passenger-only suburban heavy rail and metro lines in the capital cities for high-intensity passenger movements.

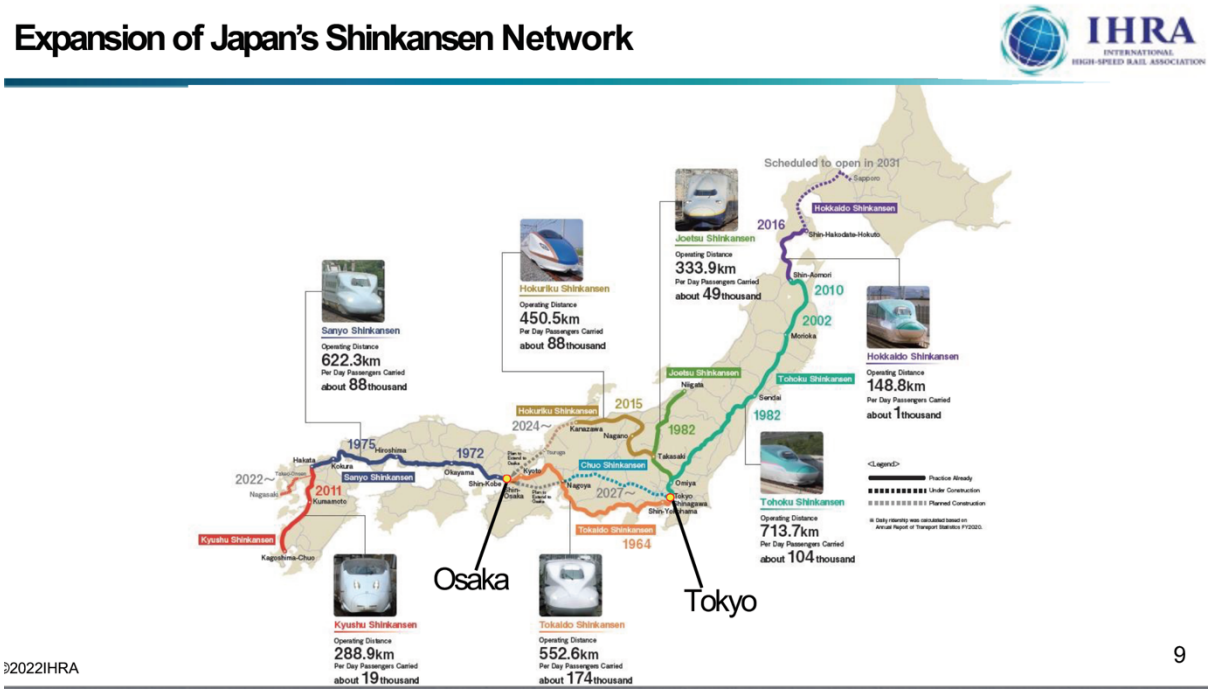
CREATE AN INTEGRATED NETWORK

High speed rail lines should integrate with existing lines where advantageous to provide greater operational flexibility. This allows high speed trains to extend their coverage by continuing on the conventional rail network. It allows a mix of passenger and freight services to use the high speed line with cross-overs to the conventional line. And it opens the possibility of new types of services, such as fast freight that cross-over from the conventional line to use the high speed line between cities.

INCORPORATE HIGH SPEED RAIL INTO THE EXISTING NETWORK

Japan was the first country to introduce a new era of passenger rail transport, when it opened its first Shinkansen line between Tokyo and Osaka in 1962. France was the next country to introduce high speed rail in 1984. Since then around 20 countries have embraced or are introducing this new approach to rail. This includes countries with much lower per capita incomes than Australia (like Turkey, China, India, Indonesia and Morocco) and those with lower populations and smaller cities than Australia, like Finland, Portugal and Denmark.

Japan's existing rail system in the 1960's was an antiquated, narrow gauge (three foot six inch gauge) network. Consequently, Japan opted for a separate, standard gauge system for its first high speed line. The network has since been extended in a number of stages to about 3000 km.



Source: International High Speed Rail Association

"Mini-Shinkansen" trains have a narrower loading gauge allowing services to extend to former narrow-gauge lines, although at lower speeds[i]

Kawasaki has developed an experimental Shinkansen train which can switch between standard and narrow gauges[ii]

While a few countries (e.g. Taiwan) have built completely separate high speed systems, the more common approach, has been to integrate high speed rail to varying extents with their existing regional or long-distance rail networks. This includes countries like France, Spain, Germany, Italy, the UK, and now in Japan. High speed trains in these countries typically utilise existing tracks to access stations in major cities, and to reach destinations beyond the high speed rail networks. These trains have therefore been designed to operate with multiple signalling and electrical power supply systems, switching seamlessly between them as required.

Spain has gone even further, building dual-powered high speed trains which can operate both on electrified and non-electrified tracks, and even change gauge between standard and broad-gauge tracks without stopping. Even Japan has utilised such approaches to extend its Shinkansen network to narrow gauge lines.

Cologne Main Station, showing a mix of high speed trains in the foreground, and local and regional trains in the background[iii]

Alstom's new 250 km/h high speed trains for Sweden will also be able to operate on existing rail lines in Sweden, Denmark and Norway[v]

Talgo 250 Dual in Spain
Note the supplementary diesel power behind the electric locomotive[iv]

Spain's latest High speed Rail project in Extramadura is part of a multi-stage corridor upgrade[vi]

This flexible approach has allowed such countries to add sections of high speed alignment, and to progressively accelerate services as new sections are added. It also cuts the costs of accessing city terminals, reduces the need for passengers to change trains, and maximises utilisation of valuable track assets.

IMPROVE PASSENGER SERVICES

As the high speed rail infrastructure is rolled out, the rolling stock will have to be upgraded to provide improved services.

Rolling stock upgrades will improve speed and performance of services

ROLLING STOCK	CURRENT TRAIN	FAST COMMUTER TRAIN	HIGH SPEED TILT	HIGH SPEED EMU	VERY FAST TRAIN
Example	 VLocity - Australia	 Alstom iLint - Germany	 Talgo Dual 250 - Spain	 Hitachi 802 EMU - UK	 Alstom Pendolino - Italy
Speed	Standard (160km/h)	Fast (up to 200km/h)	Fast (up to 250km/h)	Fast (up to 250km/h)	Very Fast (>300km/h)
Power	Diesel	Electric, Hydrogen, Battery or Hybrid	Electric, Hydrogen, Battery or Hybrid	Electric, Hydrogen, Battery or Hybrid	Electric
Services	Regional	Commuter	Long Distance	Long Distance	Long Distance
Stops	Regional towns on route	Intermediate centres on route	Regional cities and centres on route	Regional cities and centres on route	Express or major regional cities on route

Regional services are currently delivered by diesel-powered Alstom VLocity trains in Victoria and XPT and Explorer trains in NSW. The NSW trains are due to be replaced in the shortly by hybrid (1500V DC plus diesel) trains. Given the long lifetime typical of rail rollingstock, all of these trains are likely to be retired by 2050-2060. These are all non-tilting trains capable of top speeds in the range of 150 km/h and can be progressively re-deployed to provide local and inter-regional services as the rail infrastructure is upgraded.

However as the high speed rail network is rolled out, it is expected that other types of rolling stock will be needed, including:

- Fast Commuter Trains. These trains may be double-deck trains (as currently used in New South Wales) and would be designed to provide high-capacity commuter – type services, able to operate at up to 180 – 200 km/h on high speed lines where 25 kV AC power is available (such as on the proposed high speed lines out of Sydney, Melbourne and Brisbane in the longer term).
- High Speed Tilt Trains: These are loco-hauled trains designed to get passengers to long distance destinations in comfort and style. They would be capable of up to 250 km/h on electrified tracks, and perhaps 180 km/h on non-electrified tracks. They would incorporate tilting technology to improve speeds where the current infrastructure is circuitous. Initially they would provide intercapital services and intercity services. Later they would be cascaded to inter-regional services, especially to cities off fully electrified routes.
- High Speed EMU Trains: These are Electrical Multiple Unit trains designed to get passengers to long distance destinations in comfort and style. They would be capable of up to 250 km/h on electrified tracks, and perhaps 180 km/h on non-electrified tracks. They would replace high speed tilt trains to provide intercity services on major routes.
- Very Fast Trains: These trains are designed to get passengers to their destination in the fastest time possible and with exacting levels of comfort. They would be capable of over 320 km/h on electrified tracks. They would be introduced when the high speed line between Sydney and Canberra is fully implemented and electrified, and would be extended over time to other inter-capital routes, including Sydney – Melbourne, Canberra – Melbourne, and eventually Sydney – Brisbane and Sydney – Gold Coast Services.
- Special Overnight Sleeper Trains. These are making a comeback in Europe for longer haul travel. They are about to be abandoned between Sydney and Melbourne. However suitably designed overnight trains can be an attractive and more sustainable option than air travel for both business and recreational travel. They could initially operate between Sydney and Melbourne, but other routes (Melbourne – Adelaide, Sydney – Brisbane, Brisbane – Canberra, Melbourne – Newcastle, and eventually Melbourne – Brisbane / Gold Coast could be added as more sections of high speed lines are

added, allowing average speeds to be increased over time. These would have speeds comparable to fast intermodal freight trains, and operate primarily at night, thus avoiding conflicts with the faster high speed and very fast trains. They could share motive power with fast freight trains, which would be hybrid, renewable locomotives capable of utilising 25 kV AC power where available, and hydrogen plus rechargeable battery power where not.

MIX FREIGHT AND PASSENGERS

In many European countries it is also common to mix freight trains with both conventional and high speed trains on the same tracks. Typically, passenger trains operate at up to 200 km/h on such shared tracks, with freight trains operating up to 130 km/h or even faster. Only where traffic densities are very high are completely separate high speed tracks justified. The integration of freight and passenger services occurs even on the newest lines, such as the Gotthard Base Tunnel in Switzerland.

The Gotthart Base Tunnel has been designed to handle high speed trains, regional passenger services and up to 260 freight trains per day[vii]

ENHANCE FREIGHT SERVICES

Whilst passenger trains capture the attention, it is freight that "pays the bills" for most railways. Rail freight tended to lose mode share to trucks as roads have improved and trucks have increased in size and axle-weight. However, rail freight is now beginning to benefit from significant innovation, including:

- Automated shunting and automated uncoupling in yards;
- Automated loading / unloading of containers, such as in Sydney's new Moorebank Intermodal terminal;
- Bi-mode locomotives, such as the Eurogooo, which can operate on both electrified and non-electrified lines, and new locomotives powered by batteries / hydrogen;
- New types of trains which carry trucks on specialised rollingstock which can allow whole trainloads to be loaded and unloaded in as little as 45 minutes; and
- High speed freight trains which utilise high speed lines at night and carry high-value parcels and other freight.

A new "Rolling Motorway" route using French Modalohr wagons opens between Montpellier and Paris[viii]

Germany's Cargo-Beamer is building a plant to produce 500 of its specialised wagons p.a. as new intermodal routes open in Europe, such as Rostock – Kaldenkirchen[ix]

Stadler "Eurodual" Locomotive has 2800 KW using diesel, and up to 7,000 KW using electric power[x]

Digital Automatic Coupling systems are being developed in Europe, along with driverless shunting engines, to reduce terminal costs[xi]

These innovations can potentially cut costs in terminals as well as transit times by rail, making it more competitive with trucks for high-value and time-sensitive freight, such as the overnight freight market between Sydney and Melbourne. For example, Swiss National Railways has begun trials with automated uncoupling as a way to reduce "last mile" costs for rail freight.

ADAPT TO AUSTRALIAN CONDITIONS

While the distances between our major cities (Sydney – Melbourne; Sydney – Brisbane) are relatively long compared to inter-city distances common in Europe, Japan and some other countries, our topography is generally less challenging than in countries such as Switzerland, Italy, Japan, Taiwan, Turkey etc, all of which have all implemented significant high speed rail networks.

Australia also generally has relatively low train densities compared to the situation in Europe or countries like Japan. This means it makes sense to operate rail as a mixed service accommodating both passenger and freight traffic on the same tracks where possible. There are however a number of places where this can be difficult:

- Sydney, Melbourne and Brisbane all have extensive suburban rail and metro systems which can make access for longer distance passenger and freight trains an issue.
- There are also some sections of main lines with relatively high freight traffic densities, for example the Main South Line between Macarthur and Moss Vale, or the Main Northern Line between Port Waratah and Maitland.

Fortunately, some improvements have already been made to overcome these potential conflicts, for example with dedicated freight lines into Sydney. In addition, conflicts in the entry to Sydney's Central Station from the south-west (the route for trains from Canberra and Melbourne) will be reduced with completion of the metro line to Bankstown, which will free-up track capacity between Wolli Creek and Redfern. The rail approach to Brisbane's Roma Street station from the South will also be freed up with completion of the Cross-River Rail project.

Some simple track work near Erskineville Station will allow high speed trains to enter Central Station when the metro to Sydenham is completed[xii]

The new Cross-River Rail project will relieve congestion on the Merivale Bridge, allowing future high speed trains to enter Brisbane CBD[xiii]

Ultimately some enhancements to access routes into Sydney and Melbourne will be needed to accommodate higher volumes of high speed trains and new high speed rail stations. As explained later, this will mean some tunnels into a new Sydney high speed station (probably at Olympic Park) and a new tunnel into Melbourne's Southern Cross station. However, these investments will not be needed initially. Instead the key will be to begin by upgrading the main lines between the cities, to provide both faster alignments and in some cases, added capacity.

THE SYDNEY-MELBOURNE CORRIDOR

The greatest demand for faster rail services is in the Sydney-Melbourne corridor. Therefore the rest of this paper focuses on this corridor. This section provides an overview of the current conventional rail line and an outline of the proposed high speed line.

THE EXISTING CONVENTIONAL RAIL LINE

CURRENT ALIGNMENT

The current main interstate line is double-tracked between Sydney and Melbourne, except for the section between Junee and Albury. Current train volumes are within capacity limits.

Philip Laird's paper to the recent Ausrail conference[7] provides an outline of the history of the current Sydney – Canberra – Melbourne railway, and its current condition. The original line was modified mostly in the early 20th century to reduce gradients, which had become an impediment to the steam engines of the day. This involved making the line wind around a large number of tight radius curves, for example in climbing from Sydney to Mittagong, crossing the main Dividing Range between Goulburn and Yass, or overcoming the hills between Cootamundra and Junee by using the Bethungra Spiral.

At the time rail transport was far more advanced than road transport, and rail was able to haul much heavier loads and still be far faster than road. However, in the decades since then rail investment was neglected. In contrast, the Federal Government effectively subsidised the creation of the modern, dual carriageway Hume Highway between Sydney and Melbourne, enabling driving time between the two capitals to be reduced to nine hours, and providing a shorter and faster route for trucks than for trains.

Despite numerous studies and reports over the years, including the 2001 ARTC national track audit and the 2013 AECOM High Speed Rail study, nothing significant has been done to address the steam era alignments on our most important interstate rail corridor. As a result, travel times by rail for both passenger and freight trains have barely improved since the extension of standard gauge tracks from Albury to Melbourne some 60 years ago.

The rail line to Canberra is similarly disadvantaged by poor alignments, both between Menangle and Goulburn and between Goulburn and Canberra. The average speed achieved is only 70km/h, making rail significantly slower than driving or coach transport.

The route through Molonglo Gorge may be scenic, but it means trains between Sydney and Canberra are extremely slow and uncompetitive with other options

While air transport has greatly expanded in the last half-century, this mainly benefits residents of Sydney and Melbourne, our two largest cities, and does little for those living in other cities and towns in the corridor. Furthermore, new airport capacity (new

[7] Philip Laird (2022): "Bringing the Melbourne to Sydney Railway up to Standard", Ausrail Conference, December 2022.

airports or additional runways) in Melbourne and Brisbane will be needed in the future unless rail is significantly upgraded to take a meaningful role in interstate passenger travel.

Similarly, while road transport has improved, it is unlikely to improve much in the future and in contrast will suffer from increasing traffic congestion. As a result, the over-concentration of our population in our two largest cities will continue to worsen, with significant economic, social and environmental consequences. If improved rail infrastructure is not built, the only alternative to more highway congestion would be to duplicate the existing Hume and Pacific Highways, a massively expensive and environmentally damaging alternative.

Truck volumes have increased notably on the Hume and Pacific Highways with adverse safety and environmental consequences

Sydney's second airport will increase the need additional airport capacity in Brisbane and Melbourne if the rail system is not upgraded

However, upgrading rail to a similar standard now found overseas would significantly improve the accessibility of other cities and towns in South-East Australia, facilitating a more sustainable population distribution in the long term and improving the economics generally of inter-city transport. . It will also reduce the need for more airports and highways. The challenge is to find a way to achieve this over three decades, just as the Hume Highway was progressively turned from a goat track to a motorway.

CURRENT RAIL SERVICES

It is important to understand the current use of the existing rail network, as well as the potential for growth, before proposing upgrades.

Current Passenger Services

Whilst the number of longer-distance passenger services on the main interstate corridor south of Sydney has declined from previous times, there have been increases in local services from both Sydney and Melbourne. Current passenger services include:

- Twice daily Melbourne – Sydney XPT services in each direction, one during the day and one at night. These both make numerous stops to service local cities and towns on the route, and consequently are relatively slow (11 hours between the capitals, compared to around 9 hours driving time and 1.5 hours flying time terminal to terminal, or 3 hours city centre – city centre). These services are due to be replaced with new rollingstock but service patterns will be little changed.
- Three-times daily Sydney – Canberra services in each direction, taking between 250 – 270 minutes for the nominal 300 km trip. These are significantly slower and less frequent than current bus and car travel times (180 – 220 minutes; hourly or better bus services) or air services (18pprox.. 30 – 45 minutes flying time; 120 minutes city centre – city centre).
- Around 20 daily Sydney-Moss Vale local passenger services in each direction (with a couple of services extending beyond to Goulburn or southern NSW). These services are again very slow compared to driving, and involve a change at Campbelltown/Macarthur to suburban electric services.
- Approximately 4 daily Melbourne – Albury return services. These have recently been upgraded to standard gauge Vlocity trains. They take around 4 hours for the 300km journey, somewhat slower than driving (3-4 hours from Melbourne CBD depending on traffic).
- Additional services between Melbourne , Seymour, Wangaratta and Shepparton, the latter branching off at Seymour. These are also being upgraded with new Vlocity trains.

Current Freight Services

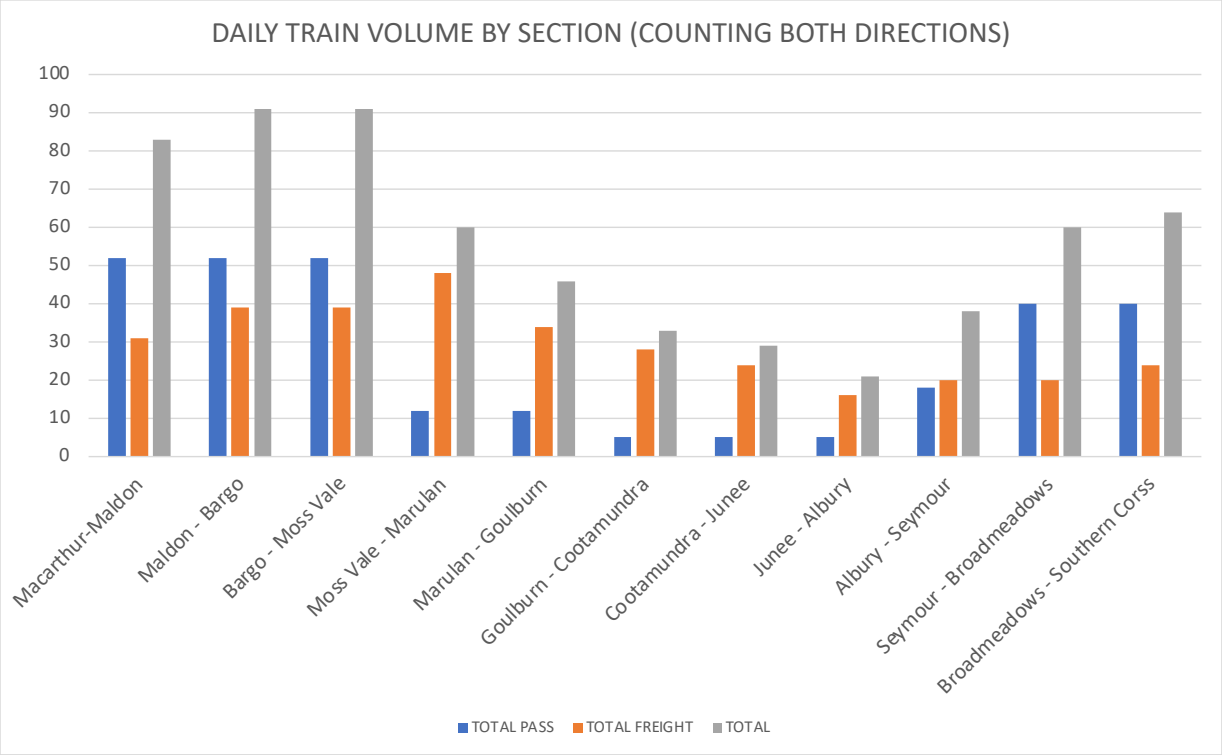
- Interstate intermodal trains (e.g. Sydney – Melbourne; Sydney – Adelaide / Perth; Melbourne – Brisbane). There are around 4-5 of these daily in each direction in the northern part of the corridor (between Sydney and Cootamundra), somewhat fewer south of that point as the trains for Adelaide and Perth divert off the main south. Most are long (up to 1800m in length), heavy (up to 5,000 tonnes) container trains, but with some non-container traffic such as automobiles carried in specialised wagons. They are typically powered by 2-3 high-power modern diesel-electric locomotives capable of 115 km/h and operate on reasonably fast schedules given the current track conditions, typically taking 12-13 hours between Sydney and Melbourne terminals. However, they are not time competitive with interstate trucks, which take around 9 – 10 hours. These trains carry international and domestic containers, and generally convey somewhat less time-sensitive freight than that carried by road, which handles almost all of the overnight freight market.
- Domestic intermodal trains serving intermediate terminals such as the Ettamogah Rail Hub near Albury, or various other locations such as Griffith and Goulburn. These generally convey either general containerised freight, or specialised containerised freight, such as Barley from southern NSW to the Brewery at Minto in SW Sydney; or export timber from Goulburn to Port Botany.
- Interstate steel trains between major steel product production centres and specialised terminals. There are typically two of these each way per day between Moss Vale and Melbourne, one which connects to Port Kembla steelworks via the Moss Vale Unanderra link, and one via Sydney.
- Grain trains, including wheat, rice and other grains, mainly from southern NSW and the Riverina to Port Kembla in NSW or to Geelong / Portland in Victoria. Depending on the grain season and time of year this can require up to 5 or more grain trains in each direction daily on parts of the Sydney – Melbourne corridor. There is also some domestic grain hauled by rail to flour mills at Maldon and Enfield.
- Limestone, Mineral and Coal trains. These operate mainly from the limestone mine at Marulan to the cement works at Berrima and Maldon to the Port Kembla steelworks; from gravel mines also near Marulan to various sidings in Sydney; and from the Tahmoor coking coal mine to Port Kembla steelworks.
- Cement, waste and other industrial trains. These include cement and clinker daily trains from Berrima to Sydney and Maldon and return, as well as thrice daily in each direction containerised waste trains from Sydney (Clyde) to the waste disposal site at the Woodlawn Mine at Tarago on the Goulburn – Canberra line. Other industrial traffic includes timber hauled south from the Albury area to Melbourne.

CURRENT TRAFFIC PATTERNS

Total rail traffic therefore varies significantly in composition and volume both at different places along the main interstate route; at different times of day/night; and at different times of the day, week and year.

The Maldon to Moss Vale section in NSW is the most critical part of the corridor as it:

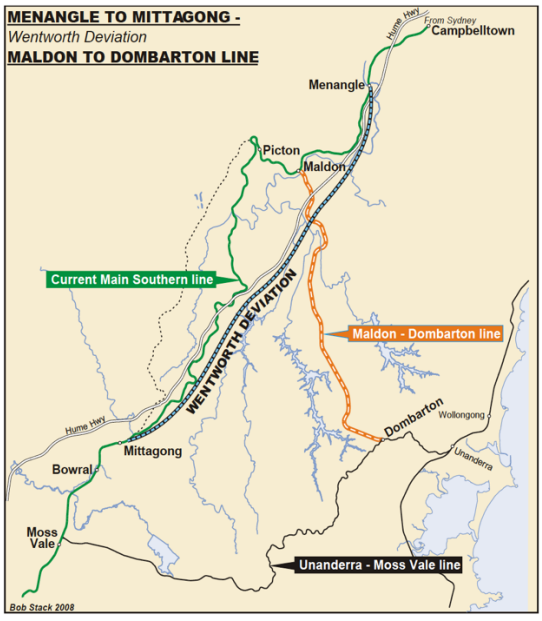
- has the highest overall volume of trains (approximately 90 per day)
- includes a wide mix of traffic types from slow industrial freight trains through to express passenger trains
- has continuous 1.3% gradients against southbound trains
- includes industrial sidings and junctions to the cement works and Flour mill at Maldon; the Tahmoor coal mine; the cement works and grain silos at Berrima and the junction to the Moss Vale – Unanderra line at Moss Vale.



The chart above shows the estimated volume of trains on different sections of the main line between Sydney and Melbourne on a typical weekday during the main wheat season.

POTENTIAL FOR IMPROVEMENT

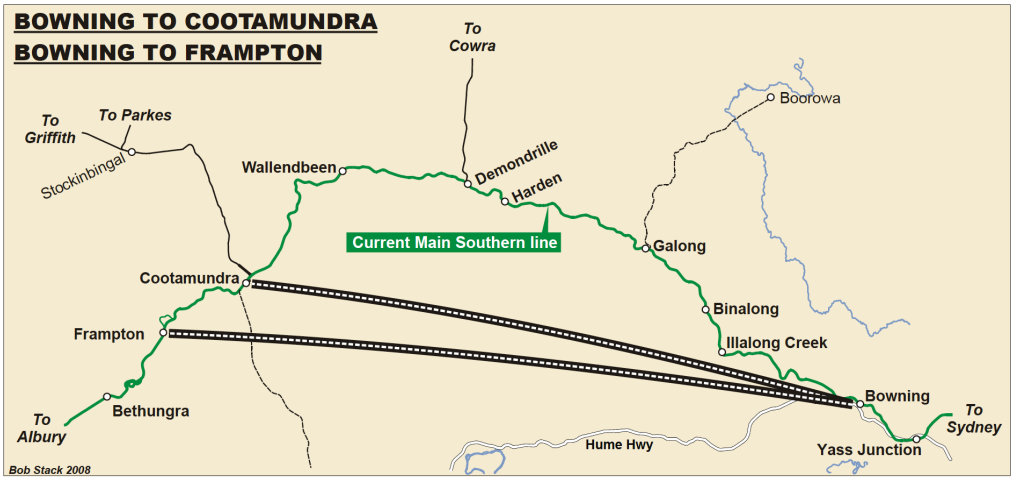
The ARTC National Track Audit examined options to upgrade the Sydney – Melbourne Main Rail Line in 2001. Phillip Laird suggests that another look should be taken at significantly improving alignments on three key sections[8] - from Macarthur to Mittagong (48km) (a.k.a. the "Wentworth Deviation"), Goulburn to Yass (68 km), and Bowning to Cootamundra (77km)[9]. He says these upgrades are still viable options to improve passenger services until genuine high speed services replace them.



The "Wentworth Deviation" between Menangle and Mittagong has long been considered essential to reduce the tortuous route via Picton, and is the obvious first step to improving our interstate rail network.

[8] https://theconversation.com/more-than-ever-its-time-to-upgrade-the-sydney-melbourne-railway-187169

[9] Laird, P, Michell M and Adorni-Braccesi G (2002), "Sydney - Canberra - Melbourne high speed train options", Australasian Transport Research Forum, Canberra



The proposed deviation from Bowning to Frampton would also eliminate a very windy section of track and significantly reduce the distance travelled. An alternative via Cootamundra would also benefit Sydney-Perth freight trains.[xiv]

These sections include some of the slowest and most winding sections of the existing line. The planned deviations would reduce the rail distance between Sydney and Melbourne from 960km to 900km, and enable significantly higher speeds for both passenger and freight. These initial sections are also seen as the potential first stages in the creation of a new high speed railway between Sydney, Canberra and Melbourne.

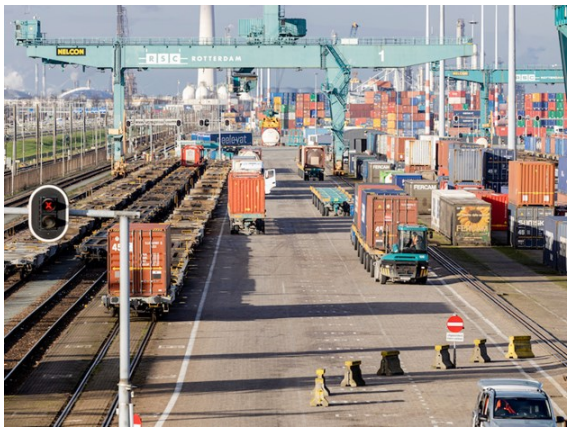
Laird has also proposed the introduction of tilt trains will further speed up longer distance passenger services on this route. A tilt train – a train designed to negotiate curves more quickly – could travel at more than 200 km per hour between Sydney and Melbourne on an upgraded alignment.

POTENTIAL FOR GROWTH

There is substantial potential for growth in rail volumes, both freight and passenger, especially if measures are undertaken to reduce travel times by rail to be competitive with road (in the near term) and even with air travel on some corridors in the longer term. For example:

- The completion of the Ettamogah Rail Hub near Albury and the commencement of operations at the Sydney Moorebank Intermodal Terminal (with fully automated loading / unloading of containers) is leading to increased volumes of rail freight in the corridor. For example, Qube has recently announced the purchase of an additional 12 high-powered locomotives to increase its Intermodal Sydney – Melbourne services[10].
- The completion of the Inland Rail between Melbourne and Brisbane is expected to see a significant increase in rail freight between Junee and Melbourne.
- A reduction of rail passenger travel times between Sydney and Melbourne to 9 hours would make it competitive with car or coach travel, and would likely lead to a significant increase in demand.
- A reduction in travel time between Sydney and Canberra to 3 hours would enable rail to be competitive with car and coach travel, and likewise lead to substantially increased demand and the need for more frequent services.
- Further reductions in travel times in the corridor would generate additional demand, enabling additional services to be operated, as well as improvements in efficiency.

[10] https://www.railjournal.com/fleet/qube-orders-locomotives-from-progress-rail/

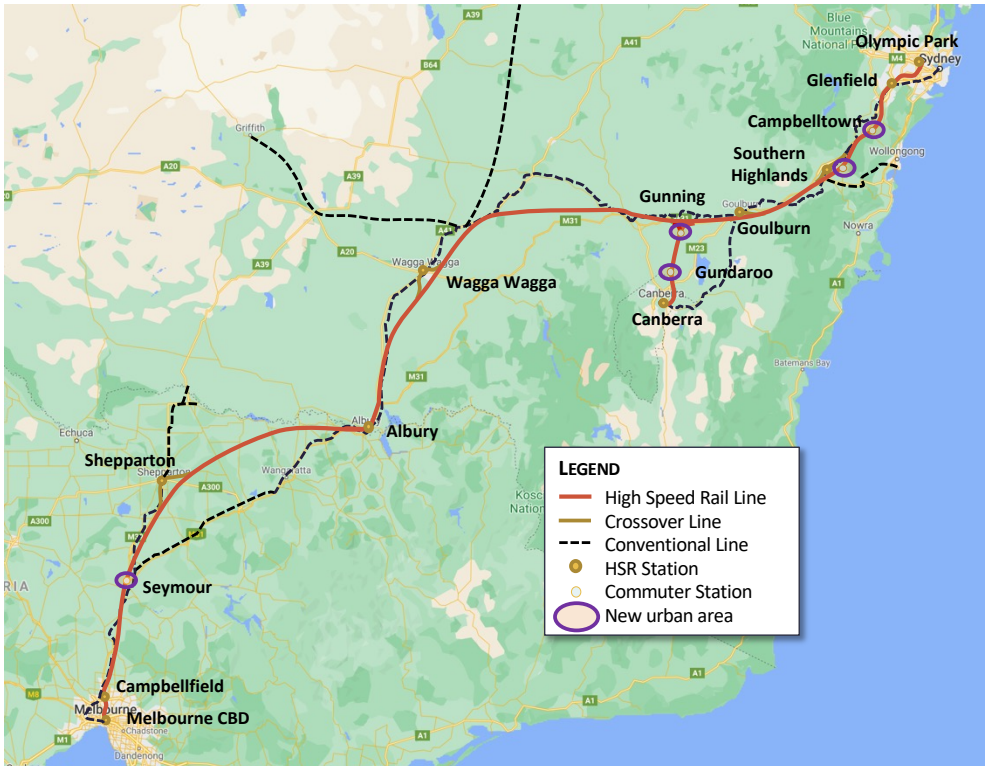


The Moorebank Logistics and Intermodal Terminal being is being built on 240 ha with strategic access to major rail and road corridors. It has a capacity 1.5 million domestic and international containers p.a., along with automated container transfer cranes[xv]

Qube has ordered 12 new high-power locomotives to handle interstate intermodal container trains between Sydney and Melbourne

PROPOSED HIGH SPEED RAIL LINE

The proposed alignment for a new high speed rail line between Sydney and Melbourne is based on the alignment proposed in the 2013 study by AECOM, with some minor adjustments reflecting the changed strategy prioritising regional growth or due to changes to conditions since the study was completed.



The 2013 study proposed an alignment that closely follows the existing conventional line south from Sydney through to the north of Canberra. From the north of Canberra the new line deviates from the existing line to Junee in order to significantly reduce the distance travelled, and then takes a more direct route past Wagga Wagga and then into Albury following the existing line. The new line then takes an alternative route to Seymour via the large regional city of Shepparton, and also avoids the more hilly terrain along the existing line. Finally, the new line closely follows the existing line from Seymour into Melbourne. It also proposed a spur line from Gunning into a station at Civic in Canberra.

The major difference in our proposal is the inter-connection of the new high speed line with the existing conventional line at key regional cites. This allows the use of the existing station in each city, which promotes growth and economic activity in the city. It also allows stages to be successively implemented, enabling trains to continue to use the conventional line until each stage is completed, and for services to be routed on either line depending on requirements and operational demand.

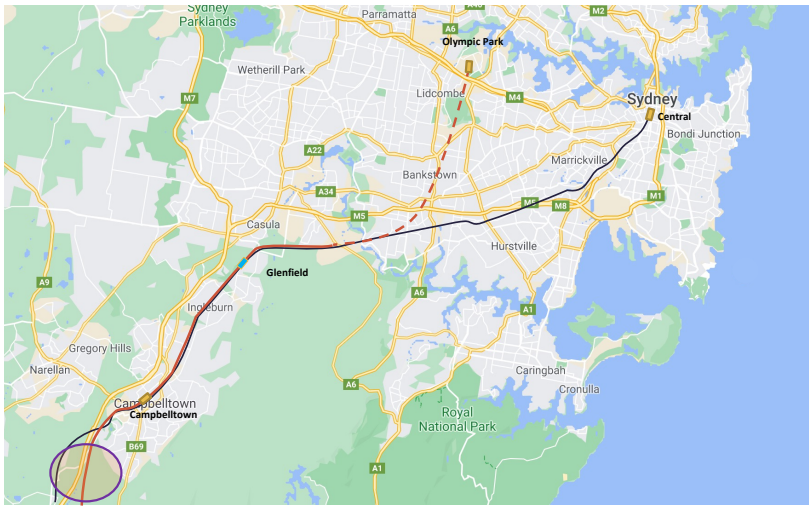
Other significant variations in our proposal include:

- A new station close to the airport in Canberra, removing the need for a tunnel under Mt. Ainslie;
- A tunnel into a new high speed rail station at Olympic Park, integrated with the Metro station currently being built, instead of a tunnel into Central station in Sydney;
- Routing the line along parts of the existing corridor through the urban area of Sydney; and
- Routing the line through Albury instead of bypassing it.

The following outlines the alignment for each section.

SECTION 1: METROPOLITAN SYDNEY

The 2013 AECOM study envisaged a tunnel from Central station to Glenfield, followed by alignment around Campbelltown to bypass the urban area south of Sydney.



Subsequent to the study, more consideration has been given to a more northerly route connecting Glenfield through to the Newcastle line near Hornsby with a tunnel through Olympic Park.

Trains can use the existing rail lines from Central station to Glenfield until the tunnel is built.

Use of the existing rail corridor (widened to four tracks) has been proposed for the line from Glenfield to Campbelltown, avoiding the environmental impact of a new alignment around the urban area.

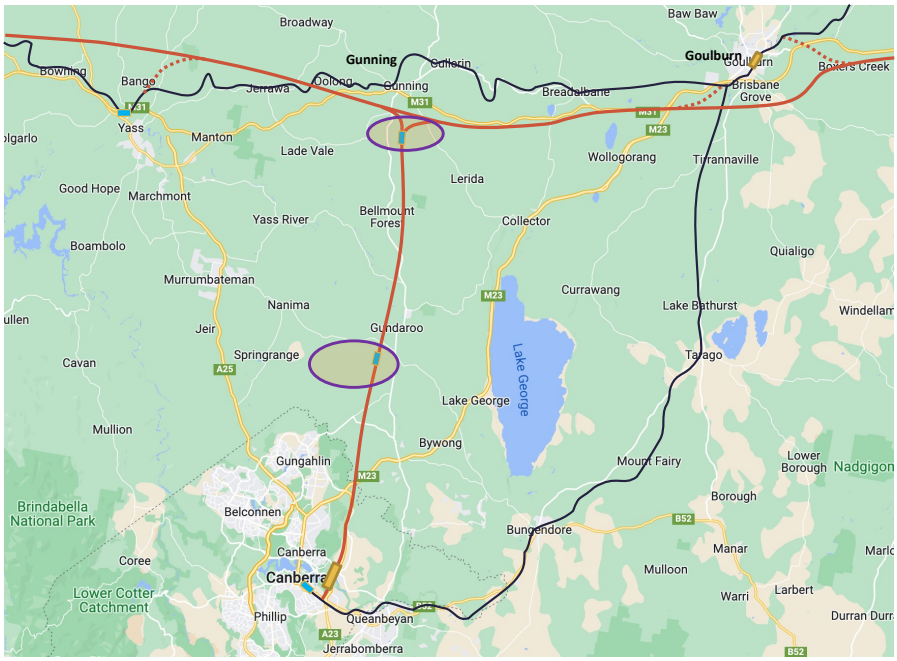
SECTION 2: CAMPBELLTOWN TO GOULBURN

From Campbelltown the proposed line follows the Hume Highway to avoid the circuitous route via Picton. Electrifying this section will allow the use of dual-mode traction engines to handle freight trains at higher speeds up the steeper gradient.

Cross-overs to the north of Mittagong and south of Moss Vale will allow some trains to use the conventional rail line to stop at Mittagong, Bowral and Moss Vale.

The new line then takes a straighter, more direct route tracking the Hume Highway to Goulburn. Cross-overs to the east and west of Goulburn will allow some trains to stop at the existing station in Goulburn.

SECTION 3: GOULBURN TO YASS AND CANBERRA

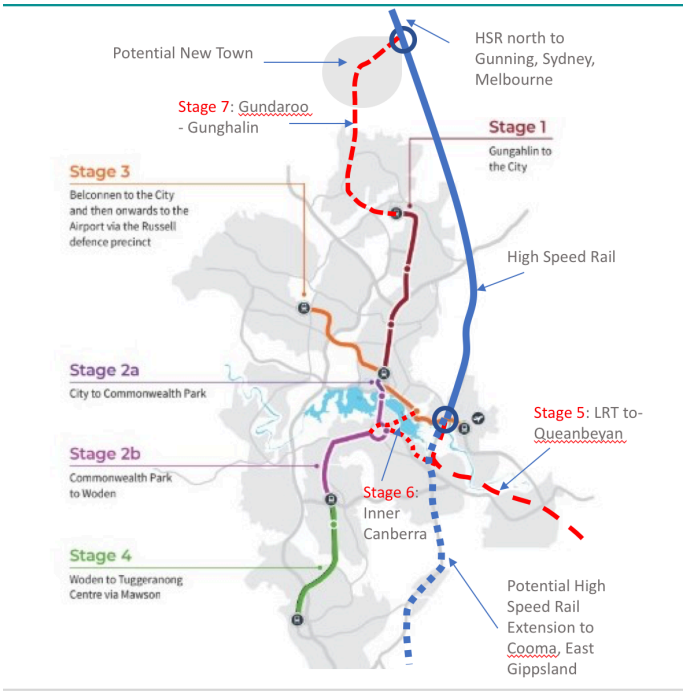


The new line continues to take a straighter, more direct route from Goulburn through to a cross-over at Yass.

A new spur line to Canberra is proposed to run from Gunning into a station next to the airport. This line will provide direct entry for long-distance passenger services into Canberra, replacing the very slow route through Molonglo Gorge.

It will also allow fast commuter services to operate from Canberra to Goulburn and Yass, including the new urban centres near Gundaroo and Gunning when they are created.

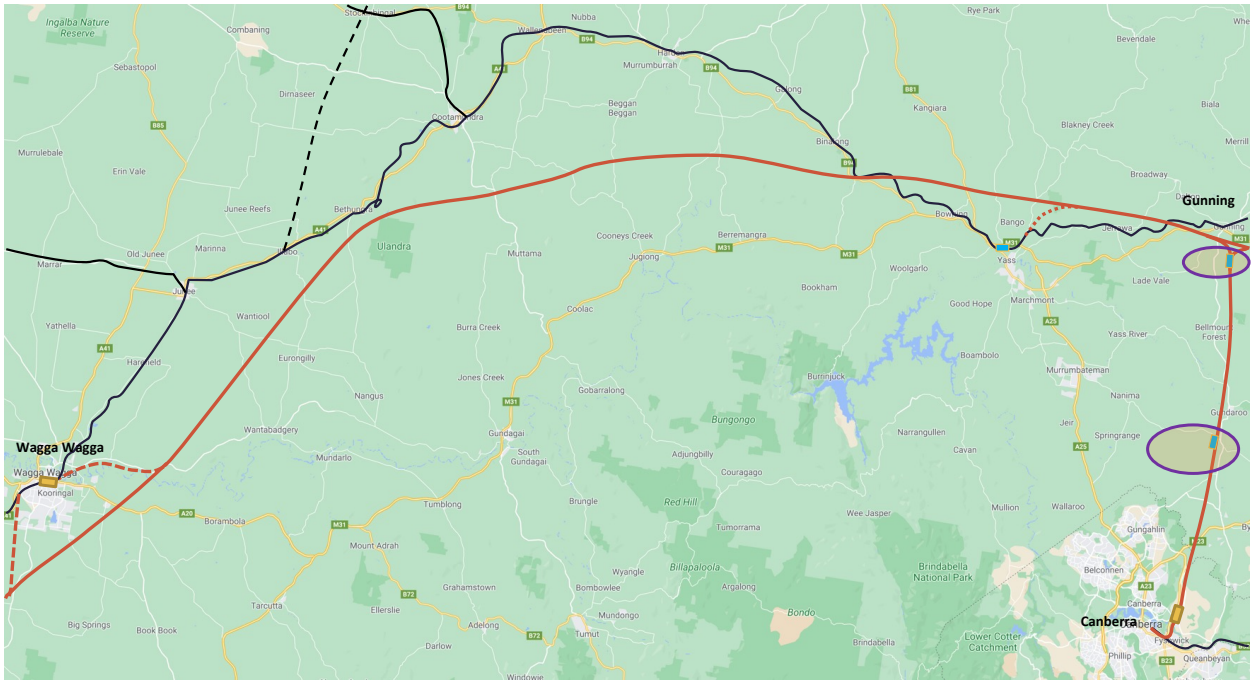
SECTION 4: CANBERRA METROPOLITAN AREA



The proposed line will follow the Majura Parkway into a new station between the airport and Duntroon, integrated with the proposed light rail line between Civic and the Airport. This will avoid tunnelling into Civic as proposed in 2013, and create a major mixed transport and business hub for Canberra next to the airport.

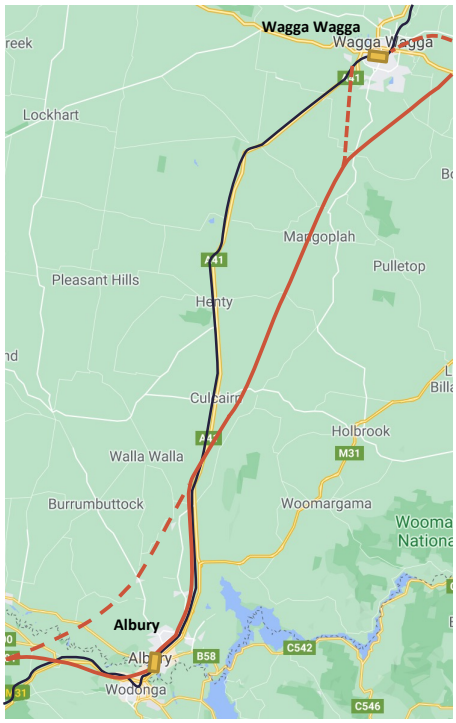
The proposed Belconnen to Airport light rail line will provide convenient access from the new station to Civic, Russell, the parliamentary triangle and the rest of Canberra.

SECTION 4: YASS TO WAGGA WAGGA



The new line continues its straighter, more direct route west until near Bethungra where it turns to the south to pass by Wagga Wagga. Cross-overs to the east and south of Wagga Wagga will allow some trains to stop at the existing station in Wagga Wagga.

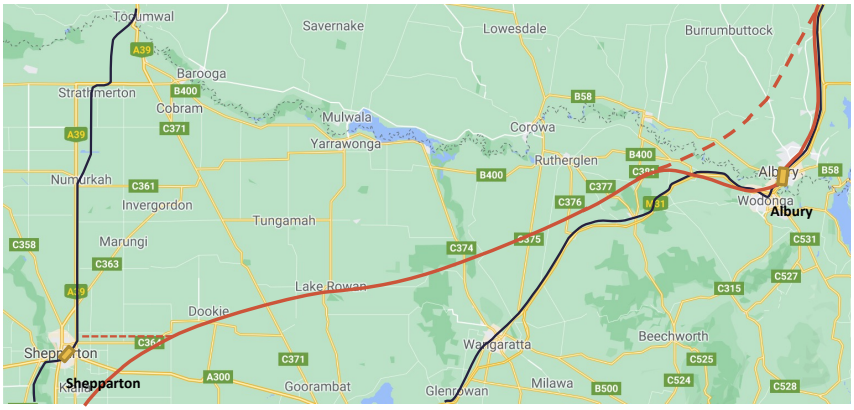
SECTION 5: WAGGA WAGGA TO ALBURY



From Wagga Wagga, the new line continues its straight and direct route to where it meets the existing conventional line the north of Albury. At this point it is proposed that the new line will use the same corridor as the existing line to enter Albury, and stop at the existing station.

At some time in the future there might be sufficient demand to build a bypass for express services to avoid the deviation and stop at Albury.

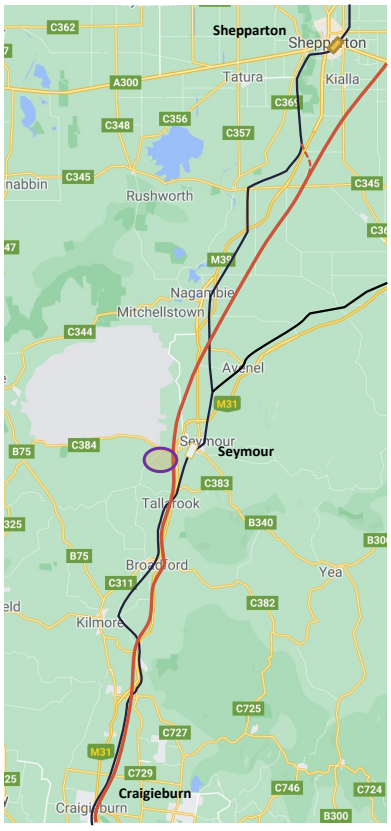
SECTION 6: ALBURY TO SHEPPARTON



The new line will take a more direct route out of Wodonga to the west to where the future bypass line would join it. It then turns to the south west to follow a straight and direct route to Shepparton. This area is subject to widespread flooding, so it is expected that viaducts will be needed to allow the free flow of floodwater.

Cross-overs to the east and south of Shepparton will allow some trains to stop at the existing station in Shepparton.

SECTION 7: SHEPPARTON TO CRAIGIEBURN



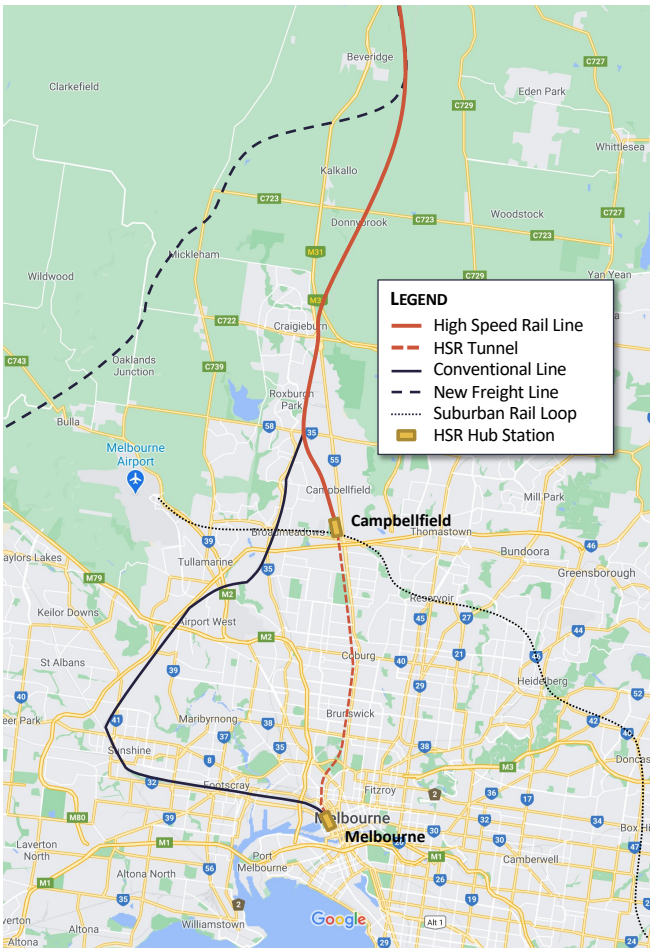
The new line continues to take a straight and direct route to the south around Seymour where it starts to follow the existing conventional line.

Cross-overs to the south of Seymour will allow trains to connect with the existing line to stop and Seymour, and to continue on through Benalla, Wangaratta and on to Wodonga and Albury.

The new line continues south tracking the existing line, with more direct alignment only where the existing line takes a significant deviation.

The new line joins the existing rail alignment near Beveridge, and connects to the existing conventional standard gauge line into the city through Broadmeadows.

SECTION 8: METROPOLITAN MELBOURNE



The new line uses the same corridor as the existing suburban line through Upfield to Campbellfield, where it enters into a tunnel to connect to Southern Cross station in Melbourne.

A new station has to be built at Campbellfield, allowing connections to services on a future suburban rail loop line running across the north and east of Melbourne.

Trains can use the existing standard gauge corridor through Broadmeadows and Sunshine into Southern Cross until the tunnel is built.

BUILD IN STAGES TO A MASTER PLAN

A careful assessment of both existing conditions and traffic on the Main South Rail Line, together with an understanding of how high speed has typically been introduced overseas, suggests that a staged approach to high speed rail is needed to meet Australian conditions.

This should begin with selected infrastructure improvements, coupled with the introduction of new types of rollingstock to take advantage of this and to steadily reduce travel times, improve competitiveness, and generate demand for higher frequency services.

This section sets out how this could be achieved. Five stages of the complete upgrade on the Sydney – Canberra – Melbourne corridor are suggested. These will eventually accommodate a trebling of rail traffic in the corridor, and enable the full range of services to operate, from high speed passenger trains and fast freight services, to local passenger services and industrial freight.

A similar approach can be applied for the Sydney – Brisbane corridor, leading to the ultimate completion of a high speed Rail system between Melbourne and Brisbane. High speed connections to the Gold Coast, Canberra and Wollongong, and upgraded connections to the Sunshine Coast, Geelong, Toowoomba, the Hunter Valley and other regions will greatly facilitate both freight and passenger movement in the megaregion.

This in turn will stimulate and support a less concentrated population settlement pattern in South-Eastern Australia, with wider economic, social and environmental benefits that go well beyond the immediate improvements in transport efficiency.

PROPOSED STAGES

It is proposed that infrastructure enhancements and rollingstock improvements should be combined in five distinct, manageable stages that progressively reduce travel times in the Sydney – Melbourne – Canberra corridor.

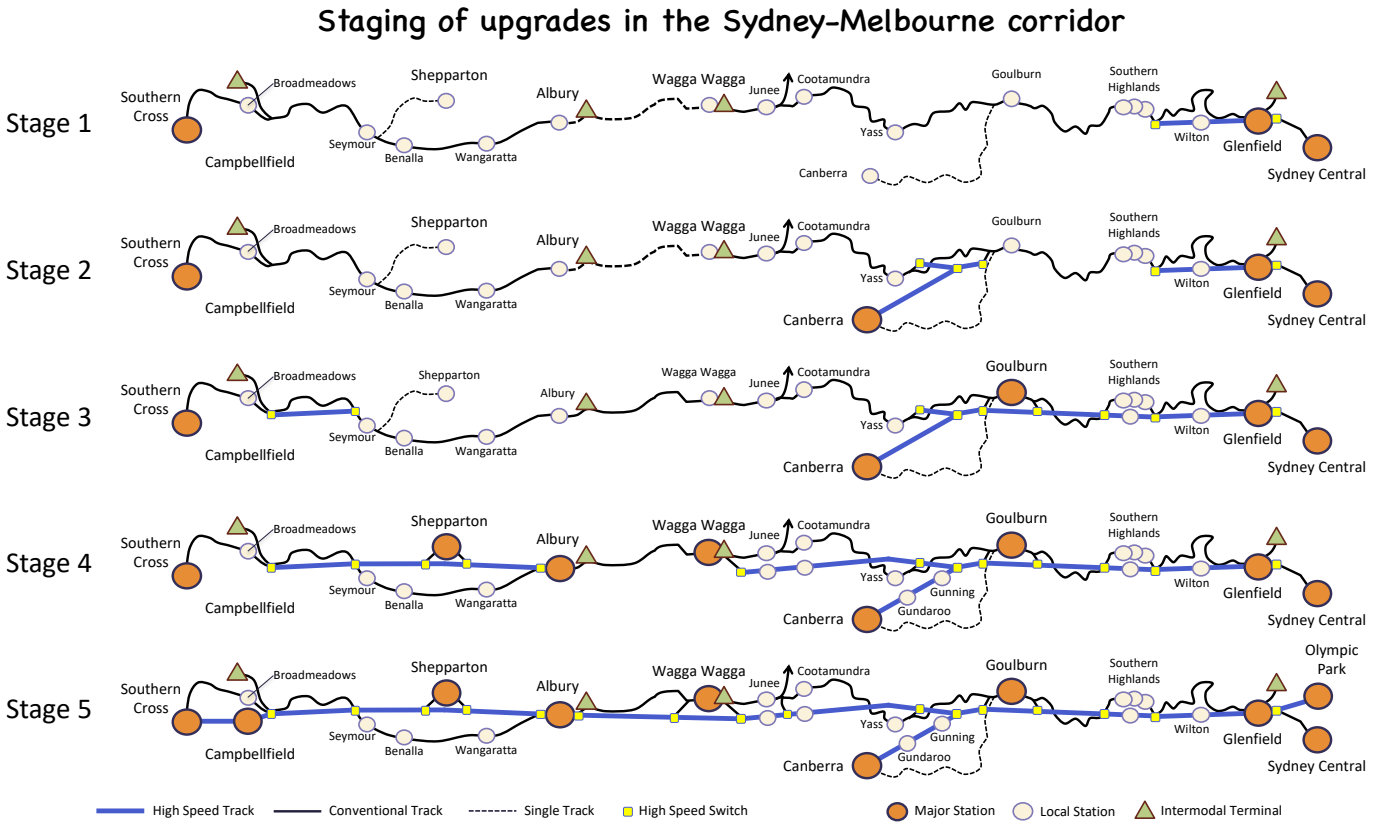
Staged Infrastructure and Service Enhancements

Stage	Key Infrastructure Enhancements	Key Service Enhancements	Fastest Freight (hrs)*	Fastest Passenger Services (Hrs)		
			Sydney - Melbourne	Sydney - Melbourne	Melbourne - Canberra	Sydney - Canberra
Now			13	11	10.5	4.2
1	Glenfield – Mittagong (Wentworth Deviation)	New High Speed Tilt Trains New Fast Commuter Trains New Sleeper Trains Bi-mode locomotives	12	9	8.5	3.0
2	Goulburn – Yass Gunning – Canberra	First Hybrid Fast Freights Additional Tilt Trains Additional Commuter Trains	11	8	7	2.2
3	Wagga –Albury Duplication Mittagong – Goulburn Broadmeadows – Seymour	Additional Tilt Trains Additional Fast Freights	10	6	5	2.0
4	Seymour – Albury Yass – Junee	First High speed Non-Tilt Passenger Trains Additional Fast Freights	9	5	4	1.7
5	Albury – Junee Melbourne Entry Sydney Entry	Additional High speed Passenger Trains Additional Fast Freights	8	4	3	1.5

(*) Most of these would operate it night, when high speed passenger services are not operating

INFRASTRUCTURE UPGRADES

The diagram below shows how the infrastructure upgrades are undertaken in the proposed stages, including the construction of new high speed track sections parallel to the existing line (but in different alignments), and the addition or upgrading of stations.



Note that stations on the existing line will be retained, and served by both local services and by long-distance regional services which operate both on high speed sections and the existing main line. For example:

- There will be a number of higher speed services between Melbourne and Wagga Wagga. These would use the existing line between Wagga Wagga and Albury, then the high speed line to Melbourne.
- Similarly, there will be express services between Albury and Melbourne using the high speed line (via Shepparton), as well as local services via Wangaratta and Seymour, which then join the high speed line.
- In New South Wales, in addition to high speed interstate services between Sydney and Melbourne, stopping at South Gunning and Albury, there will be local services from Sydney to Albury, using the high speed line as far as Yass, but then servicing stations on the existing line.
- There will also be local commuter services from Canberra to Yass and Goulburn, using the high speed line between Canberra and South Gunning.
- The Southern Highlands will be served by a variety of services. These will include hourly local services from Moss Vale / Bundanoon to Campbelltown using the existing line and servings smaller stations such as Burradoo, Bargo, Picton, Douglas park etc, plus peak hour fast commuter services through Moss Vale, Bowral and Mittagong connecting through to Sydney via the high speed line, plus Canberra high speed services stopping at the new Southern Highlands station on the high speed line.

ROLLINGSTOCK UPGRADES

The table below shows an indicative plan of how new rollingstock should be introduced to support the growing services, and the way in which older rollingstock can be cascaded to other services as additional high speed trains are introduced.

Stage	New Trains (a)	Example of Rollingstock	Allocation	Notes on Re-Allocations
1	5 X Bi-mode High Speed Tilt Trains	Talgo 250 Dual	Used on Sydney – Canberra and Sydney- Melbourne services	NSW Next Gen regional trains re-allocated to additional Sydney-Melbourne day trains and to other routes
	2 X Night Sleeper Trains	Night-Jet Sleeper Trains (Europe)	Shares locomotives with Fast Freights	
	10 X Bi-mode Freight/Pass Locos	Eurodual Electric/Diesel	Allows additional fast Intermodal Freight Trains Daily	Bi-Mode locos included in 3-unit consists with existing diesels, allowing additional industrial / intermodal freight services to be run.
	4 X Fast Commuter Train	Alstom iLint	Sydney-Southern Highland fast commuter services	
2	10 X Bi-mode High Speed Tilt Trains	Talgo 250 Dual	Additional Syd- Canberra, Sydney-Melbourne plus new Canberra – Melbourne Services	Displaced Tilt Trains allocated to additional Sydney – Melbourne Services
	20 X Bi-mode Fast Freight Locomotives	Eurodual or other Bi-Mode Locos	Additional Fast Freight Intermodal Services	Any diesels displaced re-allocated to intermodal / industrial freight services on existing Melbourne – Sydney line, Inland Rail etc
	6 X Fast Commuter Train	Alstom iLint	Canberra-Goulburn/Yass fast commuter services More Sydney-Southern Highlands	
3	5 X Very Fast Trains	Many options available	Replace Tilt Trains and provide increased frequencies on Sydney – Canberra Services.	Tilt Trains previously used on Sydney – Canberra Services re-allocated to Sydney – Southern Highlands, Melbourne – Albury and Melbourne – Shepparton Services
	50 X Hydrogen – Electric Freight Locos	Under Development	Additional Sydney – Melbourne Fast Freight Services	New Hydrogen-Electric Locos would displace diesels in consists, which be re-allocated to a wide variety of conventional freight services
	12 X Fast Commuter Trains	Alstom iLint	Melbourne-Seymour/Shepparton fast commuter services More for existing services	Vlocity Trains re-allocated to other Corridors in Victoria
4	10 X Very Fast Trains	Many Options Available	Melbourne – Albury via Shepparton, additional Sydney – Canberra and Sydney – Junee fast services.	Tilt trains displaced from Victorian services re-allocated to Canberra – Melbourne / Goulburn / Yass and other Services
	10 X High Speed EMU Trains	Many Options Available	Melbourne – Shepparton, Sydney – Southern Highlands Fast Commuter Services	New type of service.
	100 X Hydrogen – Electric Freight Locos	Likely to be various options available	Fast Freight and other Freight Services	Older Diesels would be being retired and replaced
5	10 X Very Fast Trains	Many Options Available	Melbourne – Sydney Interstate Express Services	Tilt Trains re-allocated to Brisbane -Sydney and other corridors
	200 X Hydrogen – Electric Freight Locos	Likely to be various options available	Fast Freight and other Freight Services	Older Diesels would be being retired and replaced

The plan is based on the assumption that older rollingstock would be replaced after typical service lives of 35 years, beginning in the next few years with NSW current fleet of XPT, Endeavour and Xplorer trains and remaining loco-hauled sets in Victoria, followed in the 2030's with retirement of older Vlocity trains in Victoria. Older diesel-electric locos used in freight service would begin to be replaced by Electrodual type locomotives in the next few years, followed by a new generation of hydrogen – electric locomotives, probably from the late 2020's. The objective would be to fully decarbonise rail by 2050 through use of pure electric or hybrid electric power, using green electricity / green hydrogen energy sources.

SERVICE UPGRADES

The proposed upgrades to the Sydney-Melbourne line will progressively create sections of parallel double-track rail corridors for high speed and conventional services. This will permit the introduction of high speed passenger services, specialised fast freights and sleeper services (running mostly overnight), an increase in lower speed regional and local passenger services, plus more double-stack container and heavy industrial freight trains.

Each new section will increase the range and number of services offered. When the full corridor has been upgraded, the high speed passenger and fast freight services will operate either exclusively or mostly on the high speed tracks. The lower speed existing conventional line will cater mostly for regional passenger services, industrial traffic and heavy double-stack container

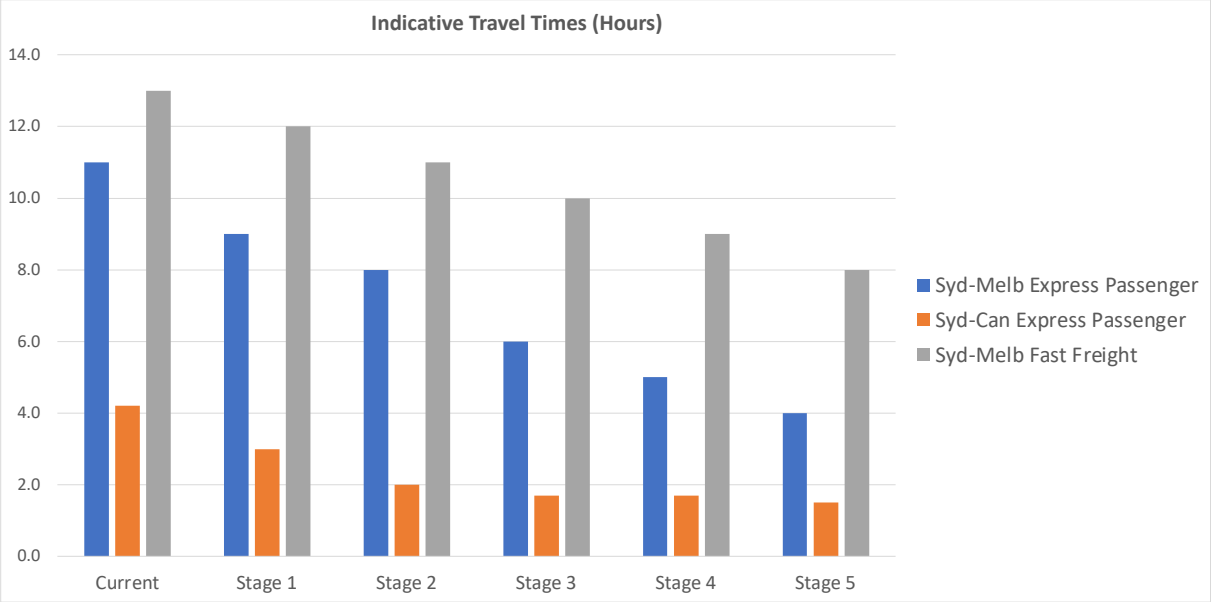
trains. In addition, the availability to run most services on either line will provide a level of operational flexibility and resilience that is not available today.

The table below shows how the potential increase in services could be built up.

Daily Train Volume	Current	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Syd-Melb Express	0	4	8	12	18	24
Syd-Melb Regional	4	4	6	6	6	6
Syd-Can Regional	6	10	16	18	20	24
Syd-SH/Glbn Commuter	40	50	54	60	70	80
Can-Melb Regional	0	0	4	6	8	10
Can-Alb Regional	0	2	2	4	4	6
Can-Glbn/Yass Commuter	0	0	6	10	16	20
Shep-Melb Commuter	0	0	0	0	10	12
Alb-Wang-Melb Regional	8	8	10	6	8	10
Alb-Shep-Melb Regional	0	0	0	12	14	16
Shep-Melb Regional	8	10	14	18	20	24
TOTAL PASS	**66**	**88**	**120**	**152**	**194**	**232**
Fast Intermodal Freight	0	4	8	12	16	20
Other Intermodal Freight	10	12	14	16	18	20
Industrial Freight	38	40	44	48	52	52
Melb - Inland Rail Freight	0	8	12	16	20	24
TOTAL FREIGHT	**48**	**64**	**78**	**92**	**106**	**116**
TOTAL	**114**	**152**	**198**	**244**	**300**	**348**

As can be seen, the benefits apply to both freight and passengers. Careful design is needed to ensure compatibility of design standards and safety, but such integrated railways exist commonly around the world, especially in Europe.

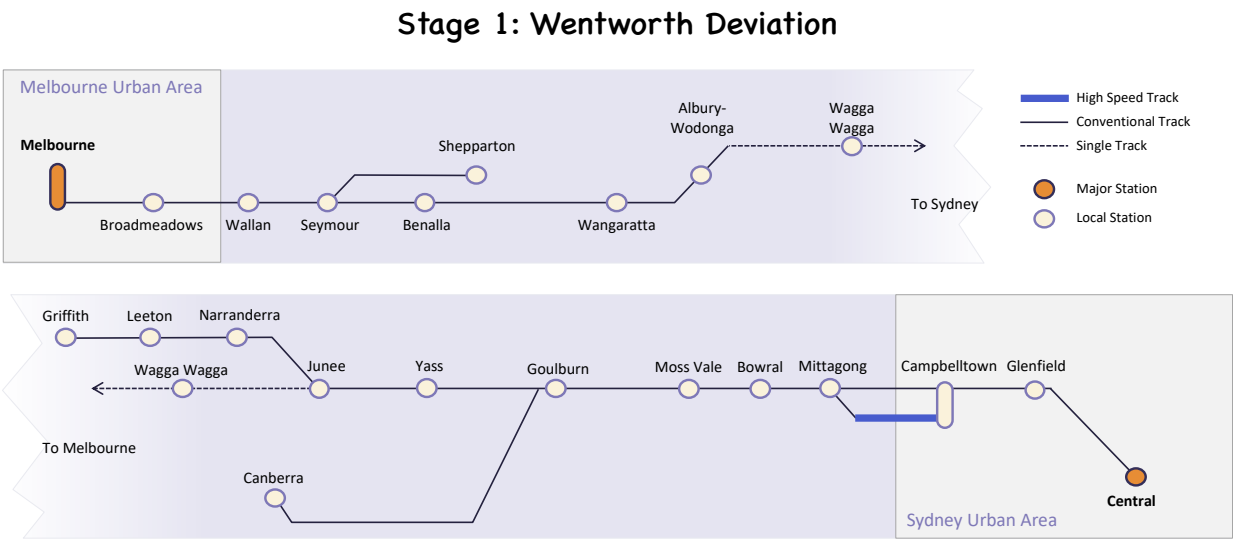
The following chart shows how travel times for both passenger and freight will be reduced in each of the stages.



Indicative travel Times after completion of each stage

OVERVIEWS OF EACH STAGE

STAGE 1: WENTWORTH DEVIATION AND TILT TRAINS

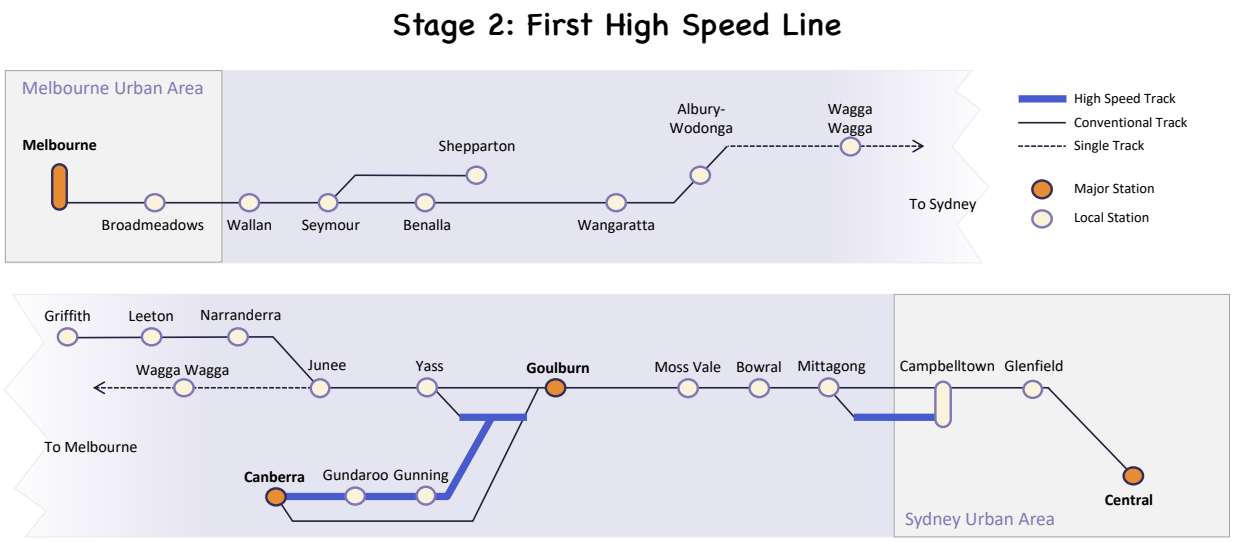


The combination of a better alignment south of Sydney and the introduction of new rollingstock would enable travel times of 3 hr for the five-times daily Sydney – Canberra services; 9 hours for the daily Sydney – Melbourne express services; 10.5 hours for the twice daily Sydney – Melbourne regional stopping services; and 10 hours for the overnight sleeper service.

- **Construction of the Wentworth Deviation** between Macarthur and Mittagong, which would create a high speed (250 km/h) route bypassing the current circuitous route via Picton, Bargo etc. The new route would be engineered for future high speed trains. However, it would immediately reduce travel times for both existing long-distance passenger trains and for intermodal freight trains by around 25-30 minutes. The route would have maximum gradients of 2.2% and would be electrified at 25 KVAC.
- **Utilisation of the new Macarthur – Mittagong Line**. The new line would accommodate Sydney – Melbourne, Sydney – Canberra and Sydney – Southern Highlands fast passenger services. It would also carry some interstate and potentially intrastate intermodal freight services. The new high speed line is expected to have a ruling gradient of 2.5%, and analysis of existing 1800m superfreighters - typically three modern high-powered diesels with gross train weight of 5,000 tonnes - would be able to handle those gradients. In future bi-mode high-powered freight locomotives similar to the Euro9000 would be able to utilise the 25 KVAC power on the line to climb it at significantly higher speeds.
- **Utilisation of the existing Macarthur – Mittagong Line.** The relocation of current long-distance passenger services as well as Interstate Intermodal services from the existing main south line between Macarthur and Mittagong will reduce the volume of traffic on this section of the line, currently the most heavily used on the main South. This will enable higher reliability for remaining local passenger and industrial freight services, and could also allow for additional local passenger services to accommodate the significant population growth expected around Marulan and Picton.
- **Introduction of new, high speed tilt trains** between Sydney, Melbourne and Canberra. These would be bi-mode electric / diesel or electric / hydrogen, able to operate on both 1500V DC and 25 KVAC, with a design maximum of 250 km/h on electrified, and 180 km/h on non-electrified track. (Such trains already exist – the Talgo 250 Dual). By utilising tilt technology and high-power, such trains would further reduce travel times on remaining sections of the Sydney – Canberra route by 30 minutes, and on remaining sections of the Sydney – Melbourne route by 90 minutes, in the latter case for express services which would reduce the number of stops from the current eighteen to at most four (Moss Vale; Goulburn; Wagga and Albury).
- **Introduction of a daily overnight sleeper service** between Sydney and Melbourne, with a travel time of around 10 hours and up to 6 stops. All up there would be a doubling of daily services between Sydney and Melbourne from two per day each way to four per day each way. Services between Sydney and Canberra would increase from three per day each way to five per day each way.

- **Bi-Mode passenger locomotives**. The new services (Tilt Train Expresses to Canberra and Melbourne and the Overnight Sleeper (non-tilting) service to Melbourne) would all utilise the same fleet of bi-mode locomotives, allowing some efficiencies in operation. As mentioned, examples of such locomotives already exist in commercial operation (e.g. the Talgo 250 Dual locomotives), but there are expected to be additional options in future from other manufacturers.
- **Introduction of fast commuter trains** providing services between Sydney and Mittagong, Bowral and Moss Vale in the southern highlands plus a new station at Wilton when completed.
- **Re-allocation of existing rollingstock**. The new regional trains currently on order by Transport for NSW for Sydney – Melbourne and Sydney – Canberra services would be utilised as follows:
    - The sets expected to replace the twice daily current XPT services between Sydney and Melbourne would continue to provide a twice-daily stopping service between Sydney and Melbourne, but operating during daylight hours, one with an early morning departure from each capital (and late afternoon arrival); the other with a late morning departure and late evening arrival time).
    - The sets intended for Sydney – Canberra services would be re-allocated to provide a new fast Commuter service between Sydney and the Southern Highlands / Goulburn. The reduction of about 25 minutes in travel times would make such services significantly more attractive than the current slow services provided via the existing line, which are uncompetitive with driving times to Sydney. Subject to further assessment, it is expected that this would enable up to 5 such fast commuter services daily in each direction, of which a couple would continue beyond Moss Vale to service Exeter, Bundanoon and other small stations as far as Goulburn.

STAGE 2: FIRST HIGH SPEED LINE



The implementation of new track built to support high speed services between Goulburn and Yass, and to Canberra, would reduce travel times for express passenger services to 8 hours between Sydney and Melbourne; 6 hours between Canberra and Melbourne; and 2.5 hours between Sydney and Canberra.

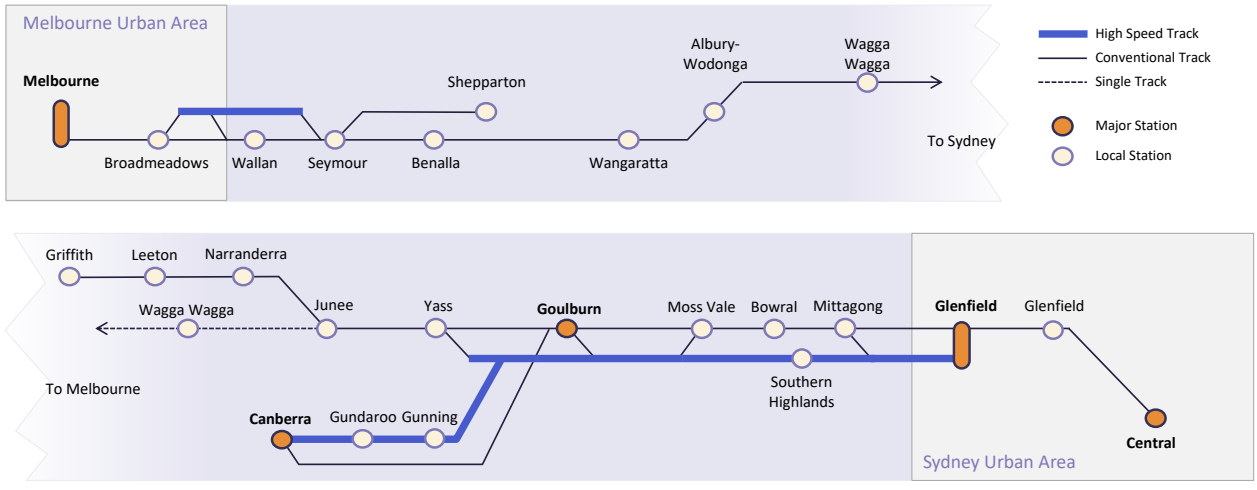
- **Construction of a new high speed line between Goulburn and Yass**, further reducing travel times for long-distance passenger and interstate intermodal freight services by at least 30 minutes. This line also provides the entry point near Gunning) for the new high speed line to Canberra.
- **Construction of a new high speed line between Gunning and Canberra**. This line will follow the broad alignment outlined in the 2013 AECOM high speed rail study, and would be engineered for speeds up to 300 km/h (to utilise the second generation of high speed trains). The new line would also be designed to incorporate future stations at each of the new town developments north of Canberra. This section (and the Goulburn-Yass section) would most likely be electrified at 25 KVAC for commuter trains and future very fast trains to Sydney when stage 3 is completed.
- **Introduction of fast commuter services into Canberra**. These would be either battery- or hydrogen-electric trains with 2 or 3 cars operating to Goulburn and Yass from Canberra station.

- **New Canberra HSR station**. It is proposed that Canberra's high speed rail station located between Canberra Airport and Duntroon, adjacent to Majura Parkway (the alignment for the high speed line), located directly above the light rail link between Civic and Canberra Airport.
- **New town development**. It is proposed that new urban centres should be created north of Canberra, one just north of Gunghalin, and another south of Gunning, near the junction of the line with the high speed line to Melbourne.
- **Integration with the Light Rail system.** This location would avoid the cost and disruption of tunnelling under Mt Ainslie and into Civic. Instead the connection to Civic would be via the light rail line already planned for the next stage of Canberra's light rail network (Stage 3A). This can provide a fast and high frequency connection to Russell, Civic, Northbourne Avenue and the Parliamentary Triangle as well as Woden (via Light Rail stage 2, currently under construction), with other planned extensions in the future to Belconnen (Light Rail Stage 3b).
- **Additional passenger services**. It is envisaged that:
    - there would be a very substantial increase in rail travel demand between Sydney and Canberra, justifying perhaps 8 trains per day in each direction (subject to further assessment).
    - in addition, direct Canberra – Melbourne tilt trains services could be introduced once the infrastructure works in Stage 2 were completed, together with an additional Sydney – Melbourne express day service in each direction.
- **High speed rail servicing centre**. The creation of this corridor would also enable the establishment of a high speed rail servicing facility parallel to Majura Parkway and north of the proposed station. In the long term it may also be feasible to extend the corridor south to Cooma (and even beyond, to Melbourne via Gippsland) and protection of this corridor should be undertaken by the High Speed Rail Authority in conjunction with the ACT Government.
- **Light rail to Queanbeyan**. The replacement of the existing (very slow) rail service through Queanbeyan to Kingston by the new high speed service then enables the former rail corridor to be converted to light rail as part of Canberra's growing light rail network, allowing fast and frequent connections between Queanbeyan (and Bungendore beyond) and the Parliamentary Triangle, Civic, Woden etc.

STAGE 3: MAIN LINE IMPROVEMENTS

The implementation of new track built to support high speed services between Southern Highlands and Goulburn, plus between Broadmeadows and Seymour, would reduce travel times for express passenger services to 6 hours between Sydney and Melbourne; 5 hours between Canberra and Melbourne; and 2.0 hours between Sydney and Canberra.

Stage 3: Main Line Improvements



- **A new high speed line between Mittagong and Goulburn**. This section of the main line is the most heavily trafficked. The new high speed line will provide increased capacity overall as well as travel time savings for the long-distance passenger and freight services using the new line. Local passenger services as well as fast commuter services to the Southern Highlands towns of Mittagong, Bowral, Moss Vale, Exeter and Bundanoon as well as industrial freight services would continue to use the existing line, with the fast commuter services using the Wentworth Deviation from Mittagong

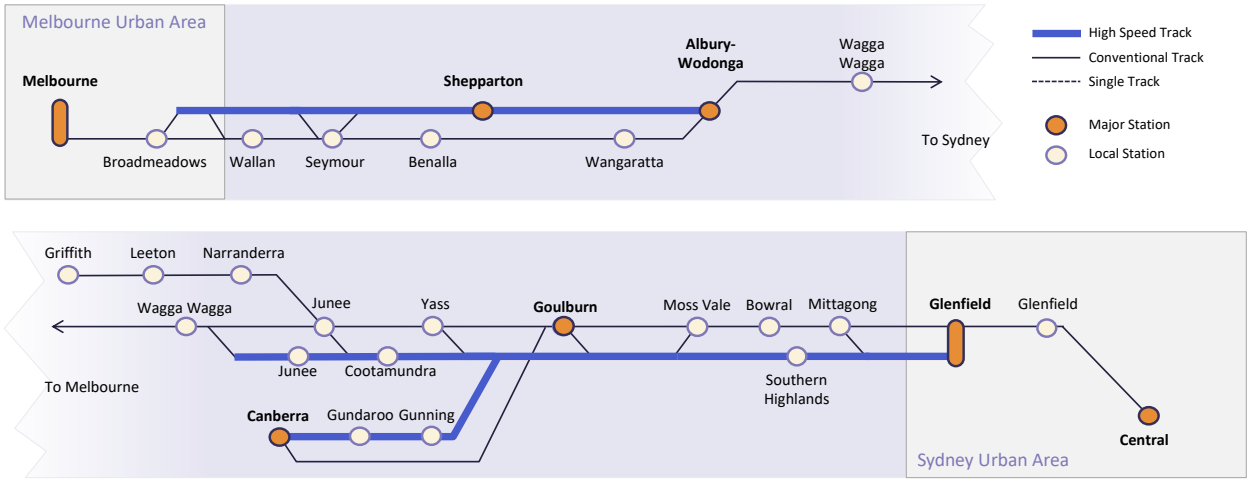
to Sydney. This would be electrified at 25 KVAC to allow very fast, purely electric (dual voltage 25 kV AC / 1.5 kV DC) trains to operate between Sydney and Canberra.

- **Duplication of the main line between Junee and Albury**. Traffic on this line will be increasing both because of the additional traffic between Sydney and Melbourne, and because of the additional double-stack container trains between Melbourne and Brisbane using the Inland Rail. This section would not be electrified given the need for clearances for double-stack containers. It is generally straight and suitable for relatively fast speeds for passenger trains and so would be the last section to have its own dedicated high speed line.
- **New high speed line between Broadmeadows and Seymour**. This part of the Main South is relatively windy and slow, and significant travel time savings will be possible with the new fast line. This is also expected to be needed to cope with increased volumes of freight on the existing line. This section could be electrified at 25 KVAC for faster train operations, but is not needed until very fast trains are introduced after the full line between Melbourne and Yass is completed.
- **First Very Fast Train services**. With the completion of the new high speed sections all the way from Macarthur to Canberra, it will be possible to introduce the first services using the fastest non-tilting high speed trains. These will probably have a top speed in the vicinity of 300-320 km/h, well within existing high speed rail capabilities (which are up to 400 km/h, and currently 350 km/h in commercial service in China).
- **Additional fast passenger services** between Sydney and Melbourne, and between Canberra and Melbourne. These Express Services would now have travel times between the capital cities of 6 hours.
- **Additional freight services**. The duplication of the Junee-Albury line and the new high speed line between Broadmeadows and Seymour will permit a significant increase in freight services, both between Melbourne and Brisbane via the Inland Rail Line, and between Melbourne and Sydney. This will be assisted by the introduction of new Bi-Mode Freight Locomotives, able to use 25 KV AC on electrified portions of the line (in particular the steep climbs between Sydney and Mittagong, and between Broadmeadows and Seymour) and high power hydrogen / battery propulsion in non-electrified sections.
- **New commuter and long-distance passenger services**. The reduced travel times due to the new high speed line in Victoria will facilitate significantly increased services to Seymour, Shepparton, Wangaratta and Albury, as well as more services on the long-haul routes to Sydney and Canberra.

STAGE 4: FIRST VERY HIGH SPEED SERVICES

The implementation of new track built to support high speed services between Seymour and Albury, plus between Yass and Wagga Wagga, would reduce travel times for express passenger services to 5 hours between Sydney and Melbourne; 4 hours between Canberra and Melbourne; and 1.7 hours between Sydney and Canberra.

Stage 4: First Very High Speed Services



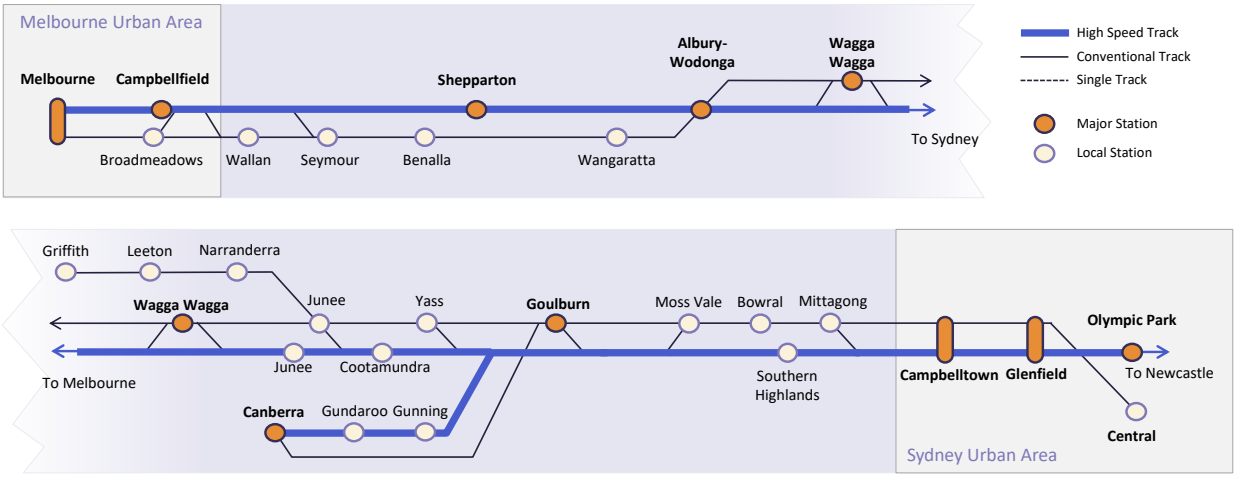
- **A new high speed section on the main line between Yass and Junee.** This would cut a further 45 minutes travel time between Sydney and Melbourne for passenger services and a similar improvement for fast intermodal freight services.

- **A new high speed line between Seymour and Albury.** The high speed line is expected to go through (or close to) Shepparton, leaving the existing line between Seymour and Albury via Wangaratta for an increasing volume of freight trains, especially those between Melbourne and Brisbane via the Inland Rail.
- **New town developments**. Pressure on the existing settlements in the Southern Highlands is likely to create demand for a new town. This should be planned in conjunction with a new station on the high speed line. Additional urban development around Goulburn and Gunning is also expected.
- **Additional services**. The new high speed sections above will allow further expansion of both passenger and freight services. With travel times in particular coming down below two hours for Sydney-Canberra, it is likely that rail will take a significant share of airline traffic on that corridor, and higher frequency services to Canberra will be needed. In addition, there are likely to be increased local commuter services between Canberra, Goulburn and Yass as populations in new towns as well as existing towns north of Canberra expand.
- **Cascading of Canberra's Tilt trains**. As new non-tilting rollingstock is introduced for Sydney-Canberra and Sydney-Southern Highlands services, the older tilting sets can be cascaded to provide additional services, for example between Sydney and Melbourne and Canberra and Melbourne.

STAGE 5: COMPLETION OF HIGH SPEED SYDNEY-CANBERRA- MELBOURNE

The completion of new track built to support high speed services between Albury and Wagga Wagga, plus entries in Sydney and Melbourne high speed stations, would reduce travel times for express passenger services to 4 hours between Sydney and Melbourne; 3 hours between Canberra and Melbourne; and 1.5 hours between Sydney and Canberra.

Stage 5: Completion of the High Speed Line Sydney-Canberra-Melbourne



- **Entry into Sydney's HSR Station**. Assuming a HSR Station in Sydney is to be located in Olympic Park, there will need to be an entry to that station from the south-west. An option could be a full four-track corridor from Macarthur to Glenfield and on as far as about East Hills on the surface, with two of the four tracks reserved for high speed services (Passenger with some fast freight during the day; mostly freight at night plus any overnight sleeper services), and the remaining two tracks for local suburban and also industrial freight services. Beyond East Hills a separated high speed line in tunnel would be needed all the way to Olympic Park, potentially under Bankstown, with an interchange station with Bankstown station. This station would be the only one between Glenfield (Sydney's southern HSR Station) and Olympic Park. It is accepted that this option would be slower than other options involving a completely underground entry to Sydney' high speed station from somewhere in the vicinity of Glenfield (as in the 2013 AECOM study) or even further out past Campbelltown. However, connectivity between high speed rail and existing suburban rail and metro lines is critical to maximise the catchment and convenience of high speed rail, and is likely to be more beneficial than any travel time cost due to an interchange station at Bankstown. However, this aspect would need further study.
- **Entry into Melbourne**. The 2013 AECOM study proposed an underground entry to Southern Cross station from the vicinity of Cambellfield, and this appears the most sensible. It will produce significant travel time savings compared to the current indirect entry via Sunshine. A four-platform arrangement at Southern Cross with at least two long platform faces would be needed to accommodate high speed rail trains north to Sydney, Canberra, Wagga Wagga, Albury,

Shepparton and Wangaratta. The northern Melbourne HSR station at Campbellfield would allow connections to other stations on the suburban line as well as destinations such as Melbourne Airport via the Suburban Rail Loop.

- **A new high speed line between Albury and Junee**. Together with the entries into Sydney and Melbourne, this will complete the whole corridor between the two capitals.
- **Complete electrification of the high speed line.** Any sections of the line not electrified would have this completed, allowing operation by purely electric trains (though these would have dual voltage 25 kV AC / 1.5 kV DC capability).
- **New Very Fast Train services**. New, fully electric trains capable of perhaps 320 km/h top speeds (or above) can be introduced between Sydney and Melbourne when the full corridor is completed and electrified at 25 KVAC (except for some tracks into Melbourne and Sydney). The hybrid trains previously used on this line would be cascaded to other lines (such as Sydney – Brisbane, Sydney – Orange etc).

MAXIMISE THE BENEFIT OF HIGH SPEED RAIL

There are two key factors that will measure the success of the implementation of high speed rail – a smooth transition into operations and an increase in regional growth. The success of the transition into operations will depend largely on establishing the right bodies with the right skills to manage and operate services on high speed lines. The success of the implementation of the high speed line as a lever of regional growth and economic development can be greatly enhanced by coordinating regional development in combination with the opening of new sections of the high speed line.

ESTABLISH APPROPRIATE GOVERNANCE ARRANGEMENTS

Key to the success of high speed rail in Australia will be the development of the capabilities to design, build and operate high speed lines in Australian conditions. The experience from Spain (see appendix) suggests strongly that high speed rail can work in Australia provided:

- The concept is well-designed, adopting both local experience and international experience as relevant
- Appropriate governance arrangements are in place. This will mean a single, national, government owner of the track and related infrastructure assets which can provide clear interfaces with any operator(s) of high speed trains
- Appropriate use of the latest engineering techniques to minimise construction costs. This includes the latest tunnelling techniques, use of pre-cast viaducts where possible, concrete embedding of tracks to reduce maintenance, 25 kV AC supplied from green energy suppliers, in-cab signalling, high-quality maintenance and safety regimes etc.

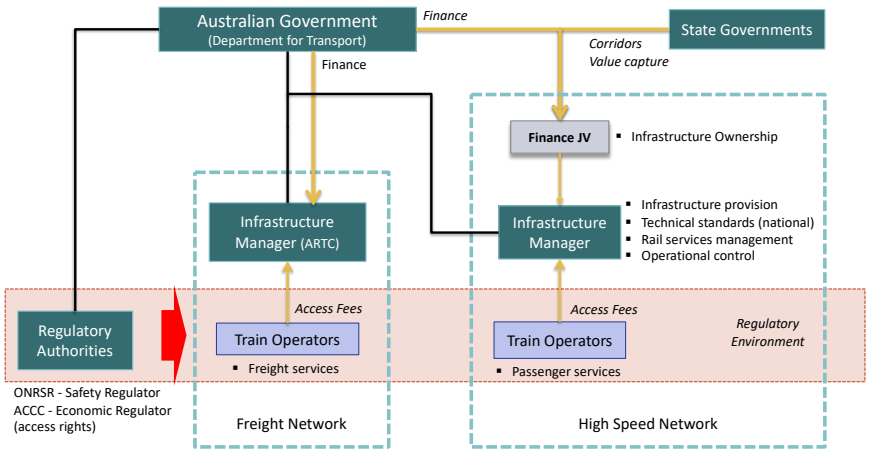
This is similar to Australia's development of the Snowy Mountains Scheme, what was then one of the biggest engineering projects in the world. After establishing the appropriate intergovernmental agreements and governance mechanisms, the scheme drew on the experience of the world experts in dams and hydro power (at that time mostly in the USA). It went on to pioneer many safety and other innovations, including being one of the first organisations in the world to demand safety belts in vehicles.

A similar level of excellence will be required to establish high speed rail in Australia. In this case, the leading experts are far more likely to come from Japan, France, Spain, Germany or Italy than from English-speaking countries like the US or UK, which lag well behind world's best practice.

PROPOSED ARRANGEMENTS

The proposed high speed line will be new rail infrastructure, and often in new land reservations. It will also be built to new standards within Australia for groundworks, civil engineering, rail infrastructure, signalling and rolling stock. It is therefore recommended that the governance of high speed rail be separated from the existing governance of the conventional Inland Rail Network.

The current governance arrangements for the Inland Rail Network provide a guide that can be utilised for deign of the governance of the high speed network.



FUNDING AND STRATEGIC DIRECTION

The Australian Government has to provide the strategy and predominant funding of the capital costs of high speed rail. Some funding will come from States and the ACT Government, and rail operators should be able to fund their own rollingstock.

The objective is to use high speed rail as a lever to increase the population and economic performance of regions outside the major capital cities. The intention is to balance growth between regional and capital cities, rather than continue to grow our capital as mega-cities on a global scale. Only the Australian Government can provide the leadership and strategic planning to implement this vision.

It is expected the new High Speed Rail Authority (HSRA) will provide lead the strategy and planning for high speed rail. The high speed rail network will become national infrastructure, which means that the HSRA has to manage the planning and implementation of the network and services. This includes specifying services to be delivered; balancing investment across the states and nation; ensuring services are safe, secure and sustainable; and promoting a transport network that is efficient and productive.

Redirecting growth into regional areas has to be a federal policy supported by the relevant state and territory governments. High speed rail is essential infrastructure for regional cities which will benefit all Australians, but requires massive investment that only the Australian Government can provide. In addition, a long-term commitment to the success of regionalisation is required. The economic viability of high speed rail in Australia is based on the benefits of regionalisation, which means that the investment will take a long time to recoup.

SEPARATION OF OWNERSHIP, INFRASTRUCTURE MANAGEMENT AND RAIL OPERATIONS

Given the high capital cost of rail infrastructure, it is generally agreed that the "below rail" fixed infrastructure should be in public hands, and that the rolling stock and operations should be in private hands or some form of Public Private Partnership. The 2013 AECOM study adopted this principle in its recommendations for the governance of a future high speed rail system:

Infrastructure Ownership Joint Ventures

While it is recognised that the bulk of the funds for high speed rail infrastructure will have to come from the Australian Government, the state governments have a role to play in providing the land for the rail corridor and in capturing land value uplift resulting from rail infrastructure investment.

It is therefore recommended that a joint financing arrangement be entered into for each section of high speed track. The relative equity in the joint venture should reflect the relative equity provided by each partner, which may vary over time depending on future investment requirements.

The funding would be provided to the Infrastructure Manager to build the rail infrastructure. Operating returns from the Infrastructure Manager to the financing joint venture would then be split between the partners based on their relative equity in the financing joint venture.

Infrastructure Management

It is proposed the railway track and infrastructure for the new network should be managed by a new government agency. It is critical that a high standard of track quality is built and maintained in order to support high speed services. This means that management of the network's infrastructure (which crosses state borders) should be under the control of a single national agency.

The Infrastructure Manager will also be responsible for the technical standards for high speed rail. Technical compatibility between the existing rail system and the high speed rail system will be required to allow trains and services to operate on both networks.

As this is a new network, the agency should be responsible for building and maintaining the network from the outset. It should enter access arrangements for use of land easements from state governments. It would also be responsible for the control of trains using the network. This includes managing the scheduling, timetabling, pathing and control of trains using its network.

One option is to extend the role of Australian Rail Track Corporation (ARTC) to include ownership and management of the new network. The ARTC already provides a single point of access for the Interstate Rail Network, the standard gauge interstate track across Australia, which it either owns or leases from state governments. The Interstate Rail Network is predominantly used by freight services), along with some long-distance and regional passenger services.

However it is recommended that a new government-owned body be established. Australia does not have a depth of experience in building and operating high speed rail. Therefore the agency will have to draw on experience from countries running high speed rail networks. Building and operating high speed rail is also very different from the conventional rail network. Therefore separation of roles between the two networks will allow the high speed infrastructure manager to establish itself without the constraints of simultaneously managing a conventional rail network.

Train Operators

Train operators are licensed to provide services using the rail network infrastructure. Train Operators should have complete control of their business and train operations within the standards and operational constraints of the high speed network.

It is expected that there will be three train operators offering passenger services using high speed rail, and potentially others offering specialised services.

- It is recommended that the Australian Government establish a government-owned carrier to offer fast commuter and long-distance services using the high speed line (and the conventional line during the construction of the various stages of the high speed line). This carrier would own and operate new high speed rolling stock purchased for these services.
- It is expected the current state operators will use the high speed line within their home state, with some services continuing out of their home state.
- It is possible private sector operators may offer specialised services e.g. long distance sleeper services.

In addition it is likely that freight operators could use some sections of the high speed line.

REGULATORY AUTHORITIES

Train Operators should be subject to the economic, safety and customer service regulations set by the existing regulatory authorities for rail services.

Safety

The Office of the National Rail Safety Regulator (ONRSR) is the current body that has responsibility for regulatory oversight of rail safety in every Australian state and territory. Its objectives are to encourage and enforce safe railway operations and promote and improve national rail safety. The new high speed line would come under the responsibility of this body.

Access Rights and Access Charges

The Australian Competition and Consumer Commission (ACCC) is the national body with responsibility for access to the Interstate Rail Network nationally and the Hunter Valley Network in NSW. It is proposed the new high speed line should fall under the ACCC. This means the new high speed line should be a "declared service" under current regulatory arrangements for rail infrastructure.

The issue of Access Charges is a critical one. It is not expected that above rail operators would be able to generate sufficient profits to pay for the expensive below rail infrastructure, and there are relatively few rail lines in the world where this occurs. The same is true for highways, where road users receive the benefits of enormous government investment in what is considered national infrastructure.

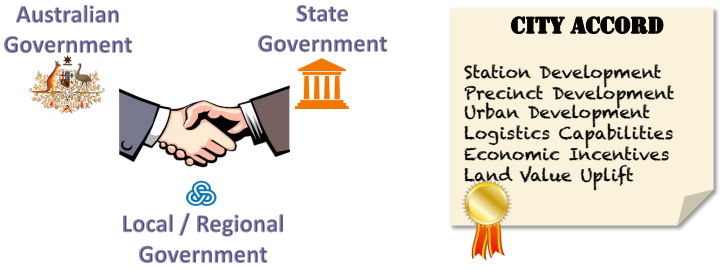
Rail access charges need to be realistic or they will quickly make any rail services uneconomic, and hence nullify the whole objective of the investment. Access charges are a contentious issue, even in Europe with much higher population densities and greater history of using rail, especially for passenger services. The EU has taken the view that governments have a major role in developing a balance between road and rail modes. This has been critical for economic development of Europe, and will be in Australia. Therefore a realistic approach to access charges will be needed in Australia.

COORDINATE WITH REGIONAL DEVELOPMENT

There are a range of development opportunities that should be undertaken in conjunction with the rollout of high speed rail to a regional city. The World Bank[11] has identified a number of key factors in maximising the benefits of high speed rail:

- The station should be located close to the city centre, preferably close to established business activities.
- The station should become a city transport hub with good local, sub-regional and regional services.
- Creating a station with signature architecture will enhance its image and sense of place.
- Land should be released for mixed-use development, including offices, residential, conference facilities, public services and open space.
- Using a mix of public and private sector investment will optimise the value for the government.
- Establish a development corporation to manage collaborative public-private real estate development in the station precinct.

The OECD[12] argues that regional cities must leverage their competitive advantages, and not rely on national subsidies. Greater growth occurs when cities are able to mobilise their own local assets and resources, rather than depend on support from the national government.



But most of these opportunities need state or federal government assistance to be realised. Therefore it is recommended that the three levels of government should form an accord outlining what projects will be undertaken and the funding or other contributions to be made by each government.

A BUSINESS AND TRANSPORT HUB

Stations for high speed services should become major urban activity hubs in their own right.

They will be the key transport hub for the city and its immediate region, playing a role somewhat akin to an airport. They need to become an integrated transport hub, connecting regional and local public transport to the high speed rail. And they will need to offer food and retail facilities for travellers, including local residents simply using the station as a transport hub.

They will also become major complexes and a focus for business within the regional city. They should provide meeting facilities and work spaces for business travellers who may need them for short or extended periods, or even co-working and distributed office spaces for more regular arrangements. Larger stations should include a hotel to accommodate travellers to the city or passing through.

CENTRAL CITY REVITALISATION

New or upgraded stations in regional cities will drive urban renewal and economic activity. International experience shows that well integrated, thoughtfully designed and strategically located stations serve as a catalyst for urban renewal and mixed-use development in their surrounding precinct. It suggests the station should be located close to the city centre, preferably close to established business activities. Land should be released for mixed-use development, including offices, residential, conference facilities, public services and open space.

[11] World Bank (2014), Regional Economic Impact Analysis of High Speed Rail in China
[12] OECD (2009), Policy Brief: How Regions Grow

It is recommended that large-scale precinct development should be undertaken by a development authority with the power to plan and manage the renewal project.

NEW URBAN DEVELOPMENT

The purpose of implementing high speed rail is to attract more people to live in regional cities. This requires planning and development of new urban areas in or around a regional city with a high speed station. Planning schemes need to be prepared in readiness for release in line with the expected increase in growth of the city.

ENHANCED LOGISTICS CAPABILITIES

Shifting freight from road to rail could have a major impact on regional economies. The high speed rail network will allow the replacement of point-to-point distribution by long haul trucks with the hub and spoke movement by rail freight services and local distribution by truck. This assumes major regional cities have inter-modal terminals capable of quickly moving trailers between rail and trucks (cabs). This will make the movement of goods more efficient, opening opportunities to attract more manufacturing into regional cities. New types of trains, such as the Modalohr trains in France or the CargoBeamer trains in Germany, may make this a much more viable prospect than in the past.

ECONOMIC INCENTIVES

Consideration needs to be given to the provision of economic incentives to coincide with the opening of a high speed rail line into a regional city. The opening of the line will make the city a more attractive place to live. This could be enhanced by the provision of additional incentives to attract people, businesses or facilities, such as major hospitals or university campuses, to relocate the city. The attraction of new businesses is particularly important to provide jobs for new residents. This will require longer planning and potentially coordination across all levels of government.

LAND VALUE UPLIFT

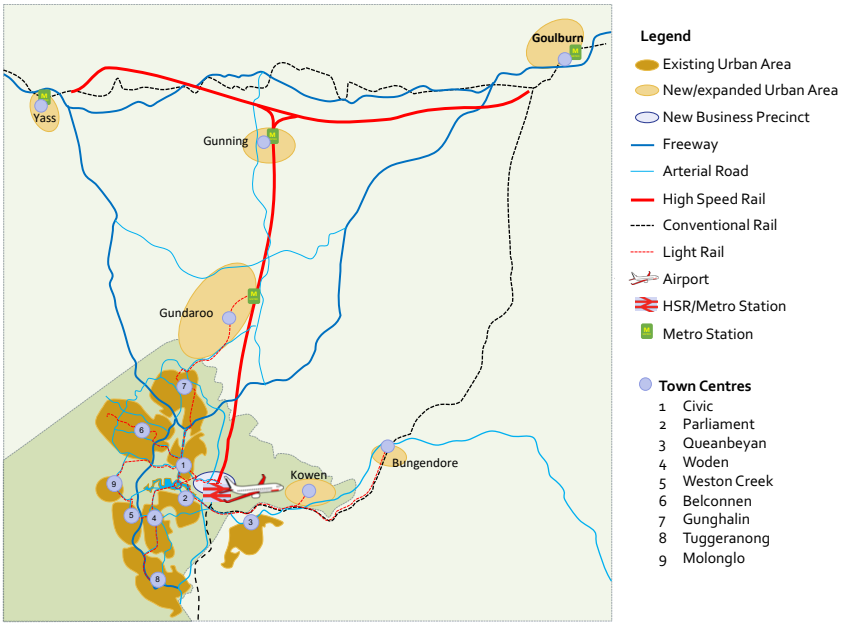
It is well-known that land near a railway station attracts a premium. One study in China has shown that the development of an HSR station contributes to about 3–13% of land value increase of the nearby area, and the effect is stronger if the land is closer to the HSR station. As a result, China's municipal governments have raised significant fiscal revenues through land sales to real estate developers. They put the new HSR station in an undeveloped area, and bundle it with an urban development plan called an "HSR new town". There are at least 139 cities with at least one "HSR new town" in China.

Capturing the uplift in land values is a state government responsibility. They should use their relevant infrastructure contributions tax to capture the uplift in urban and precinct land values when the high speed rail is connected to a regional city. These funds should be hypothecated to the station and high speed line infrastructure. However these arrangements need to be put in place as soon as possible to prevent land speculation and the loss of any land value uplift to private individuals.

USE CANBERRA AS THE FOUNDING STONE

Implementation of the high speed rail section out of Canberra to Goulburn and Yass should be given high priority. It is a standalone project that will facilitate regional growth and development as well as upgrades to the existing rail network. In addition, it requires all elements for the provision of high speed rail services in Australia to be addressed. Therefore it is best placed to serve as an early foundation for a national high speed rail network in Australia.

Construction of the Wentworth Deviation takes precedence in the proposed stages because it is a "no regrets" project bypassing very circuitous track with the most traffic on the line. It will benefit all travel on the main line and requires less preliminary work to start.



SCOPE

The Canberra section of the high speed rail line is largely a self-contained project that is worth doing in its own right. It can be treated as a "no regrets" project. It has sufficient benefits that its success will not be determined by the addition of future stages, and is not dependent on the completion of the full Sydney-Melbourne high speed line. However it will establish faster passenger (commuter) services and demonstrate the regional benefits that implementation of later stages will rely on.

This section of line is essential infrastructure to open the potential for dramatic growth of the population of Canberra. The line opens two new areas for expansion of the urban area north of Canberra that need faster rail connections to be considered as suburbs of Canberra. It also frees the existing rail line to Bungendore, allowing Canberra's light rail network to be expanded to support a third proposed urban renewal area (Kowen) as well as connecting the nearby town of Bungendore. It is expected that these benefits will justify the implementation of this section of high speed line as a standalone project.

PROOF OF CONCEPT

This project contains the two elements needed to prove the validity of the two hypotheses that underpin our approach to the implementation of high speed rail in Australia. Many economists consider the distances too long and our population too dispersed to make the implementation of high speed rail economic in Australia. Therefore the implementation of high speed rail in Australia has to overcome two key challenges:

- That high speed rail is a key enabler of regional economic growth, not just an alternative to air and road transport.
- That high speed rail needs to be considered as an upgrade to the existing rail network, and not as a separate system.

While studies can support or dispel these hypotheses, they cannot be completely proven until tested with the actual implementation of high speed rail. This creates a tremendous challenge when the benefits are largely dependent on connecting Sydney and Melbourne, as in the approach adopted by the 2013 study.

This project encompasses both aspects needed to show that high speed rail (faster connections) promotes regional growth and that it has to be implemented as an upgrade to the existing network:

- The new high speed track connects both Goulburn and Yass to Canberra, creating the opportunity for growth and development in each city.
- This limited section of high speed track will be integrated with the existing network in order to add new services (including ones that will extend beyond this track) and also improve the performance of existing services operating between Goulburn and Yass.

NATIONAL INFRASTRUCTURE

The high speed line crosses the border between NSW and the ACT, which makes it national infrastructure. In fact, it is unlikely to proceed without federal leadership, backed by both the ACT and NSW governments.

The primary justification for this section of line will be regional economic benefits from the growth of Canberra, but a significant portion of its cost will be the rail infrastructure in NSW, and the primary source of funds will be the federal government. It is therefore an opportunity for the Australian Government to lead the planning and implementation of this line. This would give the Australian Government a similar role for national passenger services as it already has for national freight services.

NATIONAL RAIL CARRIER

Similar to the rail infrastructure, the new services using this line will cross state borders, opening the opportunity to create a national rail carrier.

It is proposed that this new carrier should offer commuter services (between Goulburn and Yass to Canberra) and long distance passenger services (to Sydney and also Melbourne) when the new line opens. The proposed long distance services would use the conventional line to operate services to Sydney and Melbourne, and other major regional cities on the line.

New services from a national carrier will also enable improved rail technologies to be adopted. In particular, it is recommended that new tilt trains using hydrogen fuel cells or batteries alone should be acquired. This will leverage the proven ability for tilt trains to improve the performance of services on this route, plus seed the transition to renewable energy in the rail industry.

GOVERNANCE ARRANGEMENTS

Despite being a small project, it requires a completely new high speed line to be built across two states. This creates the need for new governance arrangements for passenger rail in Australia.

It is proposed the new high speed line should be owned and built by the Australian Government through land reservations owned by the relevant state/territory governments. This arrangement is achieved by creating new financing joint ventures for each section of track. It also creates the need for a new authority to build and manage the high speed rail infrastructure. This requires skills and expertise that are not readily available in Australia. Therefore this section of line creates the need for new governance arrangements to be put in place, that will carry on for all future stages.

RAIL STANDARDS

This section will ultimately carry very fast Canberra-Sydney and Canberra-Melbourne services, potentially operating at up to 350km/h. Therefore the track should be built to the appropriate standards to support these services. Not only does this require the establishment of an Infrastructure Manager with the appropriate capabilities, but it is probable that the standards set for this section of track will continue to be applied across all future sections when they are implemented.

REGIONAL CITY DEVELOPMENT

This paper argues there is a range of development opportunities that should be undertaken in conjunction with the rollout of high speed rail to a regional city. Goulburn and Yass can be used to explore and test ideas relevant for Australia's regional cities. These could then be used as a template for the development of other regional cities as they are connected to the high speed network.

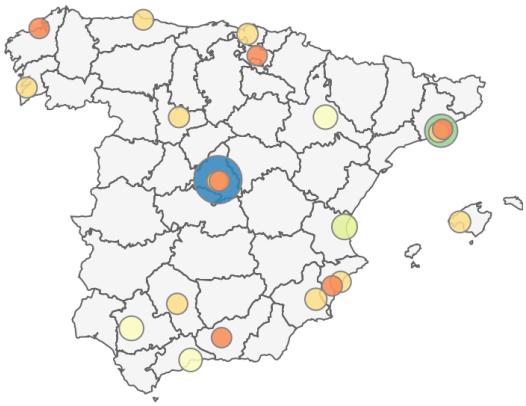
TRANSPORT INTEGRATION

One of the objectives of this project is to create a mixed business and transport hub at the new high speed rail station in Canberra. This will require precinct planning to establish the precinct and transport planning to integrate the station with the airport and Canberra's light rail network. Canberra already sets a very high standard for urban planning. This is an opportunity to build on its existing structure to establish a major activity centre that will be core to Canberra's long term growth.

CASE STUDY - HIGH SPEED RAIL IN SPAIN

Spain provides an interesting comparison with Australia in the context of high speed rail from a number of perspectives:

- With a population of 47 million spread across an area of 505,000 sq. km, its population density is comparable with South - East Australia (18 million across approximately 200,000 sq.km. in the corridor between the Sunshine Coast and Geelong, with 16 million of those living in the 20 largest urban centres.)
- A fairly urbanised population distribution. In Spain's case, Madrid (population 3.2 million) and Barcelona (pop 1.6 million) are the two largest cities, but there are 20 cities with 2022 populations above 250,000 people. In contrast, South-East Australia is more dominated by Sydney, Melbourne and Brisbane, but with a further 7 cities with populations over 250,000.
- Distances in Spain are significant, and the topography is actually more challenging than in South-East Australia.
- Spain had a moderate-sized rail system, complete with a gauge problem like Australia when talk of high speed rail began around 1990, about the time Australia was beginning to discuss the Speedrail proposal for high speed rail in Australia.



Spain's Population Distribution (2022). [13]

COUNTRY/CITY	POP ('000)	%	COUNTRY/CITY	POP ('000)	%
SPAIN	**47,615**		**AUSTRALIA**	**25,700**	
Madrid	3,256	6.8%	Sydney	4,857	18.9%
Barcelona	1,622	3.4%	Melbourne	4,779	18.6%
Valencia	814	1.7%	Brisbane	2,485	9.7%
Sevilla	703	1.5%	Gold Coast	707	2.8%
Zragoza	674	1.4%	Newcastle-Maitland	510	2.0%
Malaga	568	1.2%	Canberra	482	1.9%
Murcia	437	0.9%	Sunshine Coast	356	1.4%
Palma	401	0.8%	Central Coast	340	1.3%
Las Palmas	381	0.8%	Wollongong	306	1.2%
Bilbao	354	0.7%	Geelong	289	1.1%
Alicante	334	0.7%	Toowoomba	144	0.6%
Cordoba	328	0.7%	Ballarat	112	0.4%
Valladolid	318	0.7%	Bendigo	103	0.4%
Vigo	297	0.6%	Albury-Wodonga	98	0.4%
Gijon	277	0.6%	Melton	77	0.3%
Eixample	266	0.6%	Coffs Harbour	74	0.3%
L'Hospitalet	257	0.5%	Wagga Wagga	57	0.2%
Latina	256	0.5%	Shepparton	54	0.2%
Carabanchel	254	0.5%	Port Macquarie	50	0.2%
LARGEST 20 CITIES	**11,797**	**24.8%**		**15,880**	**61.8%**
(a): https://worldpopulationreview.com/countries/cities/spain					
(b): Estimated Resident Population, June 2021 (ABS)					

Comparison of Population in Spain (2022) and South-East Australia (2021)

However, unlike Australia, Spain decided to proceed with high speed rail. Its first line, from Madrid to Seville, a distance of 471km, was opened in 1992. As Murray Hughes[14] notes "The AVE line to Seville was born out of a need to cut journey times to Andalusia. Any train travelling from Madrid to Cordoba had to negotiate a single-track bottleneck dominated by a long climb over the steeply graded Despenaperros pass, where sharp curves restricted speeds to no more than 100 km/h or sometimes just 70 km/h". This is reminiscent of the situation in Australia, where trains leaving Sydney need to negotiate slow, winding alignments whether headed north, west, south or south-west.

Like Australia, Spain also now has an extensive motorway network, and the usual airport infrastructure found in modern countries. But unlike Australia, Spain has built a network of high speed rail lines over the last 32 years, at an average of around 100km. It now totals over 3,000 km, the second largest network in the world.

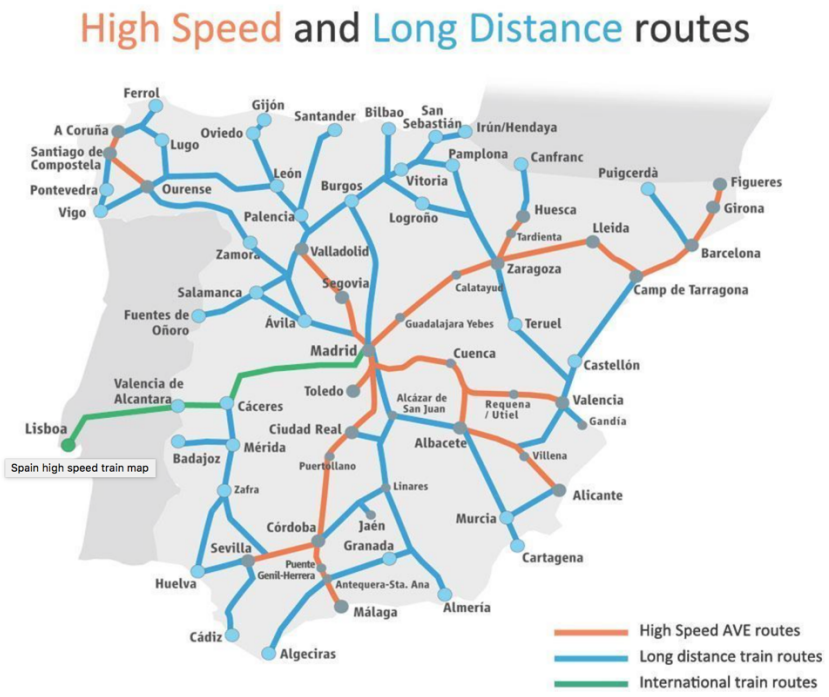
As a result, rail travel times are significantly different between Spain and South-East Australia. For example, one can travel from Barcelona in the north-east to Cadiz in the south-west, a distance of 1100km, in under 7 hours by train (160 km/av speed), much faster than driving even on an excellent motorway network, whereas it takes 11 hours for the 960 rail journey from Sydney to Melbourne (average speed 87 km/h), two hours longer than by car.

Several features of the approach in Spain to high speed rail are worth noting:

- The current system was the result of an ambitious, but well-executed plan.
- The high speed rail elements connect with and utilise the existing rail network, which was initially mostly broad-gauge. Initial high speed lines were also built as broad gauge, but later lines are being built as standard gauge, or able to be converted easily to standard gauge when required.

[13] https://worldpopulationreview.com/countries/cities/spain
[14] Murray Hughes (2020): "The Second Age of Rail – A History of High speed Trains". The History Press.

- The initial high speed lines radiated out from Madrid, but later lines are forming a network of cross-regional links. For example current projects are extending the high speed network down the Mediterranean coast, and are also extending towards Portugal and to France.



And the network and range of services are still growing. For example, in the last six months:

- Passenger services began using an upgraded 193 km mixed-traffic route between Plasencia and Badajoz in Extremadura on July 2022, following the inauguration of three sections of new alignment totalling 146 km by King Felipe VI the previous day. In the longer term, the line is intended to form part of a high speed corridor linking Madrid with Extremadura and potentially Lisboa in Portugal.
- Passenger services on a 75 km high speed line between Burgos and a junction with the Madrid – Valladolid – León line at Venta de Baños began on July 2022, the day after a formal inauguration by King Felipe VI. It is planned that this will eventually form part of a high speed corridor to the French border[15].
- In November 2022, a third high speed rail operator, IRYO, announced it would begin operations in Spain in December, with the aim of gaining 30% of the high speed market during 2023 with services to multiple cities[16]. This operator is using similar trains to those operating in Italy. These will join French trains operated by Ouigo (a subsidiary of France's SNCF), and a wide variety of Spanish high speed trains operated by RENFE, the national rail operator in Spain.
- In December 2022 high speed services began using the latest 16km extension to the city of Murcia. A high speed line is planned from a junction at El Reguerón to Cartagena. This will complete the Levante high speed network as originally envisaged in the early 2000s, linking Madrid with Albacete, València, Alacant, Murcia and Cartagena[17].

INNOVATIVE APPROACHES

Another feature of Spain's high speed rail system is its innovation. As mentioned this includes:

- Tilt Trains to overcome the many speed restrictions on existing lines due to curvature.
- Dual voltage trains to be able to utilise the international standard 25 kV AC 50 hertz as well as the Spanish broad-gauge standard of 3 KV DC supply.
- Hybrid locomotives to extend high speed services to non-electrified tracks.
- Gauge-changing trains to overcome the change-of-gauge problem.

[15] https://www.railwaygazette.com/high-speed/high-speed-line-to-burgos-opens/62183.article
[16] https://www.railwaygazette.com/high-speed/iryo-brings-italian-style-to-spanish-high-speed-rail-services/63016.article
[17] https://www.railwaygazette.com/high-speed/spanish-high-speed-network-extended-to-murcia/63212.article

- Light-weight, low-floor high speed trains, which have the highest energy efficiency of any such trains in the world.
- Innovative engineering to overcome some of Spain's topographical challenges, including some massive bridges and lengthy tunnels.
- Progressive introduction of services, with sometimes only a few high speed services per day in each direction initially. Services are then ramped up to match demand.
- Agreement for multiple train operators to use the same tracks. This allows competition based on services, but maximises utilisation of the fixed assets.
- Extension beyond Spain's borders into France and Portugal, with international services due to operate between Paris and Madrid, and between Rome and Madrid (6-7 hour journey times). These are expected to be popular and demonstrate that rail is attractive well beyond the artificial 3-hour limit sometimes thought to be a barrier.

As a result, a wide variety of rollingstock from a variety of manufacturers (including Talgo, Siemens, Alstom, and Bombardier) now utilises Spain's high speed network, with some extending onto the existing non-high speed network. Most secondary lines also include freight as well as passenger trains, including high speed trains (operating at less than full speed).

Talgo-built (left) and Siemens-built (right) high speed trains in Spain

Alstom Double-deck High Speed Train in Spain on Paris – Madrid service. Operator Ouigo is due to extend services to other Spanish cities in 2023.

It is interesting as well that Portugal has now decided to commence building high speed lines, no doubt inspired by the success in Spain.

The Spanish experience suggests strongly that high speed rail can work in Australia provided:

- The concept is well-designed, adopting both local experience and international experience as relevant
- Appropriate governance arrangements are in place. This will mean a single, national, government owner of the track and related infrastructure assets which can provide clear interfaces with any operator(s) of high speed trains
- Appropriate use of the latest engineering techniques to minimise construction costs. This includes the latest tunnelling techniques, use of pre-cast viaducts where possible, concrete embedding of tracks to reduce maintenance, 25 kV AC supplied from green energy suppliers, in-cab signalling, high-quality maintenance and safety regimes etc.

Australia once had the engineering capability to build what was then one of the biggest engineering projects in the world (the Snowy Scheme) after establishing the appropriate intergovernmental agreements and governance mechanisms and drawing on the experience of the world experts in dams and hydro power (at that time mostly in the USA). The Snowy Scheme went on to pioneer many safety and other innovations, including being one of the first places in the world to mandate safety belts in vehicles.

A similar level of excellence will be required to establish high speed rail in Australia. In this case, the leading experts are far more likely to come from Japan, France, Spain, Germany or Italy than from English-speaking countries like the US or UK, which lag well behind world's best practice. We could do well to follow the example of Spain given some of the parallels to our situation.

AUTHORS

Dr Garry Glazebrook	Garry is a retired transport and urban planner with over 40 years' experience in government, consulting and academia. He has recently formed Fastrack Australia to raise awareness of the potential for higher speed rail in South-East Australia.
Dr Ross Lowrey	Ross is a retired consultant and member of the Town and Country Planning Association in Victoria with a passionate interest in regionalisation. He has conducted extensive research into the importance of high speed rail for regional growth and development.

Fastrack Australia is a not for profit website to promote the development of high-speed rail in South-East Australia, to address issues such as congestion and unaffordable housing in our major cities, by enabling a more balanced pattern of population and economic growth.

https://www.fastrackaustralia.net/

PICTURE SOURCES

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