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1 Overview

This chapter examines a range of issues related to the existing and future infrastructure that affect the ability of rail to service the forecast demand for rail freight along the Corridor. Specific issues addressed include:

1.1 Intermodal terminals

The development of route options for the Corridor requires supporting infrastructure such as terminal facilities to ensure that potential benefits can be realised. In particular, the forecast increases in freight demand indicate that capacity constraints at existing terminal facilities will need to be addressed as part of any development of the Corridor after 2009.

The existing intermodal terminals in the three capital cities are constrained by space limitations, preventing the terminals from providing for longer trains without loading inefficiencies. The constraints and opportunities at each of these terminals include:

- In Victoria, the Australian Government has approved $110 million for the construction of a new grade separated rail link between the Dynon Intermodal Precinct and the Port of Melbourne. The constraints surrounding the Dynon terminals prevent longer trains being accommodated in the terminal and any significant expansion. The proposed Tottenham Yard would allow longer trains to be made up but it cannot be used for loading and unloading containers. The only opportunity to load and unload 1,800 metre long freight trains would be the expanded facilities at Altona or Somerton;

- The Sydney freight rail operations involve a number of disparate terminal facilities with individual characteristics and limitations, including Camellia, Chullora, Cooks River, Leightonfield, Minto, Port Botany and Yennora. None of these facilities has sufficient expansion potential to provide for longer trains and the anticipated increase in demand. The Sydney Ports Corporation (SPC) proposes a major expansion of the facilities at Enfield to increase intermodal terminal capacity. In addition, terminals are being considered at a number of ‘greenfield’ and existing sites at Eastern Creek, Ingleburn, Menangle and Moorebank that would enable increased freight terminal capacity in Sydney when constructed;

- The Acacia Ridge intermodal terminal is the main facility in Brisbane but it is currently restricted due partly to the Beaudesert Road level crossing. A recent funding commitment will address this issue and enable the terminal to be expanded to provide additional sidings and provision for longer trains. Other Brisbane terminals are smaller with reduced capacity and provide little benefit to the Corridor. In addition, terminal developments are being considered at Bromelton and Parkinson; and

- Existing and proposed regional terminals in each of the three states provide additional capacity and the potential to handle the distribution of freight in the Corridor. These include Shepparton and Wodonga in Victoria; Parkes, Narrabri, Blayney and Bathurst in New South Wales; and Toowoomba in Queensland.

Currently the management of terminals in Melbourne and Sydney, including operations and upgrading terminal capacity, is under the control of private train operators, QR and freight forwarders, while the Acacia Ridge facility in Brisbane is owned by QR and managed on a multi-user basis. Therefore the provision of much of the terminal infrastructure in the Corridor would need to be financed by the private sector and the costs of this infrastructure may be substantial. The National Intermodal Terminal Study by Meyrick and Associates estimates the cost of a 150,000 TEU (Twenty foot Equivalent Unit) terminal to be $13.5 million. Available land and proper transport planning will be important to ensure that future increases in intermodal capacity necessary to support the development of the Corridor are achievable in the period 2009-2014.
1.2 Port operations

The amount of import and export freight that can be captured on rail will depend on the efficiency of access to and the capacity of rail transfer at the ports. Research indicates that the majority of freight arriving at the ports is distributed within the metropolitan areas of the capital cities and is not a significant issue for end-to-end freight movements in the Corridor. However, the linkages to the ports are important considerations for potential increases in regional freight that will benefit from improved rail services.

One of the most significant port-related issues for the Study is rail access between the intermodal terminals and the ports:

- In Melbourne, the Dynon Port Rail Link currently under construction will provide a grade separated rail line into the port area but due to the number of separate berths around the port, rail access is not available at all berths. When completed this new link will enhance rail operations and remove the main impediment to efficient operations between the port and the Dynon terminals.

- In Sydney, there are significant constraints to the provision of good rail access to the port due to the dense urban development and topography. The proposals to expand the rail facilities to provide for 600-metre trains within the port and complete the duplication of the connection between the port and Enfield will enhance Sydney rail freight operations.

- In Brisbane, rail access to the port involves using the metropolitan rail network and the associated infrastructure constraints impose on the ability to operate longer trains between the port and Acacia Ridge. Many of these issues are being considered in the future infrastructure strategy planning by governments and the rail industry, but are yet to be committed to implementation. When completed these works have the potential to provide for longer freight trains and more efficient operations.

1.3 Road connections

The Study analysis suggests that there are no significant road/rail connections that would impact on the viability of the rail corridor, beyond those currently anticipated in existing approved projects in Melbourne and Brisbane. In Sydney, connecting roadworks may be required, depending on the location of new or enhanced intermodal terminal facilities required to handle forecast demand.

1.4 Current investment plans and future additional infrastructure

The following rail-specific infrastructure issues have also been addressed:

**Committed rail infrastructure projects** – the state of the rail network at the base year is a key consideration in the comparison of alternate route options for the Study. ARTC has commenced a major upgrade of the existing Coastal Route with a significant investment committed over the next three years.

The current and future program of works assumed in the Study is based on discussions with ARTC and publicly available information on the ARTC website.
The committed program of works relevant to the Study includes:

- The $1.4 billion ARTC program of improvements to the existing Coastal Route;
- An additional $270 million of Australian Government funding towards the concrete sleepering of the ARTC interstate track between Melbourne and the New South Wales / Queensland border;
- Planned ARTC improvements on other parts of the standard gauge network; and
- Various state government projects in Victoria, New South Wales and Queensland.

The 2009 base case network assumes that all current and committed programs will be complete by that date. The Study identified further improvements that are required to address network deficiencies.

**Major rail network constraints** – there are several major infrastructure constraints that impact on the ability of rail to provide an optimal service along the existing Coastal Route without significant capital investment. These include the metropolitan rail network constraints through northern Sydney, the vertical grades and horizontal curvature through the Cowan Bank, and similar geometric constraints and environmental consideration through the Hawkesbury River area.

The Toowoomba Ranges poses a similar challenge to the movement of freight trains west of Brisbane for any options along the Far Western Sub-Corridor. Queensland Rail and Queensland Transport have investigated the concept of a new rail crossing of the Toowoomba Ranges in some detail and this has been included in the route options considered in the Study.

**Design criteria and costing approach** – Any new construction should be designed in accordance with appropriate design criteria to produce a network suitable for the nature and scale of freight activities anticipated. Similarly any existing track deficiencies will need to be addressed to ensure that the proposed network provides a complete and appropriate network.

The design criteria adopted for the Study are based on the current Code of Practice for the Defined Interstate Rail Network. Key design criteria include:

- Desirable maximum speed for freight trains 115 km/h
- Maximum axle load for freight trains 30 tonnes
- Minimum vertical clearance above top of rail 7.1 metres
- Horizontal geometry radius for 115km/h 1,200 metres
- Maximum desirable gradient 1.25%
- Maximum allowable gradient 2.50%
- Crossing loops train length 1,800 metres
- Rail for new or upgraded track 60 kg/m
- Concrete sleepers for new or upgraded main line track and crossing loops.

The costing of each component has been developed on the basis of current and recent costing data and covers all elements of the capital cost including land acquisition to ensure a thorough and consistent approach.
Train operations – the relative efficiency of train operations is largely driven by transit time, reliability and availability.

Transit time can be defined as the overall time from the origin terminal to the destination terminal including pick-up and delivery (PUD) components. The end-to-end rail transit time is the component that can be improved through consideration of new route options and horizontal or vertical realignment of existing track. However, the actual transit time also includes additional delays from operational constraints imposed by single line track systems and associated safe working requirements. The existing curfew arrangements within Sydney affect transit time but have a greater impact on reliability and availability.

The Study determined that the key operational design considerations for the Study should include provision for 1,800-metre long trains and 30-tonne axle loads.
2 Introduction

This chapter assesses infrastructure capability and train operation requirements that will be necessary to support the business demand and forecast for rail freight through the Corridor. The main issues relate to:

- **Intermodal terminals** – The development of route options for the Corridor requires supporting infrastructure such as terminal facilities to ensure that potential benefits can be realised. In particular, the forecast increases in freight demand indicate that capacity constraints at existing terminal facilities will need to be addressed in the foreseeable future. This section provides an overview of existing terminal infrastructure, the timing and location of future capacity constraints and the options being developed to address those constraints;

- **Port operations** – The amount of import/export freight that can be carried by rail will depend on the efficiency of access to and the capacity of rail transfer at the ports. Research indicates that the majority of freight arriving at the ports is distributed within the metropolitan areas of the capital cities and is not a significant issue for end-to-end freight movements in the Corridor. However, the linkages to the ports are important considerations for potential increases in regional freight that will benefit from improved rail services. This section describes the rail facilities at each of the major port facilities in Melbourne, Sydney and Brisbane and the relevance to rail freight movements along the Corridor;

- **Train operations** – The relative efficiency of train operations is largely driven by transit time, reliability and availability. This section examines these issues and related constraints;

- **Committed rail infrastructure projects** – The state of the rail network at the base year is a key consideration in the comparison of alternate route options for the Study. ARTC has commenced a major upgrade of the existing Coastal Route with a significant investment committed over the next three years. This section outlines the current ARTC investment plans;

- **Major rail network constraints** – There are several major infrastructure constraints that impact on the ability of rail to provide an optimal service along the existing Coastal Route. This section examines the major infrastructure constraints including Northern Sydney, Cowan Bank, the Hawkesbury region and the Toowoomba Ranges; and

- **Design criteria and costing approach** – Any new construction should be designed in accordance with appropriate design criteria to produce a network suitable for the nature and scale of freight activities anticipated. Similarly any existing track deficiencies will need to be addressed to ensure that the proposed network provides a complete and appropriate network. This section outlines the development of the relevant design criteria and the approach adopted for costing of each component to ensure a thorough and consistent approach.
3 Intermodal Terminals

3.1 Terminal operations

Intermodal terminals are an essential component of rail operations as they provide the interface between the rail linehaul movement of freight and the road distribution to and from ports or other end customers. The major intermodal terminals within the Corridor are located in Melbourne, Sydney and Brisbane, with some smaller terminals in regional cities. The terminals in Melbourne and Brisbane link rail operations between the interstate standard gauge lines and the Victorian broad gauge and Queensland narrow gauge networks.

Pacific National (PN) is the largest train operator in this business sector and manages the Chullora terminal in Sydney and the South Dynon terminal in Melbourne. Queensland Rail (QR) recently appointed P&O as an independent operator of the Acacia Ridge terminal in Brisbane. Other rail operators are required to seek access to existing terminal facilities or develop their own terminals.

The size, location and configuration of terminals have a significant impact on the efficiency of rail freight operations. A major issue with the original terminals in Melbourne, Sydney and Brisbane is that they are restricted in length (and in their potential to be extended), which limits the length of trains that can be assembled. Operating curfews, the proximity of residential areas and poor rail connections between terminals and ports restrict the efficient movement of export freight, especially in Sydney. Height restrictions into the terminals also impede the operation of double stacked trains on the east coast.

The gain from improving infrastructure along the Corridor would be negated if the intermodal terminal facilities at each of the key capital city locations which cater for international, interstate and regional freight movements are inefficient.

The recent National Intermodal Terminal Study identified the importance and need for additional intermodal capacity in the major capital cities in the future, particularly in Sydney and Brisbane, with a significant shortfall in capacity by 2020. This reinforces the need for action well before then to allow the necessary lead-times for land acquisition and terminal development to be put in place. Suitable locations in these two cities may become increasingly difficult to establish given competing land uses. Regional intermodal terminals are likely to be driven by natural location advantages (for example, as collection points for surrounding regional agricultural or mineral produce) or specific regional industry drivers.

3.2 Future demand and terminal capacity

Terminal capacity and operation is a function of train operation and commodity type. These factors are determined by train operators according to the type, frequency and size of trains they operate. Inefficiencies at terminals can dilute the benefits gained from the train operator’s efforts to improve the linehaul. For the purposes of this Study, terminal management, operation and improvement have been determined by rail operators and have not been significantly affected by route choice. Provision of terminals and upgrading terminal capacity is currently managed by private train operators, QR and freight forwarders, and this is expected to continue.

The need for capacity improvements at the Dynon and Acacia Ridge terminals is unlikely to be affected significantly by route options but is more closely related to general freight growth. Anticipated growth in general freight activity and the possible shift in traffic from road to rail as a result of cost or other pressures will further increase rail freight demands and the need to expand terminal facilities.
The need for additional capacity at existing terminals outlined above would not be materially different for any of the potential route options being considered. The cost of different options should therefore not be affected by the need to improve terminal capacity.

In Sydney, where terminal capacity is widely dispersed and operating at close to capacity, relocation of freight trains from the existing Coastal Route to an alternative inland route may provide significant benefits as the need to provide additional capacity in Sydney would be removed. This applies not only to the terminal facilities but also to line capacity.

Future upgrades to terminals to provide for future operational improvements will be required over the 25-year Study analysis period. These improvements will potentially produce a substantial benefit to the operational efficiency at the terminals, with resulting improvements in pickup and delivery time, reliability and availability. These benefits have not been incorporated into the analysis, but provide a potential additional improvement to rail compared to road.

The need for terminal capacity improvements and their timing are considered to be independent of the options being considered for rail corridor development. As a result, no costing allowance has been made for any expansion of terminal facilities for any of the route options being considered for the Study. It is expected that this will be a cost incurred by the terminal providers and the operators at the time when the facilities are required.

### 3.3 Melbourne terminals

#### 3.3.1 Current operations

The main intermodal terminal in Melbourne is the Dynon/South Dynon complex. The terminal accommodates interstate and intrastate container trains, and is adjacent to the main steel transhipment facility for broad gauge services to the Port of Hastings on Western Port Bay.

The terminal is located close to the main port facilities that handle container import and export. Other terminals operated by private entities are distributed on the western and northern suburbs of Melbourne, including Altona and Somerton.

Figure 1 shows the location of the main terminals in metropolitan Melbourne relative to Swanson Dock and Appleton Dock, including:

- Dynon/South Dynon/North Dynon;
- Port of Melbourne (Swanson Dock and Appleton Dock);
- Tottenham;
- Altona;
- Altona North; and
- Somerton.
Figure 1 - Melbourne terminals locality plan
The Victorian Government is aiming to increase the amount of freight moved by rail to and from commercial ports to 30% of the total freight task by 2010. Central to this strategy are plans to improve the rail link between the Dynon intermodal precinct (including the Dynon, South Dynon and North Dynon terminals) and the Port of Melbourne by providing new dual gauge access with grade separation across Footscray Road.

The Dynon Port Rail Link, as the project is known, will improve road and rail traffic flow, and is mainly funded by the Australian Government ($110 million) with some funding from the state government and the Port. Associated with the project is a committed investment by ARTC to provide a standard gauge link between Sunshine and Brooklyn on the western approaches to Melbourne.

The Australian Government has also allocated AusLink funding to upgrade the existing single track main line and crossing loop between Tottenham junction and West Footscray. This will double the number of bi-directional tracks, together with dual gauge tracks between West Footscray and Dynon. These projects will enable better rail access to existing intermodal terminals to the southwest and north of Melbourne, and facilitate both the expansion of these outer suburban terminals and the creation of new terminals.

The constraints surrounding the Dynon terminals prevent any significant expansion and the only opportunity to put together longer freight trains proposed on the Corridor would be at the Tottenham Yard (however, this facility could only be used to make up or break up trains as it does not have space to load and unload trains) or at expanded facilities at Altona or Somerton. While there are many restrictions preventing the double stacking of containers on the freight rail network, the Dynon terminals are capable of loading containers onto double stacked trains without any significant changes to the current loading equipment and operations.

### 3.3.1.1 South Dynon terminal

The South Dynon terminal is located on the southern side of Dynon Road adjacent to the Port of Melbourne, the Melbourne CityLink and the urban freeway network, and two kilometres from the Melbourne central business district (CBD). The terminal is the principal hub of PN’s interstate rail network, with total throughput estimated at 680,000 TEU per year. The main South Dynon container facility can accommodate trains up to 1,200 metres.

There is a direct rail and heavy duty road access for international containers to and from the Port of Melbourne, but the majority of traffic passing through the terminal to the port has its origin or destination in Melbourne. Road access to the Dynon intermodal precinct is provided by a good network of arterial roads and major freeways immediately adjacent to the terminals. This provides an excellent mechanism for distribution of freight to and from the terminals by road from both the metropolitan and regional areas.

While improvements to the South Dynon terminal could benefit train operations in the Corridor, improvements in rail access between the terminal and the port would have little impact as only a small proportion of freight in the Corridor is taken to the port for export.

### 3.3.1.2 Dynon and North Dynon terminal

The Dynon and North Dynon terminal is located on the northern side of Dynon Road. The area known as Dynon is leased by PN but train operators ARG and Queensland Rail National (QRN) have purchased access rights from VicTrack for the part nearest South Kensington, generally known as North Dynon. The Dynon and North Dynon terminal also has a direct heavy duty road connection to the Port of Melbourne.

The Dynon and North Dynon facility has 10 rail lines around 500 metres long with a throughput of 200,000 TEU per annum.

Figure 2 shows an aerial view of the South Dynon, Dynon and North Dynon terminals.
3.3.1.3 Port of Melbourne precinct

Swanson Dock in the Port of Melbourne is Australia’s largest container port, and is located only a few hundred metres from the South Dynon intermodal terminal with both heavy duty road and rail access. Dock facilities are provided on both the east and west side of the dock. East Swanson Dock is operated by Patrick and West Swanson Dock is operated by P&O Transport Australia. Appleton Dock is used by the Australian Bulk Alliance (ABA) and Patrick.

The facilities at East and West Swanson Dock have rail lines catering for trains up to 1,500 metres. East Swanson Dock has a rail throughput of around 85,000 TEU per annum and West Swanson has a rail throughput of around 44,000 TEU per annum.

3.3.1.4 Altona North

QRN manages the intermodal facility in Altona North as its base for its north-south interstate rail freight business. It caters for trains up to 560 metres in length and has a rail throughput of around 35,000 TEU per annum. This is likely to grow significantly with QRN’s future plans for expansion of interstate operations.

3.3.1.5 Altona

Freight operator SCT has an intermodal facility located at Westlink Court in Altona. The facility caters for interstate non-bulk goods, primarily loaded into vans, but with some intermodal containers. SCT considers vans to be a more
efficient form of transport than containers for domestic freight, and has pioneered the use of ‘hi-cube’ vans on the east-west corridor.

Altona has rail lines catering for trains up to 1,500 metres in length and currently has a rail throughput of 13,000 TEU per annum.

3.3.1.6 Somerton

P&O uses the 120-hectare Austrak intermodal terminal and business park located on the main interstate railway close to the Hume Highway at Somerton. The terminal is currently used for export containers only but there are plans to significantly expand the operations. It has rail lines of around 750 metres and on completion of the current expansion plans it will have a capacity of 600,000 TEU per annum by rail.

3.3.2 Proposed developments – Melbourne intermodal terminals

3.3.2.1 Tottenham

The existing railway marshalling yard at Tottenham is not currently active apart from the storage of wagons. ARTC has indicated plans to separate the standard gauge main line and the sidings so that they can be leased. The Tottenham site has capacity for trains over 1,800 metres long. Operators have indicated a preference to develop the site so that 900-metre long trains loaded at South Dynon can be formed into 1,800-metre long trains at Tottenham, rather than South Dynon, where the shunting blocks access to the yard.

3.3.3 Summary

Overall Melbourne currently has capacity and terminal issues; however, it does have scope for expansion.

3.4 Sydney terminals

3.4.1 Current operations

Sydney’s existing intermodal network for export and domestic containers comprises six relatively small intermodal container terminals at Camellia, Chullora, Cooks River, Leightonfield, Minto and Yennora. The combined capacity of these terminals is around 500,000 TEU (as at 2004).

The NSW Freight Infrastructure Advisory Board report to the New South Wales Government indicated that it expects that Sydney will require an aggregate intermodal terminal capacity of at least 1.2 million TEU per annum by 2020, with further capacity for port growth and a higher rail modal share.

With the exception of Minto, existing terminals are located on constrained sites with limited capacity for growth, and cannot play a major role in meeting the New South Wales Government’s nominated target of a fourfold increase in the number of containers transported by rail by 2011.

The Sydney Ports Corporation (SPC) has indicated an intention to develop the Enfield terminal adjacent to the existing shunting yards for empty storage. Improvements are planned for 600-metre long trains to be accommodated at each of the Port Botany container terminals.

In addition to these terminals, there are a number of other terminals proposed to be built across Sydney. Some of these terminals have relevance to the Corridor while others will service different markets.

The Southern Sydney Freight Line (SSFL) will provide better access between the interstate main line to terminals such as Chullora and Enfield. However, restrictions will still exist between the terminals and the port and along routes through northern Sydney.
Many of the Sydney terminals are located in built-up areas across the metropolitan region. As a result, they are restricted in their ability to expand the scale of operations and road access to the sites. In most cases, the adjacent arterial road network is congested and access to the urban freeway/tollway network is constrained, particularly during morning and afternoon peak hours. Generally, the existing urban development prevents any real improvement opportunities.

If any of the terminal operators were to consider major expansions to their operations, then access arrangements would need to be considered as part of the normal planning requirements for any development proposals.

Figure 3 shows the location of the main terminals in Sydney relative to Port Botany.
Figure 3 - Sydney terminals locality map
3.4.1.1  Chullora

The Chullora facility occupies part of the old Chullora Workshops site located approximately 18 kilometres west of the Sydney CBD. The facility is owned and operated exclusively by PN and is used for domestic inbound and outbound freight. The terminal currently handles about 300,000 TEU per annum. It is accessed from the eastern end of long sidings parallel with the main goods lines. Long trains are assembled or disassembled on the sidings adjacent to the main line and trains are received and dispatched from these sidings. However, the operating capacity of the terminal is restricted to trains 350 metres long.

PN uses this facility primarily for domestic interstate container traffic, and has ceased rail movement of export containers between Chullora and Port Botany. Although the site has good access to the rail network, which would be further improved by the planned SSFL, a significant growth of interstate container traffic could put the terminal under pressure. Like other Sydney terminals, any further expansion requires significant capital expenditure.

Figure 4 - Aerial photograph of Chullora terminal

3.4.1.2  Cooks River

The Cooks River rail terminal is owned by SPC and is located near St Peters, approximately 10 kilometres southwest of the Sydney CBD and a similar distance from Port Botany.

Cooks River is the major base for FCL’s Sydney operations, with five trains a week to Perth and a weekly train to Adelaide (with loading for Alice Springs and Darwin). Brisbane and Melbourne are also key FCL freight destinations. The majority of FCL containers are domestic traffic. FCL also maintains a large transit warehouse at Cooks River, where all loading and unloading is carried out.
The facility is also used by Patrick PortLink, MCS, Lachlan Valley Rail Freight and South Spur Rail, which run export container trains into Port Botany from country New South Wales. It caters for 400-metre long trains, with a total throughput of 150,000 TEU per annum. Only 10,000 TEU containers are loaded as the site principally provides for empty containers.

The site is constrained by surrounding urban development, with no realistic opportunity for expansion.

### 3.4.1.3 Yennora

The Yennora facility is located approximately 23 kilometres west of the Sydney CBD and is operated by Patrick PortLink and QRN. Patrick PortLink uses the facility to assemble trains taking export containers to Port Botany. ARG east-west trains are also assembled at Yennora, and following the purchase of ARG, is now the base for QRN interstate terminal operations out of Sydney.

The site caters for trains up to 500 metres in length and has a rail throughput of around 50,000 TEU per annum, most of which are export containers destined for Port Botany.

### 3.4.1.4 Camellia

The Camellia terminal is approximately 20 kilometres northwest of the Sydney CBD and is owned and operated by Patrick PortLink. The terminal is a container freight facility and is the site of two empty container storage and repair facilities. There is a daily service to Port Botany for both imports and exports. The Toll Newcastle terminal is also serviced from Camellia.

Camellia caters for trains up to 680 metres in length and has a rail throughput of around 80,000 TEU per annum.

### 3.4.1.5 Leightonfield (Villawood)

The small terminal at Leightonfield (or Villawood) on the main south railway is operated by Mannway. The main services to the terminal comprise container traffic to Port Botany with the major client being BlueScope Steel. Steel from Newcastle and Port Kembla is moved by road to Leightonfield and then transported by rail to Port Botany. South Spur Rail operates one train per day.

Leightonfield has a single siding and rail throughput of up to 20,000 TEU per annum, most of which is steel from BlueScope Steel destined for Port Botany.

### 3.4.1.6 Minto

The Minto facility is located approximately 35 kilometres southwest of the Sydney CBD. Operated by Macarthur Intermodal Shipping Terminal Pty Ltd (MIST), the site is adjacent to the main Sydney to Melbourne rail line. Train operator Lachlan Valley Rail Freight provides several services a day.

The current Minto facility caters for trains up to 390 metres in length and has a rail throughput of around 45,000 TEU per annum.

MIST and Austrak own an adjacent land holding and are jointly seeking to significantly expand the Minto terminal to add at least a further 200,000 TEU per annum capacity to the terminal.

A significant shortcoming of the current arrangements at the Minto site is the length of the rail sidings. The proposed development will incorporate an enlarged import/export facility to cater for port trains, with sidings of 600 metres, as well as an interstate facility with sidings of 1,800 metres.
3.4.2 Proposed Developments – Sydney intermodal terminals

3.4.2.1 Enfield

A large portion of rail container traffic in Sydney is the short-haul movement of export shipping containers to and from Port Botany, as distinct from the largely domestic container traffic carried by rail on the interstate intermodal trains. Road congestion is driving a concerted effort to make better use of rail-based facilities for both business sectors.

The site, which is close to Chullora on the main goods lines, enjoys good access to Port Botany and the rail network in general.

SPC has indicated proposals to develop and expand the Enfield terminal adjacent to the existing shunting yards. This will create empty storage facilities and enable improvements that will allow 600-metre trains to be accommodated by all container terminals at Port Botany.

Currently, the eastern side of the Enfield marshalling yard is retained for railway operating purposes, but most of the site is now redundant. It has been acquired by SPC for development as an Intermodal Logistics Centre (ILC), with an intermodal facility at the core.

The development would provide capacity for 300,000 TEU per annum on two 920-metre sidings and six large warehouses. Trains carrying up to 80 TEU to and from Port Botany would provide a competitive alternative to moving all containers by road. The project is currently subject to considerations by the New South Wales Government after the completion of environmental impact assessment processes.

Figure 5 - Proposed Enfield ILC concept layout

Source: Sydney Ports Corporation
3.4.2.2 Moorebank

The Australian Government is considering the possible development of an intermodal terminal on land currently owned by the Department of Defence at Moorebank. This site is an ideal location for a terminal, supported by industry, as it provides ready access to the proposed SSFL and connections to Sydney ports, both by rail and the WestLink M7 ring road.

The site at Moorebank has sufficient land to enable the development of a substantial intermodal terminal facility that would provide for longer trains and greater throughput by rail than other facilities around Sydney. In addition, it may provide a range of associated services on the site that would enable the significant expansion of road/rail operations.

3.4.2.3 Ingleburn

Patrick Corporation is proposing to develop a new intermodal terminal at Ingleburn adjacent to its car pre-inspection and servicing facility. The Environmental Impact Statement for the project indicates a proposed capacity to service throughput of up to 43,000 cars and 54,000 TEU annually.

3.4.2.4 Menangle and Eastern Creek

Long-term development of greenfield sites at Menangle and Eastern Creek would enable longer trains to be handled in purpose-built terminals, but these locations are disadvantaged by their remoteness. Eastern Creek would likely require the construction of a new 18-kilometre railway.

3.4.3 Freight Infrastructure Advisory Board report

In October 2005, the New South Wales Government released a report called Railing Port Botany’s Containers: Proposals to Ease Pressure on Sydney’s Roads by the Freight Infrastructure Advisory Board (FIAB) chaired by the Hon. Laurie Brereton for public comment. The report proposes a network of intermodal terminals throughout Sydney, including Enfield, Moorebank and Eastern Creek, an expansion of the existing terminal at Minto and development of the planned facility at Ingleburn to help achieve the Government’s objective of increasing freight movements by rail from 19.5% to 40% by 2011.

FIAB recommended that adequate provisions be made to allow common user, open access operations, and for terminals to have 24-hour operations and be located next to key arterial road corridors, with dedicated freight lines, distribution and warehousing areas.

The report has been referred to Professor David Richmond, head of the New South Wales Premier’s Infrastructure Implementation Group, to prepare a New South Wales Government response. He has accepted submissions and advised the Government on a container freight plan to support an expansion of Port Botany. Submissions closed at the end of February 2006. The matter remains under New South Wales Government consideration.

3.4.4 Summary

Significant increases in intermodal terminal capacity are required to meet future demand.

3.5 Brisbane terminals

3.5.1 Current operations

The intermodal terminals in Brisbane are centred on the Acacia Ridge facility in the southern suburbs of Brisbane. The Port of Brisbane Multi-modal Terminal at Fisherman Islands is the main export facility and has full standard gauge and narrow gauge access.
Other facilities in the Brisbane area include Moolabin at Tennyson and proposed facilities at Bromelton and Parkinson/Larapinta outside the Brisbane metropolitan area. The locations of these facilities are shown in Figure 6. In addition, there is a facility being considered at Yatala on the Gold Coast line.

Access to the Brisbane terminals is via arterial roads and from there to the freeway network. Access to Acacia Ridge is via a local access road to Beaudesert Road. From there, the Ipswich Motorway is about three kilometres to the northwest and the South East Freeway is about eight kilometres to the east. There are no current plans to change these arrangements and it is expected that they will remain in place for the foreseeable future.
Figure 6 - Brisbane terminals locality map

Legend
- Proposed intermodal terminal
- Existing intermodal terminal
- Inoperative rail infrastructure
- Other rail infrastructure
- Major road
**Acacia Ridge**

The Acacia Ridge terminal is located 14 kilometres south of the Brisbane CBD and is Queensland’s largest road/rail intermodal terminal. The terminal is owned by QR and managed on a multi-user basis. QR recently appointed P&O as an independent operator to manage the terminal and negotiate access agreements with rail operators. Like the combined Dynon terminals in Melbourne, the Acacia Ridge facility comprises two terminals:

- A standard gauge terminal, owned by QR and currently used by PN; and
- A narrow gauge terminal, serving the intrastate network operated by QRN and accessed by PN trains.

**Figure 7 - Aerial photograph of the Acacia Ridge terminal**

The standard gauge terminal handles the majority of interstate container traffic moved by rail on the Brisbane-Sydney and Brisbane-Melbourne (via Sydney) routes.

The narrow gauge terminal handles a large volume of container freight moving northbound to a wide variety of Queensland destinations.

According to the South East Queensland Freight Intermodal Terminal Study (SEQFITS), the terminal has three train arrivals in the morning of 1,300-1,500 metres, and one steel and general train of 1,200 metres. There are up to four departures daily plus a steel train. In addition, there are four trains a week to Fisherman Islands carrying export containers and three trains a week to Rocklea.
SEQFITS indicates that the Queensland Government proposes to expand the capacity of Acacia Ridge by grade-separating the existing level crossing at Beaudesert Road, and increasing rail capacity through the metropolitan network to the Port of Brisbane with signalling upgrades and crossing loops.

This would provide increased capacity between Acacia Ridge and Fisherman Islands, improving the competitiveness of rail freight to the Port of Brisbane. Funding has now been announced for the grade separation of Beaudesert Road that will then enable the terminal to expand southwards to provide three or four 1,500-metre tracks.

SEQFITS estimates the total throughput at the Acacia Ridge terminal to be around 380,000 TEU per annum for combined narrow and standard gauge activities, though QR has indicated that the capacity can be increased to provide for at least 750,000 TEU per annum.

### 3.5.1.1 Port of Brisbane Multi-modal Terminal

The Port of Brisbane Corporation operates the Brisbane Multi-modal Terminal (BMT) at Fisherman Islands within the port precinct. The BMT is mainly used to move international cargo and has no empty storage or other ancillary services.

The BMT is linked to the interstate standard gauge rail network and the Queensland narrow gauge rail network via a direct dual gauge line to the Acacia Ridge intermodal terminal. Recently, local businesses such as Incitec, Yatala Brewery and MetalCorp have begun trucking containers from nearby industrial sites to the BMT for rail transport to North Queensland or interstate.

Access to the BMT is via Lytton Road, a two-lane road that provides direct access from the Gateway Motorway interchange immediately south of the Gateway Bridge. There are no plans at this stage to upgrade Lytton Road to provide further capacity.

![Figure 8 - Fisherman Islands (BMT) master plan](source: Port of Brisbane website)
3.5.1.2 Moolabin

The Brisbane base for PN Queensland’s (PNQ) narrow gauge operations (formerly the QRX terminal) is located at the Moolabin Goods Terminal at Tennyson, approximately 10 kilometres south of the Brisbane CBD. The facility receives an average of 18 trains a week, operated by PNQ and serving a wide range of destinations along the Queensland coast.

The Moolabin facility does not have standard gauge access, although it is located only a few kilometres from the standard gauge main line on the Yeerongpilly-Corinda line. A new dual gauge line from Yeerongpilly to Moolabin would give PN access to its own terminal.

3.5.2 Proposed Developments – Brisbane intermodal terminals

3.5.2.1 Bromelton

Developers have acquired large areas of land adjacent to the existing interstate standard gauge rail line in the vicinity of Bromelton. There are separate commercial proposals to develop an intermodal terminal on this land and the various options are in the early planning stages. The Queensland Government has not evaluated any of the potential options at this stage. If developed, the extra capacity of such a terminal may partially offset future constraints at Acacia Ridge.

3.5.2.2 Parkinson/Larapinta

A 3.5 kilometre site at Parkinson identified in SEQFITS is located on the interstate rail line adjacent to Beaudesert Road and near the Logan Motorway. The site is close to the Acacia Ridge terminal and has a potential land area of around 170 hectares.

3.5.2.3 Yatala

There are two 1,800-metre sites at Yatala on the Gold Coast rail line. This line does not currently have any capacity for freight trains and would require a significant investment to provide a standard gauge connection to the interstate main line.

3.5.3 Summary

There are potential challenges for terminal capacity in Brisbane once Acacia Ridge reaches capacity. Several sites have been suggested but proposals have not been fully developed at this stage.

3.6 Regional terminals

Existing and proposed regional terminals in each of the three states have the potential to provide additional capacity and provide collection and distribution opportunities for freight to/from regional centres. Regional centres that are possible freight collection and distribution centres in the Corridor include Shepparton and Wodonga in Victoria; Parkes,Narrabri, Blayney and Bathurst in New South Wales; and Toowoomba in Queensland.

Figure 9 shows the locations of regional terminals in Victoria, New South Wales and Queensland.
Figure 9 - Regional terminals locality plan
3.6.1 Victoria

There are two main proposals for regional terminals in Victoria, located at Shepparton and Wodonga. Shepparton is a major fruit and wine producing area that could contribute freight destined for Melbourne and Brisbane to route options through that part of Victoria. Similarly, Wodonga could contribute freight to route options passing through Albury/Wodonga.

3.6.1.1 Shepparton

Patrick manages a broad gauge terminal facility five kilometres outside Shepparton at the rail yard at Maroopna. The facility manages around 24,000 TEU per annum, with approximately 90% travelling to Melbourne for export and the remainder travelling to the Western Australian domestic market. Train length is limited to 480 metres.

The City of Greater Shepparton is planning the development of the Goulburn Valley Freight and Logistics Centre at Moorpoona. The site is located two kilometres south of the Midland Highway and covers approximately 370 hectares of rural grazing land.

3.6.1.2 Wodonga

The development of an Intermodal Freight Terminal, supported by Wodonga City Council, is proposed at Barnawartha, 14 kilometres south of Wodonga. The facility would be on the Melbourne-Sydney main line and be owned by the Council and managed by a terminal operator. The 440-hectare site could accommodate trains up to 2,000 metres long.

3.6.2 New South Wales

All the proposed terminals in regional New South Wales are located along regional rail lines throughout the state, some of which have been considered as possible route options in this Study. It is unlikely that they would provide significant freight to the Coastal Route options but could provide a loading point for freight on various inland options being considered.

3.6.2.1 Blayney

FCL Interstate Transport Services established an intermodal terminal at Blayney in 1994. It is located approximately 270 kilometres west of Sydney, between Bathurst and Orange, and is mainly export-oriented.

The operation is Australia’s busiest inland container terminal, with freight throughput exceeding 55,000 TEU in 2004. There are three rail sidings and 20,000m² of hardstand, plus a 500m² transit warehouse and a modern two-storey office. Patrick PortLink provides trains between the terminal and Port Botany, and FCL complements these rail services with road freight services.

As Blayney is located adjacent to some of the route options being considered in the Study, it is likely to contribute freight to those options, providing alternatives for export freight through Melbourne or Brisbane as well as increasing current export activities though Sydney. The terminal is also likely to contribute additional domestic freight to various route options.

3.6.2.2 Parkes

The Parkes facility is located approximately 365 kilometres west of Sydney and 170 kilometres south of Dubbo. It is owned and operated by FCL. The facility is said to be located at the ‘crossroads of Australia’ where the Newell Highway (linking Melbourne and Brisbane) intersects with the transcontinental railway (linking Sydney and Perth). FCL has announced expansion plans for the facility. It is primarily concerned with the domestic intermodal business.
Parkes is also located on some of the route options being considered and is likely to contribute domestic freight to those options.

3.6.2.3  Narrabri
The Narrabri facility, operated by Auscott, is located approximately 400 kilometres northwest of Sydney with nearby access to/from the Newell Highway. The facility is primarily used to move export containers of cotton from Narrabri and surrounding areas by rail to Port Botany and Brisbane ports. The principal rail service provider is South Spur Rail.

3.6.2.4  Bathurst
A concept plan has been developed for the establishment of a regional road/rail freight complex at Kelso near Bathurst. The complex would include an intermodal facility with associated rail infrastructure, containerised goods storage areas, warehousing facilities and highway frontage facilities. Potential uses include bulky goods storage, small warehousing and storage for rural produce.

3.6.3  Queensland
Australian Transport & Energy Corridor Ltd (ATEC) has proposed an intermodal terminal at Toowoomba. Other regional intermodal terminals in Queensland are north of Brisbane, and are outside the Study area.

3.6.3.1  Toowoomba
The Study is aware that there are suggested developments at Toowoomba.

3.6.4  Summary
Regional terminal capacity should not be an impediment to the development of the North-South Rail Corridor.
4 Port Operations and Rail Access

Australia’s imports and exports are expected to significantly increase in the future, putting additional pressure on ports and their transport linkages. The ports connected to the freight transport logistics chain within the Corridor are at Melbourne, Sydney and Brisbane. All have strategies in place to cater for the anticipated increase in shipping activity. However, rail access to the ports is likely to present ongoing challenges for the industry.

There are many issues that impact on freight transport logistics, both nationally and internationally. Changes to these structures affect the amount and type of freight moving through the ports and thus the potential for freight movement by rail. To adapt to these changes, governments and port authorities must maximise the efficiency and commercial viability of each port through regular expansion, the creation of deeper shipping channels and the provision of new rail connections.

The movement of containers to ports is mainly via road. However, state governments have set targets to increase the movement of containers by rail. While this is a positive move, it may have little relevance to the Corridor as the majority of import/export freight delivered to each port is consumed within local metropolitan areas.

Delivering containers by ship directly to the port where the product is consumed is still generally regarded as the most efficient means of delivering freight. Land bridging by road or rail from one port to another capital city on the east coast is currently avoided for cost and efficiency reasons.

Container movements between Melbourne, Sydney and Brisbane principally comprise locally manufactured products being transported to end users in other state capital cities. The proportion of interstate freight travelling to and from the ports is generally a small proportion of the overall freight task. The operation of the port-to-terminal train shuttle movements can generally be considered separately to the route options for the Corridor.

However, there is a significant movement of regional freight, including coal, grain and containers, to Australian ports for export. Some of this freight, especially containers, can be captured as rail freight on the Corridor. Freight can also be moved to other ports along the eastern seaboard, including Port Kembla and Gladstone.

One of the most significant port-related issues for the Study is rail access between the terminals and the ports:

- In Melbourne, the Dynon Port Rail Link will provide a grade-separated rail line into the port area. However, rail access is not available at all berths due to the number of separate berths around the port;
- In Sydney, there are significant challenges to the provision of good rail access to the port due to dense urban development and topography; and
- In Brisbane, rail access to the port requires access across metropolitan residential areas.

Consultation with key stakeholders throughout the Study has indicated that the ports have limited relevance to the end-to-end transport of freight along the Corridor, with land bridging considered largely irrelevant to freight movement in the Corridor.

Proposed port developments at Melbourne, Sydney and Brisbane confirm that all three ports are aiming to meet forecast demand growth.

This provides an opportunity and a challenge for the Corridor. Ideally, a dedicated rail freight corridor that is separate from congested passenger services during peak periods should be developed to operate rail freight services into metropolitan areas. Land acquisition and land reservation decisions may be required to establish such corridors.
Some growth in regional ports over time is also necessary to handle an increase in freight volumes (mainly bulk) and any rail corridor developments should take this into account.

Port operators have confirmed that the majority of freight movement to/from the ports is destined for locations within the metropolitan areas of the major cities. Limited freight is transported beyond these centres along the Corridor, with relatively little moved by rail. However, the movement of goods and produce from regional centres to the ports will benefit from improved access provided by the various route options.

4.1 Port of Melbourne

The Port of Melbourne is Australia’s largest container and general cargo port. In 2004/05, the port handled 38% of the nation’s container trade (1.9 million TEU) and was visited by approximately 3,400 vessels. The Port of Melbourne handles nearly $70 billion of trade annually. Figure 10 shows an aerial view of the Port of Melbourne.

The movement of goods to/from the Port of Melbourne is principally related to the Melbourne metropolitan area. The movement of freight through the Dynon intermodal terminal to the port is generally regional freight that would gain advantages from improved rail services.

The freight terminals are located at berths off and along the Yarra River near the river mouth and at Gellibrand Pier. Visiting vessels need to enter through the heads of Port Phillip Bay and travel north for more than 50 nautical miles to access the berths.

**Figure 10 - Port of Melbourne terminals with rail link access**

Source: Google Earth
4.1.1 Port facilities
The main dock facilities are:

- The Swanson Dock East terminal. Operated by Patrick Corporation, it has one rail track and one siding and can consolidate 1,500-metre trains. The facility handles more than 85,000 TEU per annum via rail and approximately 600,000 per annum TEU by road;

- Swanson Dock West Container Terminal. Operated by P&O Ports, it has one rail track that can handle 565-metre trains. The facility handles more than 44,000 TEU per annum via rail and over 135,000 TEU per annum via road;

- Appleton Dock. It handles break-bulk and dry-bulk (grain and other), and has one rail track and one siding servicing Australian Bulk Alliance, and three common user sidings; and

- Webb Dock. It is currently serviced by road only; however, the reinstatement of a disused rail link to the dock is under consideration.

4.1.2 Future port strategies
The Victorian Government has set a target to move 30% of statewide port-related freight by rail by 2010. This is a significant increase, even though rail’s share of port traffic has increased from 10% in 1999 to around 19% in 2003-04. Such an increase is unlikely to have a substantial impact on rail freight movements along the Corridor, as most of the Melbourne-Sydney and Melbourne-Brisbane freight movement is produced or used locally rather than being imported or exported through the port. However, the strategy could increase the tonnage of rural product carried to the port by rail for export.

The Port of Melbourne Corporation has indicated that while the target is achievable, the growth will need to come from local distribution across metropolitan Melbourne (within 60 kilometres of the port). Regional or intrastate export freight is already predominantly on rail and there is very little interstate freight imported or exported through the port.

The rail freight target and other objectives have been developed to provide a sustainable freight network that will serve forecast demand. The main strategies are listed below.

4.1.2.1 Victorian Freight and Logistics Strategy
The Victorian Freight and Logistics Strategy brings together the whole-of-government freight transport-related policy directions and strategic initiatives. This strategy has been, and will continue to be, the rationale for planning and prioritising freight transport-related investments, and regulatory, pricing and organisational reforms of the Victorian Government.

The freight transport-related policy directions and strategic initiatives have emanated from the following strategies: Linking Victoria, Growing Victoria Together, Melbourne 2030 and Victoria: Leading the Way Economic Statement.

4.1.2.2 Melbourne Port@L
Melbourne Port@L is a long-term strategic framework for improving the efficiency of the Port of Melbourne by integrating the port and the adjacent freight transport facilities into a single world-class intermodal hub.

The Melbourne Port@L initiatives seek to:

- Enhance rail and road access to and between rail and shipping terminals;
- Use information technology to improve logistics chain performance;
• Reduce road congestion around the port;
• Free up strategic land around the port for freight-related activities;
• Encourage growth of outer metropolitan intermodal terminals servicing the port; and
• Increase the port’s capacity, including the container terminal capacity at Swanson Dock.

Projects under the framework include the Dynon Port Rail Link, relocation of the Melbourne wholesale markets, the closure of Coode Road, extension of Swanson Dock, reconnection of the Webb Dock rail line and on-dock rail terminals at Appleton Dock, Victoria Dock and Webb Dock.

4.1.2.3 Channel Deepening Project

As the Port of Melbourne is located at the northern end of Port Phillip Bay, the shallow depth of the bay requires vessels to navigate a route to the port via specified shipping channels.

The Channel Deepening project, which involves the creation of deeper shipping channels, will enable larger ships to access the port. The project is currently the subject of an environmental assessment process and will proceed if the necessary approvals are obtained.

4.1.2.4 Dynon Port Rail Link Project

The port has recently introduced new on-dock rail links, and there are plans in place for further significant rail link upgrades. The Dynon Port Rail Link project has been approved and construction is expected to commence in the second half of 2006.

Currently, the only rail access into the port is via a single dual gauge rail level crossing off Footscray Road, which impedes free flow of both rail and road traffic. The Dynon Port Rail Link will provide a dual gauge rail line into the port area and elevate Footscray Road over the crossing rail line. However, due to the number of separate berths around the port, rail access is not available at all berths. When completed, this new link will enhance the rail operations and remove the main impediment to efficient operations between the port and the Dynon terminals.

4.2 Sydney ports: Port Botany

The rail terminals at the Sydney ports are located within two sites at Botany Bay and Sydney Harbour. These sites are separated by approximately 10 kilometres of land and are within 10 kilometres of deepwater shipping lanes. Both regions are managed by SPC.

With the growing importance of containerised and bulk liquid cargoes, Port Botany is rapidly becoming the focus for port trade in Sydney. The facilities at Port Botany now account for approximately 70% of total trade throughput at Sydney ports. Figure 11 shows an aerial view of the Port Botany terminal.

The movement of goods to and from Port Botany is principally related to the Sydney metropolitan area, and travels via a rail shuttle service between the port and Enfield along a dedicated freight line.
While Port Botany is located 12 kilometres from the Sydney CBD and is well serviced by road and rail networks, increasing congestion in the Sydney metropolitan area and dense urban development and topography are affecting the movement of freight to Port Botany and the provision of good rail access to the port. The existing facilities at Port Botany are expected to reach operational capacity by 2010. Plans to build a new container terminal and improved rail facilities to cater for 600-metre trains within the port and complete the duplication of the connection between the port and Enfield will enhance rail operations.

Figure 11 - Port Botany terminals with access to rail links

Source: Google Earth

4.2.1 Port facilities

The terminal at Port Botany has two components, with P&O Ports operating an on-dock rail container facility adjacent to its container terminal on the southern side of Brotherson Dock, and Patrick Corporation operating intermodal transport facilities on the northern side of Brotherson Dock. A third intermodal terminal is operated by P&O Transport but is primarily used to store empty containers.

The terminals have the same rail connections and are served by a number of operators, including PN, Patrick PortLink, South Spur Rail, Lachlan Valley Rail Freight and ARG. P&O has a rail throughput of around 80,000 TEU per annum while the Patrick facility has a rail throughput of around 125,000 TEU.

The main constraint on rail operations is the single line into Port Botany, which results in considerable shunting to service the rail terminals. The maximum train length that can be received at the dock is 1,000 metres; however, with three 360-metre sidings, longer trains need to be split to use the terminal. Improvements are planned by the SPC that will allow 600-metre trains to access all terminals at the port.
4.2.2 Future port strategies

The container terminal facilities at Port Botany are being expanded to cater for the growth in container trade. The project, shown in Figure 12, will provide a third terminal at the port that includes:

• A third container terminal;
• A new rail/road transport corridor, including the accommodation of 600-metre trains; and
• Rationalisation of existing sidings to increase the number of train movements from an average of five trains (10 movements) a day to up to 10 trains (20 movements) a day by 2020.

Figure 12 - Proposed third terminal, Port Botany

The New South Wales Government has a number of strategic documents that will be used to guide the planning and development of Sydney into the future. One of these is the City of Cities document. The City of Cities strategy includes objectives to improve movement of people and freight around Sydney. Key initiatives will need to manage the development of the Port Botany area and congestion associated with the movement of freight to and from the port.

The proposed SSFL will also improve the delivery of freight to the port by improving movement from the interstate rail network to the main rail terminals at Chullora and Enfield.

4.3 Port of Brisbane

Terminals for Brisbane are located at the Port of Brisbane on Fisherman Islands and at several facilities along approximately 15 kilometres of the Brisbane River. Managed by the Port of Brisbane Corporation (PBC), the main port complex on Fisherman Islands is the only purpose-built, intermodal port complex in Australia. Figure 13 shows an aerial view of the Port of Brisbane.
Brisbane is Australia’s leading beef and cotton port, handling about 50% of Australia’s total beef and cotton exports. In 2004-05, the Port of Brisbane handled 14% of the nation’s container trade (approximately 26 million tonnes) from 2,300 vessel visits. Freight handled in the facilities include containers, motor vehicles and break-bulk cargo.

Rail access to Fisherman Islands involves access across the metropolitan rail network. Road access to and from the port currently operate satisfactorily with direct access to the Gateway Motorway via a two-lane access road. There are no plans to upgrade this access at present but it will need to be monitored in the future to ensure it does not become a constraint on the movement of goods to and from the port.

Infrastructure constraints hinder the operation of longer trains between the port and Acacia Ridge. Many of these issues are being considered in the future infrastructure strategy planning, but are yet to be committed to implementation. When completed, these works have the potential to provide for longer freight trains and more efficient operations.

**Figure 13 - Brisbane ports at Fisherman Islands and locations along the Brisbane River**

4.3.1 Port facilities

The Brisbane Multi-modal Terminal (BMT) located on Fisherman Islands is the interface between rail, road and the container terminals at the port. The integration of these transport modes, a dual gauge rail link and the location of the BMT behind the container terminals enables the movement of large volumes of intrastate freight into and out of the port by rail. However most domestic interstate containers terminate at Acacia Ridge and are not transported to the BMT.

Fisherman Islands is connected by a dual gauge line from South Brisbane. The increased freight activity resulting from the continuing expansion of the port and the associated rise in rail movements is restricted by the shared infrastructure through Brisbane urban rail network connections to Acacia Ridge.
Of the nine existing container terminals on Fisherman Islands, Patrick Corporation operates Berths 1-3 and 7-8 and P&O Ports operate 4-6. From early 2006, Berths 1-3 will undergo redevelopment to cater for motor vehicles, general and break-bulk cargo. During this time, Patrick Corporation will relocate its services to Berths 7-9.

4.3.2 Future port strategies
The following Queensland Government strategies set out the future direction of the state’s infrastructure development and many impact on the port and associated rail-related activities.

4.3.2.1 South East Queensland Infrastructure Plan and Program
The South East Queensland Infrastructure Plan and Program (SEQIPP) is a key component of the South East Queensland Regional Plan. It is a 10-year commitment to fund the necessary infrastructure to support regional growth. The plan recognises that freight demand in the region is likely to double by 2020. The key initiatives relevant to the port are the proposed expansion of the Acacia Ridge rail terminal. In addition, increased rail capacity should be facilitated through the metropolitan network to the Port of Brisbane with signalling upgrades and crossing loops.

4.3.2.2 Fisherman Islands Port Expansion
The Fisherman Islands Port Expansion project (see Figure 8) will effectively extend the length of the island by 1.8 kilometres and provide space for additional berths. Reclamation commenced in January 2005 and sand surcharging of the first 15-hectare area is underway.

4.3.2.3 Fisherman Islands Motor Vehicle Precinct
A 28-hectare, dedicated motor vehicle precinct will be developed on the Fisherman Islands site. This will service the growing trade in vehicles imported from Japan, Korea and Thailand, with Brisbane as the major import port for four-wheel drive vehicles. This will provide a return load for containerised motor vehicles from the manufacturers in Adelaide and Melbourne to Brisbane. The precinct will improve the opportunity for the movement of cars by rail.
4.3.2.4 Brisbane AutoStradTM terminal

Patrick Corporation has developed a revolutionary automated straddle carrier facility, the first of its kind in Australia, using 10-metre, 65-tonne straddle carriers fitted with sophisticated motion control and navigation systems that allow them to operate unmanned, moving and stacking containers from the quay into holding yards, onto vehicles, and back to quay cranes with a high degree of accuracy. Figure 14 shows an aerial view of the Brisbane AutoStradTM terminal.

Figure 14 - Brisbane AutoStradTM terminal

Source: Port of Brisbane

4.4 Review of regional ports

In Victoria, the Port of Geelong handles a wide variety of cargo, including bulk liquid (crude oil, petroleum, chemicals), unitised (export aluminium), palletised (bagged rice), break-bulk (steel, timber) and dry bulk (import alumina, calcite, fertilisers, grain, woodchip).

The Port of Hastings is situated in Western Port Bay, some 80 kilometres southeast of Melbourne. It is linked to Melbourne by road and rail, and a pipeline carries petroleum products to refineries near Melbourne. The port handles exports of steel plate and colorbond steel cladding, iron, ferrous alloys and LPG. Import trade consists of petroleum products. The port also handles coastal movement of steel, crude petroleum and LPG.

The Victorian Government considers the Port of Hastings to be the preferred site for future (international) container development, once capacity at the Port of Melbourne is reached sometime after 2030. Such arrangements would require the development of suitable connections (preferably standard gauge links) between the Melbourne terminals and the Port of Hastings to provide the necessary freight linkages to the Corridor.

In New South Wales, the Newcastle Port Corporation (NPC) manages commercial shipping activity in the Port of Newcastle. The product mix is export bulk coal, copper concentrates, grain and some woodchips. Port Kembla is located approximately 75 kilometres south of Sydney and is the city’s closest specialist industrial port. It serves much of regional New South Wales, handling major trading commodities such as coal, iron ore, steel products and grain. These New South Wales ports will potentially benefit from an improved rail network along the Coastal Route through...
better access and more train paths. Inland route options would provide little benefit to these ports, other than freeing up some of the capacity on the Coastal Route.

The Port of Gladstone in Queensland is located 525 kilometres north of Brisbane. The port’s facilities cater for the import of raw material and the export of finished products associated with major industries in the region. Multi-user facilities cater for the export of the region’s coal and mineral and agricultural resources. The port is one of the world’s top five coal export ports, handling 44 million tonnes of coal from a total throughput of more than 63 million tonnes in 2004-05. It is located north of Brisbane and is effectively outside the Study area, but would potentially benefit from some of the route options that improve access to the west of Brisbane if it was linked with future rail development in intrastate rail freight operations in Queensland, particularly for bulk minerals.

As noted above, the regional ports have limited relevance to the Corridor and the end-to-end movement of freight. However, the provision of an improved rail service along the Corridor has potential benefits for the movement of freight to and from these regional ports.

If constructed, the Dawson Valley Railway (DVR) could allow diversion of considerable freight volumes (particularly coal) from Brisbane to Gladstone. Consequently, this could ease some capacity constraints on the Toowoomba Range, and particularly through the metropolitan network in Brisbane.

4.5 Road/rail connections

The completion of already announced road/rail/port interface projects will enhance rail’s performance on the Corridor. In Melbourne, the Dynon Port Rail Link includes the upgrades to Dynon Road necessary to improve rail access but in the medium to long term, the road/rail mix will need to be addressed. In Sydney, the extent of future road works will be dependent on the ultimate location of additional intermodal facilities and strategies related to the movement of freight out of Port Botany. For example, siting of new intermodal terminals in Sydney would require spur lines and some roadworks, depending on the location, to facilitate the movement of freight. In Brisbane, the proposed road works at Beaudesert Road have been incorporated in the upgrade program for Acacia Ridge. Proposed developments at Bromelton and/or Parkinson would require associated roadworks for access.

In regional areas, the main project involving the construction of additional road infrastructure relates to the possible upgrade of the Warrego Highway from Toowoomba to Brisbane. Issues in relation to the road crossing of the Toowoomba Ranges are being looked at separately by AusLink. The existing rail crossing of the Toowoomba Ranges also has significant operating constraints and is looked at as part of this Study. The different grades and requirements clearly suggest that co-location of modes is an unviable option.
5 Train Operations

Having examined the major infrastructure projects, including terminal and port access requirements, the Study Team was also required to identify key parameters necessary to ensure the efficient operation of trains along the Corridor. Train efficiency is determined by a range of parameters including:

- Transit time, which is largely determined by the speed of trains;
- Reliability of the service relative to the timetable;
- Availability of trains on the network;
- The provision of crossing loops and passing lanes;
- Train length; and
- Permissible axle loads.

5.1 Interrelation of transit time, reliability and availability

As noted in chapter 3: Market Assessment and chapter 4: Demand Analysis, discussions with operators have indicated that transit time is important in providing rail with the most competitive position for movement of freight. However, transit time is not the sole basis of a freight forwarder’s rationale for transporting goods by a particular mode. More important are the levels of reliability and the availability of the container to the customer at the terminal. These are determined by loading, transporting and unloading efficiency.

5.1.1 Transit time

Transit time can be defined as the overall time taken to move freight from the original terminal to the destination terminal, including pickup and delivery (PUD) components. However, if the PUD is considered as a separate component of the overall transit time, the end-to-end rail transit time is the component that can be improved through the consideration of new route options and horizontal or vertical realignment of existing track.

The rail transit time needs to be considered in two components; the raw transit time and the actual transit time. The raw transit time is the time that a train can travel the network based on the design geometry and the related speed controls. The actual transit time includes time delays resulting from operation on single line track systems, safeworking requirements and interaction with other networks (including adhering to Sydney curfew arrangements).

Much of this additional delay is related to the need for trains to pull into crossing loops to allow trains to pass in the opposite direction. This is exacerbated by safeworking provisions and the associated signalling controls along the network. These elements can increase raw transit time by as much as 30% to 40%.

The end-to-end rail transit time has been assessed in two components: the raw running times are assessed as part of the train simulation modelling task; and the increase applied due to operational parameters.

To reduce overall point-to-point transit time, line speed for intermodal trains over most of the route options was set at 115 km/h, allowing that on some sections, slower speeds will be dictated by unavoidable gradients and curvature. This target must also be achievable with standard locomotives and wagons with a maximum trailing load of up to 3,500 tonnes for two 4,000 hp locomotives or up to 4,000 tonnes for two 4,300 hp locomotives.
5.1.2  Target transit times

Train operational factors suggest various scenarios to meet market requirements for terminal-to-terminal transit times, assuming acceptable levels of reliability can be achieved.

ARTC has indicated that the North and South Coast Alliance projects will reduce transit times for 1,500-metre super freighters to 10 hours and 40 minutes for the Melbourne-Sydney route and 15 hours and 30 minutes for the Sydney-Brisbane route. The Melbourne-Brisbane terminal-to-terminal transit time on the Coastal Route is therefore 26 hours and 10 minutes, broadly consistent with the assumptions in the Demand Analysis chapter of this report.

Improvements to transit times will result in improved rail service reliability and availability. The Study considers the requirements for Melbourne-Brisbane terminal-to-terminal transit times of:

- 33 hours
  PN claims the current terminal-to-terminal transit time to be 35.1 hours. However, the network audit carried out for ARTC indicated that a transit time of 33 hours was necessary to be competitive with road and attract a reasonable market share.

- 30 hours
  After allowing six hours for unloading, reloading and servicing at each end, 30 hours is considered the maximum transit time allowable to meet the ARTC objective of a 72-hour (three-day) equipment cycle time. It also provides the maximum journey time for a realistic ‘second morning’ delivery with late loading cut-offs (9 pm departure to 3 am arrival on the second morning).

- 28 hours
  Realistic second morning deliveries in Brisbane and Melbourne can be achieved with a 28-hour transit time between terminals; however, trains would have to be fleetted to do this. ARTC has committed to a 28-hour transit time in its NSW Lease Agreement, a 20% improvement over current practice. A faster target time of 27 hours was adopted in the AIRE Pre-Feasibility Study (Melbourne-Brisbane) by Maunsell (2000). In a review of that study, ARUP noted that transit times of this order would require an alternative route to reduce overall travel distance.

- 24 hours or less
  If transit times can be reduced to 24 hours or less, it becomes possible to achieve a two-day turnaround of rolling stock. A 22 to 23-hour transit time would provide crew savings and enable the turnaround of locomotives, which are the most valuable asset on a train. Locomotive fleet sizes could then potentially be reduced.

  After allowing six hours for loading and unloading at terminals, a two-day turnaround of wagons would require a transit time of 18 hours. However, it is important to note that freight users have indicated that the increased gains from lower transit times are smaller once an objective of around 27 hours is reached.

5.1.3  Reliability

The reliability of the system is generally defined as arrival within 15 minutes of the scheduled (timetable) time. The impact of safeworking provisions and associated communications controls, together with the limited number of train paths and single lane tracks, mean delays are often compounded on the network.

An 80% reliability rating can be achieved with an efficient railway system. However, limited crossing loops and fewer passing lanes on the east coast network, especially when combined with freight train curfews through the Sydney area, mean that reliability currently falls well below this level. The Study Team has determined the following existing reliability levels between the east coast capitals:
Melbourne to Sydney – rail 50%, road 98%;
Sydney to Brisbane – rail 45%, road 98%; and
Melbourne to Brisbane – rail 40%, road 98%.

Improved reliability on the rail system will provide rail with a much more balanced offering against the reliability offered by road.

The Study considers reliability as an input to the Demand Modelling process (refer chapter 4: Demand Analysis). The Study adopted a target reliability of 95% and the route options were designed to provide the necessary crossing loops/lanes to ensure this target is achievable.

Reliable train operations on single lines dictate infrastructure requirements such as long or closely spaced crossing loops, efficient train control systems, train condition monitoring devices, adequate refuge siding capacity, a high standard of active protection at level crossings and the availability of alternative routes.

An important element of reliability is locomotive power. Ageing locomotives decrease arrival time reliability. The mainstay of the interstate locomotive fleet is PN’s 120 NR-class locomotives, which will be approaching 20 years old in 2009. Many older locomotives are also used in the interstate fleet.

PN has indicated that if an inland route were to proceed, it would prefer to operate locomotives without stopping for servicing. This would require locomotive runs of over 1,750 kilometres through sparsely settled and partly mountainous country, with few railway maintenance facilities en-route. The reliability of locomotive power is therefore a key issue, particularly in view of the age of the fleet and the steep grades on some of the existing and potential routes.

5.1.4 Availability

Availability is defined in two ways: the window in which the customer must deliver the freight to the terminal for it to be loaded onto the train prior to departure; and the window when the freight is available to be collected from the destination terminal.

The ‘service availability’ is effectively the cut-off time for loading. It is determined by the time required for the loading of containers at the terminal and preparation of the train for departure. Trains must make sure they can access the available train paths on the network to meet the scheduled departure time.

Several elements can impact on availability, including:

• The elapsed transit time and required arrival time at the destination, which determines departure times;
• The number of train paths and fleeting of trains, which affect the number of trains that can depart and still meet the scheduled ‘latest’ arrival time;
• The priority given to the service in relation to opposing services and passenger services, and the train length in relation to crossing loop length and frequency; and
• Maintenance and capital works, which are necessary to ensure the network continues to operate in a safe and efficient manner.
The Study Team has determined the following existing availability levels between the east coast:

- Melbourne-Sydney: 25%;
- Sydney-Brisbane: 25%; and
- Melbourne-Brisbane: 45%.

Availability is a key element of the demand modelling work for the Study and is inherently linked to transit time and reliability. Improved transit times generally produce improved availability and the demand model incorporates an element that recognises these relationships.

5.1.5 Passing lanes and crossing loops

Some causes of delay are endemic to day-to-day operations. Of these, the need for opposing trains on single line railways to cross or pass each other is the most significant. The location, length and frequency of passing lanes and crossing loops are significant factors in providing reliable rail services.

Crossing loops are typically short sections of track parallel to the main line that allow one train to pull off the main line and permit opposing trains to cross. They are typically only of sufficient length to allow a full train to pull off and await the arrival of the opposing train.

Passing lanes are typically longer sections of parallel track that allow trains from opposing directions to cross as well as one train to pass another slower moving train travelling in the same direction.

5.1.5.1 Operational requirements

The location of passing lanes and crossing loops is determined by considering operating requirements, topographical limitations and planning restrictions. Trains arriving at a lane/loop must wait for the opposing train to arrive and pass. The closer the loops, the shorter the average waiting time.

For the purposes of the Study, it was assumed that the ARTC program for upgrading crossing loops and providing passing lanes on the Coastal Route provides sufficient operational capacity for the Study analysis period. No further upgrades of this nature have been adopted for the route options along the Coastal Route. For the inland route options, 2.5-kilometre crossing loops have been allowed for. These have been spaced at 80-kilometre intervals to provide one hour between loops for trains travelling at an average speed of 80 km/h.

5.1.5.2 Physical requirements

The ideal site for a crossing loop is level tangent track, with a slight downgrade at each end, with no road crossings and no watercourses. The downgrades help arriving trains to decelerate and departing trains to accelerate, saving time and fuel.

Many of the inland route options traverse favourable terrain, but some sections such as between Narromine and Binnaway are in hilly country where trains would be required to stop in the crossing loop. Starting a heavy train from a loop at the foot of a gradient would incur significant time and operational cost penalties and such arrangements should be avoided wherever possible.

5.1.5.3 Alternatives to crossing loops

While +ARTC is constructing longer crossing loops and passing lanes on the Coastal Route, the density of traffic on the inland route options does not require such measures.
One alternative approach is to adopt ‘moving block’ safeworking. Moving block is an efficient way of increasing track capacity and provides greater train control flexibility to reduce journey times. This is currently being considered by ARTC.

Moving block requires modern communications networks, but eliminates the need for fixed signals. On the inland route options, it may offer significant benefits, particularly at the northern end, where traffic density is unlikely to warrant the provision of passing lanes.

5.1.6 Train length

The maximum length of trains has been steadily increasing over time because pressure is constantly being applied by operators to maximise the productivity of timetable paths, crews and equipment. The maximum train length on the interstate ARTC network at present is 1,800 metres. The existing Coastal Route caters for 1,500-metre trains, with limited capacity for trains up to 1,800 metres. The ARTC improvements will provide for 1,800-metre trains between Melbourne and Sydney. The Study has adopted a maximum train length of 1,800 metres as the target for all route options considered.

The train length on the Sydney-Brisbane Coastal Route is unlikely to extend above the present 1,500 metres, due to cost factors and the difficulty of working long trains through the congested network north of Sydney.

5.1.7 Axle load

Higher axle loads affect locomotive power requirements and result in trains with higher payloads. Axle loads are dictated by track and bridge strength, with most of the existing interstate network limited to 20 tonne axle load (tal) at 115 km/h or 23 tal at 80 km/h. With the progressive upgrade to concrete sleepers by ARTC and other upgrades considered for the Study, axle loads up to 30 tonnes are achievable however under current standards, operating speeds would be restricted.

5.2 Other train operation considerations

In addition to the key market parameters of transit time, reliability and availability, other train operation issues also need to be considered, including:

- Security and safety;
- Operating cost;
- Locomotives and rolling stock;
- Imbalance of traffic;
- Multiplicity of operators; and
- Legislative issues.

5.2.1 Security and safety

One of the great advantages of containerisation has been improved security from pilfering, which has been reduced to minimal levels, according to discussions with parties involved in the Study consultation process. There still remains the threat of loss or theft of whole containers, which is lessened with door-to-door road haul as there is no need to process containers through terminals. This is generally a matter of terminal security, as once a container is on a train the risk of theft or loss is minimal.
The risk of terrorist incidents is probably highest in areas of dense population. The Coastal Route through Sydney has the greatest security risk as it is arguably the prime target for interruption of freight flows and any incident would have a significant impact in the dense metropolitan area. The risk of terrorism disrupting or damaging trains is expected to be minimal for inland routes that bypass the metropolitan Sydney and Newcastle areas and traverse more sparsely settled country for most of its length.

5.2.2 Operating cost

Increased train productivity reduces operating costs, enabling a lowering of freight rates to customers and stimulating an increase in traffic. Many of the factors affecting train productivity are related to the provision and maintenance of rail infrastructure. Faster speeds, shorter routes, longer crossing loops, passing lanes, flatter grades and consistent operating conditions all contribute to improved operating efficiency. These factors are all considered within the operational cost modelling for the Study.

5.2.3 Locomotives and rolling stock

The standard interstate locomotive at present is the 3,000 kw (4,020 hp), 22 tonne axle load (tal) NR-class owned by PN (originally purchased by the National Rail Corporation). A 1,500-metre intermodal train is usually pulled by two NR locomotives. However, the NR-class locomotives are now more than 10 years old.

A new generation of locomotives has been ordered from EDI Rail by SCT for its east-west services. At 3,200 kw (4,300 hp), these GT46C-AC model locomotives will be marginally more powerful with a similar axle load. They will be fitted with alternating current (AC) traction motors, the first application of this technology on the interstate network.

The GT46C-AC model locomotives will be more fuel-efficient, incorporate semi-steer bogies, microprocessor control and electronic brakes, making them ideal for travel on steep gradients along the route options considered in the Study.

Competition between train operators results in new wagon designs tailored to customers’ needs and built to exploit the potential of Class 1 track (as defined in the Code of Practice for the Defined Interstate Rail Network) and the 7.1-metre height clearance. All recently built wagons are suited for 25 tal, although they cannot operate at this capacity at present as track strength on most of the interstate network limits axle loads to 23 tonnes.

As the network is upgraded, new rolling stock is likely to be introduced by operators to take advantage of the improved capability. This may include axle loads of up to 30 tonnes and double stack containers, if network constraints are addressed.

The reference train adopts three GT46C-AC model locomotives and a mixed wagon fleet comprising wagons suitable for domestic, automotive and shipping containers, steel plate and slab wagons, general merchandise vans and grain hoppers.

5.2.4 Imbalance of traffic

There is significantly greater northbound rail freight than southbound (refer chapter 3: Market Assessment). The road transport industry has historically had a similar issue on this corridor but as southeast Queensland has developed, the trade is becoming more balanced. This could be replicated on rail with the right marketing effort and suitable access arrangements.

The higher proportion of empty wagons returning south can affect train operations in a number of ways. Firstly, return wagons are not normally subject to the same time-critical scheduling, although maximising equipment efficiency does require a rapid turnaround. Secondly, empty wagons are lighter, enabling very long trains of empty wagons to be operated within maximum allowable loads.
Provision of long passing lanes and crossing loops facilitates the efficient working of such trains, so fewer train movements may be necessary on the southbound route. Surplus locomotive power may also be shut down on the return leg to conserve fuel and minimise wear.

5.2.5 Multiplicity of operators

It is expected that the Corridor would be open to any train operator that can satisfy safety standards and pay the relevant access charges. This may have a detrimental impact on line capacity. More operators chasing limited demand will result in shorter trains occupying a greater number of train paths, a less than desirable situation in a network with a limited number of available paths. Differential access pricing has the potential to favour the operation of longer trains.

5.2.6 Legislative issues

The Corridor crosses the jurisdiction of the governments of Victoria, New South Wales and Queensland so ongoing train operations will be covered by the safety regulations of three states.

State regulators are in the process of adopting more nationally consistent approaches to the application of safety accreditation, investigation and auditing nationwide. With greater consistency between jurisdictions, the impact of different safety regulatory jurisdictions on train operations is not expected to be a major issue for the Corridor options.

5.3 Freeing up the Coastal Route

As indicated in the Market Assessment and Demand Analysis chapters, rail has the greater share of the freight market in the Melbourne to Brisbane sectors compared to road. Conversely, most Melbourne-Sydney and Sydney-Brisbane freight is currently transported by road. All of this freight is currently moved along the existing Coastal Route. If one of the inland route alternatives was developed, it is likely that a significant proportion of the Melbourne-Brisbane freight would transfer to the new inland route.

This would potentially free up additional capacity on the Coastal Route and provide opportunities for operators to capture more of the shorter distance freight on rail. There would be some economic benefits if this occurred.
6 Proposed Upgrade Projects

The network for the 2009 base case assumes that all current and committed programs will be completed by that date. The Study identified further improvements that are required to address network deficiencies.

The committed program of works and future works investigations assumed in this Study are based on discussions with ARTC and publicly available information on the organisation’s website, together with other works planned by the three state governments.

ARTC plans to invest $1.4 billion by 2009 to improve the rail infrastructure between Melbourne, Sydney and Brisbane. This includes 17 new passing lanes between Melbourne and Junee (10 kilometres to 15 kilometres in length), bridge strengthening and replacement, track strengthening, curve improvements, re-sleepering and re-railing, and signalling and communications improvements.

The Australian Government has allocated a further $270 million, which will be used by ARTC to complete the concrete sleepering on the existing main rail line between Melbourne and Sydney and Newcastle and the Queensland border.

ARTC also proposes to complete additional improvement works under the lease of the New South Wales standard gauge rail network. Some of these works will affect sections of the rail network being considered as potential route options for this Study. Other works will improve associated parts of the New South Wales network that will either feed traffic onto the route options in the Corridor or provide alternative routes.

The various state governments will contribute toward works that improve the metropolitan and state rail networks. Improvements to rail access arrangements at terminal and port facilities will also provide flow-on benefits to the interstate rail freight industry.

The New South Wales Government is working with ARTC to develop the SSFL. This will reduce the impact of the curfew on freight train movements through the Sydney metropolitan rail network.

The Victorian Government is undertaking work to improve the network and remove major constraints. This includes working with the Australian Government and the ARTC on improved connections to the Port of Melbourne (the Dynon Port Rail Link project) and the Wodonga Rail bypass. The Queensland Government has also announced Brisbane urban network improvements.

The Queensland Government is planning the Southern Infrastructure Corridor (SIC) which is included in the SEQIPP. This is a key future rail project with the potential to influence the direction and volumes of freight flows into Brisbane, and hence the dynamics of the various corridor options. The proposal is currently being evaluated, including more detailed assessment of the various options for corridor alignment. In broad terms, the SIC envisages a rail link between Ebenezer (near Ipswich) and the interstate standards gauge line in the general vicinity of Bromelton. This has the potential to ease some of the current capacity constraints for rail freight between Toowoomba and Brisbane by bypassing the congested Ipswich-Brisbane network.
7 Major Rail Infrastructure Constraints

While there is a significant program of works in place to address many of the infrastructure constraints in the Melbourne-Brisbane rail corridor, there are some major issues that remain unresolved. This section outlines some of those constraints, proposals that are under consideration (where appropriate) and the approach adopted in the Study.

The three key areas are northern Sydney, Cowan Bank and the Hawkesbury River region.

7.1 Sydney-Newcastle (northern Sydney)

It has long been recognised by key stakeholders that the Sydney metropolitan area represents the greatest challenge for rail planners in the delivery of optimised freight and passenger services. Intermodal freight traffic from Brisbane, Melbourne, Adelaide and Perth, coal traffic and local port container traffic all compete with passenger services for train paths on Sydney’s metropolitan rail network.

Track access and network flexibility are issues here, with very few passing loops or contingency infrastructure to manage conflicts between passenger and freight traffic. Steep hills to the north of Sydney also make it difficult for freight trains as their heavier loads mean they travel more slowly than commuter trains and their greater length adds to line congestion.

ARTC has commissioned a study to investigate options for addressing the infrastructure constraints in northern Sydney (i.e. between Strathfield and Gosford). Early indications from ARTC suggest that funding in the region of $200 million may be required to effectively address the problem, apart from the Cowan Bank tunnel.

The proposal includes a range of works between Homebush/Strathfield and West Ryde that can be broken down into two projects:

- A rail grade separation in the vicinity of North Strathfield to allow up trains to access the metropolitan freight network without the need to cross down tracks; and
- Completion of full quadruplication between North Strathfield and West Ryde.

The New South Wales Department of Transport has indicated that the additional capacity provided by these works will not provide a substantial improvement to the movement of freight trains because suburban commuter trains will consume a high proportion of the additional capacity generated. Analysis undertaken during this Study has indicated that passenger demand to the north of Sydney has been reasonably stable in recent years. Accordingly, it is possible that the additional capacity would benefit freight train movements through northern Sydney.

This Study assumes that the existing works program will not fully resolve the northern Sydney issues and that a significant investment will be necessary to achieve resolution. This issue will require further investigation by ARTC, RailCorp and the New South Wales Department of Transport.

7.2 Cowan Bank and Hawkesbury River section

The Cowan Bank section of the Sydney-Brisbane track located to the north of Sydney presents significant challenges for infrastructure and rail traffic alike, primarily due to the steep gradients encountered. These gradients adversely affect the speed of freight trains travelling between Sydney and Brisbane. The impact on freight train speeds is greater
than on passenger services and requires careful management of timetables to minimise delays to other services. Currently the movement of freight trains through this part of the network can take up to four times as long as the comparable passenger train time.

Figure 15 - Cowan Bank, Hawkesbury River section concept alignment

The Cowan Bank issues have been the subject of a number of commissioned studies. Recommendations have included a two-track tunnel between the Hawkesbury River and Berowra (south of Cowan) and associated track realignments to improve passenger transit time.

The proposal includes a straight tunnel that would not be as steep as the present Cowan Bank track to improve travel speeds. It is understood that the proposal was principally developed to improve the capacity and speed of passenger train services to the New South Wales Central Coast area. The proposal would retain the current track to provide overflow and emergency capacity.

The benefits to freight trains were a secondary consideration to the objectives of the scheme. Accordingly, it is understood that freight trains would continue on the existing track. Travel time benefits would be minimal but there would be fewer restrictions on freight train timetables. The Study assumes that the existing travel speeds on this section will remain for the duration of the assessment period.

The Study has developed a route option that is designed to address the geometric issues from Mount Ku-ring-gai through to the Hawkesbury River. The Study route option for this section has been developed on the basis of previous concept alignments prepared for RIC, and takes into consideration topographical and environmental limitations. The Study route option has an indicative cost of around $1.2 billion.
7.3 Toowoomba Ranges Crossing (Gowrie to Grandchester)

Any of the inland route options being considered require a connection to Brisbane through the Toowoomba area. The existing narrow gauge track through the Toowoomba Ranges is slow and difficult to negotiate for larger trains. There are numerous curves with radii as low as 100 metres which, combined with steep grades averaging around 2%, make the existing link difficult to negotiate, particularly for larger trains with heavy trailing loads. However, the operations modelling undertaken for the Study has indicated that the design train can negotiate the route, though the route would need to be standard gauge (or dual gauge subject to QR and QT approval) and the travel speed would be around 10km/h.

QR and QT have jointly developed an option that involves a new rail connection between Gowrie and Grandchester that includes a long tunnel under the Toowoomba Ranges, and substantial reconstruction and realignment of existing infrastructure to connect back to the existing network. The option has been identified by QR and QT as the preferred solution to the challenge of the Toowoomba Ranges crossing and has been adopted as the basis of the route option developed for the Study.

QR has provided information on the Gowrie to Grandchester proposal to guide the development of a route option for the Study. It should be noted that the project is included in the Queensland Government SEQIPP and is identified for construction during 2015-16 to 2025-26.

A number of other alternatives are possible to address the crossing of the ranges and provide the connection to Brisbane. One of these is the Cunningham Gap proposal, which crosses the ranges and connects the existing track at Warwick with the existing Coastal Route. The early analysis undertaken in the Study identified that the design of the Cunningham Gap proposal and supporting infrastructure in accordance with the design standards adopted for the Study would result in a more expensive outcome than the Gowrie to Grandchester proposal.

A further alternative was identified during the course of the Study, proposing the Toowoomba Ranges connection as a joint corridor with the Warrego Highway. This alternative was considered and discarded due to the different design requirements of the road and rail infrastructure and the associated cost implications.

The Study route option shown in Figure 16 is designed to reflect the QR vertical and horizontal alignment and ensure consistency with the current proposal. The Study route option has an indicative cost of around $1.6 billion. However, to be effective it needs to connect to the existing rail infrastructure to the west, and is generally not considered as a single stand alone option, but is combined with other options to complete the network connection.
Figure 16 - Gowrie to Grandchester concept alignment

Source: Study GIS
8 Infrastructure Design Criteria and Costing

8.1 Existing Coastal Route infrastructure design criteria

It is important to understand the standard of construction on the existing rail infrastructure when considering the design criteria to be adopted for future improvements to the track between Melbourne and Brisbane.

For the purposes of the Study, the existing route linking Melbourne, Sydney and Brisbane is referred to as the Coastal Route. The base case for the rail infrastructure on the Coastal Route is its condition in 2009 upon completion of the current ARTC improvement program. Further details of the base 2009 network are detailed in chapter 6: Route Options.

It is assumed that all temporary speed restrictions will be addressed through the ARTC improvement program, the concrete sleeper project and various maintenance works. The limitation in 2009 is the posted track speed that will be achieved following the completion of the ARTC improvement program.

ARTC has advised that further improvements will specifically target journey time and reliability. This can be best understood by identifying the criteria of the existing railway infrastructure and examining the impact of the proposed ARTC upgrade works.

The railway infrastructure between Melbourne and Sydney (that is, Tottenham to Chullora) has the characteristics outlined in Table 1. The railway infrastructure between Sydney and Brisbane (that is, Chullora to Acacia Ridge) has the characteristics outlined in Table 2. The tables also demonstrate the level of improvement that will be achieved through the ARTC investment program.
Table 1 - Melbourne-Sydney (i.e. Tottenham to Chullora)

<table>
<thead>
<tr>
<th>Tottenham to Chullora</th>
<th>At 2006</th>
<th>At 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>954.5 km</td>
<td>954.5 km</td>
</tr>
<tr>
<td>Average train speed¹</td>
<td>74.9 km/h</td>
<td>90.9 km/h</td>
</tr>
<tr>
<td>Train journey time</td>
<td>13.4-16.0 hrs</td>
<td>N/A</td>
</tr>
<tr>
<td>Timetable</td>
<td>12.75 hrs</td>
<td>10.5 hrs</td>
</tr>
<tr>
<td>Run time²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crossing loops – Melbourne to Junee</td>
<td>29</td>
<td>17 (passing lanes)</td>
</tr>
<tr>
<td>Crossing loops – Junee to Sydney</td>
<td>Nil – two tracks</td>
<td>Nil – two tracks</td>
</tr>
<tr>
<td>Minimum crossing loop length</td>
<td>870 m</td>
<td>1,500 to 1,800 m</td>
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<tr>
<td>Rail weight</td>
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<tr>
<td>Sleeper type</td>
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<td>Concrete</td>
</tr>
<tr>
<td>Allowable axle load</td>
<td>23t @ 115km/h</td>
<td>23t @ 115km/h</td>
</tr>
<tr>
<td>Vertical clearance</td>
<td>4.05 m</td>
<td>4.25 m</td>
</tr>
</tbody>
</table>

¹Average train speed is the distance between terminals divided by the run time.

²Run times are taken from the ARTC Melbourne-Sydney-Brisbane Route Option Study, October 2004.
Table 2 - Sydney-Brisbane (i.e. Chullora to Acacia Ridge)

<table>
<thead>
<tr>
<th>Chullora to Acacia Ridge</th>
<th>At 2006</th>
<th>At 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>966.9 km</td>
<td>966.9 km</td>
</tr>
<tr>
<td>Average train speed</td>
<td>55.3 km/h</td>
<td>64.5 km/h</td>
</tr>
<tr>
<td>Train journey time</td>
<td>18.5-22.5 hrs</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>17.5 hrs</td>
<td>15.0 hrs</td>
</tr>
<tr>
<td>Crossing loops – Sydney</td>
<td>Nil – two tracks</td>
<td>Nil – two tracks</td>
</tr>
<tr>
<td>to Telarah</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>Crossing loops – Telarah</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to Acacia Ridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum crossing loop</td>
<td>374 m</td>
<td>1,500 m</td>
</tr>
<tr>
<td>length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail weight</td>
<td>47/53/60 kg/m</td>
<td>47/53/60 kg/m</td>
</tr>
<tr>
<td>Sleeper type</td>
<td>Timber/concrete</td>
<td>Concrete from Newcastle to the NSW/QLD border</td>
</tr>
<tr>
<td>Allowable axle load</td>
<td>23t @ 115km/h</td>
<td>23t @ 115km/h</td>
</tr>
<tr>
<td>Vertical clearance</td>
<td>4.05 m</td>
<td>4.25 m</td>
</tr>
</tbody>
</table>

1 Average train speed is the distance between terminals divided by the run time.
2 Run times are taken from the ARTC *Melbourne-Sydney-Brisbane Route Option Study*, October 2004.

### 8.2 Capital Cost Model

The capital costs associated with providing the necessary rail infrastructure to transport the forecast volumes of freight along the Corridor have been considered along with operations and maintenance costs.

The adopted rates for the construction elements were based on a review of available literature, recent rail infrastructure construction and supplier costs. These rates have been tabulated to create an interactive estimating spreadsheet (Capital Cost Model) that generated the total capital costs on a defined segment of track based on the conceptual route design and the extent of the anticipated construction activity. The rates adopted are based on 2006 costs and exclude GST.

The Capital Cost Model provides an efficient way to estimate capital costs of a route option given the adopted infrastructure criteria and the conceptual design of the route segment. The Capital Cost Model formed one element of the modelling approach developed to optimise the route selection process.

The four elements input to the Capital Cost Model were:

- The adopted track design criteria;
- The horizontal and vertical alignment produced quantities for construction components;
- The constraints and existing conditions information from the Study Geographic Information System (GIS); and
- The cost database.
Construction duration has been addressed by determining the likely combination of durations for the critical infrastructure elements.

The model relied on a database of unit costs for all identified rail infrastructure items, then referred to the concept design and the Study GIS to extract the quantities (such as route segment length, number of bridges, number of level crossings) for each route option.

### 8.2.1 Costing database

The backbone of the Capital Cost Model was a Costing Database that defined unit rates. It is an interactive operating system able to distinguish between predetermined characteristics such as geographic region, track operational status, track condition and underlying geological conditions. All information required for the Capital Cost Model was supplied from the Study GIS and the concept design.

### 8.2.2 Computer Aided Design (CAD)

Computer design packages such as InRoads/InRail were used to model existing conditions and generate route designs, including alternative horizontal and vertical alignments based on prescribed performance criteria. It should be noted that the quality of the designs achieved through this approach is directly related to the quality of the information available in the Study GIS. The quality of the base data in the Study GIS was considered suitable for the development of concept designs at the level required for the Study.

Using the base data in the Study GIS, the CAD software was able to generate a comprehensive set of quantities and design data that includes:

- Length of existing/proposed track;
- Track grade;
- Track curve radii;
- Locations, quantities and types of turnouts, crossovers and diamonds;
- Formation area requiring stripping from toe of batter to toe of batter along the route;
- Cut and fill volumes based on a standard cross-section;
- Tunnel lengths; and
- Tunnel cut volumes based on a standard cross-section.

The concept design was optimised to try and balance cut and fill by adjusting track geometry. Given the high-level nature of the route geometry determination in the Study, a standard track cross-section was adopted along with standard cut and fill batters.

A strong interface was developed between the CAD packages and the Cost Database. Information was in the form of a concept design detailing each route option and a construction quantities list. The construction quantities were incorporated into the Capital Cost Model.

### 8.2.3 Study GIS

In the same way as the CAD design production, the quality of the information available in the Study GIS determined the accuracy of costs generated by the Cost Database.
The Study GIS interfaced with the CAD concept design for each route option and provided the following infrastructure data:

- Bridge locations (minor and major);
- Level crossing locations (minor and major);
- Area of land acquisition per route option based on the 1:50,000 topographic map series;
- Generic underlying geological conditions and soil depth profile; and
- Existing track infrastructure (bridges, culverts and level crossings).

The output from the Study GIS was incorporated into the Capital Cost Model to determine the total capital cost for each route option.

8.3 Proposed infrastructure design criteria

Detailed criteria for rail infrastructure were defined for the Study to achieve the most competitive freight train journey times (and the flow-on benefits to reliability and availability). It was also necessary to assess the most cost-effective route options and consider the progressive development of these routes.

ARTC, PN and QR were consulted in the development of the adopted criteria. The Study also considered the relationships between operating and infrastructure requirements (for example, axle load, design speed, train length, locomotive power, etc.).

For the development and costing of route options for the Study, it was necessary to define criteria to describe the infrastructure for the proposed railway. The criteria proposed have been derived primarily from the Code of Practice for the Defined Interstate Rail Network (COP) and from reference to previous studies related to the Corridor. In terms of infrastructure criteria, the same criteria have been adopted for all new and enhanced track sections.

Adopted criteria were used to plan and develop conceptual studies and are not intended to form the basis of preliminary or detailed design.

Further development of these criteria for more detailed design will require reference to the COP, the requirements of ARTC and the relevant government agencies in the three states traversed by the Corridor.

The infrastructure criteria developed for the Study include:

- Operational requirements, including speeds, train mass and axle loads, train dimensions and track spacing;
- Geometric alignment, including curve radii and gradients;
- Track components, including railway formation, rail, sleepers, ballast, track installation, drainage, turnouts, fencing and signals/communications;
- Passing lanes and crossing loops;
- Double stacking;
- Voice communications;
- Safeworking and train control;
- Other infrastructure, including underbridges and overbridges, grade separations, level crossings and tunnels;
• Other on-cost items, including whole of life costs, costs of environmental limitations, planning, design and management, contractor site establishment/overheads and profit, land acquisition; and
• Contingency allowance for risk.

**8.3.1  Summary of key railway infrastructure criteria**
The key criteria adopted for the Study are set out below.

8.3.1.1  **Operational requirements**
- Desirable maximum speed for freight trains 115 km/h
- Desirable maximum speed for passenger trains 160 km/h
- Maximum axle load for freight trains 30 tonnes
- Maximum axle load for passenger trains 20 tonnes
- Minimum vertical clearance above top of rail 7.1 m

8.3.1.2  **Geometric alignment**

Table 3 - Maximum train speeds and corresponding minimum curve radii

<table>
<thead>
<tr>
<th>Maximum Train Speed (km/h)</th>
<th>Minimum Radius (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>500</td>
</tr>
<tr>
<td>100</td>
<td>800</td>
</tr>
<tr>
<td>115</td>
<td>1,200</td>
</tr>
<tr>
<td>160</td>
<td>2,000</td>
</tr>
</tbody>
</table>

- Maximum desirable gradient 1.25%
- Maximum allowable gradient 2.50%

8.3.1.3  **Crossing loops**
- Train length to be accommodated 1,800 m

8.3.1.4  **Track**
- Rail for new or upgraded track 60 kg/m
- Existing rail 47 or 53 kg/m
- Turnouts on main line track to diverge at not less than 1:21.
- Concrete sleepers for new or upgraded main line track and crossing loops.
- Concrete bearers for main line turnouts and crossovers on new or upgraded track.
- Timber sleepers and bearers will be retained where existing track does not require upgrading.
8.3.1.5  Drainage

- 300 mm of ballast below the bottom of the sleeper.

- New and upgraded track to clear 1:100 year flood.
- New and upgraded track to drain freely 1:100 year rainfall.

8.3.1.6  Level crossings

- Grade separation is to be adopted as standard for major arterial or key urban roads.
- For existing and proposed level crossings, the following upgrades are to be included:
  - Flashing lights for train speeds up to 115 km/h;
  - Flashing lights and boom barriers for train speeds above 115 km/h to 160 km/h; and
  - Provision for grade separation if future speeds rise above 160 km/h.

8.3.1.7  Bridges

- All bridges to be designed to Australian Bridge Design Code.

8.3.1.8  Safeworking and train control

- In-cab communications-based train control systems to be adopted.

8.3.1.9  Double stacking

- Double stacking to be provided for new construction; however, it is only achievable on the inland route options.

8.4  Operational requirements

8.4.1  Speed

To improve transit times, reliability and availability in the Corridor, it is necessary to provide a network capable of higher travel speeds. To be competitive with road services in these markets, it is expected that the maximum speed for freight trains will need to be up to 115 km/h. Such a maximum speed will enable options to be developed that achieve average speeds of about 80 km/h, making a run time of around 20 hours potentially achievable between Melbourne and Brisbane with the associated reliability benefits. Passenger services will be able to operate in the Corridor at up to 160 km/h.

It is considered more appropriate to adopt a higher baseline speed with local restrictions than to limit the line speeds to a lower value and provide a less competitive network.

These target train speeds are readily achievable with equipment and infrastructure already deployed in Australia. If sustained over substantial distances, these speeds offer the prospect of transit times comparable to or better than road travel in the same corridors.

8.4.2  Train mass and axle load

In addition to speed, the main determinants of a railway’s travel characteristics are train mass and size. To provide for 100-tonne freight wagons with four axles, a maximum axle load of at least 25 tonnes is necessary. Wagons of this gross mass already operate on the standard gauge network and continuing demand to accommodate such axle loads can be expected from rail operators to improve overall productivity. A similar trend has been observed in North America.
For passenger trains expected to operate at speeds greater than 115 km/h, a maximum axle load of 20 tonnes is appropriate.

Consideration of axle loads does not materially change the relative outcomes between different route options and is not likely to have a significant influence on the overall capital cost. Discussions with ARTC, PN and QR representatives indicated a preference for the adoption of 30-tonne axle loads as the target criteria for the Study. Such a target allows for the future improvement of the network over the 25-year horizon being considered in the Study. Accordingly, the costing of the various route options has been developed on the basis of a 30-tonne axle load.

8.4.3 Train dimensions
The height, width, length and distance between bogies and distance between axles for all rolling stock are assumed to be in accordance with existing standards defined by the COP. For railway infrastructure, this suggests the following criteria for minimum clearances:

- Lateral: Centreline of track to any structure 3.0 metres
- Vertical: Top of rail to soffit/intrados of structures to allow for double stacking 7.1 metres

Vertical clearances to overhead wires will be greater and depend on the codes relevant to the function of the wire. For track with existing overhead electric contact wires in Sydney and Brisbane vertical clearances are sufficient only for single stack container trains.

8.4.4 Track spacing
The adopted minimum distance between adjacent track centres for main lines and crossing loops is 5.0 metres. The adopted minimum distance between adjacent track centres is 4.0 metres.

8.5 Geometric alignment
The Study uses the existing COP as the basis for developing a design for current and new track involved in the route options considered.

Existing track alignment makes up a considerable proportion of all route options considered in the Study and is fundamental to the existing Coastal Route and any further refined alignments. A number of discrete and separable geometric improvements to the Coastal Route have been considered while a number of discrete and separable new routes and upgrade alignments have been considered for the various inland options.

In each of these route options, an alignment has been chosen that aims to maximise the line speed. It is expected that these upgraded sections may ultimately be used at much higher speeds than the adopted target minimum speed of 115 km/h, but for the foreseeable future would only be used at that speed. However, where large earthworks or significant cost are required, the alignment has been compromised to at least satisfy 115 km/h minimum speed, albeit using the limits of the COP guided cant and cant deficiency requirements.

8.5.1 Curve radius
In engineering terms, a 1,200-metre curve radius has been adopted as the desirable radius for optimum speed benefits. This radius will provide for 140 km/h freight train speeds at 125mm cant and 75mm cant deficiency if this is a requirement in the future.

The Study has adopted the largest practical radius, subject to terrain, adjacent development and environmental constraints.
8.5.2 Track gradient

Maximum track gradient also depends on complex trade-offs between operational requirements, such as locomotive power and speed, and an optimal design based on terrain characteristics. For example, the track provider may seek to minimise construction and maintenance costs using a steeper gradient, but train operators may seek flatter gradients to reduce fuel consumption or locomotive power requirements.

The Study adopted a maximum desirable gradient for freight trains of 1.25% or 1 vertical in 80 horizontal. The preferred maximum allowable gradient is 1.50% or 1 vertical in 67 horizontal, although some sections require gradients of up to 2.50% or 1 vertical in 40 horizontal. These grades have been avoided except in exceptional circumstances.

As with other infrastructure criteria, the same gradient criteria have been applied to all route options developed to ensure an equitable comparison between routes.

8.6 Track components

8.6.1 Component design

The Study has adopted the COP as the basis for developing a design for existing and new track involved in the route options considered. The Study Team approached the issue of infrastructure standards that may be applicable over the term of the Study (25 years) in terms of the initial and ‘ultimate’ design configuration. The initial situation comprised the ‘minimum standards for viable operation’ while the ultimate or year 25 standard comprised ‘desirable engineering standards for desirable market response’.

The initial minimum engineering standards are those that will provide a level of transit time and rolling stock utilisation that accords with ‘entrant’ market response. In engineering terms, this equates to train loads of 21 tonne axle loads and locomotive axle loads equivalent to the NR locomotive (22 tonnes), together with a 32 hour transit time (approximately equal to the current performance). This performance standard equates to a configuration including 47kg/m rail on good quality sleepers (timber or concrete) and suitable formation and ballast.

For the purposes of this Study, this means that where the route options use existing track it may need to be upgraded to this minimum standard. Where this is not possible using the existing in-track components, the ultimate configuration involving concrete sleepers and 60kg/m rail has been adopted. This approach has also been adopted for any new track constructed for the base case.

For the ultimate (year 25) design, the minimum engineering standards are those that accord with a fully developed market with high utilisation and market share and where the efficiency and cost-competitiveness of the operation is paramount. In engineering terms, this equates to train loads of 30-tonne axle loads and a travel speed of 115 km/h.

8.6.2 Railway formation

The railway formation will include embankments and cuttings. These must be planned in accordance with the geotechnical requirements of the site in each case. For planning purposes, the formation should include a 150-mm thick capping layer of compacted earth immediately below the bottom of the ballast and a 300-mm thick compacted earth layer below the capping layer.

This 450 mm of compacted earth should be above the invert of adjacent drainage ditches in cuttings, above the adjacent natural surface for track at grade, and above the top of the underlying earthworks for embankments. Slopes of embankments and cuttings depend on the geotechnical characteristics of the materials, but a nominal slope of 2V:1H is proposed for the purposes of the Study.

The width of the formation varies to accommodate the necessary track structures, drainage, access roads and fencing along the railway.
The development of the concept designs has targeted a nominal balance of earthworks cut and fill for the purposes of design and cost estimation. Site topographical constraints have often prevented this from being achieved and fulfilling suitable design geometry has taken priority over earthworks balance.

Figure 17 illustrates the typical arrangement adopted for the railway formation for the purposes of the Study.

**Figure 17 - Adopted typical rail formation arrangement**

8.6.3 Standard track formation construction quantities

The standard track formation cross-section generated the earthworks requirements by applying the cross-sections to the proposed CAD concept alignment based on the horizontal and vertical geometry criteria adopted for the Study.

The CAD-generated concept design was used to determine the total area of surface strip required per section of new track based on toe of batter to toe of batter at 50 metre centres along the alignment.

The Study GIS was used to assign a generic underlying geology category for each segment of new track to enable different rates for cut and fill based on broad geological conditions.

An allowance was made for final preparation of the sub-grade layer prior to placement of the engineered fill. The engineered fill used to create the track formation included an allowance for a maintenance access road.

The capping layer beneath the track ballast was assumed to have a fixed depth of 150 mm, with cross fall of 1 in 60 based on the standard cross-section adopted for the Study.
Upgrading of existing track was assumed to include replacement of the capping layer as well as the ballast, sleepers and track.

An access track passable in all weather by four-wheel drive vehicles should be provided along the entire railway (except at overbridges and underbridges).

8.6.4 Track gauge

It is proposed that the track for the Corridor will be standard gauge or 1,435 mm between rails.

Dual gauge track has been assumed in Victoria and Queensland, where a new route option coincides with an existing broad gauge or narrow gauge track.

8.6.5 Rail

On the Coastal Route, ARTC’s 2005/2009 program will utilise much of the existing rail, which is generally 53 kg/m and heavier. This will restrict axle loads and therefore productivity until 60 kg/m rail is installed. Excessive operation of 25-tonne axle loads on rail lighter than 60 kg/m can overstress the rail web, particularly where it joins the rail head, and is not recommended. Nevertheless, 25-tonne axle loads can be, and are, supported on 47kg/m and 53 kg/m rail, but these sections are subject to rigorous and frequent inspection to detect incipient failure of the rail.

Some existing segments on various inland route options being considered in the Study have rail weights of 40, 47 and 53 kg/m, which also limit axle loads. Until adequate rail is in place, the ability of the railway to accommodate even the existing 100-tonne wagons will be impaired, but this does not necessarily mean that 25 to 30-tonne axle loads cannot operate. Such loads will require travel at lower speeds, where rail is lower weight.

For new or reconstructed track, rail is to be 60 kg/m Australian Standard rail. This upgrade can be progressive, but is key to the ultimate performance of the railway. This 60 kg/m rail is available domestically and can accommodate the target 30-tonne axle loads. Turnouts and fittings for 60 kg/m rail are also readily available.

8.6.6 Sleepers

Most of the existing sleepers in Victoria, New South Wales and Queensland are timber. Replacement timber sleepers of suitable quality and quantity are increasingly costly and difficult to obtain. In recent years, the lifecycle cost of concrete sleepers has proven to be less than that of timber. In terms of holding track gauge and ride quality, concrete is also proving superior to timber.

The Australian Government has allocated an additional $270 million to be used by ARTC to complete the replacement of timber sleepers with concrete sleepers on the existing main rail line between Melbourne and Sydney and from Newcastle to the Queensland border.

Sleepers for any other new or upgraded main line track sections and passing lanes should be made of reinforced concrete and manufactured to the Australian Standard. They should be placed at 600 mm centres, or 1,667 sleepers to the kilometre. Bearers for main line turnouts and crossovers should be concrete. Sleepers and bearers for yard tracks and sidings may be timber.

8.6.7 Ballast

The depth of ballast for new and upgraded main line tracks and passing lanes should be at least 250 mm below the bottom of the sleeper (or preferably 300 mm) as required by the COP.

The costs for delivery of ballast by both track and rail were determined by the location of the proposed works with respect to the likely location of a ballast supply quarry. The volume of ballast has been determined as 1.66m³ per lineal metre of track for single track and 3.19m³ per lineal metre for double track, based on the standard cross-sections adopted for the Study at a bulk density of 1.6 tonne/m³.
8.6.8 Track installation
The rate for track installation has been derived from rates for laying and compacting bottom ballast on a completed capping layer, placement of sleepers, placement of rail, fixing of rail, placement and compacting of top ballast, tamping, welding and testing. The rates have been factored for geographic location to cover the difficulties associated with access, availability and delivery.

8.6.9 Drainage
Good drainage is essential for stable, reliable and safe track. All new and upgraded track is to be located above the flood level corresponding to a probability of 1 in 100 years. A flood of this height should pass under the soffit of any bridge and culverts should be designed to pass flows of the associated magnitude.

All new and upgraded tracks and formation should be designed, built and maintained to drain freely with no impairment to operations from a storm of 1 in 100 year intensity.

8.6.10 Turnouts
It has been assumed that two standard gauge turnout configurations would be required for all crossing loops and passing lanes. The taper angle for a standard gauge turnout should be 1:8 for low speed turnouts and 1:24 for high speed turnouts.

8.6.11 Fencing
Railway fencing is subject to legislation in each of the three states within the Corridor. In general, continuous fencing of the railway or rail reserve is not warranted and creates an unacceptable barrier to those who want or need to cross or access the tracks. For the purposes of the Study, provision has been made for new livestock fencing along 30% of any new or upgraded track in rural areas and cyclone fencing on 70% of new or upgraded track in built-up areas.

8.6.12 Signalling and communications
A uniform system of train control along the entire Corridor is desirable. A communications-based control system is expected to be feasible by 2010, which is consistent with the timeframe considered under this Study. This system would require receiving and transmitting equipment on all trains operating on the railway, but would avoid the requirements for a system of colour light signals and the associated need for electric power supply at remote locations. Provision for the required interlocking of points has been included in the cost estimate.

8.7 Passing lanes and crossing loops
The ARTC investment program for the Coastal Route includes 17 passing lanes ranging in length from six kilometres (Tottenham) to 17 kilometres (Henty to Culcairn) between Melbourne and Junee and 33 passing lanes and crossing loops between Telarah and Acacia Ridge, generally with capacity to accommodate trains up to 1,500 metres. The ARTC program indicates construction using 60 kg/m rail, concrete sleepers, resilient fastenings and 1 in 12 turnouts.

It is proposed that crossing loops on any of the inland route options would be provided to accommodate trains of at least 1,800 metres. This reflects the expectation that by 2009 all ARTC track between Melbourne and Brisbane will have 1,500-metre crossing loops and that rail operators will continue to pursue the ability to operate longer trains. Recent developments in locomotive power, braking and train control also suggest the evolution of longer trains. The location and lengths of crossing loops and passing lanes on the inland route options will depend on the preferred route and anticipated train frequency.

For costing purposes, crossing loops on the inland route options are assumed to be 2.5 kilometres, located in favourable terrain (with no grade separations, tunnels or major bridges) and to the same standard as any new track. It has been
assumed that an unconstrained train will require a crossing loop every 80 kilometres if travelling at an average speed of 80km/h.

8.8 Double stacking

In addition to the challenges of improving geometry and transit time on the Coastal Route, there is a need to increase the train height clearance to 7.1 metres to allow for the operation of double stack containers and ‘hi-cube’ wagons.

Double stacking is a loading technique that involves stacking one container on top of another. This technique can occur where the infrastructure clearance above the rail height is at least 6.5 metres (7.1 metres is desirable) and specialised wagons purpose-built for this application are used.

Numerous factors need to be considered when increasing height restrictions, including infrastructure such as bridges, tunnels, overhead electrification, gantries and signals, station canopies, footbridges and rail side structures. All of these aspects have potentially high cost implications, some more severe than others.

The Coastal Route has been assessed for double stack trains. There would be significant construction costs north of Sydney through the Hawkesbury River area and as far north as Newcastle. There are many tunnels and road overbridges that constrain train height, and some significant ‘through truss’ railway bridges such as the bridge across the Hawkesbury River at Woy Woy.

However, the most severe constraint on train height is the electrical overhead system on the Sydney metropolitan network and the intercity line from Sydney to Newcastle. As it is not practical to operate double stack trains under overhead electrified wires (due to height constraints), an independent freight line between Sydney and Newcastle would be required. The cost of this is prohibitive.

Between Melbourne and Cootamundra there are significant height obstacles: three short tunnels, some road overbridges and through truss bridges at Melbourne and Albury. Removing these restrictions would be relatively expensive, but not impossible. The cost for double stack operation has not been calculated as part of the Study due to the lack of detailed data on overbridges and other overhead structures.

On the inland route options where the constraints are not as onerous, a double stack operation is considered achievable. From the outset of operations on an inland route, an initial double stack operation could be achieved with appropriate design between Brisbane and Parkes, connecting with the existing double stack route to Adelaide and Perth.

North of Cootamundra, there are no major obstacles on existing lines, but entry through the Brisbane electrified suburban area and the Port of Brisbane is a significant constraint for a 7.1-metre height clearance, unless a totally new route to Acacia Ridge or another terminal is planned. Modification to the wire height and suburban railcars in Brisbane may be feasible to permit double stacking on a dual gauge track but such operations are likely to be viable only for short distances.

The main restriction to double stacking into Melbourne is the Bunbury Street tunnel at the western end of the Dynon and Port of Melbourne precinct. All freight trains entering the Dynon terminal complex and the ports have to pass through this tunnel.

The removal of this obstacle is one of the most complex and expensive steps in creating a double stack route into the Dynon complex. The outer suburban terminals avoid this restriction but require longer road transport travel (or single stacked shuttle services) to deliver freight to customers and the port. The standard gauge freight line into Melbourne is independent of the electrified metropolitan passenger network and does not have any conflict with the overhead electrified wires.
The Study has assumed that double stacking will not be required on the Corridor during the timeframe assessed. However, all new track construction was designed to cater for double stacking to ensure new route options do not add further constraint to any future proposals for double stacking along the Corridor. Costs of structures on any new route options allowed for the necessary clearances.

### 8.9 Voice communications

Voice radio communication is an essential part of railway operations. Appropriate voice radio communication should be provided along the entire railway.

It is assumed that suitable communications coverage will be provided by appropriate organisations and the service provided to train operators as an operating expense.

### 8.10 Safeworking and train control

A uniform system of train control along the entire Corridor is a desirable objective. A communications-based train control system that would rely on radio based telecommunications is expected to be feasible by 2010, broadly consistent with the timeframe considered in this Study.

Such a system would require receiving and transmitting equipment on all trains operating on the railway, but would avoid the requirements for a system of colour light signals and the associated need for electric power supply at remote locations.

Although these communications systems would be useful for automatic train stopping or automatic train control as well as transmission of information about train health and location, it would need additional information as to the lie of points and integrity of the rail. These issues are currently under study and development in Europe and North America as well as in Australia.

For the purposes of this Study, it is assumed that no system of coloured light signals and associated power supplies will be provided on new or upgraded sections of track.

ARTC is proposing to introduce in-cab signalling. This would significantly improve train operations, increase track capacity and reduce journey times. The timeframe to achieve this has yet to be developed by ARTC.

### 8.11 Other infrastructure

Other infrastructure may also require definition for the Study to ensure that entire project costings are able to be determined. The following general criteria are considered appropriate for this purpose.

#### 8.11.1 Underbridges and overbridges

Bridge structures under the railway should be designed to the requirements of the Australian Bridge Design Code for the maximum axle load and design velocity, that is, 30 tonnes at 115 km/h or 20 tonnes at 160 km/h.

Bridge structures over the railway, such as those for highways, canals, conveyors, other railways or other purposes, should be designed to the requirements of the Australian Bridge Design Code.

There are many site-specific conditions that affect the cost of bridge construction, including geographic location, span complexity, ground conditions, flow and flood conditions (for water crossings), architectural considerations, construction methodology, construction access, availability of skilled resources and equipment and load requirements.
The rates adopted for the Study were dependent on the level of information obtained from the Study GIS. The Study GIS contains details of the length of existing structures and provides estimated lengths for new structures based on watercourse polygons of creeks, rivers, lakes and associated wetlands.

Square metre rates were adopted for bridge types categorised as major or minor, with a separate allowance made where culverts were deemed appropriate instead of a bridge structure.

8.11.2 Grade separations
Rates for grade separation have been calculated using typical details for approach roads and spans provided on recent VicRoads projects. These rates were calculated on the basis of single or dual lanes of traffic travelling in each direction.

Grade separation was assumed necessary at major arterial road crossings. It was assumed that any minor road crossed by new track alignment would be modified to create access parallel to the track for interconnection to new bridge crossings or level crossings at a maximum spacing of 10 kilometres.

8.11.3 Level crossings
Safety at existing level crossings will be of interest to rail operators and communities along the Corridor.

It is proposed that no new level crossings should be provided at major arterial roads along the Corridor on any section of new or upgraded railway. Any new crossings of arterial roads should be grade separated.

It is possible that some future (minor) road crossings would be level crossings, but this would be subject to assessment and approval of appropriate safety measures and community assessment by relevant authorities. However, it should be noted that no new level crossings are permitted in Victoria without Ministerial approval.

Allowance has been made for level crossings (with a suitable level of protection) at a number of minor roads not suitable for grade separation or closure/modification.

8.11.4 Tunnels
The design development of a number of the route options identified a need for tunnels to be constructed to address gradient, curvature and speed constraints on existing routes, improve travel time and address terrain limitations.

A standard tunnel cross-section was developed for the Study to estimate the cost of route options.

The actual track construction through the tunnel has been assumed to include engineered fill, capping layer, ballast, sleepers and track, with the track installation cost increased to cover working in a confined environment.

8.12 Other on-cost items

8.12.1 Whole-of-life costs
In the development of a railway, there are numerous trade-offs between initial capital costs and ongoing maintenance costs. An appropriate balance can be found by seeking to minimise the capital and maintenance costs over the life of the asset under consideration. Such detailed assessment was not considered practical for the Study.

As a surrogate, the capital investment generally follows the criteria in the COP and the maintenance expenditure is expected to be at a level comparable to the current level of expenditure for Class 1 or Class 2 railways (as defined in the COP) in the Corridor.
8.12.2 Costs of environmental limitations

The environmental limitations that impact on route selection and construction costs are outlined in chapter 7: *Environmental Assessment*. Extensive research and database consolidation has been undertaken to populate the Study GIS such that it can identify environmental issues that may affect route selection.

Large-scale infrastructure projects such as major rail work involve significant expenditure on various environmental processes, including:

- Conduct of environmental impact statements;
- Development of environmental management plans;
- Implementation of environmental management plans; and
- Monitoring of environmental management plans.

It is recognised that the creation of new rail corridors will have an impact on the environment through which the corridors pass. There will be loss of vegetation along the width of the Corridor formation. As such, an allowance has been made in the cost estimates relating to compensation for loss of habitat and to cover replacement of vegetation within and adjacent to the Corridor, or elsewhere as deemed appropriate.

If any of the route options considered in the Study proceed to the feasibility stage, it will be necessary to assess the ambient noise levels at locations where major works are to be undertaken and/or where the number of trains will cause a perceptible increase in noise emissions from the railway. This assessment, combined with estimates of the expected noise levels and consideration of the relevant regulations, will help define what noise control, if any, is appropriate at various places along the line.

For example, along the existing Coastal Route where there is already substantial rail traffic, the incremental noise levels may be quite small. For alternative route options, where there is little if any train noise, the increment may be significant. It is also likely that the ambient noise levels along alternative route options are lower than for the existing Coastal Route.

An allowance has been incorporated in the project costing to allow for these environmental considerations.

8.12.3 Planning, design and management

Creation of an alternative route for freight trains from Melbourne to Brisbane or significant upgrade of the existing Coastal Route will require detailed planning, significant design effort and ongoing management to ensure the works are completed in accordance with all relevant legislation and specifications.

An allowance has been incorporated in the project costing to allow for these factors, based on a percentage of the base construction cost for each separate route option.

8.12.4 Contractor site establishment/overheads and profit

An allowance has been incorporated in the project costing to allow for contractor site establishment, overheads and profit, based on a percentage of the base construction cost for each separate route option segment.

8.12.5 Land acquisition

For a true comparison of route option costs, especially in comparing upgraded existing alignments with alternative greenfield alignments, it was necessary to provide an estimate of the costs associated with land acquisition for each of the route options considered in the Study.
As the Study involved an examination of broad corridors rather than actual alignments, it was not possible to be accurate with acquisition costs as actual detailed land usage and valuation assessments were not able to be undertaken.

The approach adopted was to utilise the Study GIS to determine the area of land acquisition required for each route option and relate that to the 1:50,000 topographic map series. A standard corridor width of 50 metres was assumed, with additional land to accommodate batters included where identified by the CAD alignment design.

Indicative land valuations for every property greater than one hectare were obtained from the New South Wales Department of Lands, with properties collated by the topographic maps used in the area analysis. The values determined for each map were adjusted to allow for the value of land improvement and compulsory acquisition costs.

The 85th percentile of the values for each map was then adopted as the base rate, with the 75th percentile and the 95th percentile used as the distribution for an @Risk assessment. Rates in Queensland and Victoria were based on the adjacent New South Wales map series and additional advice on indicative rates provided by QR.

The resale of the land in potentially redundant corridors was not considered in the Study.

8.13 Risk adjustment for contingency allowance

The conceptual nature of the designs for the Study creates the need for a risk adjustment to the cost estimates in the form of a contingency allowance to cover:

- Scope growth;
- Design development;
- Unknown geological conditions in cut and tunnelling;
- Unknown ground conditions in formation earthworks;
- Uncertainty in track alignment length;
- Uncertainty in structure costs: height of bridges, flooding implications, foundation conditions and span limitations;
- Unknown construction methodology with respect to upgrading and reconstruction of existing track alignments;
- Uncertainty in the classifications of new structures as minor or major;
- Uncertainty in the availability of suitable construction materials in close proximity to the site (crushed rock, ballast) and the effect this will have on transportation costs;
- Uncertainty about the accessibility to build greenfield alignments and the costs associated with creating access;
- Uncertainty about the availability of skilled labour to carry out the work and the effect this may have on labour rates; and
- Uncertainty about the capacity of the construction industry to supply labour, materials and equipment to carry out the work in a timeframe to suit the demand, given other infrastructure and rail construction at the time.

The Study allocated risk against each element of the construction based on the level of uncertainty involved in determining both the quantity and rate of each cost element.

For items such as sleepers, where the quantity is dictated by the design, and the cost per item (including delivery and installation) can be determined with reasonable accuracy, the risk of underestimating the construction cost is lower than
for a more volatile element. A more volatile element such as tunnelling involves a number of uncertainties, including access, geological conditions, tunnelling methods and construction duration. These potentially lead to a greater risk of underestimating the actual construction cost.

A risk-based approach to calculate the likely construction cost for each route option segment was adopted utilising the @Risk program. A best-fit distribution was applied to the generated costs and the parameters that define that distribution were summarised in the Cost Matrix as the output to the Capital Cost Model.