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STATISTICAL REPORT

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Rail

Trainline 3

Bureau of Infrastructure, Transport and Regional Economics
and
Australasian Railway Association

Trainline 3

Statistical Report

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Cover photograph: V/Line Vlocity set at the newly opened Wyndham Vale Station; part of the recently opened Victorian Regional Rail Link. Photo courtesy of V/Line.

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Foreword

This statistical report is a further development of the previous rail freight performance publications series and *Trainline 1* and *Trainline 2.* These publications are collaborations between BITRE and the Australasian Railway Association (ARA).

TrainLine 3 provides an overview of freight, urban and non-urban passenger rail. The report analyses traffic levels, the provision of infrastructure and rolling stock, and railway performance.

We acknowledge the assistance of ARA and its members with providing data about the Australian railway industry.

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At a glance

Railway task

- Sydney has Australia's busiest urban heavy rail network, with approximately 272.5 million passengers carried in 2013–14. Nationwide heavy rail urban patronage for 2013–14 was approximately 627 million. Non-urban patronage was approximately 50 million. Melbourne's light rail system carried almost 177 million passengers in the same year.
- The Victorian Regional Rail Link programme was completed in June 2015. This has separated inter-city trains to Bendigo, Ballarat, and Geelong from suburban Melbourne passenger trains. This reduces inter-city transit times, which may make inter-city Victorian rail travel more attractive.
- Australia's first fully automated passenger rail system is under construction in the northwest of Sydney.
- In 2013–14 Australian railways carried almost 1.3 billion tonnes of freight. The task was dominated by bulk movements, which accounted for approximately 98 per cent of the rail freight task.
- Intrastate bulk freight in Western Australia—principally iron-ore movements—accounted for approximately 70 per cent of national rail freight tonnages. Bulk movements in Queensland and NSW—principally coal—were approximately 19 per cent and six per cent, respectively.
- Australia's total rail freight tonnage grew by approximately 25 per cent from 2012–13 to 2013–14. Despite the reported end of the mining boom, intrastate bulk tonnages in Western Australia increased by approximately 56 per cent from 2012–13 to 2013–14.
- Intermodal freight, which grew significantly from 19 519 thousand net tonnes in 2009–10 to 27 559 net thousand tonnes in 2012–13, reduced to 21 891 thousand net tonnes in 2013–14, a reduction of approximately 21 per cent.

Railway networks

- Australia's operational heavy railway network is approximately 33 300 route-kilometres, with approximately 10 per cent being electrified. There are 53 route kilometres of (heavy rail) track under construction, of which approximately 68 per cent is passenger rail.
- Australia has approximately 291 route kilometres of operational light rail/tramway.
- Melbourne has Australia's largest heavy and light suburban (excluding inter-urban) passenger rail networks at approximately 460 route kilometres and 250 route kilometres, respectively.

- The principal iron ore railways are in Western Australia's Pilbara region (2 642 route kilometres). The principal coal networks are Aurizon's central Queensland systems (1 956 route kilometres[1]) and the New South Wales Hunter Valley Coal network (approximately 785 route kilometres). Grain flows run from agricultural hinterlands to ports and for domestic processing. There are approximately 5 100 route kilometres of operational railway that are largely or exclusively used for grain haulage.

Railway performance

- Scheduled intermodal freight train transit times on the north–south interstate corridor have decreased compared to the previous financial year. Transit times on the central corridor are largely unchanged. Transit times on the Melbourne-Perth corridor have reduced slightly while on the Sydney-Perth corridor they have increased slightly.
- Of the urban passenger rail systems, Sydney has the most heavy rail passengers; approximately 15 per cent more than the second highest city for heavy rail, Melbourne. Perth, which had experienced previous strong heavy rail patronage, experienced a decline in 2013–14.
- The Victorian government's Regional Fast Rail Programme increased train speeds, enhanced rolling stock and increased service frequencies between Melbourne and regional Victorian cities. This was further enhanced by the Regional Rail Link, which became fully operational in June 2015.

1 This includes a small amount of privately owned route km (Middlemount and Caval Ridge railways, plus QAL branch) usually not included in Aurizon's figure, but part of the Central Queensland network.

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CHAPTER 1
Australia's railway industry

Trainline is a statistical compendium of Australia's railways, providing a broad range of data and analysis of the industry[2].

This compendium provides insights and an understanding of the railway industry. Australia's railways are evolving, with changes both outside and within the industry. These changes include:

- **Logistics**. Interlinked chains of international and domestic production and distribution have revolutionised the production and consumption of manufactured and processed goods. Logistics systems for bulk commodities have also broadened, such as with containerised grain, ores in containers and barging of bulk commodities from rail heads to Cape-size vessels anchored in deep off-shore waters.
- **Commodity flows.** Australia produces around 40 per cent of the world's iron ore exports, with virtually all of this being conveyed by railway from mine to port. The East Turner River valley railway corridor in the Pilbara is the world's third-busiest. The last decade has seen a tripling of these exports, enabled by new and expanded railways. Over the same period, coal exports have risen by 45 per cent, again being enabled by new or expanded railway networks.
- **Technology**. Railway operations have embraced leading-edge technology, such as the world's heaviest wagon axle loads and development of remotely-controlled iron ore trains.
- **Regional passenger service**. Regional passenger services, specifically in Victoria, have been upgraded both in rollingstock and infrastructure within the last decade leading to a doubling of traffic.
- **Urban patronage.** The introduction of frequent urban railway services with high average speeds, good bus, cycling, and parking links to high amenity stations has generated very strong patronage growth in some Australian cities. Of the urban networks, Perth's patronage has grown at the fastest rate in the last decade.

The following chapters present an overview and data on railway transport tasks performed; characteristics of the railways and train operators' rolling stock that runs; and aspects of railway performance, including safety, environment and reliability.

2 As a statistical report, the industry analysis does not consider operational, technical or regulatory aspects. Discussion of these aspects can be found in BTRE (2006). Note also, information on railway infrastructure investment levels are provided in BITRE's 2014 issue of the *Australian Infrastructure Statistics Yearbook*.

CHAPTER 2
Rail traffic

This chapter presents and profiles the Australian railway industry's principal tasks. It considers the major freight commodities moved and markets served. It also considers the passenger task—urban, passenger movements, regional and long-distance patronage.

Overview

The railway industry performs vital freight and passenger transport tasks. Railways excel in transporting large volumes of both freight and passengers. In Australia, this primarily involves moving bulk commodities (for export) and urban passenger transportation.

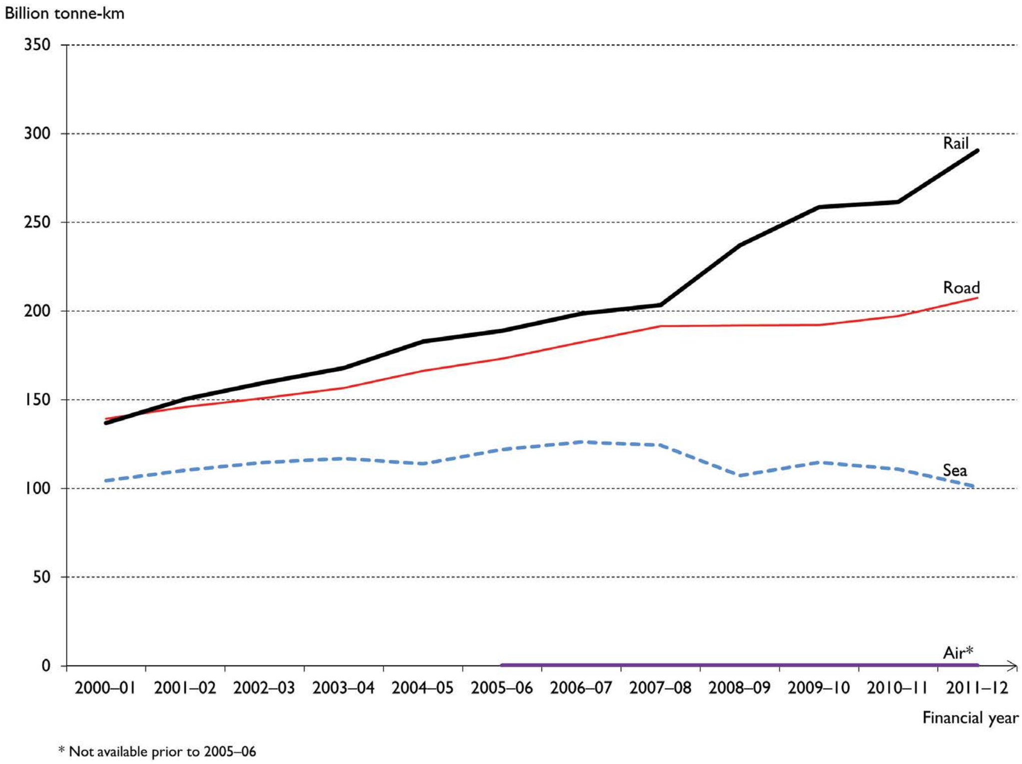
Weekday commuting to central city areas is the key passenger rail task. The surge in rail patronage in Perth since 2006 illustrates the growth in some commuter services (BITRE 2012, p. 55). Similarly, strategic investments in track and trains on some of regional Victoria's railway corridors have brought exceptionally strong patronage growth. (BITRE 2014, p. 68)

Rail transport's role in the Australian economy has increased sharply in recent years—see Figure 1. Rail now accounts for almost one-half of Australian freight transport activity, up from approximately 36 per cent at the turn of the century. Rail freight transport's strong position is primarily founded upon the transportation of iron ore and coal to ports for export. These two commodities account for over 80 per cent of Australia's rail freight tonne-kilometres (BITRE 2014a, p. 3).

Rail is also often central to moving other bulk commodities, such as grains, sugar, and mineral sands, especially to sea ports. Rail and road compete strongly for long-distance non-bulk freight, but as distances increase rail transport's competitiveness increases. Rail's mode share of non-bulk freight is highest between the eastern states and Perth (the East–West Corridor)[3].

3 BITRE 2009 *(Road and rail freight: competitors or complements?)* assesses the circumstances for rail and road competition, particularly in non-bulk freight. See, also, *Freightline 1* (BITRE 2014a, and other issues in the series) for contextual material on rail and road freight.

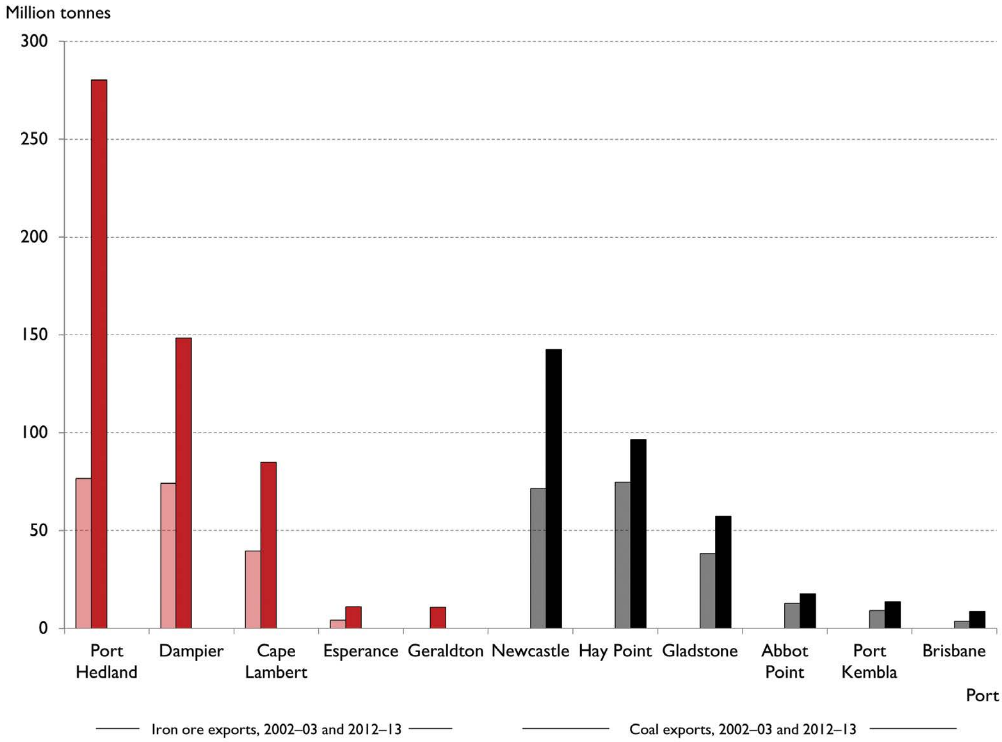
Figure 1 Estimated Australian freight volumes by transport mode



Source: Figure produced using data from BITRE 2014a, (Table 1, p. 2).

The recovery of rail's freight market share has risen sharply, particularly since the 2007–08 financial year. This rise has been driven by growth in commodity exports, with three times the volume of iron ore production in 2012 relative to 2002 and black coal production rising by 45 per cent in the decade to 2012–13 (as shown in Figure 2).

Figure 2 Exports of iron ore and coal from major Australian ports



Source: BITRE 2013, p. 14.

The growth in commodity exports has been achieved through the expansion of ports, terminals, processing, mines and railways. The railways enable Port Hedland to be the world's largest bulk export port. Newcastle is the world's largest coal export port. The East Turner River valley in the Pilbara has the third-busiest rail corridor in the world—it may become the busiest corridor in coming years[4]. The corridor also carries the world's heaviest rail wagon payloads.

Rail's non-bulk freight performance is often considered lacklustre, but there are strong performing areas. Rail accounts for the majority of inter-capital origin–destination non-bulk freight on the East–West corridor. Of the freight travelling between Brisbane and Melbourne, rail has approximately 30 per cent market share of inter-capital non-bulk freight (BITRE 2014a, p. 3). Rail also performs a key role in some regional freight flows, mainly between inland terminals and ports. Griffith (New South Wales) to Melbourne is one example.

4 BHP Billiton and Fortescue have tracks through the East Turner River valley; Roy Hill's railway is being built along that same corridor, opening in 2015. Fortescue operate wagons with 40-tonne axle loads, the heaviest in the world. The 653 km Datong–Qinhuangduo railway in China is the busiest freight railway in the world (440 million tonnes), followed by the Union Pacific–BNSF joint railways from the Powder River coal basin in the USA (400 million tonnes in 2011). Unless there is very strong traffic growth on those railways, the additional logistics capacity being built in the Pilbara will, with current infrastructure expansion projections, result in the East Turner having the busiest railway corridor in the world.

National rail freight task, tonnes

The estimated total national rail freight task is presented using data provided by above-rail train operators (Table 1). The freight task is measured in tonnes. The figures presented are conventional net tonnes, excluding tare (non-payload) weight of the vehicle.

The largest rail freight flows in Australia are bulk freight. The total rail freight task was approximately 1.29 billion net tonnes in 2013–14, of which approximately 1.27 billion tonnes (approximately 98 per cent) was bulk freight and 22 million tonnes was intermodal freight (See Box 1 for a definition of bulk freight and intermodal freight).

It is important to note tonnage data is not distance-weighted. The intermodal task would be a higher proportion of the total freight task if net tonne-kilometres were measured.[5] This is because the largest intermodal flows travel comparatively long distances; reflecting the market in which intermodal rail is most competitive against road transport.

Table 1 National rail freight task, thousand net tonnes

Year	Bulk	Intermodal	Total
2007–08	642 826	19 519	662 345
2008–09	705 039	17 481	722 520
2009–10	798 763	16 521	815 284
2010–11	-	-	-
2011–12	-	-	-
2012–13	1 012 997	27 559	1 040 556
2013–14	1 276 466	21 891	1 298 357

Notes: The table excludes traffic data for some of the smaller train operators, such as Watco, Southern Shorthaul Railroad and Sydney Rail Services. Data for 2012–13 excludes El Zorro (which ceased operating in June 2013).
Data for 2010–11 and 2011–12 are not available.

Sources: BITRE estimates; BITRE 2012a; for 2012–13 and 2013–14 data was provided by Asciano, Aurizon, Fortescue Metals Group, BHP Billiton, Rio Tinto, Freightliner, Genesee & Wyoming Australia, Qube, SCT Logistics, TasRail. Watco did not provide data for 2013–14, which affects the aggregated totals for Western Australia.

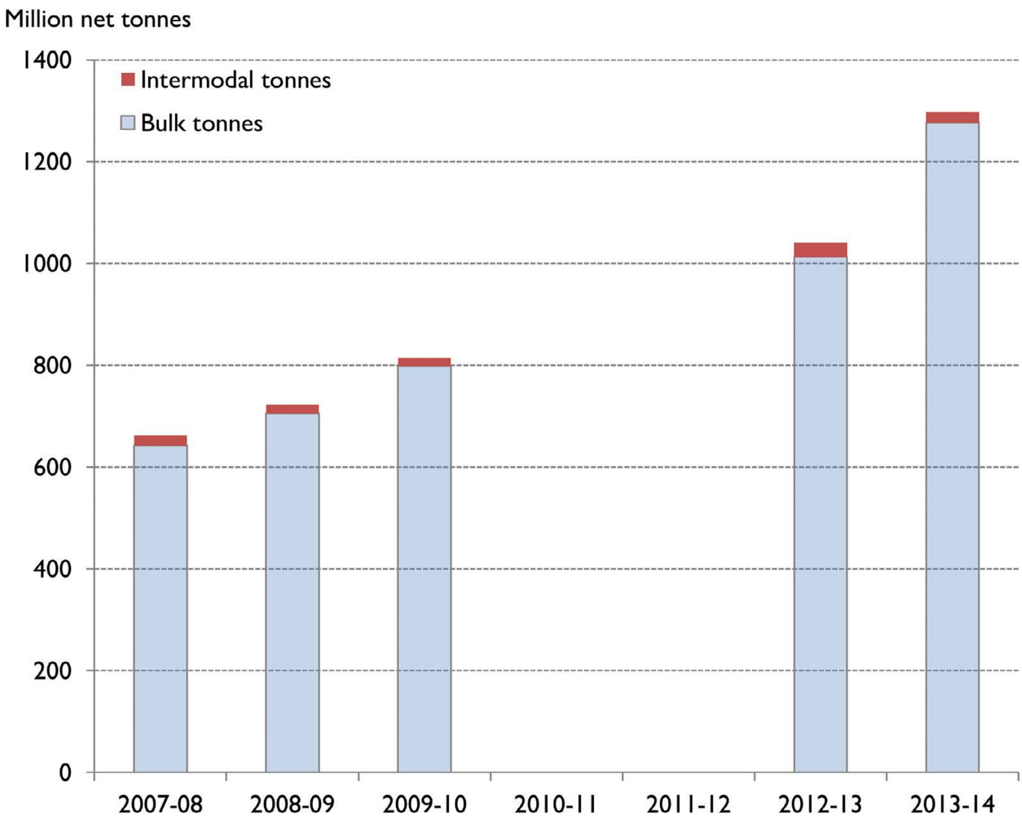
Bulk rail traffic is almost entirely intrastate, although there is some cross border rail traffic from southern New South Wales to Melbourne. The biggest bulk haulage task is in the Pilbara region of Western Australia. This represents approximately 70 per cent of Australia's total rail freight task. Other sizeable intrastate bulk flows are in Queensland (approximately 19 per cent of the total rail freight task) and New South Wales (approximately six per cent of the total rail freight task), where there are large coal movements. Despite the reported end of the mining boom, bulk freight tonnages increased by approximately 25 per cent from 2012–13 to 2013–14. A matrix of the bulk freight task by state of origin and destination is presented in Appendix E.

Combined bulk and intermodal rail freight transport has grown since 2007–08 (Figure 3). Most of this growth has been in bulk commodity transport, which itself has been driven by the mining resources sector.

5 In 2009–10, for example, the bulk task accounted for 98 per cent of net tonnes and 89 per cent of net tonne kilometres (BITRE 2012a, p.26).

Previous intermodal tonnages indicate it recovered from the Global Financial Crisis. The decline in intermodal traffic between 2007–08 and 2009–10 coincided with the economic slowdown (BITRE, 2012a, p. 15). By 2012–13 the intermodal task had increased by approximately 67 per cent since 2009–10. Tonnages reduced by approximately 21 percent in 2013–14 compared to the previous financial year but were still approximately 32.5 per cent higher than 2009–10.

Figure 3 National rail freight task, 2007–08 to 2013–14



Note: The chart excludes traffic data for some of the smaller train operators, such as Southern Shorthaul Railroad and Sydney Rail Services.

Data for 2010–11 and 2011–12 are not available.

Source: BITRE 2012a; for 2013–14 data was provided by Asciano, Aurizon, Fortescue Metals Group, BHP Billiton, Rio Tinto, Freightliner, Genesee & Wyoming Australia, Qube, SCT Logistics, TasRail; BITRE estimates.

Trainline uses specific definitions for bulk and non-bulk freight. In principle, 'bulk' freight generally involves large quantities of homogenous product that is conveyed in wagons; non-bulk freight is generally perceived as any containerised or unitised freight, generally placed or lifted into transport holds. However, in practice the 'non-bulk' freight may not be containerised; conversely bulk commodities are often conveyed in containers. In this report, 'bulk' is used to refer to anything not considered 'intermodal'—so 'bulk' includes steel, which may—in other contexts—be classified as non-bulk. 'Intermodal' is defined by the classification of train as used for infrastructure charging. Box 1 provides more insight into these definitions.

Box 1 Defining 'intermodal' and other trains

Trainline provides statistics for 'intermodal', 'steel' and 'bulk' freight movements. The definition used here for intermodal freight is 'market-based'. Defining the traffic in terms of the market served (such as relatively high priority goods for which road freight is a strong competing mode) is argued to be clearer than when defined in terms of the type of goods (notably, non-bulk) conveyed or the type of wagon used. In particular, where data for 'intermodal' trains is reported, such trains are defined as trains with axle loads up to and including 21 tonnes and a maximum speed of 115 kilometres per hour. In terms of ARTC infrastructure charges, this categorisation consists of the 'Express Freight' trains (with maximum train speed of 115 kilometres per hour and axle load up to 20 tonnes) and 'Superfreighter' trains (with maximum train speed of 110 kilometres per hour and axle load up to 21 tonnes).

These specifications reflect the competitive freight market for the conveyed traffic. Thus, the nature of the wagons themselves may not reflect the traditional perception of 'intermodal' as meaning 'more than one mode'; and may not reflect a situation where the goods can be readily transferred across modes.

As defined here, the 'intermodal' traffic can consist of wagons conveying containers on flat (or well) wagons as well as by louvre (or box) wagons. Further, the goods themselves may be bulk goods (such as grains or hay) as well as non-bulk (such as palletised tinned dog food). However, the type of train operated is unambiguous. The defining feature of an 'intermodal' train is the infrastructure charge rather than the way the goods are conveyed. 'Container' can be used to define the 'intermodal' activity but it does not convey the market within which rail is competing. For instance, containers can be used to classify goods movements but the goods within the container may include 'bulk' items such as steel, grain or minerals.

Steel movements occur on timetable-defined 'steel' trains, which ARTC defines as 'Regular Freight' trains. It is possible, however, for such trains to convey other, low-priority, goods.

Finally, bulk-freight activity is also reported. Measuring 'bulk' freight can be ambiguous because the goods traditionally classified as bulk may be conveyed on intermodal trains (in louvre wagons or containers) and, on the definition used here, will be classified as 'intermodal'. Bulk freight can also be conveyed by containerised trains; when compiling data presented in this report, train operators have classified containerised bulk goods trains (such as ores, grains, steel and mineral sands) as 'bulk'.

National freight task, by operator

Some publicly-available data can be used to determine national rail freight activity. Four major operators dominate the rail freight transport industry: Aurizon, Asciano, SCT Logistics and Qube Holdings. The two largest operators, Aurizon and Asciano, provide quarterly train-operator traffic data[6] to the Australian Stock Exchange (ASX). That material forms the basis of the data presented in Table 2, with more details provided in Appendix C.

Table 2 ASX train operator traffic trends (billion net tonne-kilometres)

Period	Asciano				Aurizon					Combined
	Coal	Other bulk	Intermodal (including steel)	Total	Coal	Iron ore	Bulk	Non-bulk—plus residual bulk from 2011–12	Total	Total
2007–08	12.7	2.8	25.9	41.4	42.8	-	13.6	4.8	61.2	102.6
2008–09	13.9	3.6	22.5	40.0	43.5	-	14.3	4.2	62.0	102.0
2009–10	18.1	3.4	22.2	43.7	45.3	-	15.2	3.7	64.2	107.9
2010–11	18.3	4.0	21.8	44.2	40.9	-	-	18.9	59.8	104.0
2011–12	20.0	5.6	23.0	48.6	41.9	6.7	-	14.3	62.9	111.5
2012–13	24.0	6.0	22.7	52.7	43.6	10.3	-	13.2	67.1	119.8
2013–14	29.2	5.1	21.5	55.8	49.2	12.2	-	12.5	73.9	129.7
2014–15	30.9	5.1	20.9	56.9	49.1	10.4	-	12.9	72.4	129.3

Note: Data sources and (where published) a breakdown of information into quarters and half-years are presented in Appendix C.

The tonne-kilometre data present one perspective of each operator's traffic task. The measure is preferable to tonnes hauled (which can be unrepresentative of the task when short haulage lengths are involved).

Coal continues to dominate for both operators, representing approximately 54 percent of Asciano's tonne-kilometres and almost 68 percent of Aurizon's tonne-kilometres. When comparing the coal operations, it should be noted that Asciano hauled 43 per cent of the 2014–15 (financial year) coal tonnage but just 38.6 per cent of the tonne-kilometres. Asciano dominates coal haulage in the Hunter Valley, where the haulage length to the port (and power stations) is less than the average lengths in the Queensland coal fields, where Aurizon dominates. Asciano's average coal haulage length in 2014–15 was approximately 190 km, compared with 232 km for Aurizon. In that context, Aurizon's average coal haul length in Queensland was 250 km but 168 km in New South Wales[7].

6 Aurizon's traffic data here refer to its own train haulages; the company also provides third-party access to its tracks (particularly Asciano trains), which the company reports through its Aurizon Network subsidiary.

7 Stock Exchange reports indicate the following data for 2014–15: Asciano's total coal ntk and tonnage were approximately 30.9 billion and 0.162 billion respectively, implying an average haul length of approximately 190 km (ntk is divided by tonnes). Equivalent figures for Aurizon's total coal ntk and tonnages were 49.2 billion and 0.211 billion, respectively, implying an average haul length of approximately 233.1 km. Asciano's average haul length is raised to some extent by the company's 250 km coal haulage between the Leigh Creek (Telford) coal field and Stirling North (Port Augusta), in South Australia, but this mine is due for closure by 2018.

Asciano's steel traffic is incorporated into its intermodal operations. Asciano hauls steel products across the interstate network, connecting the steel-making facilities in Port Kembla (Bluescope) and Whyalla (Arrium) to the mainland capital cities and the Long Island (Hastings) processing plant. That traffic was 2.8 million tonnes in 2014–15 (down from 2.9 million tonnes the previous financial year (Asciano 2015, p. 30). The tonne-kilometre figure is not provided.

Traffic volumes reflect rail's competitiveness with other transport modes (particularly for intermodal traffic) and in prevailing economic conditions. Variations in individual commodity flows arise from international demand for commodities as well as train operators winning or losing major contracts. In recent years, for example, the contract for grain haulage in Western Australia (for Co-operative Bulk Handling (CBH)) was transferred from Aurizon to Watco WA Rail (March 2012) while, in August 2012, Aurizon began hauling iron ore for Karara Mining on a 277 km route between Karara and Geraldton. Conversely, Alinta Energy has announced it will close its Leigh Creek coal mine by March 2018, for which Asciano has a current contract to haul coal by rail from the mine to Port Augusta (Australian Broadcasting Corporation, 2015).

Box 2 Further freight rail operator traffic data resources

While there are many sources for rail freight traffic data, none covers the entire network. Data sources are train operator data, and track/infrastructure manager data.

The principal published train operator data are those presented above (Table 2) for Asciano and Aurizon. Those sources also provide financial information, including revenue by commodities hauled.

There is limited information on the other freight train operators (Qube Holdings, SCT Logistics [and subsidiary, Specialised Bulk Rail], Queensland Rail, Freightliner Australia, Southern Shorthaul Railroad, Crawfords Freightlines, Glencore Rail, Genesee & Wyoming Australia, Watco and the Pilbara railways [BHP Billiton, Rio Tinto including its Weipa operations, Fortescue[8]]). TasRail provides information on tonnages of some commodities that it transports, such as logs, minerals, newsprint and cement. (TasRail 2013, pp. 9, 37–38)

Genesee & Wyoming must file reports with the USA's Securities and Exchange Commission (SEC; see the references for the web link). The filings provide information on revenue and costs for the Australian subsidiary; and insights into traffic trends.

Some one-off studies provide traffic flows data. For example, a Port of Brisbane study (Port of Brisbane, with the Queensland Transport and Logistics Council 2013, pp. 31–33) cites intrastate and interstate domestic container rail movements, by direction, whether containers are full or empty, and the origin and destination terminals of the containers.

8 Fortescue (2014, p. 11) illustrates the mining traffic data that can be inferred as being essentially railed ore. The "ore shipped—Fortescue mined ore" tonnage will correspond to ore that has been mined at Fortescue mines;the third-party ore is ore that is shipped via Fortescue's berths at Port Hedland but will have been brought to the port by road.

Box 2 Further freight rail operator traffic data resources *(continued)*

Figure 49 illustrates the primary railway infrastructure managers. Below-rail data sources from these managers include:

- Aurizon Network's aggregated traffic data and train numbers for each of its five Queensland coal systems, together with other freight and passenger services operating over its network (Aurizon Network n.d.; Aurizon Network 2015);
- ARTC's aggregated Hunter Valley network quarterly coal tonnage throughput (ARTC n.d.);
- ARTC's aggregated annual network tonnages are reported in its annual reports; and
- disaggregated tonnage data for each of Brookfield's lines (Brookfield Rail n.d. and Brookfield Rail n.d.(a); Brookfield Rail 2014 for selected 2013 grain line tonnages).
- The Australasia Railway Corporation presents high-level annual traffic data for the Darwin line in their annual reports (Australasia Railway Corporation, n.d.)

Traffic data and projections can also be provided to the infrastructure managers' economic regulators, which may then publish that material[9].

While explicit traffic data are not generally available for Pilbara railways or for east coast coal ports, the export iron ore and coal from those ports is generally moved to the ports by rail. Discussion and data sources for each of those ports can be found in *Australia's Bulk Ports* (BITRE 2013). BITRE's *Freightline* series (being published a series of reports) also presents freight flows by commodity. (BITRE 2014(a) and BITRE 2014(b))

An informal source of east-west rail activity at Gheringhap in Victoria can Graham Elliott's web site: http://ghaploop.railpage.org.au/ and the BITRE report on that data source. (BTRE 2007)

Interstate network traffic

Interstate traffic flows network are reported by line segment. Intermodal and total gross tonnes by line segment are shown in Table 3 and Table 4, with line segments ordered from north to south and east to west. The data is also shown in Figure 4, Figure 5, Figure 6 and Figure 7. There are two factors to note when reviewing the tonnages:

- Where tonnage does not move along the entire length of a segment, it has been weighted by the proportion of the line segment travelled.
- Coal traffic is excluded. This is because that traffic is not in a form that is amenable to comparison with other commodities. In particular, while coal generally does not move on the interstate network, large coal volumes briefly traverse the network near Newcastle and in the New South Wales Southern Highlands. In those locations, coal tonnages are an order of magnitude higher than all other commodities carried.

9 Aurizon's economic regulator is the Queensland Competition Authority (http://www.qca.org.au/Rail); ARTC's is the ACCC (https://www.accc.gov.au/regulated-infrastructure/rail); Brookfield Rail's is the Economic Regulation Authority [WA] (http://www.erawa.com.au/rail/rail-access).

Interstate intermodal traffic

Table 3 and Table 4 present intermodal and total tonnage levels on line segments of the interstate network.

Table 3 Gross tonnes by line segment, North–South corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2011–12	2012–13	2013–14	2011–12	2012–13	2013–14
Acacia Ridge to Casino	2.00	1.91	1.84	2.60	2.47	2.38
Casino to Acacia Ridge	2.30	2.25	2.24	3.71	3.57	3.47
Acacia Ridge – Casino	4.31	4.15	4.08	6.31	6.04	5.84
Casino to Maitland	2.00	1.91	1.83	3.22	2.91	2.80
Maitland to Casino	2.30	2.25	2.24	4.36	4.22	4.16
Casino–Maitland	4.30	4.16	4.08	7.58	7.13	6.95
Macarthur to Tahmoor	2.89	2.73	2.66	6.57	7.01	7.50
Tahmoor to Macarthur	3.28	3.26	3.21	8.06	7.99	8.63
Macarthur–Tahmoor	6.17	5.99	5.87	14.63	15.00	16.12
Tahmoor to Moss Vale	2.89	2.74	2.67	6.17	6.59	7.10
Moss Vale to Tahmoor	3.28	3.26	3.21	7.99	7.83	8.41
Tahmoor – Moss Vale	6.17	6.00	5.88	14.16	14.42	15.52
Moss Vale to Marulan	2.98	2.84	2.74	9.17	9.34	9.29
Marulan to Moss vale	3.40	3.37	3.31	15.77	14.76	13.87
Moss Vale – Marulan	6.38	6.20	6.05	24.93	24.09	23.16
Marulan to Goulburn	2.98	2.84	2.74	8.44	8.64	8.47
Goulburn to Marulan	3.40	3.37	3.31	13.48	12.62	11.38
Marulan–Goulburn	6.38	6.20	6.05	21.92	21.26	19.85
Goulburn to Cootamundra	2.98	2.84	2.74	6.71	6.95	6.55
Cootamundra to Goulburn	3.40	3.37	3.31	11.28	10.55	9.14
Goulburn–Cootamundra	6.38	6.20	6.05	17.99	17.50	15.68
Cootamundra to Junee	2.30	2.15	2.07	6.76	6.40	5.13
Junee to Cootamundra	2.49	2.39	2.38	7.98	8.23	6.64
Cootamundra–Junee	4.79	4.55	4.45	14.74	14.64	11.77
Junee to Albury	2.30	2.16	2.07	5.22	5.95	5.99
Albury to Junee	2.49	2.39	2.37	4.75	4.92	5.01
Junee–Albury	4.79	4.55	4.44	9.97	10.87	11.00
Albury to Tottenham	2.28	2.15	2.05	5.51	6.08	6.50
Tottenham to Albury	2.46	2.36	2.33	4.62	4.74	4.94
Albury–Tottenham	4.75	4.51	4.37	10.14	10.82	11.45

Source: Data provided by ARTC.

Table 4 Gross tonnes by line segment, East–West corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2011–12	2012–13	2013–14	2011–12	2012–13	2013–14
Cootamundra to Parkes	0.71	0.72	0.69	2.42	2.35	2.17
Parkes to Cootamundra	0.93	1.01	0.95	4.42	3.88	3.21
Cootamundra–Parkes	1.64	1.72	1.64	6.83	6.23	5.38
Parkes to Broken Hill	1.63	1.71	1.65	2.75	2.79	2.67
Broken Hill to Parkes	1.20	1.29	1.21	3.40	3.45	3.05
Parkes – Broken Hill	2.83	3.00	2.86	6.16	6.24	5.72
Broken Hill to Crystal Brook	1.62	1.71	1.65	4.53	4.37	4.53
Crystal Brook to Broken Hill	1.19	1.29	1.21	2.81	2.88	2.93
Broken Hill – Crystal Brook	2.82	3.01	2.86	7.34	7.24	7.46
Tottenham to Dimboola	4.28	4.13	4.08	7.21	7.72	7.76
Dimboola to Tottenham	3.66	3.44	3.40	8.53	9.46	9.42
Tottenham–Dimboola	7.94	7.57	7.47	15.74	17.17	17.18
Dimboola to Tailem Bend	4.29	4.15	4.09	6.49	5.90	5.72
Tailem Bend to Dimboola	3.68	3.46	3.41	4.99	4.57	4.41
Dimboola – Tailem Bend	7.97	7.61	7.51	11.48	10.46	10.13
Tailem Bend to Dry Creek	4.33	4.18	4.13	6.59	5.98	5.77
Dry Creek to Tailem Bend	3.71	3.48	3.44	5.03	4.61	4.44
Tailem Bend – Dry Creek	8.04	7.67	7.57	11.63	10.59	10.21
Dry Creek to Crystal Brook	5.01	5.10	5.13	7.71	7.85	8.19
Crystal Brook to Dry Creek	3.81	3.89	3.86	10.44	10.66	11.48
Dry Creek – Crystal Brook	8.82	8.99	8.99	18.16	18.51	19.68
Crystal Brook to Port Augusta	6.62	6.82	6.75	9.98	9.80	9.70
Port Augusta to Crystal Brook	5.00	5.18	5.01	10.92	10.81	10.37
Crystal Brook – Port Augusta	11.62	12.00	11.76	20.90	20.61	20.07
Port Augusta to Tarcoola	6.69	6.85	6.78	8.36	9.00	9.64
Tarcoola to Port Augusta	5.02	5.15	5.05	8.03	10.14	12.97
Port Augusta – Tarcoola	11.71	12.01	11.82	16.39	19.14	22.61
Tarcoola to Kalgoorlie	5.63	5.73	5.56	6.70	6.70	6.47
Kalgoorlie to Tarcoola	4.33	4.40	4.26	5.18	5.22	4.94
Tarcoola – Kalgoorlie	9.96	10.13	9.82	11.88	11.92	11.40
West Kalgoorlie to Koolyanobbing East	5.34	5.43	5.10	9.90	11.12	13.73
Koolyanobbing East to West Kalgoorlie	3.99	4.03	3.74	17.86	20.68	21.71
West Kalgoorlie – Koolyanobbing East	9.32	9.46	8.84	27.76	31.80	35.44
Koolyanobbing East to West Merredin	5.34	5.43	5.10	7.76	8.50	11.46
West Merredin to Koolyanobbing East	3.99	4.03	3.74	6.57	6.88	7.53
Koolyanobbing East – West Merredin	9.32	9.46	8.84	14.33	15.38	18.99
West Merredin to Avon	5.34	5.43	5.10	8.65	9.73	13.46
Avon to West Merredin	3.99	4.03	3.74	6.73	7.79	7.79
West Merredin – Avon	9.32	9.46	8.84	15.38	11.60	21.24

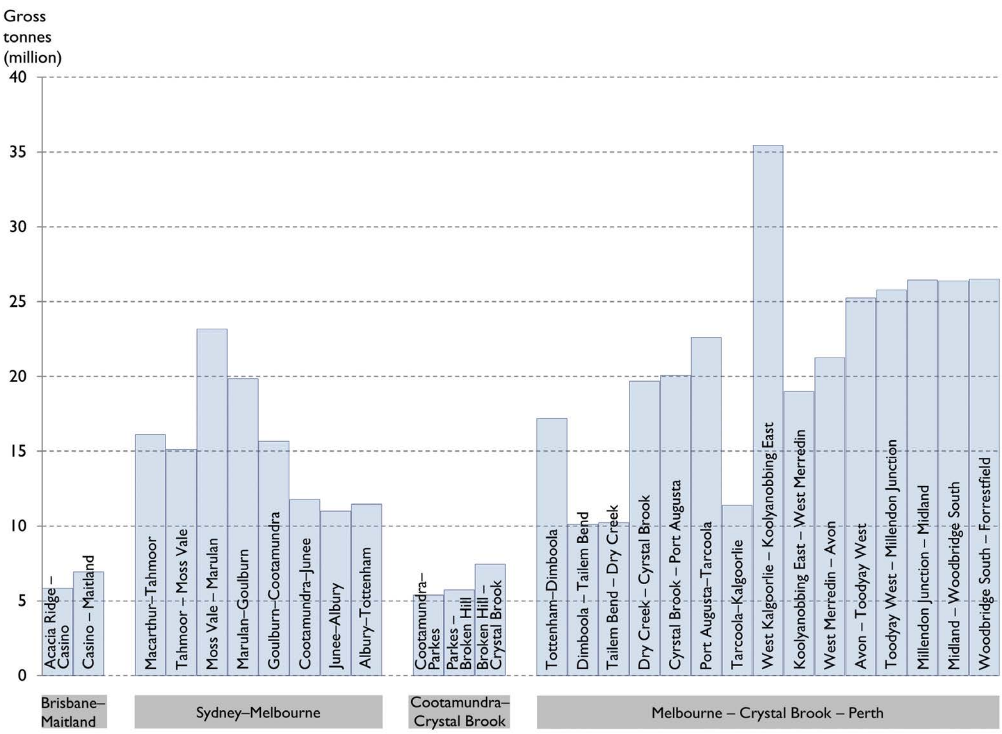
(continued)

Table 4 Gross tonnes by line segment, East–West corridor *(continued)*

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2011–12	2012–13	2013–14	2011–12	2012–13	2013–14
Avon to Toodyay West	5.34	5.43	5.10	13.07	14.49	16.70
Toodyay West to Avon	3.99	4.03	3.74	8.03	8.42	8.54
Avon – Toodyay West	9.32	9.46	8.84	21.10	22.91	25.25
Toodyay West to Millendon Junction	5.34	5.43	5.10	13.30	14.94	17.15
Millendon Junction to Toodyay West	3.99	4.03	3.74	8.09	8.56	8.63
Toodyay West – Milledon Junction	9.32	9.46	8.84	21.39	23.51	25.78
Milledon Junction to Midland	5.34	5.43	5.10	13.60	15.38	17.68
Midland to Millendon Junction	3.99	4.03	3.74	8.17	8.69	8.77
Millendon Junction – Midland	9.32	9.46	8.84	21.78	24.07	26.45
Midland to Woodbridge South	5.34	5.44	5.11	13.53	15.31	17.67
Woodbridge South to Midland	3.99	4.04	3.74	8.10	8.61	8.72
Midland – Woodbridge South	9.33	9.48	8.85	21.62	23.92	26.38
Woodbridge South to Forrestfield	5.34	5.44	5.11	13.60	15.38	17.74
Forrestfield to Woodbridge South	4.01	4.05	3.74	8.19	8.68	8.79
Woodbridge South – Forrestfield	9.35	9.48	8.85	21.79	24.06	26.52

Source: Data provided by ARTC and Brookfield Rail.

Figure 4 Gross tonnes on the interstate network, by line segment, 2013–14



Source: Data provided by ARTC and Brookfield Rail.

The variations in relatively consistent intermodal flows across the network are explained by specific flows:

- Intermodal traffic on North–South segments between Sydney (Macarthur) and Cootamundra include diverging/converging traffic at Cootamundra, from the East–West Corridor (via Broken Hill).
- Regional intermodal traffic (exports heading for the Port of Melbourne) joins the network at Junee from terminals in the Riverina (Griffith), as well as traffic from Junee to Sydney.
- Some intermodal rail traffic originates/terminates in terminals in Parkes/Goobang, for the East–West Corridor (via Broken Hill).
- Intermodal traffic flows between Melbourne and western Victoria (originally at Horsham but subsequently Dooen).
- Higher intermodal traffic volumes to the west of Crystal Brook, where the separate Melbourne/Adelaide and Sydney/Parkes flows merge. Intermodal flows fall to the west of Tarcoola; the junction with the Darwin line.

Further discussion on some of these intermodal flows can be found in the section on maritime container flows, from page 22.

On the North–South corridor, intermodal traffic by tonnage has declined on every segment over the three financial year periods, while East–West intermodal tonnages have fluctuated across the segments. Some have experienced growth; some have declined, while some have remained relatively steady. According to ARTC, intermodal market conditions have been soft on all corridors due to the slowing economy, the continuing decline in Australian manufacturing, and a trend toward importing direct into major ports rather than distribution from a single national distribution centre. The decline in Melbourne–Adelaide land-bridging transport (see page 62) as reported in *Trainline 2* has continued.

"Other" traffic on the interstate network

There are significant non-intermodal freight flows—classified as "other" in Figure 5, Figure 6 and Figure 7. An important part of this category is interstate steel traffic. Steel is moved along the length of the East–West corridor between New South Wales (Newcastle and Port Kembla) and South Australia and Western Australia (Port Augusta, Whyalla and Perth). There are also steel movements on the North–South corridor, primarily between Port Kembla and the interstate capitals.

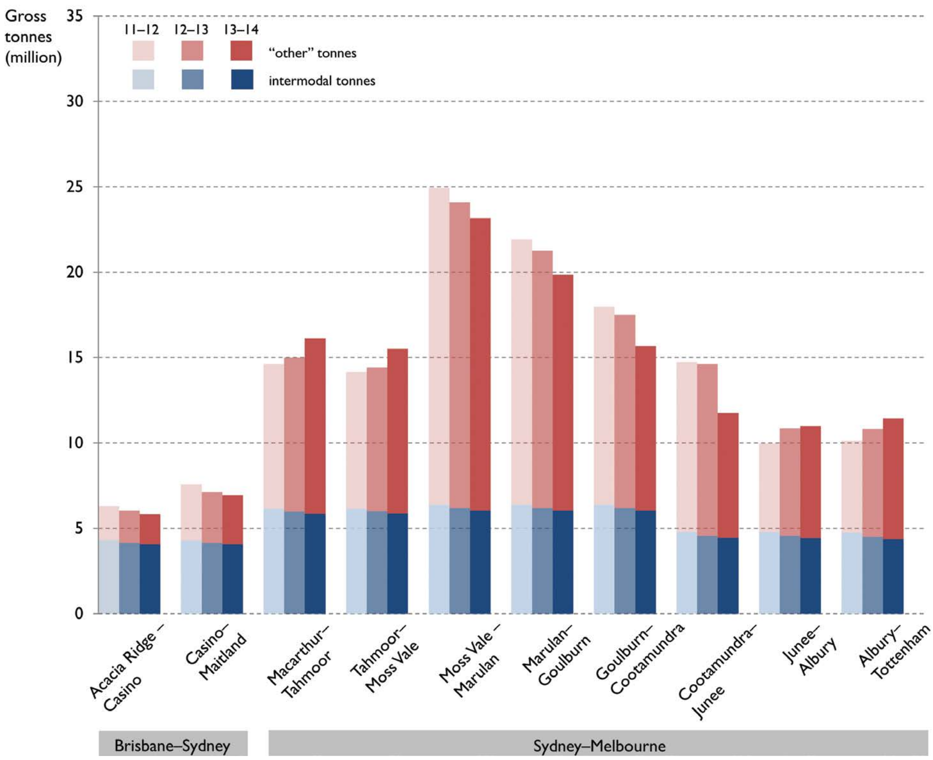
Other significant non-intermodal freight flows are as follows:

- **Grain movements**[10] generally join the network from a web of branch and secondary lines, connecting agricultural hinterlands to the port. Movements on the interstate network are heaviest close to Perth and in New South Wales.
- **Aggregate, sand and limestone** quarries in the southern New South Wales Tablelands are an important contributor to tonnages between Macarthur and Goulburn. The exhaustion of quarries in Western Sydney has resulted in expansion of mining activity in the Southern Tablelands.

10 Grain can also be transported in containers. When this is the case, grain is classified as intermodal. See further discussion of grain-in-boxes on page 44.

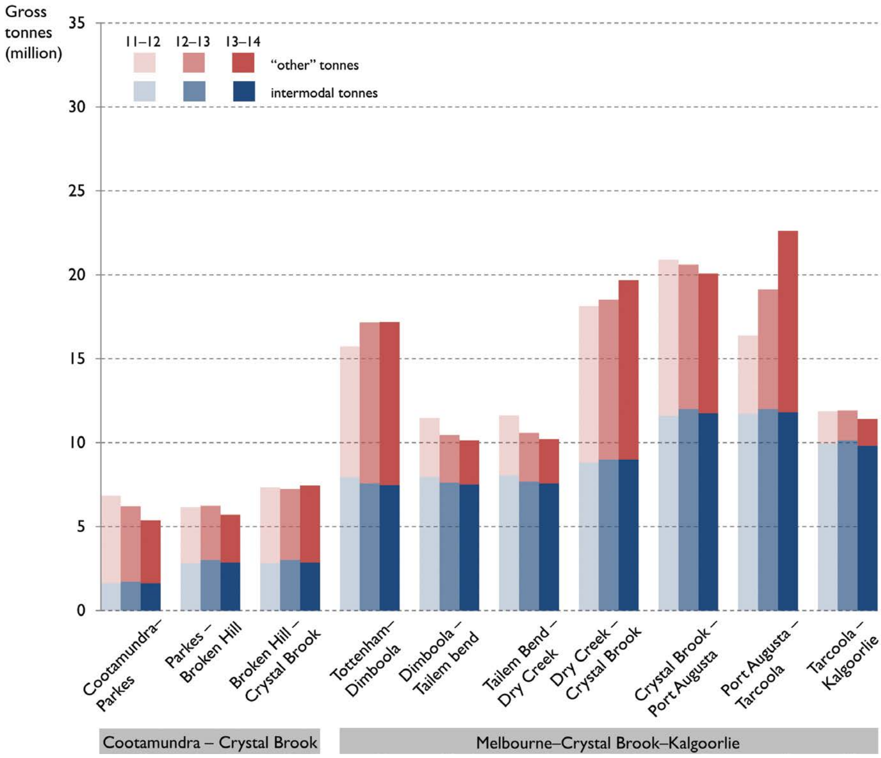
- **Iron Ore** from the Yilgarn Region in Western Australia contributes a major proportion of tonnages hauled from the West Kalgoorlie – Koolyanobbing East line segment. Iron ore is railed in two directions. It moves eastward from Koolyanobbing, via Kalgoorlie, to Esperance Port. This flow rose from 1.5 million tonnes per annum in 1995 to over 11 million tonnes in 2012–13 (Esperance Ports, 2014). Iron ore is also railed westward from Mount Walton siding (serving Carina Mine) to Kwinana. The rate of iron ore production at Carina Mine reached an annual rate of five million tonnes per annum in 2014 (Polaris Metals, 2014). "Other" freight (such as fuel and chemicals to support mining activities) between Forrestfield (Perth) and West Kalgoorlie has risen significantly from 2011–12 to 2013–14.
- **"Other" Port Augusta – Tarcoola** traffic flows also rose sharply over the three financial year periods. According to the ARTC this increase was due to Arrium iron ore traffic that entered the ARTC network at Tarcoola and proceeded to Whyalla. This traffic, however, has since ceased.

Figure 5 Gross tonnage on the North–South corridor, by line segment, 2011–12 to 2013–14



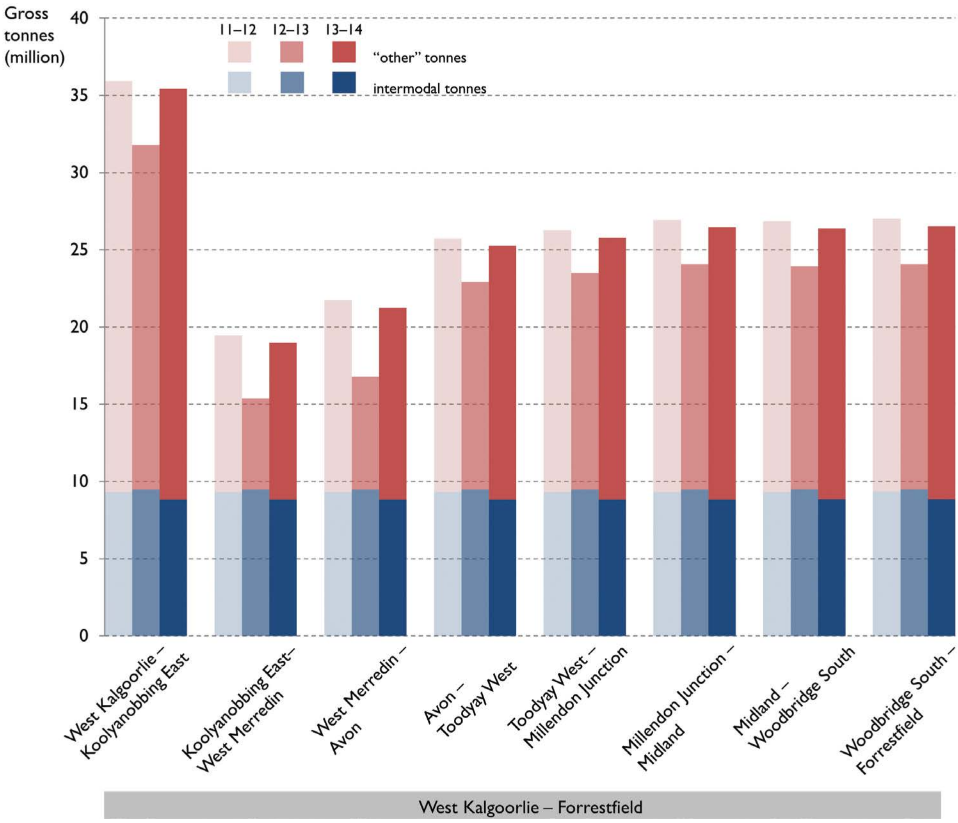
Source: Data provided by ARTC.

Figure 6 Gross tonnage on the East–West corridor, by line segment, 2011–12 to 2013–14



Source: Data provided by ARTC.

Figure 7 Gross tonnage on the East–West corridor, by line segment, 2011–12 to 2013–14

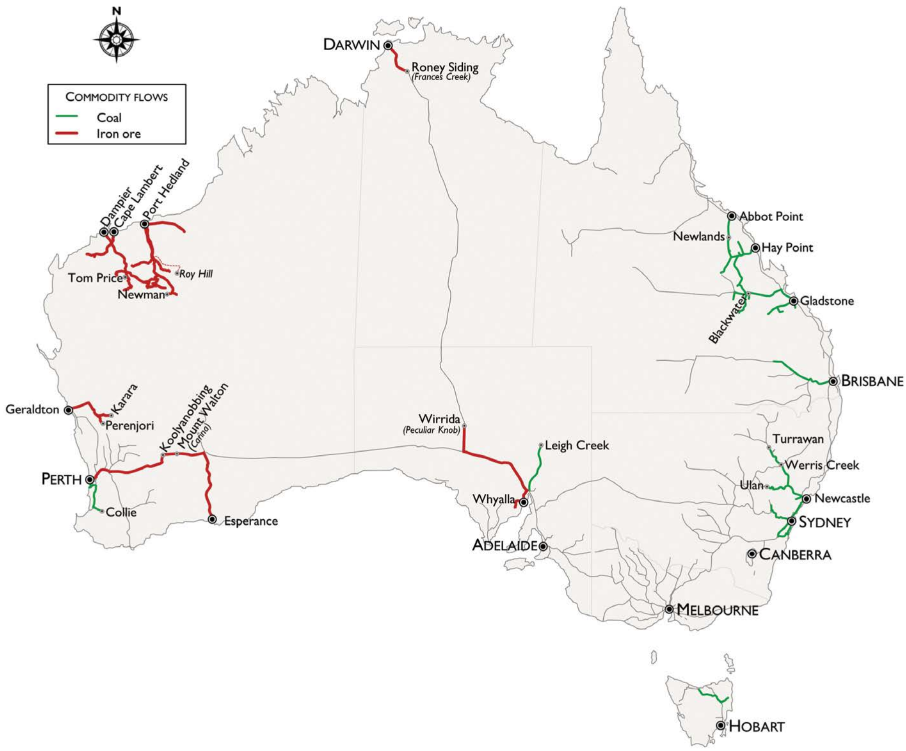


Source: Data provided by Brookfield Rail.

Rail freight traffic, by commodity

This section analyses rail freight traffic by commodity or market. Iron ore, coal, grain and non-bulk freight traffic are analysed. Iron ore and coal are the rail industry's two largest bulk freight flows.

Figure 8 Principal iron ore and coal flows, 2015



Iron ore traffic

The majority of Australia's iron ore is exported[11] almost all of which is transported to port by rail[12]. The largest flows are in the Pilbara region of Western Australia, which accounts for over 94 per cent of Australia's iron ore exports (BITRE, 2014b). The integrated railways of the Pilbara region, by infrastructure owner (Figure 9), are:

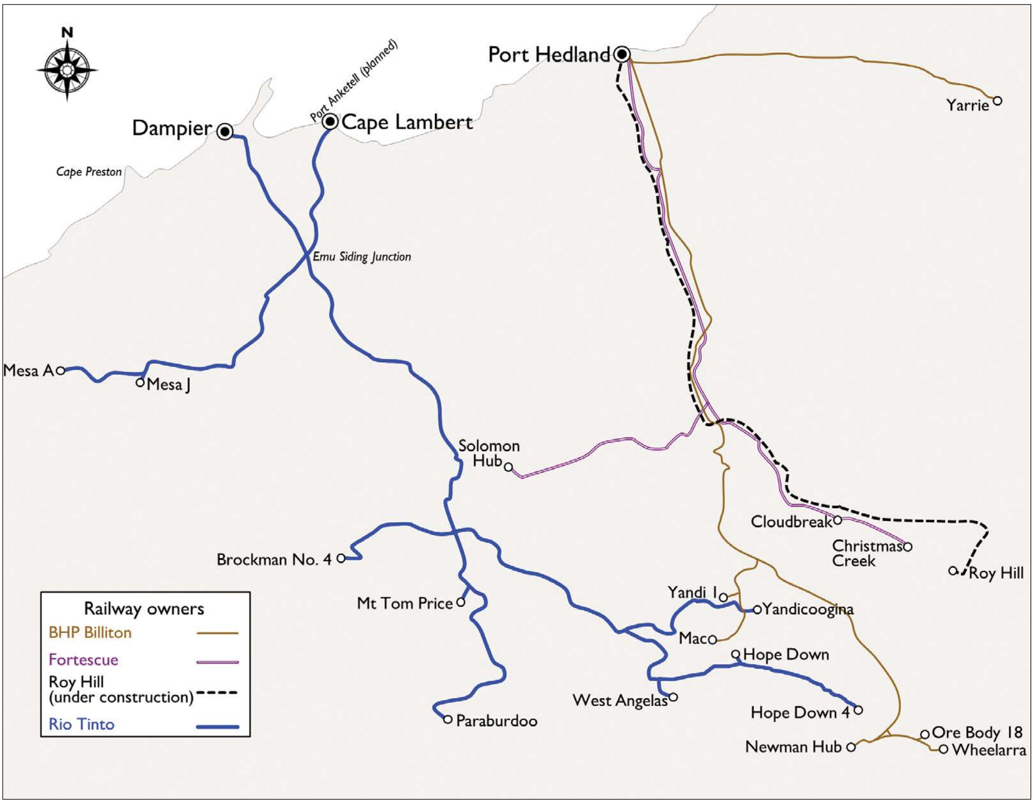
- **Rio Tinto:** the Robe River to Cape Lambert and the former Hamersley Iron's network to Port Dampier. As of 2012, trains on the Hamersley railway were approximately 2.4 kilometres long and had a capacity of 26 000 tonnes (BITRE 2013, p. 31).

11 There are two domestic manufacturers of steel, Arrium and BlueScope Steel, with a blast furnace in Whyalla and Port Kembla, respectively. Between them they used approximately 6.5 million tonnes of iron ore in 2011–12. Arrium sources its iron ore mostly from the Middleback Ranges in South Australia. BlueScope Steel use iron ore from Mount Newman (Western Australia) and Savage River (Tasmania) See BITRE 2014b.

12 Rail has an estimated 86 per cent of the domestic iron ore freight task, with road having an estimated 2 per cent. Where iron ore is used in domestic manufacturing, coastal shipping is used to shift iron ore between ports (representing an estimated 12 per cent of the domestic iron ore freight task). See BITRE 2014b.

- **BHP Billiton:** the Goldsworthy line (to Yarrie) and the Newman line run to Port Hedland. Each train on the Newman line can carry approximately 37 000 tonnes (BITRE 2013, p. 27). The Goldsworthy (to Yarrie) line ceased operations 2014 but remains mothballed.
- **Fortescue Metals Group:** the Fortescue Hamersley line from Solomon Hub and the Christmas Creek line run to Port Hedland. Trains on these lines can haul approximately 33 000 tonnes each (BITRE 2013, p. 27).
- **Roy Hill Holdings:** the recently constructed 344 route kilometre railway from Roy Hill to Port Hedland was opened for testing in August 2015 and is due to open in October 2015[13].

Figure 9 Pilbara iron ore railways, by infrastructure owner, 2015



The scale of the task means rail is the most efficient means for transporting iron ore from mine to port. Tonnages exported, by principal port, provide an indicator of tonnages hauled by the iron ore railways. See Table 5, and Figure 2 (p. 5).

13 The Roy Hill Iron Ore Project is being developed by Roy Hill Holdings Pty Ltd, with Hancock Prospecting Pty Ltd holding a 70 per cent share and with the remaining 30 per cent equity being held by a consortia of Marunbeni Corporation, POSCO, and China Steel Corporation.

Table 5 Iron ore exports, million tonnes, 2012–13

Port Hedland	Dampier	Cape Lambert (Port Walcott)	Esperance	Geraldton	Fremantle (Perth)	Port Adelaide	Darwin
280.2	148.4	84.8	11.0	10.7	3.5	1.8	1.7

Note: Cape Lambert iron ore facilities lie within the administartive area of Port Walcott. The data for Port Walcott includes a small amount of mixed goods.

Sources: Ports Australia 2014 and BITRE 2014c.

Coal traffic

The scale of coal logistics makes rail its best transport option. Most of Australia's coal is extracted in Queensland and New South Wales. Queensland coal is predominantly metallurgical (used in steel-making) while the New South Wales coal is predominantly thermal (typically used in electricity generation)[14].

Australia's principal rail coal haulage is from these two states—see Figure 8. The Central Queensland Coal Network, using narrow gauge track, is managed by Aurizon and is divided into five coal systems. The ARTC largely manages the New South Wales standard-gauge Hunter Valley system. The systems are:

- **Newlands (Queensland).** This system runs through the northern end of the Bowen Basin, to the port at Abbot Point. The line services mines at Collinsville, Sonoma, Newlands, Lake Vermont and Clermont. It was recently linked to the Goonyella Rail Corridor (Aurizon 2015).
- **Goonyella (Queensland).** Goonyella is an electrified system that also services the Bowen Basin coal region. It primarily serves the terminals at Hay Point and Dalrymple Bay. (Aurizon 2015a,). The maximum train load is 10 000 tonnes, with a 2 100 metre maximum train length (BITRE 2013, p. 53).
- **Blackwater (Queensland).** This system services the Bowen Basin coal region. It delivers coal to the export terminals at the Port of Gladstone. It also services domestic users such as the Stanwell and Gladstone power stations, Cement Australia and Comalco refinery (Aurizon 2015b). The system consists of mostly electrified duplicated lines that extend west from Rockhampton.
- **Goonyella to Abbot Point (GAP (Queensland).** This system corresponds to the 68 km railway, opened in 2011, that links the Newlands and Goonyella systems, enabling coal to be delivered to either Hay Point or (linked to capacity expansion [GAPE] through to and at) the port of Abbot Point. (Aurizon 2015c)
- **Moura (Queensland).** This system is approximately 242 route kilometres and services the Boundary Hill, Dawson, Callide, and Baralaba mines. It is single track with passing loops and is linked to the Gladstone power stations, Comalco refinery, Queensland Alumina Limited, Cement Australia and the R G Tanna and Barney Point coal terminals at the Port of Gladstone (Aurizon 2015d). The average train payload servicing the two coal terminals at the Port of Gladstone, is approximately 4 200 tonnes (BITRE 2013, p. 63).

14 Further overview of coal attributes is provided in BITRE 2013 (p. 9), while an issue of the BITRE *Freightline* series (forthcoming) will focus on coal movements.

- **Hunter Valley (New South Wales).** Coal is transported to three coal-loading terminals in Newcastle. The previous average for coal trains was between 6 000 and 7 000 tonnes each (BITRE 2013, p. 42). According to the ARTC, however, the current average is approximately 8 000 tonnes, as part of the Hunter Valley Strategy.

Table 6 Annual coal traffic, Queensland and New South Wales 2014–15

	Queensland					NSW
	Blackwater	Goonyella	Moura	Newlands	GAP	Hunter Valley
Net tonnes (m)	63.32	120	12.32	14.66	15.29	158.5
Net tonne-kilometres (b)	22.32	24.93	2	1.94	5.16	n/a

Note: Hunter Valley tonnages are also available through the web site of the Hunter Valley Coal Chain Coordinator (https://www.hvccc.com.au/DailyPlanning/Pages/SummaryPerformanceReports.aspx)

Sources: Aurizon 2015e p.9, ARTC n.d. (a) (multiple issues), data provided by Aurizon.

In addition to the main coal systems, other significant railway coal tonnages include haulages from:

- the West Moreton coal fields in southern Queensland (with approximately 8.1 million tonnes hauled by Aurizon in 2013–14 (Aurizon 2014, p. 45)), using Queensland Rail infrastructure;
- the Southern mine region at Wongawilli Colliery, New South Wales;
- the Metropolitan Colliery, near Helensburgh, New South Wales;
- the Tahmoor colliery, near Picton, New South Wales;
- the Western coal region, near Lithgow, New South Wales;
- Fingal, in Tasmania, using TasRail infrastructure; and
- Leigh Creek in South Australia (with approximately 2.5 million tonnes hauled per annum).

Aurizon and Asciano dominate coal haulage, with involvement also by Freightliner Australia and Southern Shorthaul Railroad[15]. Aurizon is the main coal train operator in Queensland, with an estimated 79 per cent market share. It has also expanded its coal operations to New South Wales, where it now has approximately 30 per cent market share in the Hunter Valley[16] (Adamson 2014).

Asciano estimates that it undertakes around 72 per cent of the South Eastern Australia coal haulage (Asciano 2014, p. 27). In recent years, it has won contracts to haul coal in Queensland and the company estimates that it has 30 per cent of the coal haulage market [measured by net-tonne-kilometres] in the state (Asciano 2014, p. 27). Asciano has further reported its total annualised contracted coal tonnage for the 2015–16 in Queensland and New South Wales is 180 mega tonnes (Asciano 2015, p. 24). Asciano also hauls coal in South Australia, from Leigh Creek to power stations at Port Augusta, but this is expected to cease in 2018, when the Leigh Creek mine is due to close. Table 7 shows the tonnes and net-tonne kilometres hauled by the two main operators in 2013–14 and 2014–15.

15 Freightliner Australia operate coal trains in the Hunter Valley on behalf of Glencore; Southern Shorthaul Railroad operate coal trains in New South Wales on behalf of Centennial Coal.

16 Aurizon provides fact sheets of each coal system it operates in—see http://www.aurizon.com.au/ourservices/coal—and it cites an "almost 30 per cent" Hunter Valley market share for 2012–13. With Aurizon estimating a 56 per cent Hunter Valley share, this implies that the other operators had a 14 per cent share.

Table 7 Coal haulage by principal train operators

	Aurizon		Asciano	
	2013–14	2014–15	2013–14	2014–15
Tonnes (million)	210.4	211.2	159.0	162.8
Net tonne kilometres (billion)	49.2	49.1	29.2	30.9

Sources: Asciano 2015, p. 30, Aurizon 2015(e), p. 3.

Approximately 90 per cent of coal extracted in Queensland and 73 per cent in New South Wales is exported. Coal extracted in South Australia and Tasmania is used domestically. Table 8 shows coal tonnages exported at principal ports.

Table 8 Coal exports, by principal ports, (million tonnes), 2012–13

Newcastle	Hay Point	Gladstone	Abbot Point	Port Kembla	Brisbane
142.6	96.5	57.3	17.7	13.5	8.6

Source: Ports Australia, 2013. Ports Australia has not updated the data.

Box 3 Further resources

BITRE (2013, *Australia's bulk ports)* includes a profile of the major coal ports as well as the landside logistics and production processes between the mine and the port facilities. Each port profile provides relevant material for additional landside traffic data and rail/terminal handling performances.

A forthcoming issue of the BITRE *Freightline* series will review the coal transport task.

Grain traffic

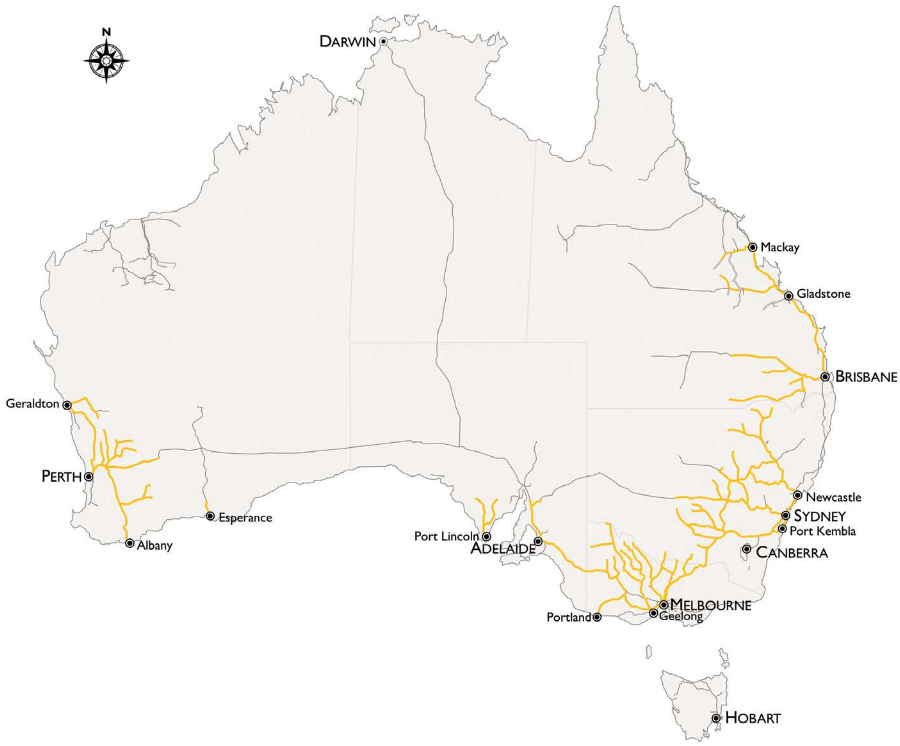
An important role for Australia's railways is hauling agricultural produce from rural areas to ports for export and, to a lesser extent, for domestic processing and consumption. Grain harvests are cereal grains, however the broader logistics task includes pulses, chickpeas and oilseed. Illustrative volumes involved are 20 million tonnes of wheat (of which around 15 million are exported); 7.5 million tonnes of barley (with almost 5 million exported); 2 million tonnes of oilseeds (and around 1 million tonnes exported); and smaller volumes of sorghum, other pulses, oats, triticale and corn[17]. There is some discussion of non-cereal movements in the non-bulk rail freight section (from p. 28).

Grain flows from the hinterland are shown in Figure 10. The flows include use of a number of branch lines which, with no other commodities being moved, are dedicated to grain haulage. In September 2015, there were approximately 5 100 route-kilometres of *operational* railway track that was largely or exclusively provided for the haulage of grain. This is a reduction of approximately 300 kilometres from the previous year, following the closure of two lines in the South Australian Mallee district in August 2015[18].

17 Australian Export Grains Innovation Centre 2014, p. 10. The levels are averages of the 2006–07 to 2011–12 levels. Oilseed (Brassica) include plants commonly referred to as canola or rapeseed.

18 Despite the closure of these lines, Gennessee and Wyoming Australia, will continue maintaining the tracks to operational status.

Figure 10 Australian grain railway flows



Notes: The railway network referred to here uses a broad definition that is based around cereals, such as soft and hard grains, but also including other agricultural food products such as pulses (or "legumes") and chickpeas. (or "chick peas") Traditional soft grains include barley, oats, rye and soft white wheat; hard grains include sorghum/millet, durum wheat, hard white wheat and spelt. Pulses include lentils. Also included here are rice and oilseed.

The map shows grain flows along the railway lines that are designated as operating in September 2015. Some railways—notably in south-west Western Australia and in central New South Wales—are not shown, having been classified as closed to traffic.

As discussed in BITRE 2013 (pp. 109–10), eighteen major ports regularly export grain, of which fifteen have rail links with the grain-growing hinterland[19].

In principle, trains are suited to conveying grains to ports for export, and to domestic processing centres. Rail dominates haulages over long distances between the grain-growing hinterland and the coastal market or port. Road movements are common where the grain-growing hinterland is closer to the ports, as illustrated in Table 9. There is a range of other factors, however, that influence the mode-choice decision. For example, as discussed in the section on rail networks, the axle loads on some grain railways are relatively low, which increases the costs of using rail or prevents the use of preferred wagons or containers. (See page 63 for further discussion on the network limitations.) These factors can make rail uncompetitive with road even over long distances.

19 These rail ports are, in decreasing order of 2011–12 grain exports, Fremantle, Melbourne, Pt Kembla, Pt Adelaide, Geraldton, Pt Lincoln, Brisbane, Albany, Esperance, Newcastle, Sydney, Portland, Mackay, Gladstone. See BITRE 2013, p. 110. Note, also, the opening in 2014 of a bulk grain export facility at Bunbury and a new grain terminal in Newcastle (Newcastle Agri-Terminal).

Table 9 Rail market characteristics, by State

	Queensland	NSW	Victoria	SA	WA
Median bin distance to port (km)	303	412	273	130	207
Rail's mode share to port	46	85	53	50	60

Note: The South Australian figures pre-date closure of the two Mallee lines in South Australia.

Sources: Australian Export Grains Innovation Centre 2014 (p. 17) See also rail and road receivals at WA ports, presented in ACIL Tasman (2009, pp. 18–19).

For longer distances and prevailing access charges, rail can provide competitive haulage relative to road; CBH (2011, pp. 11–12) illustrates the relative rail and road charges in Western Australia.

Transport efficiency and, thus, haulage costs, are a major cost factor. AEGIC (2014, p. 33) illustrates the rail transport costs for wheat, by state and grain handling company, within the overall export logistics supply chain. For a 200 km rail haul, these represent around one-third of the post-farm-gate prices through to the export vessel. As a major supply chain cost, therefore, the choice of mode can play a major role in the overall costs.

Grain traffic trends

Unlike iron ore rail transportation in the Pilbara, whose levels are governed purely by product demand and not road transport competition, improvements in road haulage productivity—longer and heavier vehicles and upgraded roads—have eroded grain rail competitiveness. The closure of the two South Australian Mallee lines is a case in point.

Grain industry and logistics changes have brought new economics and challenges to grain rail haulage. There has been a revolution in the industry structure, logistics, contractual and commercial environment.

One change has been the reduction in demand for bulk haulage, which is where rail is advantageous. A second change that has been underway is in grain receival, storage and export marketing. There has also been a change in the nature of the commercial setting between rail operators and grain handlers. These aspects are reviewed. Box 4 provides a list of additional resource material about grain railways, highlighting key inquiries and reports that review railway grain handling and infrastructure.

Grain conveyance—containerisation

Within the last decade, there has been a shift towards "non-bulk" handling of cereal grain transport. While still modest, there has been a trend away from rail hopper wagons to containerisation[20]. The recent development of grain movement in boxes is exemplified by wheat export transport. In the 2002–03 financial year, the export of wheat in containers was negligible. By 2011–12, however, the volume had risen to approximately 11 per cent of exports. The uptake containerisation has varied across the states, with approximately 1.2 per cent of South Australia wheat exports being in boxes, 1.7 per cent in Western Australia, 14.7 per cent in New South Wales, 15.7 per cent in Queensland and 33.7 per cent in Victoria.[21]

20 Fitzgerald (2014, p. 23–24) suggests that containerised complements bulk exports by allowing the demand requirements of both large- and small-scale overseas customers to be met as the container (a) caters for customers requiring smaller quantities (b) needs less infrastructure and storage at the destination port (c) allows the customer to purchase specific grades of grain for blending requirements (d) less financial risk and exposure and (e) allow just-in-time purchase and delivery relative to bulk handling.

21 Wheat Exports Australia (2012, pages 9, 12). See also Department of Transport [Victoria] (2011 p. 12) for levels of wheat and barley bulk- and container-exports through the Port of Melbourne. CBH has argued that its relatively low bulk freight rates make it more attractive to ship in bulk than in containers (CBH 2011, p. 8).

Containerisation affects rail, being less attractive than bulk non-containerised bulk transport. In Queensland, all containerised grain from inland locations moves by road (Transport, Housing and Local Government Committee 2014, pp. 91, 93). As discussed in the network section, one impediment to using rail on some Queensland railway lines is containerised grain would result in trains with axle loadings that exceed the technical limits on some of the state's (narrow gauge) rail lines (p. 63). Similarly, in its 2011 report, the Grain Logistics Taskforce reported that rail is the mode used for approximately 22 per cent of containerised grain exported through the Port of Melbourne[22]. This compares with an overall 53 per cent rail mode share for grain haulage to the port (Table 9).

Grain receival, storage and marketing

Transport forms one part of the grain supply chain logistics task. The mode choice also depends on the efficiency of the entire logistics flow, including the receival and storage components. Mode choice is heavily influenced by grain destination (domestic or export), size of shipment and distance to port. Increased on-farm storage is also more conducive to road haulage as farmers can wait for good spot prices before moving their grain.

Grain movements from the farm (whether directly harvested, or from on-farm storage) to the domestic processing plant or the export port commonly involves three key logistics stages. First, the grain may be transferred from the farm to a local receival centre (or simple grain silo). Second, it may then be stored at that centre. Thirdly, the grain is transferred to a processing plant or to the port.

Grain receival and storage is being rationalised with investment focused on consolidation into fewer, larger facilities, with larger storage levels, higher handling speeds and improved rail siding capacity. The grain handling speed at receival centres (whether from road vehicles into the storage silos or from the silos to wagons) is a key factor that determines the velocity of the grain logistics chain. For example, a recent Queensland government inquiry noted that old rail loading facilities required 12 hours to load a train whereas new "super depots" take just two hours to load and turn around a train. (Transport, Housing and Local Government Committee [Queensland] 2014, p. 97)

This consolidation of receival/storage centres can merit increased investment in rapid grain-handling facilities[23]. The principal grain handlers (CBH, Glencore-Xstrata [Viterra] and GrainCorp) continue to invest in improved wagon-loading and train-capacity systems. For example, in 2014 GrainCorp announced its "Project Regeneration" investments, which include upgrading rail loading capacity in New South Wales, Queensland and Victoria. The investment focuses on primary grain-handling sites, to triple the wagon loading rates and expand track capacity to accommodate longer ("unit") trains[24].

Changes in grain logistics management are working against rail transport. Deregulation of grain export marketing has triggered a dispersion of the logistics management and task. Traditionally, the grain receival centres were owned by a small number of state-based bulk grain

22 See footnote 21.

23 GrainCorp provides maps of its Victorian primary grain sites and receival and storage sites (http://www.graincorp.com.au/_literature_89200/South_Eastern_Victoria_Regional_Map); and (http://www.graincorp.com.au/_literature_89199/North_Western_Victoria_Regional_Map).

24 Australian Export Grains Innovation Centre (2014, pp. 11–16; 19–21) discusses grain handling and storage operators, receival site efficiencies and receival-centre consolidations.

handlers whose receival, storage and transport decisions determined the logistics environment. However, with the end of the Australian Wheat Board (AWB) "single-desk" wheat export system, other grain marketers entered the industry. There are now four main bulk handlers and more than 20 export grain marketers (Australian Export Grains Innovation Centre 2014, p. 3), with exporters often undertaking their own transport arrangements. To enable exporters to transport grain through the ports, they are provided with access to the traditional bulk-handlers' port export facilities. This is formalised in access regulations overseen by the Australian Consumer and Competition Commission (ACCC). Deregulation of the export grain market has adversely affected the haulage of grain by rail, with smaller shipments of grain being moved on diverse pathways for a broader range of bulk handlers and export marketers. This reduces rail's advantage in moving large shipments of grain for a single buyer from silo to port.

Impact on grain haulage arising from rail ownership and structural changes

The relationship between railway entities and their grain customers has changed within recent years, which has influenced mode choice. These changes include:

- **Rail industry restructuring, funding and ownership changes.** Some railways have been vertically separated, changing incentives for operating grain trains. Similarly, privatisation of railways has shifted, or removed, the long-term funding of the upkeep of grain lines (which in all cases do not recover their long-run costs). In some cases (South Australia and Western Australia especially) this has led to closure of a large number of grain railways.
- **Transfer of commercial risk.** Grain handlers and exporters now take the commercial risk on rail haulage instead of the train operators. 'Take-or-pay' contracts with train operators are the standard form of agreement[25].
- **Logistics services have been expanded.** By way of illustration, Qube Holdings offers a complete export logistics service, with bulk storage and handling, train operation, port storage and export loading (including container filling).

25 Such take-or-pay contracts include: GrainCorp, Emerald and Cargill contracting Asciano for a minimum of 13 trains and a maximum of 20 trains (Asciano 2014a, p. 60); CBH contracting Watco; Glencore–Viterra contracting Genesee & Wyoming Australia and also Aurizon; and Noble, Emerald and Cargill contracts with Qube Holdings.

Box 4 Further reading on railway grain handling

There numerous reports that consider grain networks, notably the wheat and barley flows. There is also some disaggregated data. The following are some core studies into grain railways and grain supply chains.

Overviews:

- A comprehensive overview of (essentially-cereal) grain flows can be found in the report *The cost of Australia's bulk grain export supply chains. An information paper,* and its Postscript Version 2014.1; both documents were published by the Australian Export Grains Innovation Centre.
- A review of trends in containerised grain exports can be found in the article written by Mark Fitzgerald "Container exports open market opportunities", (*Grain Business*, July 2014).

Queensland reports:

- Transport, Housing and Local Government Committee (Queensland), *Rail freight use by the agriculture and livestock industries,* Report No. 45.
- Port of Brisbane 2013, *Import/export logistics chain study*. *Summary report.* This study presents a snapshot of railed grain through the Port of Brisbane, with rail heads at Thallon, The Gums, Meandarra, Miles, Talwood, Dalby West and Malu being cited. The railed tonnage of wheat (86 per cent by rail), sorghum (13 per cent by rail) and pulse (1 per cent by rail) are presented; maize and cottonseed do not move by rail. (p. 30)

New South Wales reports:

- *New South Wales Grain Freight Review* (by Department of Infrastructure, Transport, Regional Development and Local Government, 2009). The report assesses the case for retention and investment in grain railways.
- Independent Pricing and Regulatory Tribunal (IPART) 2012, *Review of access pricing on the NSW grain line network. Transport—Final report.* The report includes 2010–11 forecast volumes by grain branch line, which provides some indication of grain volumes by line (pp. 10–11).
- Grain Infrastructure Advisory Committee 2004, *Report on rail/road options for grain logistics,* New South Wales Government. The report provides average tonnage on a number of New South Wales grain railway lines (p. 10).
- Pollard 2012, "Moving NSW wheat: the post deregulation experience", *Railway Digest,* presents a review of the logistics changes to wheat haulage in New South Wales.

Victorian reports:

- Department of Infrastructure (Victoria) 2007, *Victorian rail freight network review.*
- Department of Transport 2011, *Grain logistics taskforce report,* and Victorian Government response to Grain Logistics Taskforce Report. November 2012,

Box 4 Further reading on railway grain handling *(continued)*

South Australian reports:

- Department of Transport and Urban Planning 2003, *Eyre Peninsula grain transport. Summary report.* The report considers the case for the retention (and joint-funding by interested parties) of grain railways on Eyre Peninsula.

West Australian reports:

- Strategic design & Development 2009, *Report prepared for Freight and Logistics Council of WA on behalf of the Strategic Grain Network Committee.*
- Department of Infrastructure, Transport, Regional Development and Local Government 2009, *WA grain freight review.*
- Economics and Industry Standing Committee, Western Australia Parliament Legislative Assembly 2014, *Inquiry into the management of Western Australia's freight rail network,* This inquiry considered a range of aspects of the lease of rail infrastructure.

National reports:

- House of Representatives Standing Committee on Transport and Regional Services 2007, *Inquiry into the integration of regional rail and road networks and their interface with ports.*

Non-bulk rail freight traffic

Non-bulk rail freight movements are perceived as being containerised, although SCT Logistics, and Sadliers Logistics (for example) typically use louvre wagons for their palletised traffic. (See Box 1 for further discussion of defining non-bulk rail freight.)

Apart from rail container movements between domestic intermodal terminals, rail services also undertake maritime tasks (for import, export and Bass Strait traffic) that can be classified as follows:

- **Landbridge** movements, from one port to another. Container movements from around Hobart, to the Port of Burnie (for export or transfers to and from the mainland), and between Adelaide and the Port of Melbourne are primary examples.
- **Regional** export movements, from inland terminals to the port. This traffic includes agricultural commodities, such as sugar, cotton, rice and other grains.
- **Urban** import and export movements. These are short-haul container movements, linking the port terminal with urban logistics centres (where boxes are de-stuffed, stored or distributed to local businesses around the terminals). Empty containers are also shifted by these local rail services.

Export maritime activities are generally based around single commodities and/or a single company's logistics-based hub.

The following discussion focuses on port rail flows to or from capital cities, while noting other, non-capital city flows can operate. (Examples include Mt Isa – Townsville and [when container ships serve the port] Hobart – Bell Bay.)

Rail (and road) volumes of containers through the primary capital city ports are presented in the BITRE's regular *Waterline* series. (BITRE 2014d, tables 1.1 – 1.6, includes TEU[26] rail volumes through the ports for each of those cities.)

Landbridge and regional movements

The maps that follow present the long-distance maritime railway services linking city ports (and between the environs of Hobart and the Port of Burnie).

Port of Brisbane—Fisherman Islands

Figure 11 presents the rail container flows between Queensland intermodal terminals and the Port of Brisbane (Fisherman Islands).

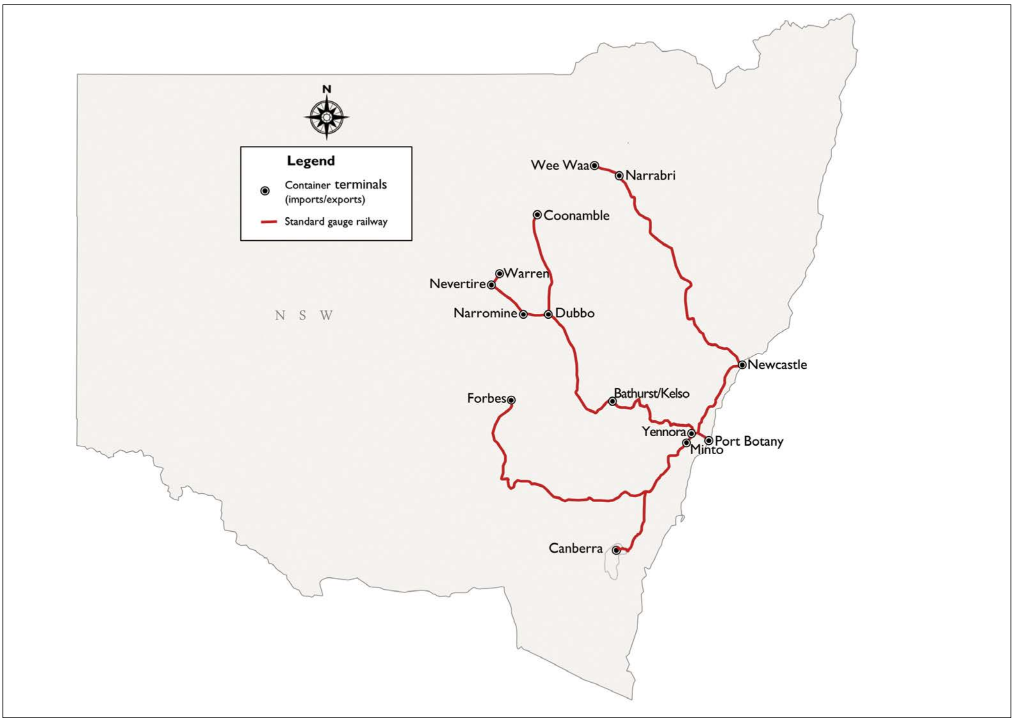
Figure 11 Rail container operations serving the Port of Brisbane (Fisherman Islands)

The Port of Brisbane used to manage export traffic, including seasonal cotton, from Dalby and Goondiwindi, but this ceased in late 2009 and September 2014 respectively. According to Aurizon, the cessation of these operations was due to the inability of rail to transport anything higher than 8'6" high containers due to the Toowoomba Range profile. This made rail transport from these centres unviable and the traffic has switched to road transport. Containers are still moved to/from northern destinations to the Port of Brisbane.

26 TEU: Twenty-foot equivalent unit.

Sydney Ports—Port Botany

Figure 12 Rail container operations serving Sydney Ports (Port Botany)



Regional services are based on export container traffic, with train movements to the hinterland conveying empty boxes for filling. Rail moves a range of containerised commodities, primarily agricultural, to Port Botany. These commodities include:

- specialised grain, conveyed from Forbes, Narrabri, Dubbo, Coonamble and Narromine;
- Qube Holding's intermodal terminal at Harefield (near Junee)[27] ships containerised grain and cardboard (from Visy's plant at Tumut);
- chick peas from Narrabri;
- cotton from Warren, Nevertire, Wee Waa and Narrabri;
- logs from Bathurst/Kelso and Newcastle (Sandgate);
- refrigerated meat from Dubbo;
- aluminium ingots from Newcastle (Bullock Island and Walsh Point); and
- scrap metal from Canberra.

27 In April 2014, Wagga Wagga City Council called for expressions of interest in development of a Riverina Intermodal Freight & Logistics Hub at Bomen, in Wagga Wagga.

Figure 13 Regional export intermodal train

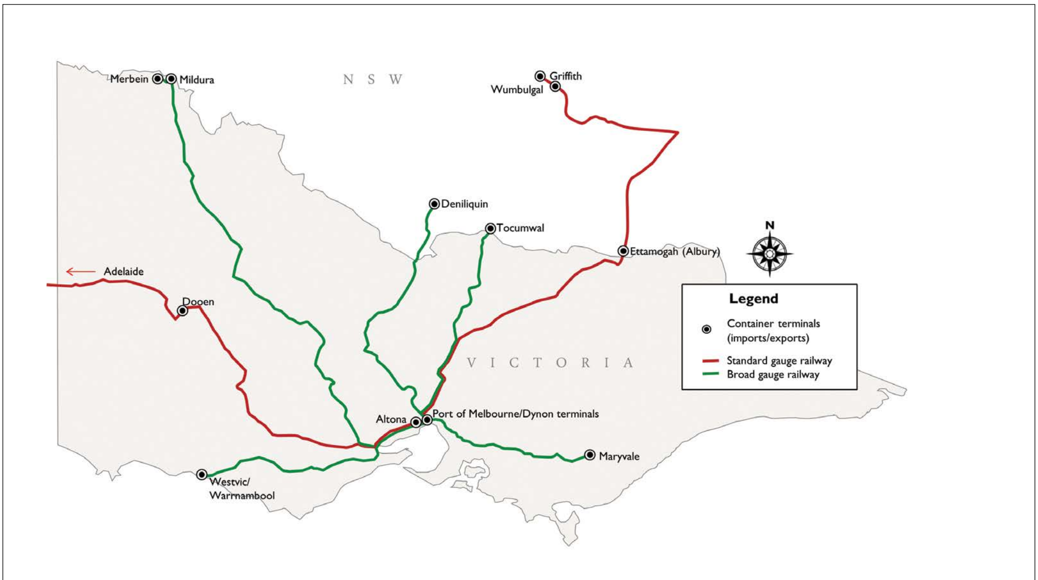
Note: The image above shows a Qube Holdings export intermodal train at Harden, enroute from Port Botany to Harefield.

Source: Photograph courtesy of Rodney Avery.

Port of Melbourne

The major regional container export flows through the Port of Melbourne are shown in Figure 14. Rail container flows through the port that originate or are destined for Tasmania are not shown. It is possible some of the Bass Strait traffic moves by rail along the North–South rail corridor.

Figure 14 Rail container operations serving the Port of Melbourne



The non-urban movements can be categorised into landbridge, western and eastern Victoria flows, and southern New South Wales flows.

Landbridging. There is an export driven landbridge movement of containers between Adelaide and the Port of Melbourne. Some of the trains operate to the stevedore rail sidings at the dock (notably, to Patrick's Appleton Dock) while other train movements are to South Dynon intermodal terminal (with the containers then being conveyed to the stevedore container stacks by road vehicles). In recent years there has been a shift from hubbing Adelaide's container movements through Melbourne (for direct sailings to and from foreign-destination ports) to shipping through Adelaide with hubbing in Singapore (in particular). As a result, there are fewer landbridge trains serving the operating between Adelaide and Melbourne.

Western Victoria. There are three logistics company-based hubs in Western Victoria:

- Wakefield Transport, at Merbein (Mildura), with logistics operations in a range of containerised agricultural and mining exports;
- Westvic Container Export Services, at Warrnambool, with agricultural and other diverse export (and domestic) traffic; and
- Wimmera Container Line, at Dooen (near Horsham), especially with grain exports (for Wimmera Grain Company).

Eastern Victoria. Containerised paper is shifted to Qube Holding's Victoria Dock in the Port of Melbourne from Maryvale in the Latrobe Valley.

Southern New South Wales. There are a range of export flows to the Port of Melbourne, including:

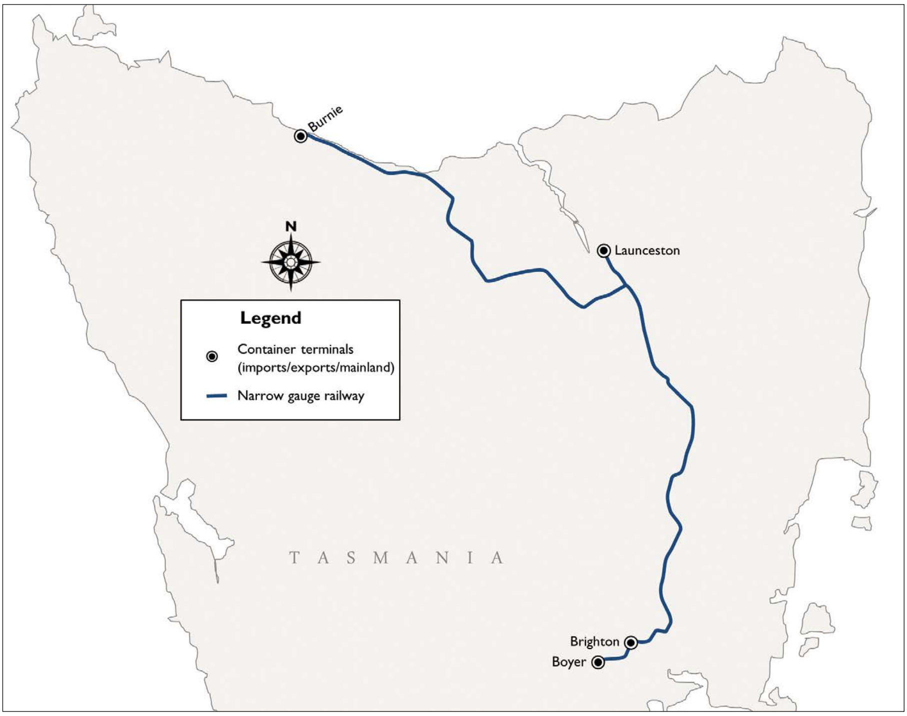
- containerised rice from Deniliquin;
- containerised grains (such as wheat, barley, sorghum) from Tocumwal; and
- containerised wine for export is undertaken from Griffith, Leeton;

- inbound and outbound products through Ettamogah Rail Hub (near Albury), including products of the Mars Petcare company; and
- cotton, wine, oaten hay, and grain from the Wumbulgal terminal near Griffith that opened in June 2015.

Tasmania—Port of Burnie

Maritime containers are landbridged between Hobart (Brighton Transport Hub) and Boyer (near Hobart) to the Port of Burnie.

Figure 15 Rail container operations serving the Port of Burnie

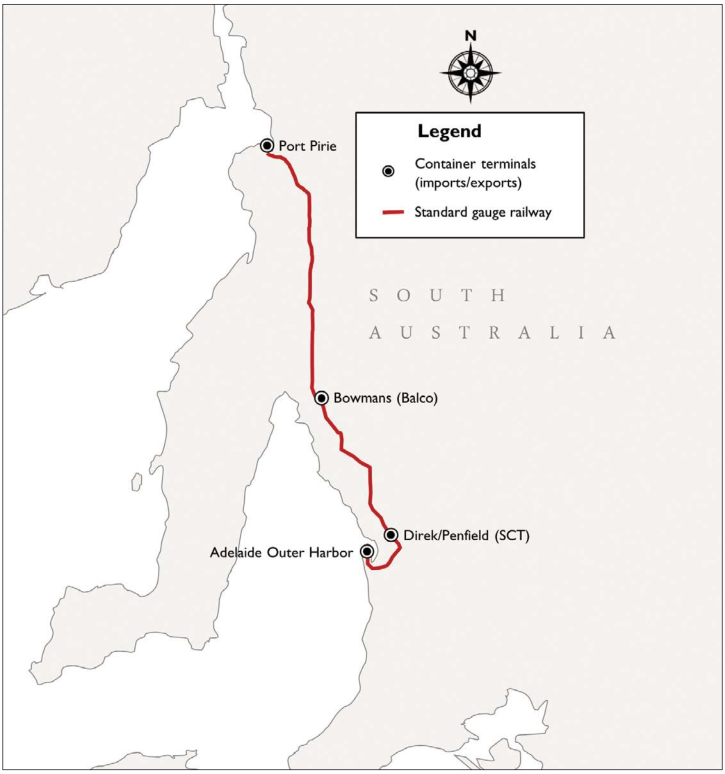


Commodities moved between the Hobart area and Burnie include paper (from Boyer) and haulage for the Toll Group logistics company. Containers are also moved from Launceston to Burnie.

Port Adelaide—Outer Harbor

There are regional maritime container traffic flows to Outer Harbor (Port Adelaide)—see Figure 16. While purpose-built containers are also used for haulage of mineral sands (such as from Kanandah, near Broken Hill, to Port Flat), these movements lie outside this analysis.

Figure 16 Rail container operations serving Port Adelaide (Outer Harbor)

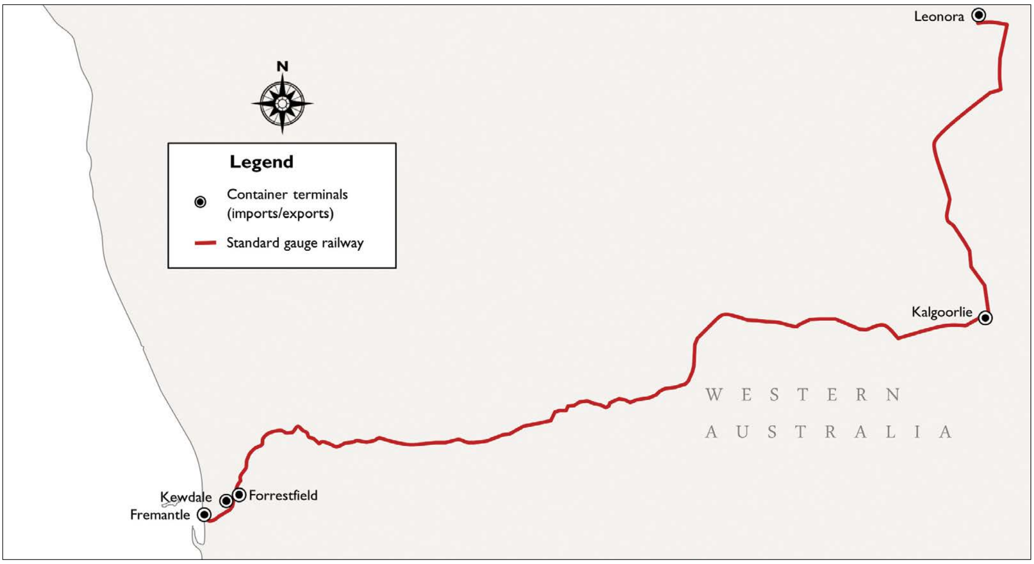


Regional trains operate between the Bowmans Intermodal Terminal (operated by Balco Australia) and Outer Harbor. The terminal is used for the export of agricultural products such as oaten hay, grain and pulses, seed, wine and pork bellies. The terminal also handles imported containerised bait tuna. The facility is also used as a consolidation point for a range of commodities, a task that would otherwise be done at the port. The terminal is served by rail services that convey containers to both Outer Harbor and the Port of Melbourne. Some Bowmans container trains also serve the Nyrstar lead smelter at Port Pirie. Containerised lead is collected for export through Outer Harbor.

Port of Fremantle—Inner Harbour

There is limited movement of regional containers to the Inner Harbour of the Port of Fremantle. These are shown in Figure 17.

Figure 17 Rail container operations serving the Port of Fremantle (Inner Harbour)



The primary regional container export flows are lead from Leonora and nickel products from a nickel smelter south of Kalgoorlie.

Short-haul (urban) maritime container movements

There are several flows of short-haul (urban) maritime container movements. These are:

- Yennora – Port Botany (approximately 40 km, Figure 12);
- Minto – Port Botany (approximately 55 km, Figure 12);
- Direk/Penfield – Outer Harbor, Port Adelaide (approximately 25 km, Figure 16); and
- Kewdale/Forrestfield – Fremantle (Inner Harbour) (approximately 24 km, Figure 17).

In addition, Salta Properties opened an intermodal terminal with rail infrastructure at Altona in Melbourne in May 2014. With shipping line Maersk an anchor tenant, the intention is to operate shuttle trains between the terminal and the Port of Melbourne (Figure 14).

The Yennora and Minto operations handle both imports and exports. The urban terminals undertake a range of logistics activities for imported goods, including storage, consolidation and deconsolidation, and onwards road distribution to nearby warehouses. Exports include empty container transfers to the port.

The short-haul movement between the SCT Logistics terminal at Direk (Penfield) and Outer Harbor involves the export of wine. The operation commenced in 2014.

The Western Australian Government subsidises the movement of containers by shuttle trains between intermodal facilities at Forrestfield/Kewdale and the Inner Harbour at Fremantle. Aurizon operates the train services on behalf of Intermodal Link Services (a part of the Intermodal Group). These operate between the Forrestfield Intermodal Terminal and the North Quay Rail Terminal at the port. Trains also operate between the Kewdale intermodal terminal and the North Quay Rail Terminal. Intermodal Link Services conveys the containers by road from that Rail Terminal to stevedore stacks at the wharf. Exports include grain that is containerised in grain-handling facilities in the Kewdale area.

Box 5 Further resources on non-bulk freight activity

There is a range of regular and one-off studies that can facilitate understanding port-rail freight flows. The ongoing and recent publications include:

- The BITRE's *Waterline* series presents quarterly data on rail traffic volumes through the mainland State capital city ports (where traffic is measured in, Twenty-foot Equivalent Unit containers).
- Each *Waterline* issue also presents port maps, which show principal rail lines within port precincts and summarises each of the regional and short-haul rail services operating between the hinterland and the port (BITRE 2014d, Appendix A).
- Fremantle Ports publish longer-run data on rail TEU volumes through the Fremantle Ports (2014, p. 5). Fremantle Ports (2012) analyses rail and road TEU movements between the hinterland and the port.
- Port of Brisbane provides survey data on rail and road container movements through the port. This is summarised (2013, pp. 10, 26).
- Port of Melbourne, et. al., (2010), provides survey data on hinterland container freight task (presented in the number of TEU) through the Port of Melbourne (pp. 48, 74–75, 102).
- Rail TEU traffic volumes are reported by the Sydney Ports Corporation in its annual report, as part of its "Port Botany Landside Improvement Strategy" (See, for example, p. 28, of Sydney Ports Corporation 2013).
- Monthly and annual rail (and road) volumes through Port Botany are presented in chart format within the Transport for New South Wales web site (see relevant web window link in the references).

Urban rail passenger traffic

Each of the mainland state capitals operates urban passenger rail services. These services provide transport conduits through built-up areas, enabling the mass movement of passengers to and from capital city centres. At their broadest, urban passenger rail services provide an alternative to private cars which minimises road congestion. These services also provide a transport alternative for those without cars.

Table 10 Urban rail patronage, 2013–14[a]

	Brisbane[b]	Sydney[c]	Melbourne	Adelaide	Perth
Patronage – heavy rail	50.9	272.5	232	8.2	63.5
Patronage – light rail		3.9	176.9	2.3	

Notes: a Methodologies for calculating patronage vary between cities.

b Brisbane does not include the seperately administered Airtrain line. Patronage for this line are included in BITRE 2014e.

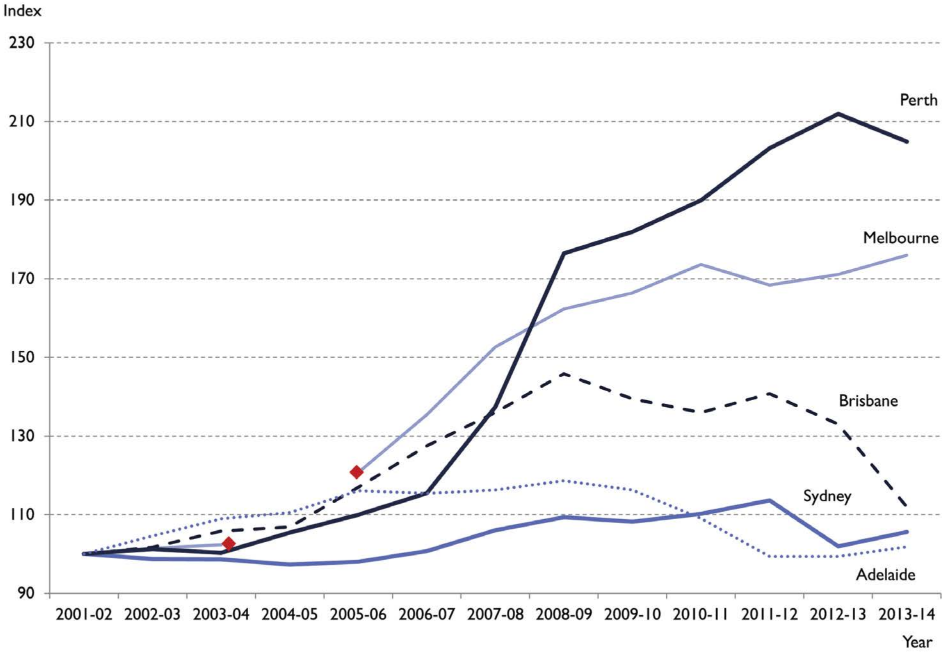
c This is a combined Sydney Trains and NSW TrainLink total.

Patronage data are those reported by operators. For some cities, data differ to those reported in BITRE 2014e. This is because BITRE 2014e adjusts data where necessary to allow comparison across networks.

Sources: Public Transport Authority of Western Australia 2014 p.44; Public Transport Victoria 2014 p.26, p 27; Department of Planning, Transport and Infrastructure 2014, p.88; Queensland Rail 2014, p.13.

Sydney has the most utilised heavy rail system. In 2013–14, Sydney's heavy rail network attracted approximately 21.5 per cent more patrons than heavy rail patrons in the second highest city, Melbourne. As Figure 18 shows, urban passenger traffic in Perth grew strongly over the last decade but declined in 2013–14. Melbourne also recorded heavy rail growth but a slight decline in light rail patronage beginning in 2013 (Figure 19)).

Figure 18 Index of heavy urban railway patronage in Australian cities

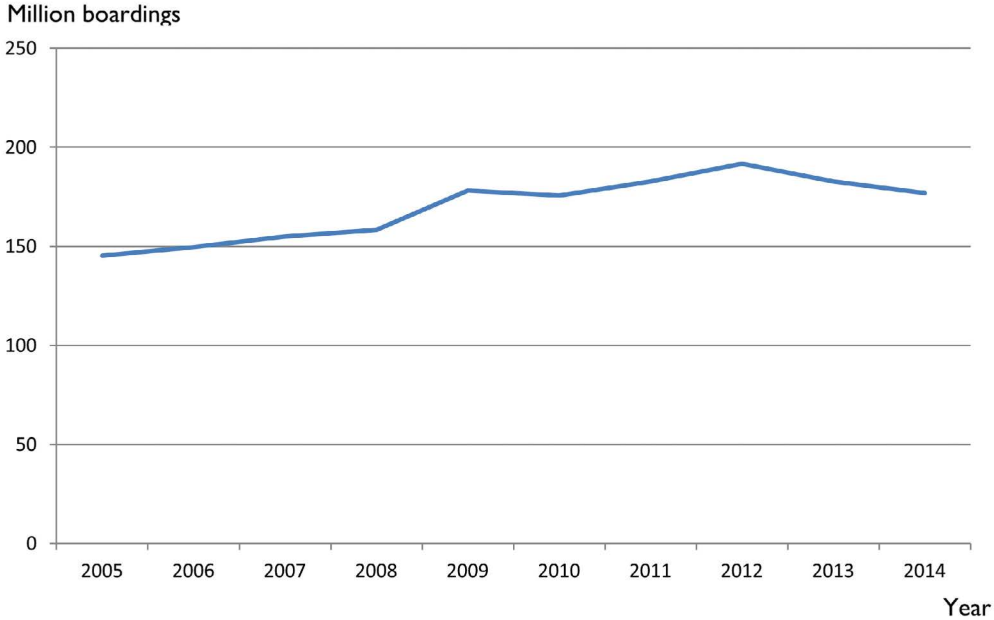


Note: There is a break in the Melbourne data between 2003–04 and 2004–05 due to a change in patronage measurement methodology. Brisbane also changed its methodology in 2010–11, however, a revised time-series for was provided for 2007–08. The index for 2007–08 (136) as been applied to the revised patronage level for that year.

Sydney Trains and the NSW Bureau of Transport Statistics are revising their patronage data collection methodology. The Sydney Trains data presented here are revised and provisional only, with the following qualifications. According to correspondence from Sydney Trains, before the introduction of Opal ticketing, train patronage was calculated using magnetic stripe ticket (MST) sales with journey multipliers for each ticket type. This includes an estimate of unpaid journeys, such as fare evasion. This method is still currently used for MST patronage calculations. Patronage is split between the two urban Sydney urban rail transport providers: Sydney Trains and NSW TrainLink, using rules for each station based on the Transport Services Customer Delay Model (CDM). Suburban stations that are serviced by both trains' operators (a shared station) have the patronage split between the operators using proportions of the CDM. With the introduction of Opal, more detailed information becomes available for each train trip. The current method of assigning Opal train patronage is consistent with the MST method and uses only the tap on location to assign the journey to a station (namely to simulate a sale at the tap on station). By using the Opal tap on location there has been an artificial growth in CBD station patronage at the expense of most other stations and lines where decreasing patronage has been calculated. A new method of assigning Opal patronage to station, line and operator is proposed which uses combination of both tap on and tap off based on a station hierarchy.

Sources: Index based on patronage data from: BITRE 2012; Public Transport Victoria 2014 p.26; Public Transport Authority of Western Australia 2015; Department of Planning, Transport and Infrastructure 2014 p. 88; Queensland Rail 2014 p.13; (Revised) data provided by Sydney Trains.

Figure 19 Light rail patronage – Melbourne



Source: Public Transport Victoria 2014.

National (external) and local (network-specific) factors explain patronage trends. The former includes economic activity (influencing employment and disposable income) and petrol prices which influence rail patronage. Fluctuations in fuel prices affect private vehicle operating costs, therefore impacting commuters' decisions about what form of transport to use, known as the mode choice. This can be observed in the 2006–2008 period when fuel prices increased significantly relative to previous years. Other macroeconomic factors which influence mode choice include mortgage interest rates, vehicle purchase costs and disposable income. A significant macroeconomic influence over the past decade has been the resources boom. This has led to higher disposable incomes and—due to the higher Australian dollar—decreased the cost of imported goods, such as motor vehicles (Reserve Bank of Australia 2014, p. 18). To the extent that consumers prefer to drive if they can afford it, an increase in disposable income and decrease in the cost of motor vehicles ownership and operation may encourage a degree of switching away from public transport.

Another factor that affects mode choice towards/from urban rail as a response to macroeconomic conditions is the non-financial relative generalised cost of rail travel. This cost includes quality of service, in-vehicle travel times, network scale and the standards of rollingstock and other infrastructure amenity. Divergent travel patterns across urban rail systems can arise when strong local factors dominate; these generalised costs, local employment patterns and road infrastructure improvements and parking charges. Specific local factors that will have some bearing on the city travel trends include:

- **Brisbane**. Fares increased by 15 per cent per annum from January 2010. The annual fare increases were halved to 7.5 per cent for January 2013 and 2014 (Translink 2012, p.68).

Correspondingly, patronage declined sharply from 2011–12, although it is beyond the scope of this publication to assess whether demand decreased because of the fare increases, investments in other transport modes, such as busways, both or combinations of known and unknown variables, The new electronic stored-value "Go Card" was introduced at that time and included cheaper off-peak travel discounts. In 2015 it was decided to keep fares at the 2014 level for the year.

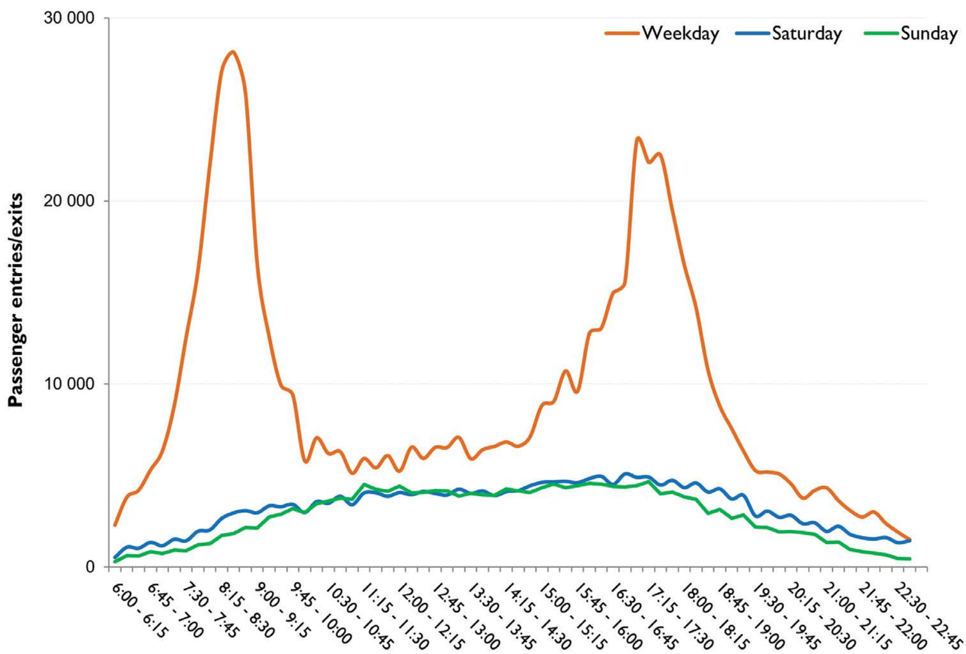
- **Sydney** experienced strong population and employment growth between the census years 2001 and 2006. However, that growth was strongest in outer areas, where radially-focused public transport offers a weaker alternative to car transport (BITRE 2012, p. 18). The growth in these areas was accompanied by significant expansions in the road network, with the M5 East Freeway and Westlink M7 opening in 2001 and 2005, respectively (BITRE 2012b, p. 296).
- **Melbourne** experienced a downward trend in light rail patronage with 3.4 per cent fewer passengers travelling by light rail in the 12 months to 30 June 2014 than for the same period in 2012–13. This can be explained by the underlying economic conditions. The strongest rate of patronage growth in Melbourne was between 2005–06 and 2008–09. Figure 18 shows the heavy rail trend and Figure 19 shows light rail. This growth corresponded with a rapid growth in employment in inner Melbourne during those periods[28]. Being serviced by relatively good heavy and light-rail (and other public transport modes), further inner Melbourne employment growth will encourage public transport patronage. Note, the 2006 figures exclude Commonwealth Games patronage.
- **Adelaide** had a marked decline in patronage, but which recovered slightly in 2013–14. This can be attributed largely to service disruptions caused by works associated with infrastructure enhancement and the Rail Revitalisation Programme renewal works. The works required extended periods of line closures from 2008. Patronage is expected to increase once the Seaford, Tonsley and Belair lines become fully operational.
- **Perth**. Much of the surge in Perth's patronage in 2006–07 reflects the opening of the Mandurah line. The two new lines built from central Perth to Butler and Mandurah provide relatively high-frequency (a minimum of four trains per hour) as well as the highest average speed timetables (off-peak and peak) across the five urban rail systems.

28 Between 2006 and 2008, the City of Melbourne Local Government Area (LGA) gained 50 400 jobs. That employment growth represents seven per cent per annum, compared with 3 per cent per annum growth experienced from 2002–2006 (BITRE 2011, p. 122).

Commuting traffic

Urban passenger rail services are largely aligned to service weekday commuter demand to and from city centres. The task is strongly skewed to morning and afternoon peak period travel, as is illustrated in Figure 20, which shows Sydney's weekday patronage pattern on a typical weekday, Saturday and Sunday in March 2013. Sydney's rail task peaks between 0830 and 0845 hours at nearly 30 000 passengers—4.5 times the task performed two hours later.

Figure 20 Urban weekday patronage pattern, heavy rail, Sydney, March 2013



Source: Bureau of Transport Statistics NSW 2015.

In each of the five cities discussed, rail has a higher mode-share for peak period commuting than at other periods, particularly for home–CBD travel; see Table 11. In Sydney, rail has the highest journey-to-work mode share for city-centre commuting, where around 46 per cent of workers use the train (Mees and Dodson 2011, p. 7). However, despite the relatively high employment density of city centres, most jobs are located outside each centre. Thus, because rail offers poorer accessibility in non-CBD areas, its overall journey-to-work mode shares are relatively low (Table 11).

Table 11 Urban rail journey-to-work mode shares, 2011

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Heavy rail (%)	7.6	16.0	11.7	2.5	7.7
Light rail (%)	–	0.1	3.6	0.5	–

Notes: Cities refer to greater metropolitan areas. For the 2011 census, ABS replaced its previous geographical definition system, the Australian Standard Geographical Classification, with the Australian Statistical Geography Standard. This led to some changes in the boundaries of greater metropolitan areas.

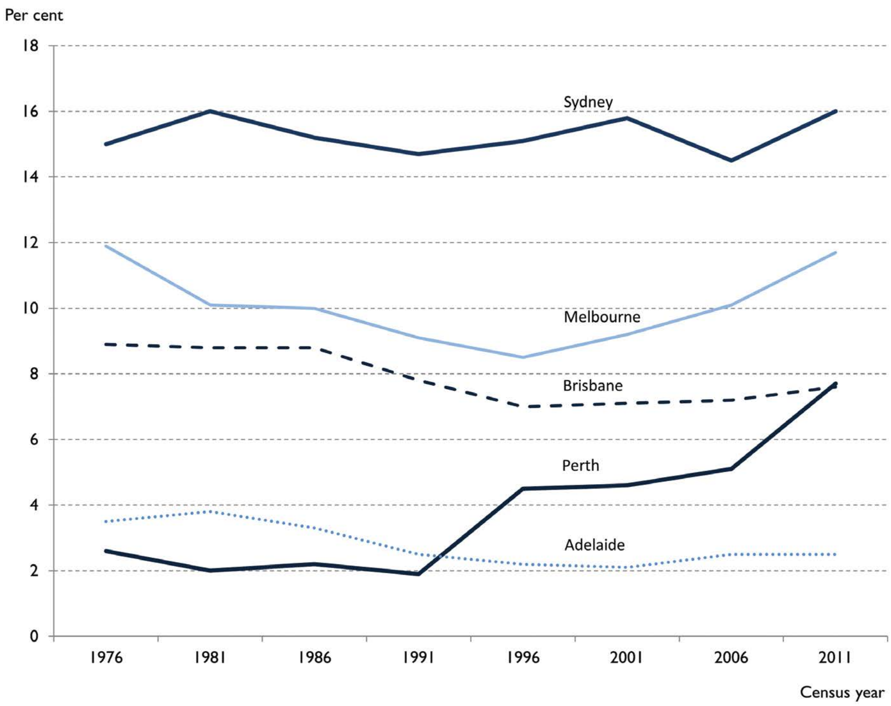
Mode shares defined as persons who caught a train/tram for all or part of their journey to work. Calculations exclude census respondents who did not specify travel mode, worked at home or did not go to work.

Tram/light rail census data includes respondents who: caught a tram/light rail; caught a train and tram/light rail; caught a bus and tram/light rail. The tram/light rail data is is therefore an underestimate because it does not include all possibilities, for example, car and tram/light rail.

Source: ABS 2011.

Following long-term declines in urban rail patronage for all cities from the mid-1970s, ridership began to recover from the 1990s.[29] Figure 21 shows the journey-to-work mode share data for heavy rail, derived from the census, since 1976. The journey to work data from 2001 closely resembles total patronage trends over the last decade (Figure 18).

Figure 21 Journey-to-work mode share, urban heavy rail



Note: Cities refer to greater metropolitan areas. For the 2011 census, ABS replaced its previous geographical definition system, the Australian Standard Geographical Classification, with the Australian Statistical Geography Standard. This led to some changes in the boundaries of greater metropolitan areas.

Sources: ABS 2011; Mees and Groenhart 2012.

29 For an analysis of public transport mode share trends, see Mees & Groenhart, 2012.

Box 6 Further reading

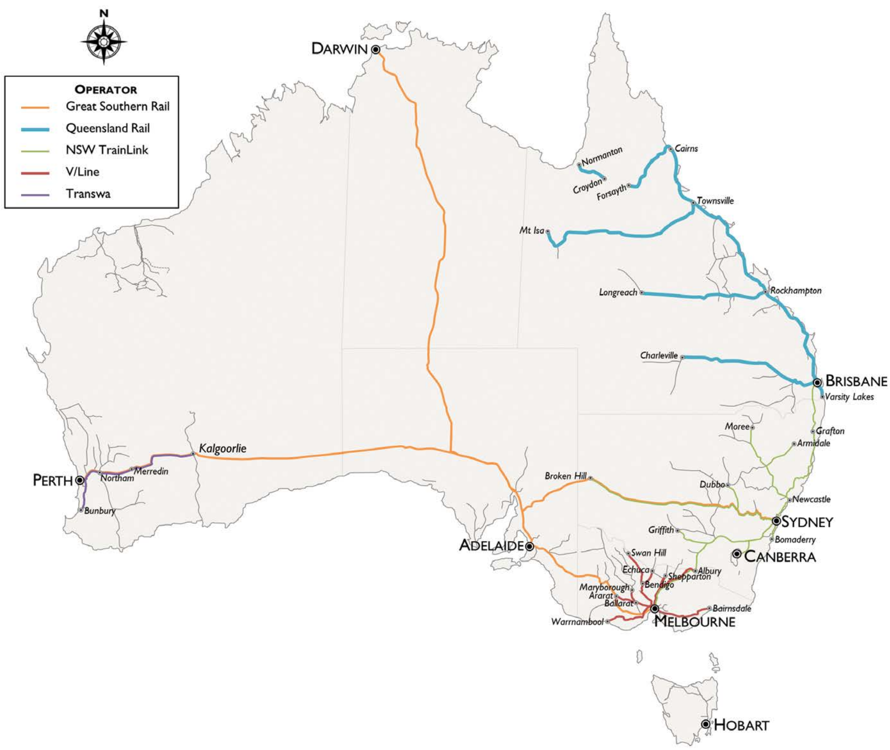
For further information on urban passenger trends, see BITRE information sheets: Urban transport: updated passenger trends—Information Sheet 59 (BITRE 2014f); and Long-term trends in urban passenger transport—Information Sheet 60 (BITRE 2014e).

BITRE 2012, *Understanding Australia's urban railways* presents an overview of Australia's passenger and freight railway systems.

Non-urban passenger traffic

Australia's railways provide a limited range of services in the inter-city, regional and long-distance passenger markets. Coverage of these services is presented in Figure 22.

Figure 22 Non-urban passenger services, by operator



Non-urban passenger traffic, broadly described as day-return (under four-hour) and long-distance (over four hours) travel, can be further classified by the primary travel markets served:

- "inter-urban" or "regional" travel, such as Sydney–Newcastle (now truncated), Sydney–Wollongong/Bomaderry, Melbourne–Ballarat and Perth–Bunbury. Such services could include daily commuting or day-return business or leisure travel;
- long-distance connections between cities (such as Brisbane–Sydney) and regional centres, such as Sydney–Canberra and Perth–Kalgoorlie;
- heritage railway travel, for nostalgia and leisure purposes; and
- tourist-focused services such as the Kuranda Scenic Railway (Queensland Rail), and Adelaide–Darwin (*The Ghan*) (Great Southern Rail).

The scale of an operator's passenger task is largely determined by the function of their railway. Table 12 shows the latest financial year patronage statistics, by operator. Railways with a large commuter task have higher patronage than those which cater largely to long-distance travel. For NSW TrainLink, for example, only a small percentage of patronage is from the former CountryLink regional network. The majority of passengers use inter-city services on the Newcastle & Central Coast, Blue Mountains, Southern Highlands and South Coast lines.

Table 12 Non-urban rail patronage, by operator, 2013–14

	Queensland Rail[a]	NSW TrainLink[b]		V/Line	TransWA
		CountryLink	Total		
Patronage (thousands)	700	1 805	34 680[30]	13 000	219

Notes: [a] Data exlude patronage on services delivered under the "TransLink" brand. Patronage data by line are not available for the Gold Coast and Sunshine Coast TransLink lines.

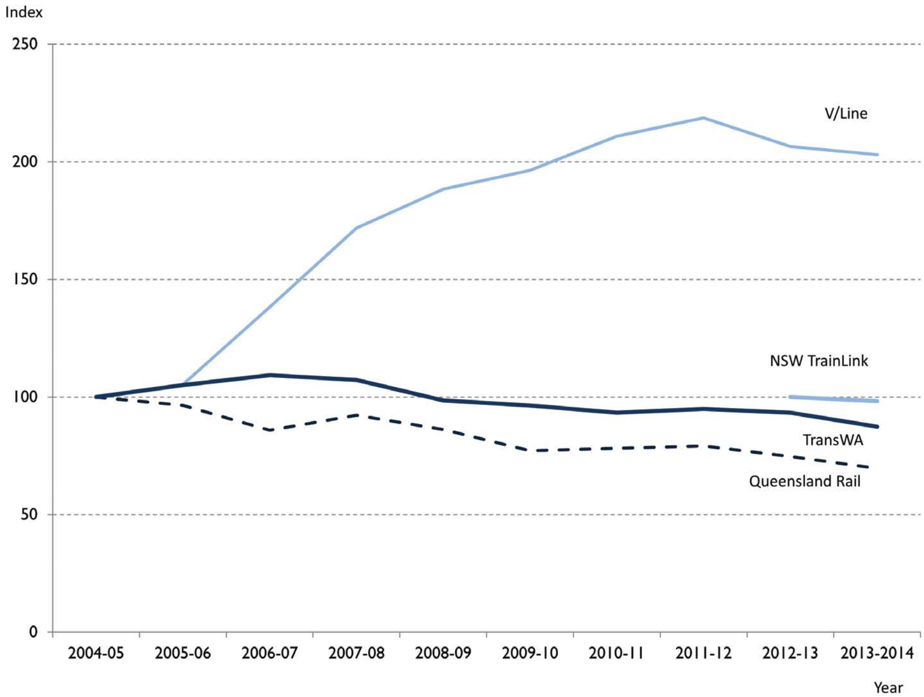
[b] "Total" data for NSW TrainLink are the combination of patronage on the former Countrylink network and CityRail (Central Coast & Newcastle, Blue Mountains, Southern Highlands, South Coast and Hunter lines). On 1 July 2013, NSW Countrylink was disbanded and became part of NSW TrainLink. The later was a combination of CountryLink's regional lines and the former CityRail's intercity lines. The NSW Bureau of Transport Statistics provides patronage by line.

Sources: VLine 2014, p. 10; Data provided by NSW TrainLink; Public Transport Authority of Western Australia 2014, p. 54; Queensland Rail 2014, p. 39.

Much like urban patronage trends, non-urban patronage is influenced by broad, macroeconomic factors and local, network specific factors. Figure 23 shows patronage trends by operator. The index for NSW TrainLink is truncated to 2012–13 due to the patronage data revision.

30 The NSW TrainLink figure is approximately double that reported in Trainline 2, due to this publication using more accurate data, as provided by NSW TrainLink and the NSW Bureau of Transport Statistics. Patronage numbers as reported in Table 12 are based on calculations by train boarding location rather than by TrainLink line. The higher number therefore includes passengers who board TrainLink trains at urban Sydney locations, even if those passengers only travel within the urban Sydney area. A person boarding a Lithgow–Sydney Central TrainLink train at Parramatta for travel to Sydney Central, for example, would thus be included. Also included would be a TrainLink passenger who boards a TrainLink train at Sydney Central, for a journey to Lithgow. Previous reporting did not capture those two passenger types, hence the significantly lower previous number.

Figure 23 Index of non-urban rail patronage, by operator



Notes: NSW Trainlink is the sum of CountryLink patronage and former CityRail inter-city lines. Further to Footnote 30 (on previous page), there is no New South Wales data presented for the periods prior to 2012–13 due to the formation of TrainLink on 1 July 2013. The 2012–13 data is an estimation the New South Wales Bureau of Transport Statistics calculated as an indexing benchmark immediately prior to TrainLink's formation. Including previous years' data would not be comparing 'like for like'.

Queensland Rail data exclude services under the TransLink brand on the Sunshine Coast and Gold Coast lines.

Sources: VLine 2014, p. 10; BITRE correspondence with NSW TrainLink; Public Transport Authority of Western Australia 2014, p. 54; Queensland Rail 2014, p. 39; historical annual reports.

Some noteworthy trends are:

- **Queensland Rail** non-urban rail travel has declined over the last decade. Long-distance and scenic railway services are vulnerable to reductions in discretionary spending because they rely on leisure travel and tourism (including foreign tourism which may be influenced by changes in the value of the Australian dollar). According to the Queensland Rail 2013–14 annual report, approximately half of its non-urban patronage for the financial year was on the Kuranda Scenic Railway.
- **NSW TrainLink.** It is not yet possible to assess meaningful NSW TrainLink patronage trends due to the formation of TrainLink on 1 July 2013. According to data TrainLink provided to BITRE, however, regional patronage declined from 1.86 million journeys in 2012–13 to 1.80 million journeys in 2013–14 and 1.76 million journeys in 2014–15. Transport for NSW (2012, p. 229) note the declining quality of long-distance services, including on-time running and frequency, has made train travel uncompetitive with cars.[31]

31 Transport for NSW is developing the Country Passenger Rail Services Strategy to improve service standards across the regional rail network.

- **V/Line** patronage has more than doubled over the last decade. This follows major upgrades between 2003 and 2006 under the Regional Fast Rail programme. (BITRE 2014 (pp. 61–70) reviews the upgrades.) The upgrades provided service enhancements that reduced scheduled transit times and increased frequencies (see p. 100). Other contributory factors on the patronage trend include a fare reduction (20 per cent in March 2007), central Melbourne employment growth, and strong population growth in the affected corridors (such as in the Melton/Bacchus Marsh area, which grew by 34 per cent between 2007 and 2012 (BITRE 2014, p. 69). The rail upgrades may have stimulated such population growth. The 2012–13 decline can be attributed to the completion of the Sunbury Electrification Project that transferred some former V/Line passengers to Melbourne Metro services (BITRE, 2014d, p. 69). V/Line (2014, p. 22) further attributes the decline to the upgrades work and lengthy temporary line closures during the 2013–2014 financial year. The opening of Regional Rail Link in June 2015, which separates inter-city trains from Geelong, Ballarat, and Bendigo from suburban Melbourne trains has further reduced scheduled inter-city transit times, which may make non-urban rail travel more attractive.
- **TransWA** patronage has declined since 2006–07, due to patronage decline on the Perth–Bunbury (*Australind*) route, which accounts for almost half of TransWA's rail patronage[32]. The service was disrupted by track work in 2008–09 (Public Transport Authority of Western Australia 2009, p. 36). The service's competitiveness was reduced in 2009–10 when the upgraded Forrest Highway was opened. This reduced road travel time between Perth and Bunbury (Public Transport Authority of Western Australia 2013, p. 39). Another possible reason for declined patronage on the *Australind* is the opening of the Perth–Mandurah line, which runs roughly parallel to the *Australind* line immediately south of Perth.
- Traffic data are not available for Great Southern Rail services (Sydney–Perth *Indian Pacific;* Melbourne–Adelaide *The Overland*; Adelaide–Darwin *The Ghan*) although, with one or two services per week, relatively modest patronage levels can be assumed[33]. Tasmania has no passenger rail services other than purely tourist railways.

32 The four services and their 2012–13 patronage are: Perth–Bunbury *Australind* (117 456), Perth–Kalgoorlie *Prospector* (95 303), Midland–Northam *AvonLink* (14 126), Perth–Merredin *MerredinLink* (6 992). (Public Transport Authority of Western Australia 2013, p. 39).

33 BTRE 2003, p. 198 provides historical traffic levels for the *Indian Pacific* ("approximately 110 thousand passengers in 2001") and *The Overland* ("approximately 80 thousand passengers in 2001").

CHAPTER 3

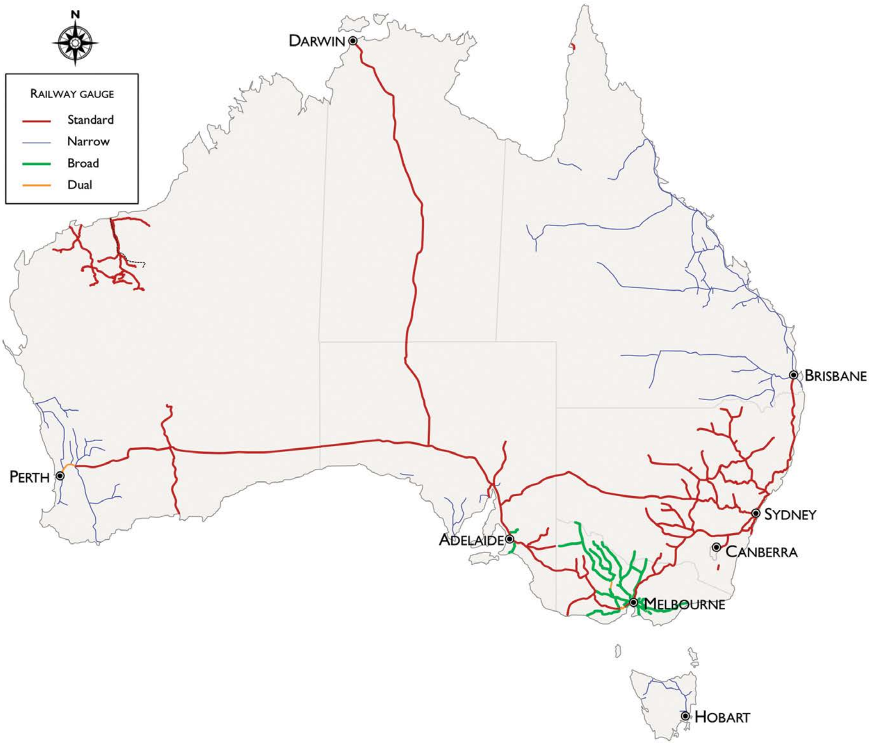
Infrastructure and rolling stock provision

This chapter analyses data on railway capital provision—railway network infrastructure and train operator rolling stock.

Railway network

Australia's railway network was constructed with different gauges at different parts of the system. In particular, the network mostly developed outwards from the State capitals, with cross-border links coming only after intrastate lines were well developed. The exception is Queensland, whose early railways consisted of a network of disparate railways that connected inland areas with coastal ports. These railways were eventually linked, forming the current Queensland network. While the aspects of the break of gauge legacy remains (Figure 24), interstate trains now operate across a continuous 1 435 mm 'standard' gauge.

Figure 24 Railway network, by track gauge, August 2015



Notes: The lines shown here are the railways that are open for traffic at August 2015. The BHP Goldsworthy line is shown but it has been mothballed since 2014.

Broad ("Irish") gauge is 1 600 mm; standard ("Stephenson") gauge is 1 435; narrow ("Cape") gauge is 1 067 mm.

Table 13 shows route kilometres of electrified and non-electrified railways in each jurisdiction. Queensland, Western Australia and New South Wales have similar-sized networks. Most of the network is single-tracked (approximately 89 per cent) although with some exceptions, such as the Sydney–Melbourne line (of which around three-quarters is now double-track) and the East Turner River corridor through the Chichester Range in East Pilbara (with some BHP Billiton double track and some Fortescue double track).

Table 13 Route kilometres of open heavy railway in 2014, by jurisdiction, gauge and electrification

State or Territory	ACT	NT	NSW	Qld	SA	Tas	VIC	WA	Total
Route kilometres by gauge									
Broad			73		253		2 921		3 247
Narrow		3	8	8 093	561	667	16	2 970	12 318
Standard	6	1 690	7 083	117	3 114		1 222	4 214	17 446
Other			1	4			30		35
Dual				36	22		32	207	297
Total	6	1 693	7 165	8250	3 950	667	4 221	7 391	33 343
Route kilometres by electrical system									
1 500V DC			641				375		1 016
25 kV AC				2 040	44			171	2 255
33 kV AC			8						8
Total			649	2 040	44		375	171	3 279

Notes: V denotes volts, kV denotes kilovolts, and Hz denotes hertz. DC denotes 'direct current' and AC denotes 'alternating current'.
Data may not add to totals due to rounding.
Does not include urban light rail and tramways; the extensive Queensland sugar tramways are excluded.
Queensland figures include the 19 kilometres of standard gauge railway at the Rio Tinto bauxite mine at Weipa.

Source: BITRE estimates, data provided by Aurizon, Rio Tinto Alcan.

Queensland has the longest length of electrified railway, principally due to the electrified line between Rockhampton and Brisbane and a number of coal lines in Central Queensland. Elsewhere, overhead power systems have been installed on lines with relatively-intensive urban and selected intercity passenger services. Around 10 per cent of the network route-kilometres are electrified. Appendix D provides an overview of the network in terms of infrastructure manager and of management structure (that is, whether the manager is vertically-integrated or vertically-separated).

New railways

808 route-kilometres of freight track and 89 route-kilometres of passenger (heavy- and light-rail) track have been opened since 2010 (Table 14).

Table 14 Railways opened from 2010

Traffic	Location	State	Length (km)	Project	Infrastructure builder
Iron ore	Mesa K – Waramboo (Mesa A)	WA	49	Mesa A	Rio Tinto
Iron ore	Cloudbreak – Christmas Creek	WA	50	Christmas Creek extension	Fortescue Metals Group
Iron ore	Tilley Siding (Morawa) – Karara	WA	85	Karara Rail Spur	Karara Mining Ltd
Iron ore	Solomon Junction – Solomon	WA	130	Solomon extension	Fortescue Metals Group
Iron ore	Hope Downs 4 railway	WA	53	Hope Downs extension	Hope Downs Joint Venture (Hancock – Rio Tinto)
Iron ore	Roy Hill – Port Hedland	WA	344	Roy Hill	Hancock Prospecting
Coal	Cameby Downs Loop	Queensland	7	Cameby Downs Loop	Queensland Rail
Coal	Goonyella–Newlands	Queensland	68	Northern missing link	Aurizon
Coal	Middlemount Rail Spur	Queensland	16	Middlemount Rail Spur	Macarthur Coal
Coal	Maules Creek – Werris Creek line	NSW	20	Maules Creek	Whitehaven
Coal	Aldoga – Wiggins Island	Queensland	13	Wiggins Island Coal Export Terminal	Aurizon
Coal	Moranhbah – Caval Ridge	Queensland	12	Caval Ridge Spur	Billiton Mitsubishi Alliance
Intermodal	Sefton–Macarthur	NSW	36	Southern Sydney Freight Line	ARTC
Inter-Urban passenger	Deer Park – West Werribee	Victoria	27	Tarneit (Regional Rail Link)	V/Line
Urban passenger	Darra–Springfield	Queensland	10	Springfield branch	Queensland Rail
Urban passenger	Glenfield – Leppington	NSW	12	Leppington line	RailCorp
Urban passenger	Epping – South Morang	Victoria	4	South Morang Extension (re-opening)	V/Line
Urban passenger	Noarlunga–Seaford	SA	6	Noarlunga Line extension	Department of Planning, Transport and Infrastructure
Urban passenger	Clarkson–Butler	WA	8	Joondalup Line extension	Transperth (Public Transport Authority)
Urban passenger light rail	Griffith University – Broadbeach	Queensland	13	Gold Coast Light Rail	Queensland and Australian governments; Gold Coast City Council, GoldLinQ
Urban passenger light rail	Lilyfield – Dulwich Hill	NSW	6	Inner West Light Rail extension	Transport for NSW
Urban passenger light rail	North Terrace – Entertainment Centre	SA	3	Port Road Light Rail Extension	Department of Planning, Transport and Infrastructure

Notes: The Epping – South Morang project was a line re–opening, using right-of-way from a railway that was closed in 1959.
A list of network additions since 1970 is at Appendix B.

Source: BITRE 2015 rail database, data provided by Aurizon.

Expansion of the mining industry has provided the source of much of the recent rail infrastructure expansion and subsequent rail freight task. Of the new railways, 711 route-kilometres have been constructed for iron ore exports, predominantly in the Pilbara region.

The development of iron ore mines in the Pilbara region of Western Australia has led to the construction of a network of railways linking mines with ports at Dampier, Cape Lambert (Port Walcott) and Port Hedland. BHP Billiton's network in the region began with the opening of the 208 kilometre Goldsworthy – Port Hedland Railway in 1965. Rio Tinto's line between Tom Price and Dampier opened in 1966. The third large mining company in the region is Fortescue Metals Group, which opened a railway between Cloudbreak Mine and Port Hedland in 2008. By early 2014, there were 2 295 route kilometres of railway in the Pilbara region. A year later Hancock Prospecting added 344 route kilometres of standard gauge single line railway to the network connecting the Roy Hill Mine to the port facility in Boodarie Industrial Estate south of Port Hedland. The Roy Hill Railway is pivotal to the development of iron ore mining at Roy Hill in the Pilbara Region—see the Pilbara railways map (Figure 9, p. 20). Processed iron ore is transported from the development site to Port Hedland. The operation uses Roy Hill's two new berths, SP1 and SP2, at Stanley Point within the port. BITRE 2013 (p. 21) presents a map of the railway, berthing stockpile facilities at Port Hedland (inner harbour). Enhancements to track and train specifications mean trains in the region are amongst the longest and heaviest in the world.

Since 2009, 110 kilometres of railway have been constructed for coal haulage. Coal exports, centred on Queensland's Bowen, Galilee and Surat Basins and the Hunter Valley network in New South Wales, rely on the railway network for moving coal to ports. New lines and additional capacity have enabled the substantial expansion of exports.

There are numerous other significant infrastructure construction and renewal activities. The Goonyella–Newlands railway in Queensland is part of the Goonyella to Abbot Point Expansion ("GAPE") project, enabling additional coal exports. Other projects include substantial Commonwealth investment in the interstate network, with new signalling, passing loops and passing lanes, re-railing, re-sleepering and re-ballasting. The Northern Sydney Freight Corridor Program, currently underway, will provide a dedicated freight track through northern Sydney and other infrastructure improvements to ease congestion. There have also been renewal and capacity-enhancing projects on urban passenger networks. Sydney's rail clearways programme enhanced the network's capacity and reliability through targeted works on key bottlenecks. Adelaide's urban passenger network has undergone extensive track renewal and the Seaford line has been electrified.

Table 15 lists railways that are being constructed in 2015, with 53 route-kilometres being built.

Table 15 Heavy Railways under construction, 2015

Traffic	Location	State	Length (km)	Project	Infrastructure builder
Coal	Rail spur to Boggabri Coal Mine	NSW	17	Boggabri Coal Mine Expansion	Idemitsu Australia Resources
Urban passenger	Petrie – Kippa Ring	Queensland	13	Moreton Bay Railway	Queensland Rail
Urban passenger	Epping– Cudgegong Road	NSW	23	North West Rail Link	Transport for NSW

The new coal spur line under construction will be serving the Boggabri Coal Mine Expansion in the developing Gunnedah Basin. The two urban passenger railways that are under construction will serve new developments in outer urban areas of Brisbane and Sydney.

Infrastructure activities extend beyond new railway construction, however, with a range of enhancement projects across the country. For example, the development of the Wiggins Island Coal Export Terminal (at the Port of Gladstone) involves a range of major railway infrastructure, including adding line capacity with additional tracks and passing loops; and enhancing train capabilities and efficiencies through extending overhead power for electric train operation (on the 107 km Bauhinia rail spur to the Rolleston coal mine).

Dedicated commodity networks

As discussed in Chapter 2, the primary railway traffic flows are iron ore, coal, grains, intermodal, and urban passengers. Major parts of the Australian railway network are dedicated to serving individual commodity flows. These are now considered.

Iron ore and coal networks

The iron ore and coal networks are illustrated in Figure 8 (p. 19). The iron ore railway networks in the Pilbara region were built by mining companies exclusively to serve the iron ore mines, as was the Karara (Western Australia) spur line and the Middleback railways (near Whyalla) in South Australia. As bespoke developments, these lines were generally built to very high standards in order to accommodate the large traffic flows envisaged. On many of the lines there has been extensive subsequent capacity expansion (signalling, track and train capacity).

A considerable number of dedicated coal lines were developed in eastern Australia, generally being grafted onto the existing mixed-traffic network. While those standards are high—and include electrified systems—they are generally of a lower standard than the purpose-built iron ore lines.

Grain railways

Grain railways usually feed into secondary or main lines. (The map of grain haulage is shown on page 24.) By contrast with iron ore and many coal railways, the grain lines are generally built to lower technical and operational standards and are in poorer physical condition. Compared to the variable, seasonal grain traffic, iron ore railways operate exceptionally long and heavy trains that run a number of times a day; consequently they are maintained to much higher standards than grain lines. By way of illustration, while Fortescue railways have 40 tonne axle-load limits, some grain railway axle load limits may be as low as 15 tonnes.

The technical and operational diversity of the grain lines—mostly reflecting the varying importance (levels) of different branch traffic flows—has led to the classification of lines according to their technical standard (and, thus weight-bearing capability or train speed), or to their economic importance or to their viability. The respective categories across the states[34] are outlined here.

34 Most of South Australia's railways have been closed and the remaining four lines have not been classified.

Queensland

The "network capabilities" of railways in Queensland are classified according to the maximum permitted axle loads on a given section of track. BITRE 2006 (p. 305) shows the prevailing axle loads that were current in 2005. Network information packs for access seekers provide details about track standards and permitted axle loads and train speeds[35]. Often the axle-load limits are 15 tonnes. It has been noted that rail cannot be used to haul containerised grain for some flows as the loaded wagons would exceed axle load limits (Transport, Housing and Local Government Committee [Queensland] 2014, p. 24).

New South Wales

The New South Wales government's grain railways are categorised by class of track. Mainline tracks can be at the highest physical condition and technical standard of "Class 1". The grain railways are either Class 3 (45 per cent of the route-km) or the lowest standard, Class 5 (55 per cent of the route-kilometres[36]). The axle load limits on these two classes of line is 19 tonnes; this compares with 25 tonnes on Class 1 lines and 21 tonnes on Class 2 lines.

Victoria

Switchpoint¸ the 2007 review of the State's rail network, established a classification of different railways (Department of Infrastructure 2007). The classification attached descending priority for track rehabilitation (or upgrading)—from a high-priority Platinum, Gold, Silver, and Bronze—to restore the railway infrastructure to the original track condition classification (which was generally Class 4 or [at a lower standard] Class 5). Note, however, that while these lines are of different operating standards, they are all suitable for 19 tonne axle load grain trains.

The Victorian government is also investing in grain and other bulk transport by rail as part of the Murray Basin Rail Project. The project involves standardising the rail line gauges that serve the Murray Basin in north western Victoria, and increasing axle loads from 19 to 21 tonnes. Gauge standardisation will enable the port at Portland (which only has a standard gauge rail connection, to compete with the dual gauge ports of Melbourne and Geelong. The project is expected to cost $416 million (Department of Economic Development, Jobs, Transport and Resources, 2015).

Western Australia

Grain railways in Western Australia are classified by their viability and competitiveness. Tier 1 lines are considered to be competitive with road transport at present and are perceived to remain competitive given probable future cost increases. Tier 2 railways are currently cost competitive with road, given prevailing rail access prices and train operating costs. Tier 3 lines are regarded as unviable as rail volumes are low and trains are uncompetitive with road transport. The lines are also typified by low (16-tonne) axle loads, with low-standard track structure. (Strategic Design and Development 2009, p. 8) In 2014, a parliamentary inquiry was undertaken to investigate aspects of the WA freight rail network, including the provision of Tier 3 railways—see the Economics and Industry Standing Committee of the WA Parliament Legislative Assembly (2014).

35 An illustration of this information can be seen with the "Information pack" for South Western Queensland (Queensland Rail) [Network Access], undated.

36 New South Wales Grain Freight Review 2009, p. 59.

Urban heavy-rail passenger networks

The geographical reach of Australia's urban heavy rail networks is extensive, even if the network coverage is not dense (see Table 16). The networks are radial—reflecting the historical development of Australian cities—with lines branching from dense Central Business Districts (CBDs) into the surrounding, low density suburbs[37].

Table 16 Network characteristics of heavy urban passenger railways, 2014

	Sydney	Melbourne	Brisbane	Adelaide	Perth
Operator	**Sydney Trains**	**Metro Trains Melbourne**	**Queensland Rail**	**Adelaide Metro**	**Transperth**
Ownership	**Public**	**Private (government franchise)**	**Public**	**Public**	**Public**
Dedicated metropolitan passenger lines (km)	190	232	90	126	173
Shared metropolitan freight/passenger lines (km)	156	171	140	-	1
Total metropolitan route length (km)	346	403	230	126	173
Electrified metropolitan route length (km)	346	373	230	44	173
Metropolitan stations (number)	178	218	125	86	70
Average distance between stations (km)	1.9	1.8	1.8	1.4	2.5
Metropolitan passenger route length under construction (km)	23	-	13	-	-
Passenger network gauge	Standard	Broad	Narrow	Broad	Narrow

Notes: Distances are route kilometres.

Metropolitan networks are defined by passenger operator boundaries with the exception of Queensland Rail. Brisbane's metropolitan network is defined here as being bounded by Caboolture, Shorncliffe, Domestic Airport, Doomben, Cleveland, Beenleigh, Rosewood, Springfield Central and Ferny Grove.

Does not include track dedicated to urban freight only.

Sources: Estimates derived from BITRE 2015; Public Transport Authority Western Australia, 2014; Data provided by Adelaide Metro.

There are a number of characteristics and trends that make each system distinctive:

- **Network expansion.** Developments in Perth's system in recent years stand apart from experiences in the other cities, where small increments have been added to each city's systems. By contrast, Perth's system has developed over the last 20 years from a very small network to a route-kilometre length that is just shy of that of metropolitan Sydney. New lines from Perth—to Joondalup / Currambine / Butler (41 km), and Mandurah (70 km), and the Thornlie branch (three km)—have transformed long-distance urban movement within the city. (See Appendix B for dates of railway openings.)
- **Network form.** Perth's system is also distinctive relative to the other networks due to the nature of the new railways. Table 16 shows Perth's network is almost 45 per cent longer than Adelaide's, but has 16 fewer stations. This station spacing has resulted in significantly higher average train speeds on Perth's Mandurah line and, to a lesser extent, the Butler line when compared to other lines (see Figure 38 on page 90). With fewer stations, good station access is primarily emphasised by rail-bus interchanges, extensive park-and-ride facilities and encouragement of (nearby) Transit Oriented Development (TOD).

37 Maps of these systems are provided in BITRE (2012).

- **Shared networks.** Brisbane, Melbourne, Adelaide and Perth systems use a different track gauge to the interstate network. This has limited operational interfaces between freight and urban passenger trains although the issue remains where intrastate freight services operate. Exceptions include the north coast intermodal freight and coal from the Toowoomba region into the Port of Brisbane and steel products between Melbourne and Long Island (via the Frankston suburban line). Sydney's network is unique in being standard gauge throughout. It therefore shares capacity with trains travelling on the interstate North–South and East–West (via Lithgow) corridors, as well as intrastate freight. The recently-opened Southern Sydney Freight Line provides dedicated southern access to Sydney freight yards, which has eliminated the previous southern Sydney curfew on their operations during passenger commuting periods.
- **Electrification.** Electrified services commenced in Sydney and Melbourne[38] from the early inter-war period using Direct Current (DC) traction power. More advanced electrical technology using Alternating Current (AC) traction power used in other Australian cities due to more recent electrification. Perth and Brisbane electrified their networks relatively recently—Brisbane from the late 1970s and Perth from the early 1990s. In Adelaide the "Rail Revitalisation Programme" includes track enhancements and the commencement of system electrification. Electric train operation commenced on the Seaford and Tonsley lines in 2014[39].

There are new passenger heavy rail lines under construction in Brisbane and Sydney—Brisbane's Moreton Bay Railway and Sydney's North West Rail Link. See Table 15 for further details.

Urban light rail passenger networks

The technological and operational differences between tramways, light rail and heavy rail are increasingly blurred.[40] This report will refer to Australia's light rail operations with an understanding that the networks, in particular in Melbourne, share characteristics with tramways. It should also be noted former heavy rail corridors form parts of the network in Melbourne, Sydney and Adelaide.

By route kilometrage, Melbourne has the world's largest light rail network. Single route operations are on the Gold Coast in Queensland and in Sydney and Adelaide (see Table 17).

Table 17 Network characteristics of light railways

	Gold Coast	Sydney	Melbourne	Adelaide
Total route length (km)	13	12.8	250	15
Segregated right of way	largely segregated	largely segregated	20% segregated	largely segregated
Routes (no.)	1	1	24	1
Number of stops (no.)	16	23	1 763	22

Sources: Currie and Burke 2013; Yarra Trams 2014.

38 Only Melbourne's Frankston – Stony Point line remains un-electrified.
39 It is not intended to electrify the line between Goodwood Junction and Belair.
40 Tramways are generally considered to have short spacing between stations and operate on roads, often sharing a right-of-way with road traffic. Light rail is considered to largely have its own right-of-way with more widely spaced stations. Melbourne's extensive system, in particular, illustrates the flexibility of light rail and its consequent definitional blurring. Light rail vehicles operate on former heavy rail lines at St Kilda and Port Melbourne. The majority of the network, however, shares right-of-way with road traffic and has relatively short spacing between stations.

Operationally, Melbourne's network is distinct, with only a small proportion of the network being segregated from road traffic, and with close spacing between stops. In character some parts of the network share the close-stop and on-road feature of buses whereas in other parts it more closely resembles the limited-stop, segregated railway. These characteristics mean Melbourne's average speed is significantly lower than other cities; see Table 31.

Sydney and Adelaide once had significant tramway systems but these were progressively closed from the middle of the 20th century. Adelaide's single remaining line runs between the Adelaide Entertainment Centre and Glenelg, via the CBD. The majority of the route length is in a segregated light rail corridor between the edge of the CBD and Glenelg, using a former heavy-rail corridor.

Sydney's light rail line, between Central Railway Station and Dulwich Hill station, runs along a former freight rail corridor, with a small segment of on-road (largely segregated) operation between Haymarket and Central Railway Station.

The Gold Coast light railway, which opened in July 2014, runs between the Gold Coast University Hospital and Broadbeach. The line has been placed along roads but the space is generally not shared with road traffic. The line runs along a dense retail corridor (Currie and Burke 2013, p.12). Average station spacing is the highest of the cities.

Non-urban passenger network

By contrast, with much of the urban rail systems, the non-urban passenger services are not stand-alone networks. Typically, the non-urban services share track with urban passenger and freight trains, although the June 2015 opening of the Regional Rail Link has reduced this in Victoria. (The coverage of the non-urban passenger operations services, by principal operator, is presented in Figure 22.) Key network characteristics of the regional passenger services, including heritage railways, are presented in Table 18.

Table 18 Network coverage of non-urban passenger rail services

	Queensland Rail	NSW TrainLink	V/Line	TransWA	Great Southern Rail	Heritage operators
Electrified route kilometres	728	449	-	-	-	1
Total route kilometres	4 617	4 275	1 655	836	7 243	555 (approx)

Notes: Queensland Rail route length includes the Gympie North – Brisbane and Brisbane – Varsity Lakes services.

Diesel services may run on electrified track. Where non-urban electrified and diesel services share electrified track (such as Rockhampton–Brisbane), the route is defined as electrified. Where non-urban diesel services share track with electrfied urban trains (such as V/Line services on Melbourne's metropolitan network), the route is defined as not electrified.

Melbourne's Regional Rail Link was completed in mid-2015 separating regional trains from metropolitan trains – giving Geelong, Bendigo and Ballarat trains their own dedicated tracks through the metropolitan system from Sunshine to Southern Cross Station.

Source: BITRE 2015.

Train operator equipment stock (excluding wagons)

Locomotives

Data on attributes of Australia's locomotives allow classification of the fleet. Data presented here use the age of the locomotive since built new, or the age since rebuilt, whichever is the lower period.[41] The age of the fleet reflects a range of different underlying influences on rolling stock investment. Figure 26 shows approximately 50 per cent of Australia's fleet was aged approximately 14 years or under at the end of 2014, compared to approximately 11 years or under the previous year. It does not show locomotives that have been introduced or are due for introduction in 2015.

What the table and figures below do not show is the degree of and type of locomotive usage. Newer locomotives tend to be assigned primary 'frontline' duties such as hauling intermodal trains across the continent or hauling coal or iron ore trains, while older locomotives tend to be assigned lesser secondary duties such as providing additional motive power behind newer locomotives and doing local or yard duties. While the NR class locomotive, which is the mainstay of Asciano's intermodal services, is almost 20 years old, they are being progressively upgraded with new engines.

Care should also be taken when comparing locomotive ages by gauge, particularly between the broad and standard gauges, where there is considerable re-gauging of the previous Victorian government owned locomotives, such as the G, T, and N classes. For example, five of the previous all broad gauge N class locomotives have been converted to standard gauge for the Melbourne-Albury V/Line passenger services.

Table 19 also shows there has been no new investment in broad gauge locomotives. V/Line has, however, invested heavily in its new VLocity DMU sets which have been progressively introduced since 2006 and which are replacing many of the previous N and A class hauled medium distance passenger services. The VLocities are not shown because they are DMU sets rather than locomotives.

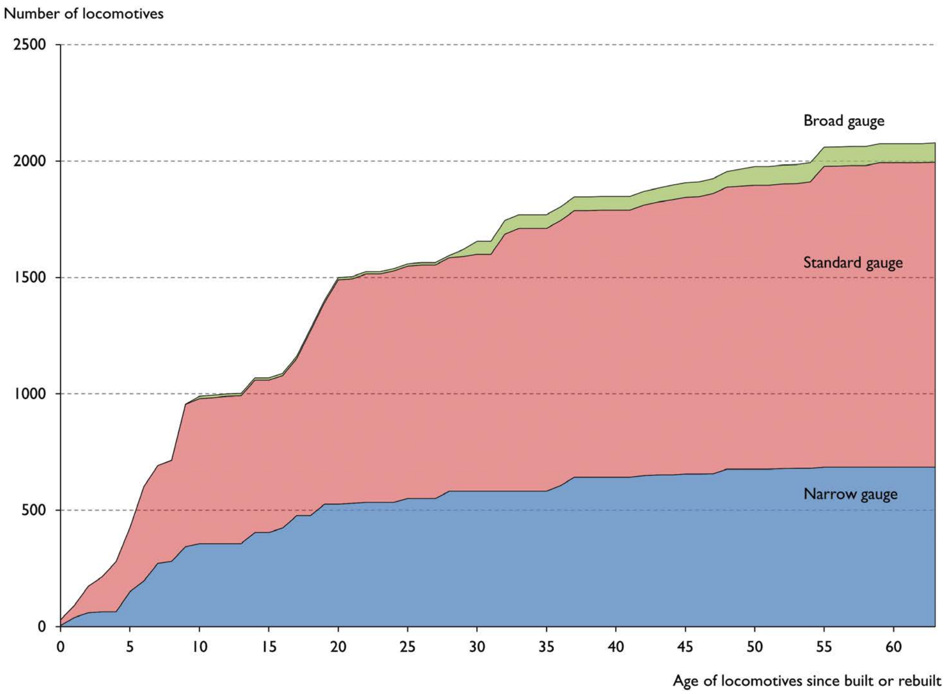
Table 19 Locomotive ages

Age range (years)	Narrow Gauge	Standard Gauge	Broad Gauge	Total
0–5	151	275	0	426
6–10	206	348	10	564
11–15	48	31	0	79
16–20	121	310	0	431
21–25	25	34	0	59
26–30	31	58	46	135
31–35	0	106	3	109
36–40	60	18	0	78
41–45	14	41	4	59
46-50	21	31	18	70
51+	8	91	3	102
Total	685	1343	84	2112

Source: BITRE analysis of data from Cleverdon 2014.

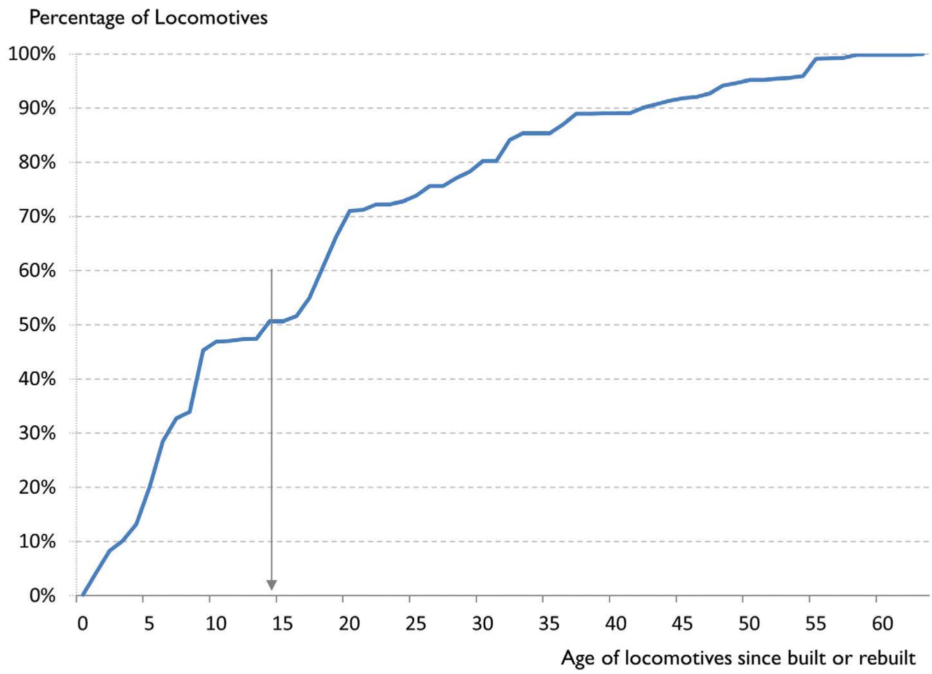
41 Rebuilt locomotives can attain the same (or better) performance and longevity characteristics as a new locomotive.

Figure 25 Cumulative locomotive age profile, by number of locomotives



Source: BITRE analysis of data from Cleverdon 2014.

Figure 26 Cumulative locomotive age profile, per cent



Source: BITRE analysis of data from Cleverdon 2014, Railpage (2015), and Clark, (2012).

Figure 27 Transcontinental Intermodal Train

Note: The image above shows an Asciano (Pacific National) Perth–Sydney intermodal train at Cootamundra West. While NR class lomotives are the mainstay of these trains, previous generation locomotives, such as the DL class, as shown in this photo (third unit), are sometimes used to provide additional motive power, particularly as banking units in the Adelaide Hills. Lead unit NR23, as shown in the image, was overhauled in March 2013.

Source: Photograph courtesy of Rodney Avery.

Box 7 Further resources

- The monthly magazine *Railway Digest*, compiles a list of current and recently completed rolling stock contracts and deliveries—for locomotives, wagons, permanent-way vehicles and passenger stock. This list is published regularly in the magazine. Railpage.com.au also provides regularly updated details of locomotives by gauge, operational status, and current operator. Railpage.com.au provides current data on locomotives.

Urban passenger rolling stock

The levels of rolling stock required by different networks are a function of a range of factors, including:

- traffic levels;
- the size of the network and the length of individual lines;
- the range of different services on each part of the network (such as offering stopping, semi-fast, and express services on a given line); and
- the average speed of services (with faster operations requiring fewer train sets).

Heavy rail stock

Urban heavy rail rolling stock is generally modern, with the last of the 1970s stock in the process of being phased out. Operators are in the ongoing process of fleet replacement or procuring additional stock. Most of the rolling stock is air-conditioned, with the remaining 24 of Sydney's non-air-conditioned S-Set trains used on low patronage lines and for stand-by services. (See Table 20.)

Most train services are provided by "multiple-unit" stock—permanently-coupled carriages. Sydney's fleet generally run as four car units, coupled into eight car trains. Elsewhere, the standard stock is the three-car EMU, generally being paired as six-car trains. There are some exceptions. The characteristics of Adelaide's rolling stock, with large numbers of one and two-car units, enables the local provider, Adelaide Metro, to cater for comparatively modest traffic levels with a broad range of configurations. In addition, there are some two car operations in Perth.

Table 20 Heavy rail rolling stock

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Vehicles (no.)	633	1 622[a]	1 308	130	267[b]
Air-conditioned vehicles (no.)	633	1 430	1 308	130	267[b]
Carriage format	Single-deck	Double-deck	Single-deck	Single-deck	Single-deck
Multiple-unit format	211 three-car	249 four-car 78 eight car	436 three-car	30 one-car; 20 two-car; 20 three-car;	48 two-car; 57 three-car
Common train formations	EMUs coupled as six-car	EMUs coupled as eight-car	EMUs coupled as six-car	DMU, up to four-car; EMUs EMU normally three-car, can couple as six car	EMUs coupled as six-car on new lines

Notes: a Sydney's S-set rollingstock is being progressively removed from service; 24 will be retained until at least 2019 for stand-by services.

b B-set rollingstock is being progressively introduced to service; 57 out of 68 three-car sets have been delivered as of August 2015.

Sources: Sydney Trains 2015; VicSig 2015; Data obtained from Queensland Rail; Public Transport Authority WA 2015a; Data obtained from Adelaide Metro.

Sydney is the only system to use double-deck carriages. Suburban single-deck trains were gradually replaced with double deck trains from 1964. The objective of this policy—facilitated by relatively generous height limits—was to increase the passenger-carrying capacity of the system on the existing infrastructure. The Melbourne system experimented with operating a double-decker train on a suburban line in the 1990s but did not proceed with this format.

Light rail

Melbourne's light rail fleet is much larger and more varied than the other cities; see Table 21. Melbourne's older rolling stock, such as the Z and A classes—introduced between 1975–1984 and 1984–1986, respectively, are comparatively short and low capacity.

Over the past 30 years, there has been a progressive move towards longer, higher capacity vehicles, using vehicle articulation rather than the coupling of vehicles (as had been the practice with Adelaide's now-heritage H-class trams). Melbourne's E class—progressively introduced from 2013—is more than twice the length of the earlier Z and A classes. Similarly, rolling stock introduced in the last decade in other cities are all over 30 metres in length.

Table 21 Light rail rolling stock

City	Vehicle type	Length (metres)	No. vehicles
Gold Coast	Flexity 2	43	14
Sydney	Variotram	29	-
	Urbos 3	33	10
Sydney total			10
Melbourne	A1 class	15	27
	A2 class	15	42
	B1 class	23.5	2
	B2 class	23.6	129
	C class	23	36
	C2 class	32.5	5
	D1 class	20	38
	D2 Class (Combino)	29.9	21
	E Class	33.5	26
	Z1 class	16	19
	Z2 class	16	2
	Z3 class	16.6	114
	W6 class	14.2	3
	W7 class	14.2	1
	SW6 class	14.2	6
Melbourne total			471
Adelaide	100 Flexity Classic	30	15
	200 Citadis	32	6
Adelaide total			21

Note: Fleet numbers are based on rollingstock in service.
Adelaide retains two heritage H class trams for tourist trips and special events.

Sources: Bombardier 2015; Currie and Burke 2013; Yarra Trams 2015; VicSig 2015a; Transdev 2015.

Non-urban passenger rolling stock

Much like urban rail rolling stock, and reflecting historical acquisitions, the composition of the non-urban passenger stock is a function of:

- traffic levels;
- service frequency;
- the size of the network and the length of individual lines;
- the range of different services on each part of the network (such as offering stopping, semi-fast, and express services on a given line); and
- the average speed of services (with faster operations requiring fewer train sets).

There are a wide range of non-urban passenger services in Australia. Thus, rolling stock, designed for individual markets and service types, vary considerably. Table 22 shows the number of individual vehicles/cars, by type and operator.

Table 22 Non-urban passenger rolling stock, by vehicle type and operator

	Queensland Rail	NSW TrainLink	V/Line	TransWA
Electric multiple unit cars (no.)	150	445	-	-
Diesel multiple unit cars (no.)	27	65	177	14
Locomotives (no.)	26	19	41	-
Carriages (no.)	27	60	133	-
Total cars/vehicles	230	589	351	14

Notes: Rolling stock may also be used in urban operations, electric multiple units in intercity operations, for example, often act as limited-stop urban trains once they enter the metropolitan network.

The above lists individual vehicles rather than sets.

Great Southern Rail's trains are hauled by Asciano, using Asciano locomotives on a 'hook and pull' basis.

Sources: VicSig 2015b; Sydney Trains 2015; NSW TrainLink 2015; Public Transport Authority of Western Australia 2015a; Data provided by Queensland Rail, V/Line 2015.

Locomotive hauled trains are primarily used for long-distance routes. A number of Queensland Rail's long-distance services, are locomotive hauled, although the diesel tilt train has recently replaced the locomotive hauled Sunlander that travels between Brisbane and Cairns. V/Line's N class locomotives haul long distance trains on both the broad and standard gauges.

Figure 28 N Class Locomotive Hauled Train

Note: This image shows a (standard gauge) N Class hauled Albury–Melbourne V/Line passenger train near Barnawartha in Victoria.

Source: Photograph courtesy of Rodney Avery.

Medium-distance regional/commuter services are generally operated with diesel multiple units (DMUs). High-performance VLocity DMUs that are capable of travelling at 160km/h are core components of Victoria's Regional Fast Rail services. TransWA uses DMUs exclusively for their service on the Perth–Bunbury and Perth–Kalgoorlie corridors. NSW TrainLink uses DMUs for the Sydney–Canberra service and intrastate services to Armidale, Broken Hill, Griffith and Moree. On board facilities, such as buffet, are provided depending on the length of the service. All DMUs are air-conditioned and generally seat two either side of a central aisle.[42]

NSW TrainLink and Queensland Rail have large EMU fleets, largely used for intercity/commuter services. New South Wales, uses its fleet is used for Wickham (Newcastle)–Sydney, Sydney–Lithgow and Sydney–Kiama (via Wollongong) services. Much of Queensland Rail's EMUs are used on the Sunshine Coast and Gold Coast lines.

A unique passenger rolling stock for Australia is Queensland Rail's fleet of tilt train (fixed-formation) sets. Queensland Rail has a fleet of electric tilt trains, used on Rockhampton–Brisbane services, and diesel tilt trains used on the Cairns–Brisbane services. (BITRE 2014, p. 60 and pp. 161–162, discusses the nature of the tilt-train services and the principles of tilt trains.)

42 NSW TrainLink's Hunter and Endeavour trains seat five across.

CHAPTER 4
Railway performance

Network indicators

Safety

Table 23 shows the normalised[43] rate of train safety occurrences, by category of event[44]. Collisions with infrastructure and running line derailments are the most common form of accident. These are followed by collisions with a person (not at a level crossing) and collisions with vehicles at level crossings.

43 Normalisation means, in this context, to transform measurements so that they can be compared in a meaningful way. In the context of the railway statistics cited here, the occurrences are reported relative to the level of railway activity that is undertaken. Clearly, the likelihood of any safety-related occurrence will rise, *cet. par.,* with the level of activity (usage) of the network. In this case, the occurrences are factored relative to the number of train kilometres operated.

44 ATSB has not published new train safety data as shown in Tables 23 and 24 since *Trainline 2* was published.

Table 23 Normalised occurrence rate, per million train kilometres travelled

Year	Period	Running line derailments	Collisions with trains	Collisions with rolling stock	Collisions with person (not level crossings)	Collisions with vehicle (not level crossings)	Collisions with infrastructure	Collisions with vehicle (level crossings)	Collisions with person (level crossings)
2002	Jul-Dec	1.37	0.08	0.06	0.29	0.24	0.27	0.41	0.07
2003	Jan-Jun	1.09	0.12	0.00	0.19	0.07	0.39	0.34	0.03
	Jul-Dec	0.78	0.09	0.03	0.28	0.16	0.43	0.50	0.11
2004	Jan-Jun	0.99	0.06	0.02	0.20	0.16	0.40	0.30	0.03
	Jul-Dec	0.96	0.01	0.08	0.26	0.15	0.55	0.37	0.04
2005	Jan-Jun	0.80	0.14	0.04	0.21	0.10	0.43	0.40	0.04
	Jul-Dec	0.75	0.08	0.04	0.27	0.08	0.70	0.39	0.04
2006	Jan-Jun	0.60	0.05	0.07	0.27	0.05	0.51	0.40	0.06
	Jul-Dec	0.70	0.15	0.05	0.24	0.12	0.69	0.47	0.04
2007	Jan-Jun	0.75	0.07	0.01	0.25	0.06	0.58	0.35	0.06
	Jul-Dec	0.83	0.11	0.03	0.21	0.06	0.51	0.27	0.04
2008	Jan-Jun	0.83	0.11	0.08	0.21	0.08	0.88	0.34	0.04
	Jul-Dec	0.55	0.11	0.03	0.31	0.02	0.79	0.29	0.01
2009	Jan-Jun	0.92	0.11	0.01	0.23	0.04	0.63	0.29	0.07
	Jul-Dec	0.78	0.09	0.08	0.37	0.05	0.65	0.24	0.05
2010	Jan-Jun	0.69	0.13	0.06	0.28	0.07	0.75	0.24	0.07
	Jul-Dec	0.85	0.04	0,01	0.27	0.06	0.57	0.27	0.02
2011	Jan-Jun	0.91	0.06	0.05	0.33	0.06	0.51	0.24	0.03
	Jul-Dec	0.68	0.08	0.01	0.26	0.08	0.52	0.27	0.09
2012	Jan-Jun	0.78	0.06	0.01	0.23	0.03	0.73	0.22	0.04

Notes: Data excludes light rail and trams.
Occurences did not necessarily result in fatality or injury.
Source: ATSB 2012.

The ATSB (2012, p. 43) notes important differences in the collection and reporting of safety occurrences between jurisdictions. For a detailed description of these differences see (ATSB, 2012, pages 43–45). Fatalities are presented in Table 24.

Table 24 Railway fatalities, by year (number)

Year	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Fatalities	42	29	30	43	44	34	32	26	26	44

Notes: Data exclude light rail and trams.
Fatality data include collisions at level crossings.
Suicides are excluded from New South Wales data.
Source: ATSB 2012.

The Office of the National Rail Safety Regulator (ONRSR), an independent body corporate with regulatory safety oversight for South Australia, New South Wales, Tasmania, Northern Territory, Victoria and the Australian Capital Territory, stated in its *Annual Safety Report 2013 to 2014* there were 93 notified fatalities on railways which the *Rail Safety National Law* (2012) regulates. These fatalities were:

- 84 acts of suspected suicide or trespass;
- Three passenger fatalities (all fall related);
- Five level crossing fatalities (four pedestrians and one cyclist); and
- One rail safety worker, associated with ill-health.

Environmental performance

The measurement of the rail industry's emissions is complicated by the need to allocate upstream emissions—from power generation sources—to downstream energy uses, such as powering electric trains. Emissions data are therefore an approximation.

Table 25 shows a revised carbon dioxide equivalent emissions estimation of the rail industry since 2005. According to the estimation, emissions have increased by approximately 20 per cent since 2005. The commodities boom and the ensuing increased rail transport of bulk materials is likely to be a cause of the higher level of emissions, as is the increased passenger task.

The emissions intensity of rolling stock and locomotive fuel efficiency also affects the industry's performance. While manufacturers have focused on maximising energy efficiency in rolling stock, changing requirements, such as higher performance and, for passenger rail, air-conditioning and on-board electronics, may increase emissions intensity.

Table 25 Rail industry's full fuel cycle carbon dioxide equivalent emissions, annual billion grams

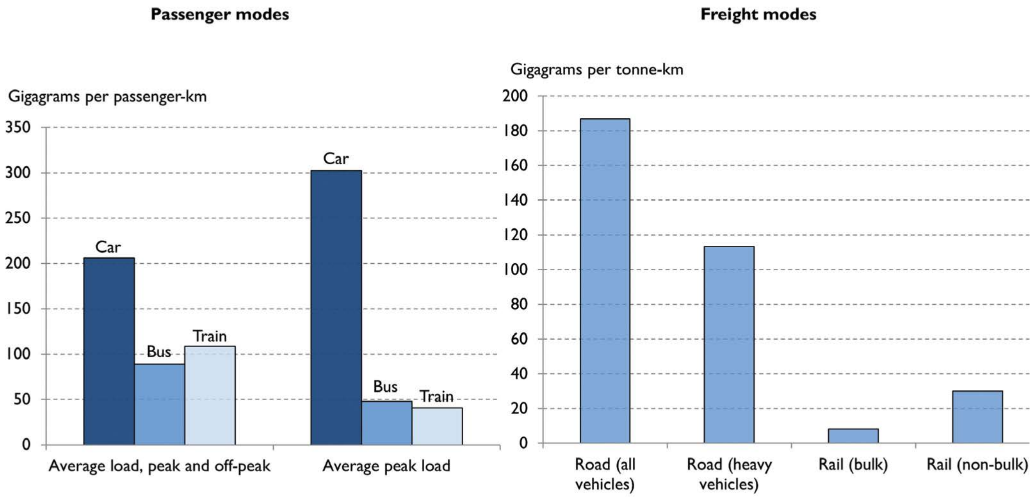
2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
4583	4592	4869	5023	5097	5163	5230	5373	5507	5686

Note: Preliminary/provisional estimate.
Source: BITRE estimates.

The emissions intensity of freight rail is low relative to road freight vehicles. (Figure 29).'

Urban passenger rail transport creates less relative pollution than cars, especially during peak period travel. Over the full day, the gap in average emissions intensity is less substantial, however, since off-peak rail travel generally has much lower average occupancy levels and road vehicles are less subject to congestion.

Figure 29 Estimated emissions intensity of passenger and freight modes, 2007, carbon dioxide equivalent



Notes: "Average load (peak and off-peak)" is the national average occupancy, by mode, over the day, for all passenger travel (both urban and non-urban). For buses, if intensity estimates were restricted solely to urban use, then average values would be substantially higher.

"Road (all vehicles)" is the average across all rigid and articulated trucks as well as light commercial vehicles.

"Road (heavy vehicles)" is the average across rigid and articulated trucks.

"Rail (bulk)" is the average for private, dedicated bulk railways. Bulk traffic on railways shared by non-bulk trains would likely have a higher emissions intensity.

Source: BITRE estimates.

Interstate network indicators

This section considers a range of indicators of the interstate network, namely the railways between the state capitals (and, additionally, including Darwin).

Access revenue yield indicator (ARTC)

The Access revenue yield data provided by ARTC is the revenue per '000 GTK that a reference superfreighter train generates for ARTC in specific line segments.

Access revenue is the infrastructure manager's income derived from train operators using the railway. The ARTC's access charge has two components: a flagfall charge, which is a reservation charge for booking a train path on a given line segment, invariant with tonnage; and a variable charge, which varies directly with the train operator's gross tonne kilometres. Thus, as tonnage on the train rises, the average access charge per tonne will decline.

This access charging regime provides an incentive for train operators to operate longer trains. In principle, operating longer trains enables infrastructure managers to achieve greater tonnage throughput, as there is a limit to the number of trains that can operate over the network. However, to have longer trains requires trackage that can deal with the length. In recent years, interstate network infrastructure has been expanded to take longer trains. If train operators respond to the access charging structure by running longer trains, effective freight costs per tonne fall.

The indicator presented below is an index of the maximum access yield for the interstate network managed by ARTC, based on ARTC data and analysis. The indicator measures the changes (relative to the base year) in the maximum access revenue yield per gross tonne kilometre. Changes in this composite indicator may reflect changes in:

- real access charges (higher charges will increase the indicator);
- train operators' use of existing capacity (heavier/longer trains will lower the indicator); or
- enhancements in rail infrastructure and train operators' uptake of those enhancements (more uptake of improvements, through heavier trains, will lower the indicator).

As shown in Table 26, since 2005–06, the average yield has increased on all of the East–West corridor line segments. On the North–South corridor, the average yield has increased on the Acacia Ridge-Border loop and Macarthur–Albury segments, while it has decreased on the Border loop – Newcastle and Albury–Tottenham segments.

Table 26 Index of real maximum access revenue yield, interstate network (2009–10 = 100)

	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14
North–South corridor									
Acacia Ridge – Border Loop					100.00	99.36	101.41	100.64	103.03
Border Loop – Newcastle	102.39	101.79	97.92	100.60	100.00	99.36	101.41	100.64	103.03
Macarthur–Albury	96.61	96.07	97.95	100.62	100.00	99.38	101.43	100.64	103.06
Albury–Tottenham	109.36	108.72	105.72	100.62	100.00	99.38	101.43	100.64	103.06
East–West corridor									
Melbourne–Adelaide	97.64	97.55	94.94	100.60	100.00	99.38	101.44	100.65	103.06
Adelaide–Kalgoorlie	92.77	92.68	90.23	100.60	100.00	99.36	101.42	100.64	103.04
Cootamundra–Parkes	93.94	93.41	97.98	100.60	100.00	99.38	101.44	100.66	103.05
Parkes – Broken Hill	96.23	95.68	97.91	100.60	100.00	99.37	101.43	100.65	103.04
Broken Hill – Crystal Brook	85.43	85.35	82.95	100.60	100.00	99.37	101.43	100.65	103.04

Source: Data provided by ARTC.

Interstate network utilisation

Train frequency on the interstate network

The numbers of scheduled weekly intermodal trains that originated and terminated in the given city pairs are shown in Table 27. These origins and destinations are those of trains, and not those of goods on the trains. For example, Brisbane–Melbourne trains will often dwell in Sydney where goods are loaded and unloaded.[45] Caution is also needed when comparing train numbers. Train numbers can decline when average train sizes increase.

The number of scheduled intermodal trains has fallen on the North–South corridor since 2006. On the East–West corridor, the number of scheduled intermodal trains between Melbourne and Perth has increased, offset by fewer trains between Melbourne and Adelaide, between Adelaide and Perth, and between Sydney and Perth.

The decline in Melbourne–Adelaide trains can be attributed to the reduction in land-bridge freight between Adelaide and the Port of Melbourne. These falls have arisen because a higher proportion of ships now call direct, with containers from Adelaide now transhipped at an overseas hub (notably Singapore) to vessels that deliver containers to their respective destination port. Previously, a higher proportion of containers were railed between Melbourne and Adelaide, with the Port of Melbourne as the hub for direct sailings to and from destination ports.

Table 27 Number of weekly intermodal services, by city pair

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
North–South corridor										
Brisbane to Sydney	4	1	1	1	1	1	2	2	2	2
Sydney to Brisbane	5	0	0	0	0	0	0	0	0	2
Sydney to Melbourne	4	6	3	0	2	2	3	2	2	1
Melbourne to Sydney	6	6	3	0	2	2	3	2	2	0
Brisbane to Melbourne	19	18	16	17	15	15	15	15	15	16
Melbourne to Brisbane	18	18	17	17	15	15	15	16	16	16
Brisbane to Adelaide		5	5	3	3	3	2	2	2	2
Adelaide to Brisbane		5	4	3	3	3	2	2	2	2
East–West corridor										
Melbourne to Adelaide	17	17	17	17	11	12	9	9	8	6
Adelaide to Melbourne	17	17	17	17	11	12	9	9	9	6
Melbourne to Perth	14	15	16	15	18	19	20	20	20	20
Perth to Melbourne	14	15	16	15	17	19	20	20	20	20
Sydney to Perth	8	8	8	7	7	7	8	9	10	8
Perth to Sydney	8	8	8	7	7	7	8	9	10	9
Adelaide to Perth	0	0	2	2	0	0	0	0	0	0
Perth to Adelaide	0	0	2	2	0	0	0	0	0	0
Central corridor										
Adelaide to Darwin			5	7	7	6	7	6	6	6
Darwin to Adelaide			5	6	6	6	7	6	6	6

Sources: Working timtables of infrastructure managers (ARTC, Sydney Trains, Brookfield Rail and Genesee & Wyoming Australia).

45 Asciano/Pacific National trains dwell at Chullora. Aurizon trains dwell south of Sydney, at Glenlee Junction.

Weekly trains by interstate line segment

The total number of scheduled weekly interstate intermodal and steel trains on each line segment is presented in Table 28. This is an indicator of the intensity of the usage of the interstate network. Table 28 differs from Table 27 because it includes all trains that travel along a given corridor, including those that continue on to another corridor. A train travelling from Melbourne to Perth, for example, will be counted on all line segments on that route. Table 27 also includes those trains that do not travel from capital city to capital city, such as the Melbourne-Griffith (MC and CM) trains.

The most intensive use of the network by interstate trains continues to be on the Crystal Brook – Port Augusta segment. This segment is used by interstate intermodal trains travelling to and from Perth; intermodal trains between Adelaide and Darwin; and steel trains from Newcastle and Port Kembla to Port Augusta, Whyalla and Perth.

The Sydney–Cootamundra and Cootamundra–Melbourne line segments remain the busiest on the North–South corridor. In addition to intermodal and steel trains, these segments are also used extensively by passenger and bulk commodity (mostly grain) trains.

Steel train operators have consolidated some steel and intermodal traffic into single trains for efficiency's sake. The latest ARTC working timetable (August 2015) now lists some trains previously annotated as steel trains as intermodal. The Wollongong–Melbourne and Wollongong–Brisbane trains are cases in point.

Table 28 Total weekly interstate intermodal and steel trains, by line segment[46]

Line segment	2006	2010	2015
North–South corridor			
1. Brisbane–Sydney	63	49	42
2. Sydney–Melbourne			
Sydney–Cootamundra	84	68	58
Cootamundra–Melbourne	63	53	49
East–West corridor			
3. Sydney–Crystal Brook via Broken Hill			
Sydney–Parkes via Lithgow	6	9	12
Cootamundra–Parkes	21	20	20
Parkes–Crystal Brook	27	29	34
4. Melbourne – Crystal Brook			
Melbourne–Adelaide	78	71	59
Adelaide – Crystal Brook	51	57	64
5. Crystal Brook – Perth			
Crystal Brook – Port Augusta	67	86	91
Port Augusta – Tarcoola	60	71	77
Tarcoola–Perth	60	59	65

Sources: Working timtables of infrastructure managers (ARTC, Sydney Trains, Brookfield Rail, and Genesee & Wyoming Australia).

46 These totals do not include the 29 QUBE Holdings trains that operate between Sydney and June/Harefield. While these trains are intrastate, they operate along a portion of the Sydney-Melbourne interstate sector. Also, some previous QUBE Holdings trains travelled between Melbourne and Junee and were thus interstate by definition, but now all run Sydney-Junee/Harefield and are thus intrastate.

Train flow patterns on the interstate network

Train flow indicators provide information about the flow of trains across the network. Flows improved from 2010–2015 due to infrastructure investment and renewal such as new or improved signalling, additional long passing loops, and passing lanes.

Table 29 summarises three related indicators of train flow for the primary line segments: train dwell time; number of train stops; and average train speed, comparing the years 2010–2015. Brisbane–Adelaide (and return) trains have been included in a new separate row. This is because these trains now take a new route via Broken Hill and Crystal Brook Junction. As such, they are no longer counted in the Sydney-Melbourne and Melbourne Adelaide corridors. They are also not counted in the Cootamundra-Crystal Brook corridor as these trains transit Crystal Brook Junction, not Crystal Brook itself.

It should also be remembered that Table 29 only provides information about intermodal services, which share the line with other trains such as bulk goods trains, steel trains and passenger trains. Changes to the nature and scale of these other trains' operations may influence intermodal train flow patterns in ARTC's train path planning. For example, Melbourne–Albury V/Line passenger trains now share the Melbourne-Albury corridor with intermodal trains since standardisation of the previous broad gauge line from Seymour to Albury; something which did not happen in 2010. It is beyond the scope of this publication to assess what actual influence other trains' operations may have on intermodal train flow patterns.

Table 29 Scheduled inter-capital intermodal train flow patterns

Line segment/ direction	Number of weekly intermodal services		Average speed		Average number of stops		Average scheduled transit time (mins)		Average dwell time (mins)		Percentage dwell time (per cent)		Dwell time per stop	
Year	2010	2015	2010	2015	2010	2015	2010	2015	2010	2015	2010	2015	2010	2015
North-South corridor														
Brisbane to Sydney	19	16	53	57	9	8	1 119	1027	198	117	18%	11%	23	15
Sydney to Brisbane	18	16	51	55	8	7	1 150	1067	162	156	14%	15%	19	23
Sydney to Melbourne	20	13	64	68	4	3	906	853	80	62	9%	7%	22	23
Melbourne to Sydney	20	12	68	71	4	2	850	808	54	31	6%	4%	14	13
Brisbane to Melbourne	18	12	56	58	13	11	2 108	2 001	397	304	19%	15%	31	27
Melbourne to Brisbane	18	12	57	62	13	10	2 044	1 892	345	216	17%	11%	28	22
East-West corridor														
Melbourne to Adelaide	32	25	63	63	6	3	786	792	102	98	13%	12%	18	28
Adelaide to Melbourne	31	26	59	58	6	5	850	855	148	153	17%	18%	24	28
Adelaide to Perth	18	20	66	66	14	14	2 429	2 422	378	359	16%	15%	27	26
Perth to Adelaide	17	20	59	58	18	18	2 698	2 765	668	680	25%	25%	37	38
Cootamundra to Crystal Brook	4	4	68	67	10	4	1 113	1 147	227	278	20%	22%	24	69
Crystal Brook to Cootamundra	6	9	65	56	10	5	1 164	1 357	251	342	22%	25%	26	68
Brisbane to Adelaide	n/a	2	n/a	55	n/a	16	n/a	3 040	n/a	730	n/a	24%	n/a	45
Adelaide to Brisbane	n/a	2	n/a	58	n/a	16	n/a	2892	n/a	587	n/a	20%	n/a	41
Central corridor														
Tarcoola to Darwin	6	6	72	71	5	4	1 878	1 897	288	225	15%	12%	58	56
Darwin to Tarcoola	6	6	69	70	6	4	1 970	1 939	319	222	16%	11%	55	56

Note: The number of services excludes trains that do not run the entire line segment. Cootamundra to Crystal Brook, for example, excludes Sydney to Perth trains that run via Lithgow (five trains).

The 2015 north south corridor calculations exclude eight Melbourne–Brisbane (both directions – four trains each per direction) intermodal designated trains which now also carry steel products and are thus subject to steel train speed restrictions of 80 kilometres per hour. These eight trains were included in calculations in Trainline 2.

Sources: Working timtables of infrastructure managers (ARTC, Sydney Trains, Brookfield Rail and Genesee & Wyoming Australia).

(a) Dwell time and number of stops

Dwell time indicators show the time trains are scheduled to spend 'dwelling' (stationary) in railway yards and passing loops. Reasons for dwelling include:

- operational—such as changing train crews or refuelling;
- loading and unloading freight at intermediate destinations; and
- track capacity and traffic—trains may need to wait in passing loops and sidings for others to pass or overtake.

North–South corridor

Compared with 2010–11, trains have had fewer stops in 2015. This reflects ARTC's investment strategy on the corridor: new and extended passing loops between Brisbane and Sydney, additional passing lanes between Sydney and Melbourne, conversion of the parallel broad gauge line between Seymour in Victoria and Albury in New South Wales to standard gauge, and upgraded signalling at pinch points.

Sydney is a major market served by the Brisbane–Melbourne (and Brisbane–Adelaide trains), where freight is offloaded and unloaded. This increases the corridor's average dwell times. Aurizon trains dwell at Glenlee Junction (Aurizon uses a separate shuttle service between its Yennora yard and Glenlee Junction to transfer freight.) This stop is an important revenue generating activity and therefore enhances the economic viability of rail services. Some dwell times are therefore of the train operators' volition, while some are imposed. It is important to consider this when measuring dwell and travel times to assess the railway's performance.

When viewing the entire North–South corridor, average dwell times have reduced on all segments compared to 2010 but exclusion of the eight now combined intermodal-steel trains influence the result. This is because some of the eight trains dwell in Sydney to onload and offload freight. Previous reporting captured this dwell time but exclusion of the trains has removed it.

East–West corridor

Assessing traffic flows on the East–West corridor is more complex because it consists of several intersecting lines that, for Perth bound trains, intersect at Crystal Brook Junction in South Australia. For Sydney–Perth trains, calculations do not include Sydney–Cootamundra (part of the North–South corridor) and the alternative Sydney–Parkes via Lithgow route.

Dwell times between Adelaide and Perth have increased on all corridors except for trains travelling from Melbourne to Adelaide and Adelaide to Melbourne. Like the North–South corridor, trains dwell at intermediate destinations and for operational reasons. Two significant operational dwell locations are at Cook and Spencer Junction (Port Augusta) in South Australia. Both locations are used for crew rest breaks, crew changes and the refuelling of some trains.

- Operators stop at intermediate destinations to onload and offload freight. Adelaide is the largest intermediate city on the corridor. Asciano operates a terminal at Islington, SCT Logistics operate from their terminal in Bolivar and Aurizon uses a terminal at Port Flat. Another significant intermediate terminal is at Goobang Junction (Parkes) in New South Wales. Adelaide and Goobang Junction are also the easternmost points at which double stacked trains can operate.

- A significant change to train flows since 2010 is on the East–West corridor between Cootamundra in New South Wales and Crystal Brook in South Australia. The number of stops has halved. This is a reflection of ARTC's investment in the corridor. Existing loops have been extended to fit 1 800 metre trains and two new loops have been constructed. The signalling system has also been upgraded in sections, particularly between Cootamundra and Parkes. Average overall transit times, however, have increased slightly because trains are dwelling for longer periods. Thus, a number of short dwells, mostly caused by network capacity constraints, have been eliminated. However, stops at intermediate terminals and sidings, such as Goobang Junction and Broken Hill, are now longer.

Central corridor

Dwell times on the central corridor have decreased, largely because there are fewer stops than in 2010. Genesee & Wyoming Australia owns the integrated Darwin–Tarcoola railway. Their Darwin–Adelaide trains generally include the following characteristics:

- Trains originate/terminate at the intermodal terminals at Berrimah (Darwin) and the Islington freight terminal (Adelaide);
- Trains stop at intermodal terminals in Katherine, Tenant Creek and Alice Springs; and
- Operational stops at Tarcoola and Spencer Junction are common.

(b) Average speed

Average train speed is a measure of physical railway performance—both train and infrastructure. As with other train pattern indicators, average speed is partly determined by train operator factors such as locomotive power and whether the operator picks up and drops off freight en route. Prevailing speeds also reflect a range of infrastructure-based factors, including the number of stops, track alignment, and track condition.

Table 29 shows that average scheduled speeds have increased on all segments of the total North–South corridor compared to 2010. There are fewer scheduled stops on both sectors of the North–South corridor and scheduled transit times have reduced for trains travelling in both directions. This improvement may partly be due to the building of new passing lanes and duplication of the track between Albury and Seymour.

Speeds on the East–West corridor are largely unchanged, except for east-bound trains between Crystal Brook and Cootamundra, whose scheduled average speed has decreased. This reflects longer dwell times on the sector, even though the scheduled number of stops has halved. Trains typically dwell at Goobang Junction for extended periods, for crew changes and to load and unload freight. Goobang Junction is also the easternmost point for double stacking on the Perth–Sydney corridor. The average dwell time at Goobang Junction for east bound trains is 146 minutes.

Average speeds on the Central corridor have remained stable.

Track indicators for the interstate network

The indicators presented in this section provide information on infrastructure quality and freight train flow patterns on the interstate network.

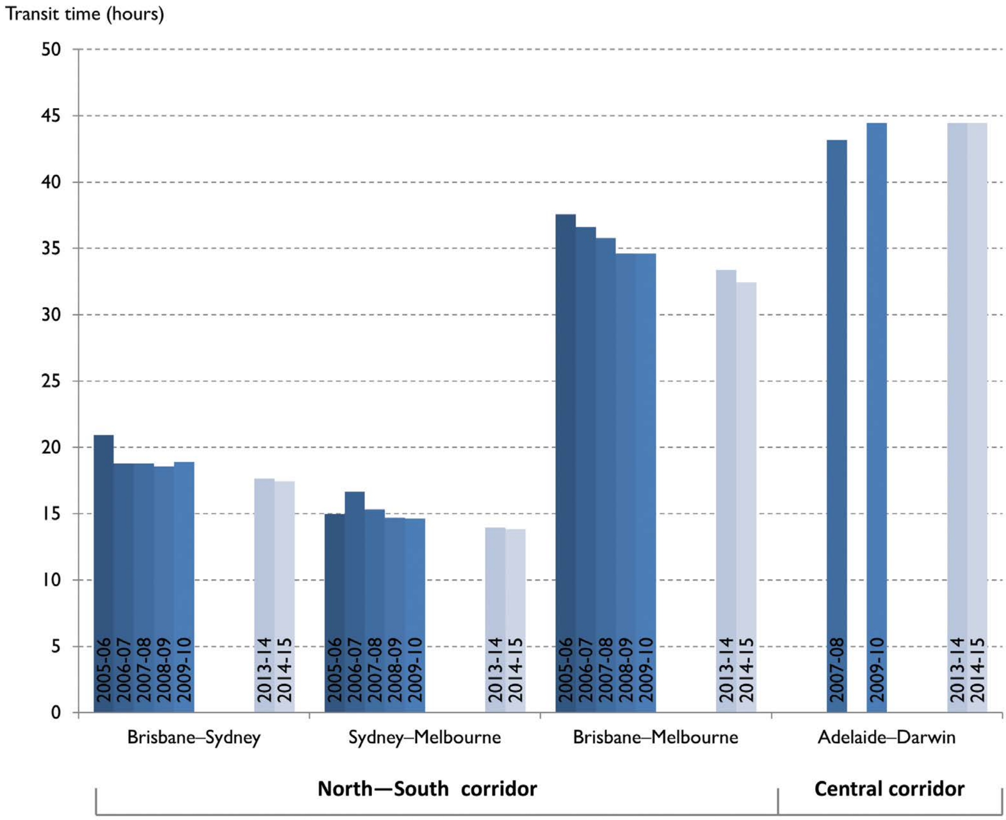
Scheduled intermodal transit time

The scheduled intermodal transit time indicator is the average timetabled transit. Figure 30 and Figure 31 present the average scheduled intermodal transit time for trains on eight city pairs, for the North–South, Central and East–West corridors respectively. These data are presented in Table 29.

Scheduled transit times are influenced by factors including line speed; the number of stops en route; the number and type of other trains on the line (particularly when the route has single track or in shared urban networks); operator-dependent factors such as time spent in intermediate cities; and, for Sydney–Perth trains, the route used. As infrastructure enhancements are completed, a number of these factors are changing and thus reducing transit times. The Southern Sydney Freight Line is a case in point.

Transit times on all sectors of the Melbourne–Brisbane corridor have continued to decline. Transit times on the Central corridor have remained stable.

Figure 30 Average scheduled transit times, North–South and Central corridors, 2005–06 to 2013–14



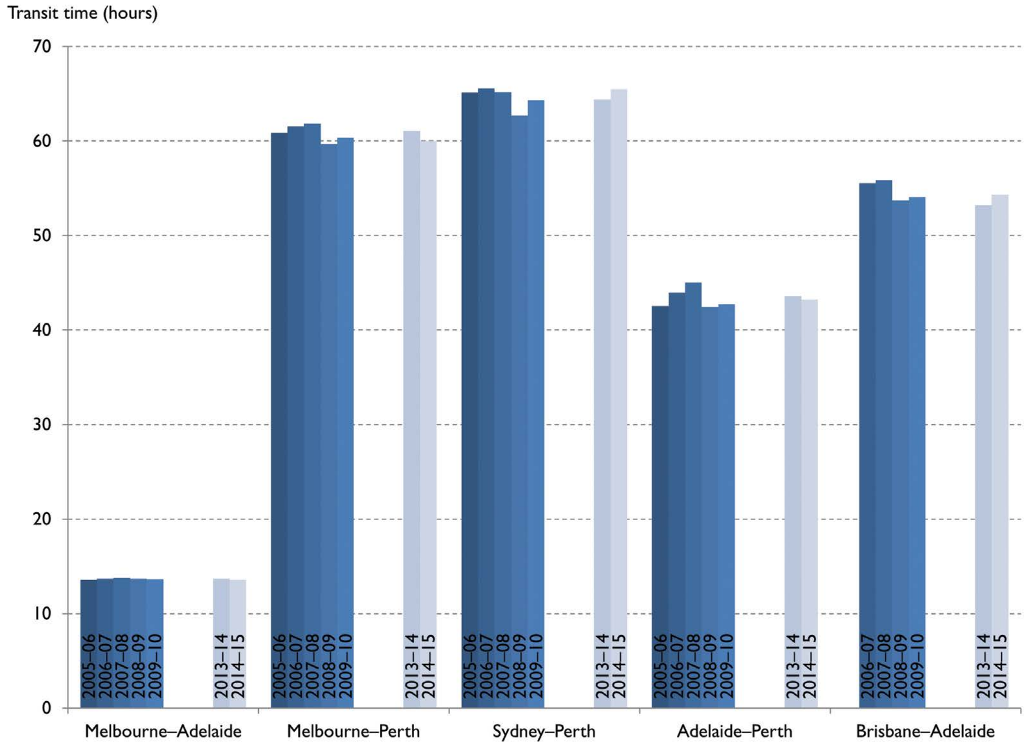
Notes: Calculations include all intermodal designated trains on a given line segment. The Sydney–Melbourne calculations, for example, include Brisbane–Melbourne trains.

For 2005–06 to 2009–10, BITRE calculated average scheduled transit times from infrastructure managers (ARTC, RailCorp and Brookfield Rail) working timetables that were current for the last week of June each year. In 2013–14, ARTC timetables effective from 6 April 2014 to 21 June 2014 were used. For the Central corridor, ARTC timetables were used in conjunction with Genesee & Wyoming Australia's timetable, effective as of 30 April. In 2014–15, ARTC timetables effective from 19 April 2015 were used. For the Central corridor, ARTC timetables were used in conjunction with Genesee & Wyoming Australia's timetable, effective as of April 2015.

Sources: Infrastructure managers' working timtables (ARTC, Sydney Trains, Brookfield Rail, and Genesee & Wyoming Australia).

Average transit times on the East–West corridor are mixed when comparing 2014–15 to the previous financial year. On the total Melbourne–Perth corridor scheduled transit times have reduced by approximately one hour. The one hour reduction has been gained between Adelaide and Perth. On the total Sydney–Perth corridor scheduled transit times have increased by approximately two hours. Caution is needed, however, when assessing the Sydney–Perth corridor as some west bound trains travel via Cootamundra West and others via Lithgow. The Cootamundra West corridor is longer but flatter, while the Lithgow route is shorter but steeper. The discussion on page 63 includes a more detailed discussion of train flow patterns by corridor.

Figure 31 Average scheduled transit times, East–West corridors, 2005–06 to 2013–14



Notes: Calculations include all trains on a given line segment. The Melbourne–Adelaide calculations therefore include Melbourne–Perth trains.

Calculations for west bound Sydney–Perth trains are based on a combination of the two routes these trains take: via Cootamundra and via Lithgow.

For 2005–06 to 2009–10, BITRE calculated average scheduled transit times from infrastructure managers (ARTC, RailCorp and Brookfield Rail) working timetables that were current for the last week of June each year. In 2013–14, ARTC timetables effective from 6 April 2014 to 21 June 2014 were used. Brookfield Rail provided their timetable used in the week beginning 6 April 2014. In 2014–15, ARTC timetables effective from 19 April 2015 were used. Brookfield Rail provided their timetable used in the week beginning 6 April 2015 and Sydney Trains provided their timetable used in the week beginning 20 April 2015.

Sources: Infrastructure managers' working timtables (ARTC, Sydney Trains, Brookfield Rail and Genesee & Wyoming Australia).

Train reliability on the interstate network

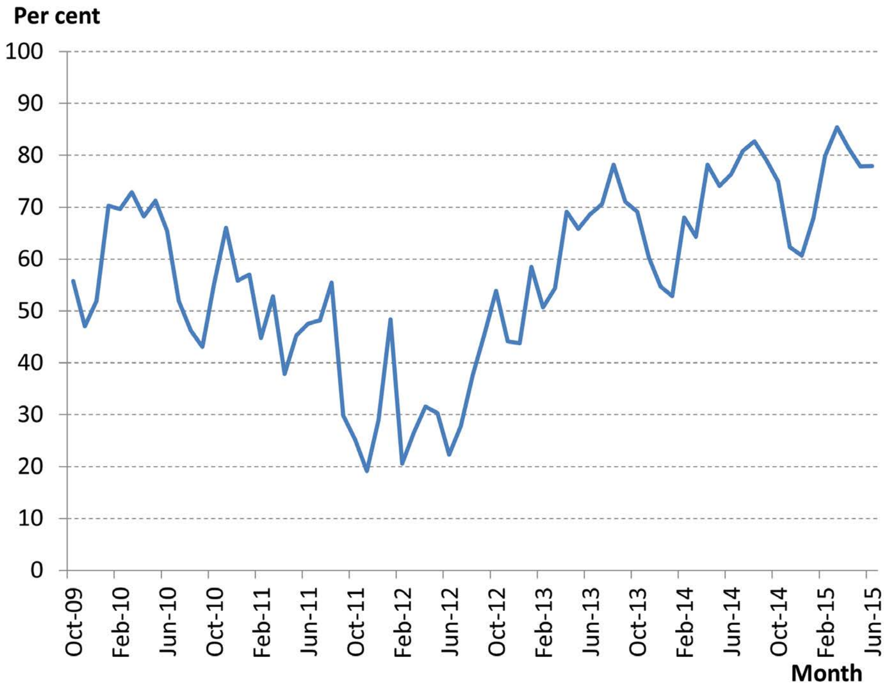
The ARTC publishes performance indicators relating to key service quality areas including reliability. Detailed information regarding reliability by city pair is available on the ARTC website.

Reliability can be affected by train and track issues. Problems for train operators include mechanical issues with rolling stock, delays at terminals, flow on problems from other operators' delays, and problems beyond operators' control such as trespassers and vandalism. These problems can cause significant delays across the network and trains entering the network late. This requires infrastructure managers to allocate train paths without compromising their obligations to other operators.

Infrastructure issues can also impact reliability. Track quality problems can result in (temporary) speed restrictions and track closures. Signalling failures can also cause delays. Infrastructure maintenance and renewal, as well as weather conditions, are important aspects in infrastructure reliability. Flooding in the New South Wales Hunter Valley in April 2015, for example, caused a temporary complete closure of both the Hunter Valley and North Coast lines.

Figure 32 and Figure 33 show the percentage of intermodal trains that left the ARTC network within 30 minutes of schedule. The data are collected monthly and is subject to significant variation due to the impact of individual events.

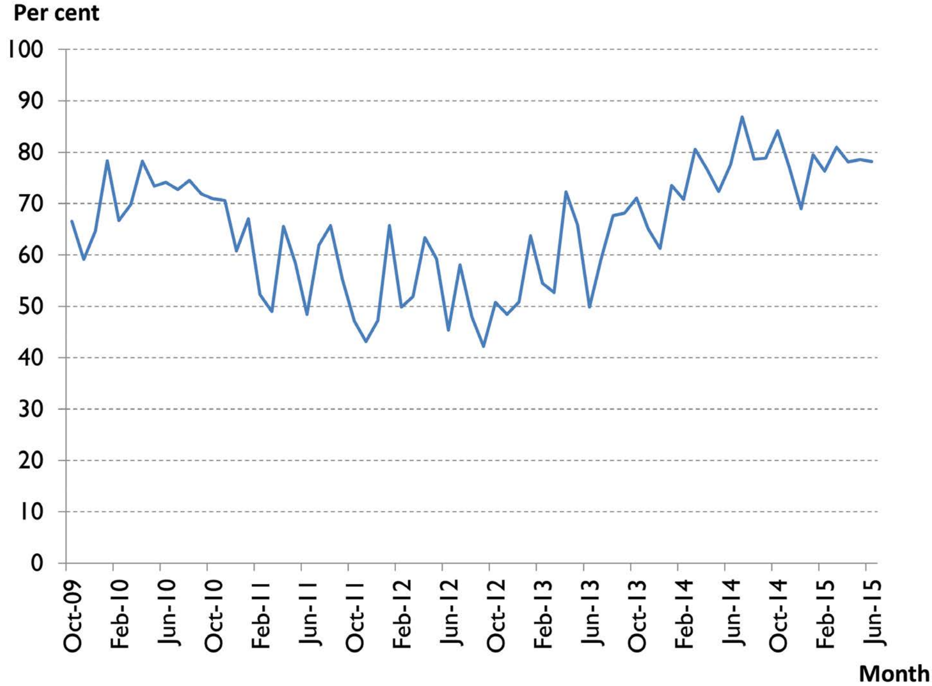
Figure 32 North–South corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Data provided by ARTC.

Reliability on the North–South corridor (Brisbane–Islington Junction, Botany/Macarthur/Unanderra–Melbourne) decreased from early 2011 to mid-2012. During this period, the track between Sydney and Melbourne was subject to many temporary speed restrictions and increased maintenance activity due to reported rough-riding and mud holes (ATSB 2013, p.5). In December 2011, the ARTC embarked on the "Ballast Rehabilitation Programme", to replace fouled ballast and improve track drainage on the corridor. Temporary speed restrictions have been progressively removed and reliability improved from mid-2012. Despite fluctuations, long term reliability has increased since June 2012.

Figure 33 East–West corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Data provided by ARTC.

Reliability on the ARTC's East–West corridor (Cootamundra/Parkes–Kalgoorlie and Melbourne–Kalgoorlie) has remained relatively stable, but generally improved since February 2014. There was a small decline from August 2011 to early 2013. During this period, high track utilisation, due to the commencement of iron ore services, meant unhealthy trains[47] on the Crystal Brook–Tarcoola section had limited opportunities to recover. Reliability has since improved due to the installation of Centralised Train Control signalling (CTC).

Permitted train lengths on the interstate network

The permitted train length is an important component of overall track capacity. On Australia's mostly single track this is often determined by the length of passing loops. Since the mid-1990s in particular, infrastructure managers have invested in longer passing loops and passing lanes (approximately 6–8 kilometres in length) across the interstate network. Permitted train length can also be constrained by track alignment and gradient.

Permitted unrestricted train lengths on the interstate network are as follows:

- 1 500 metres on Brisbane–Sydney;

47 ARTC defines a "healthy" service as one which: (a)presents to the network within tolerance (on time within tolerance), is configured to operate to its schedule and operates in a way that it is able to maintain its schedule; (b) or is running late only due to causes within the network, but only when the root cause is outside the rail operator's control; (c) or is running within tolerance, regardless of previous delays (ARTC 2014).

- 1 500 metres, on Melbourne–Adelaide (1 800 metres restricted); and
- 1 800 metres on Sydney–Melbourne, Cootamundra – Crystal Brook, Adelaide–Kalgoorlie, Tarcoola–Darwin.

The 'unrestricted' train length is the length up to which operators can operate any scheduled service without reference to the track manager; the length is shorter than the prevailing standard loop length on the line segment. The 'restricted' train length is the maximum train length permitted on the line segment (under restricted access terms, trains that exceed the prevailing loop length can be operated by ensuring trains that have to be passed can be accommodated within the prevailing loop length).

Since 2007–08 passing loops have been constructed on the Cootamundra–Parkes section and additional passing lanes added on the single track sections between Junee and Melbourne to allow unrestricted 1 800 metre trains.

Double stacking capability on the interstate network

Like train length, the ability to double-stack containers on wagons is important to track capacity. In Australia, double-stacking involves stacking one hi-cube (9 feet 6 inch, or 2.896 metres high) container on top of another and to carry them in a low-floor (well) wagon. The top of the stack must be no higher than 6.5 metres above the top of the rail, and mass limits must not be exceeded. Double-stacking is permitted west of Parkes and west of Adelaide.

Clearances on the North–South corridor are restricted to single-stacking of hi-cube containers. The increasingly prevalent higher maxicube (10 feet 6 inch, or 3.20 metre) containers must be conveyed within the specialised low-floor well wagons.

The central corridor line can accommodate double-stacked containers and road freight vehicles (for the transport of oil) 'piggybacked' on rail flat wagons.

Track quality of the interstate network

The maintenance and standards of railway infrastructure are important to the operating performance of trains. The permitted track speed and the smoothness of the ride of the wagons are strongly influenced by the quality of the infrastructure, the maintenance regime and the underlying economic life of the infrastructure.

Figures 34 to 37 illustrate engineers' physical measures of average track condition by line segment. These indicators use a 'track quality index' (TQI). In reading the index, the interpretation is that the lower the number the higher the track quality.

The composition of the index varies between infrastructure managers, reflecting both differences in priority and different operational environments across the network. Therefore these index numbers should not be used to compare track conditions across line segments managed by different infrastructure managers. However, relative changes in TQIs can meaningfully be compared. Box 8 provides details of how these indices are calculated for each track manager.

Box 8 Calculating track quality indices

For safety, maintenance, planning and regulatory reasons, infrastructure managers regularly measure the condition of their track. In essence, managers measure the extent to which the railway track deviated from the 'designated' (or 'true') alignment. Infrastructure managers can report a global indicator of track condition on a given line segment. The ARTC produced a 'track quality index' (TQI) as part of their Access Undertaking agreement with the Australian Competition and Consumer Commission. The TQI is a statistical measure calculated from the standard deviations of a number of different track geometry parameters. The TQI for a given line segment is taken as the average of the individual TQI sample readings. The parameters that are measured include rail placement, vertical and horizontal alignment, and twist.

On a regular basis on the inter-capital city network, infrastructure managers operate a train with a 'track geometry measuring car'. The carriage is equipped with instruments that measure and record a range of different geometric parameters. There is a variety of track geometry measuring cars in Australia and hence a number of different means of measuring and analysing the parameters that make up the TQI. Further, track quality is reported as a composite measure of the different geometric parameters; this composite measure can differ between systems depending on the parameters used.

The following are the track quality measurements and indicators for the national network.

The ARTC's and Genesee & Wyoming Australia's TQIs, standardised across both networks, consists of:

- gauge;
- twist (short), measured over two metres;
- vertical irregularities ('top'), deviation over a 20 metre inertial reading (average of left and right rail); and
- horizontal line irregularities ('versine'), 5/10 metre chord emulation (average of left and right rail).

These are based on average of Standard Deviations over 100 metre sections.

The charts are indicative of trends in track condition for a given line segment. In normal conditions, the track condition should not deteriorate appreciably between one year and the next.

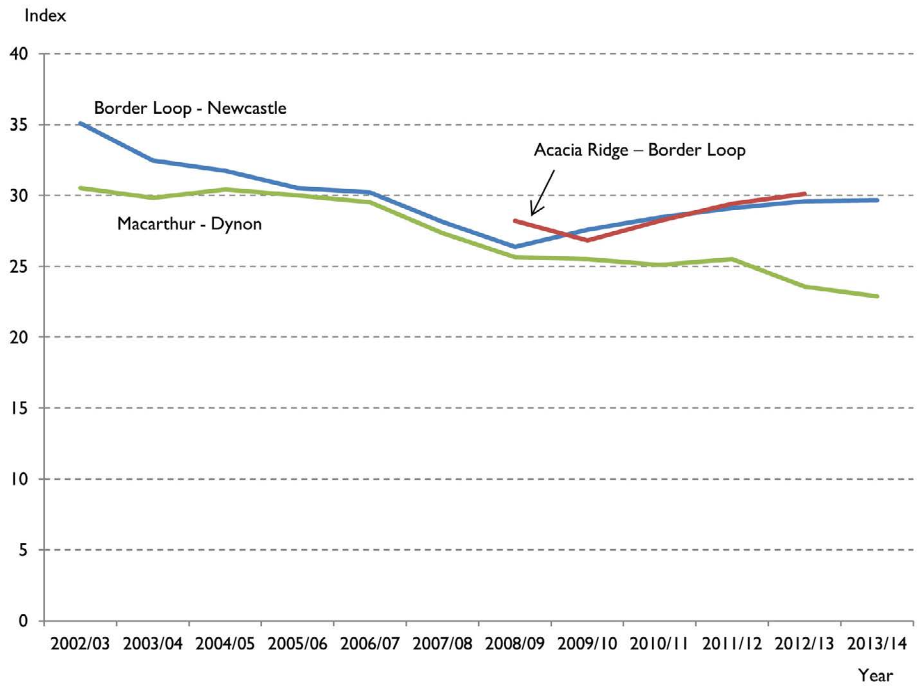
The speed of track quality decline is influenced by a range of factors, including the quality of renewal material and work, the level and type of track usage, climatic and local geographical factors, and the skill and timeliness of ongoing maintenance work.

The TQI values for most ARTC line segments have been trending down—that is, the track quality has been improving. Genesee & Wyoming Australia's TQI has remained relatively stable.

Investment has been undertaken to upgrade ARTC's interstate track. In particular, near-life-expired timber sleepers have been replaced with concrete sleepers on the North–South corridor and the Cootamundra–Parkes line.

This investment is particularly evident in the Cootamundra – Crystal Brook line segment TQI, which has decreased substantially since 2010–11 (Figure 35). From 2011–12, the ARTC's "Ballast Rehabilitation Programme" has resulted in a decrease of the Macarthur–Dynon TQI (Figure 34).

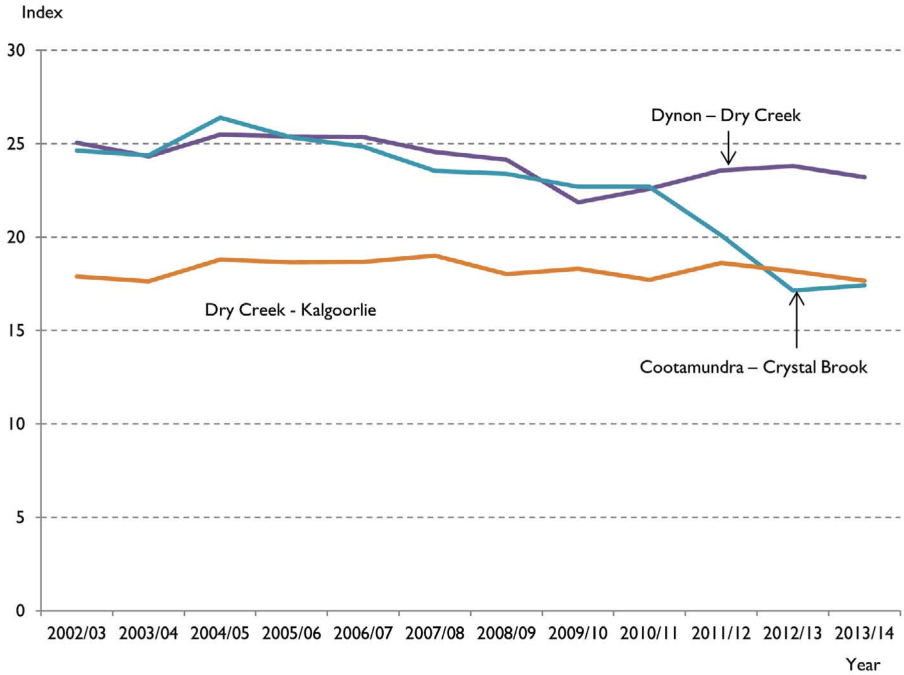
Figure 34 ARTC track quality index, North–South corridor



Note: Lower indices indicate higher track quality.

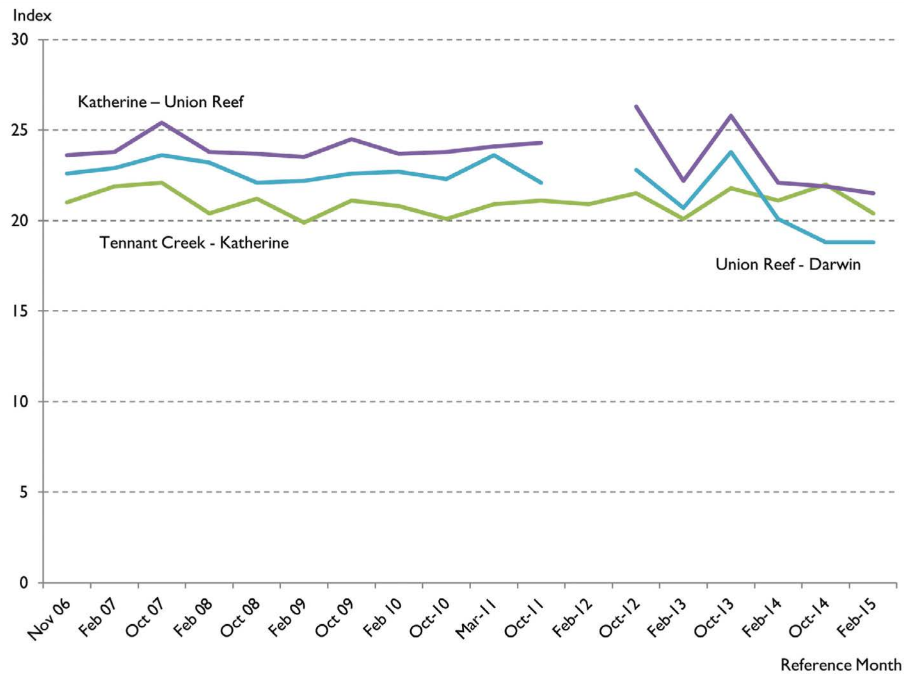
Source: Data Provided by ARTC.

Figure 35 ARTC track quality index, East–West corridor



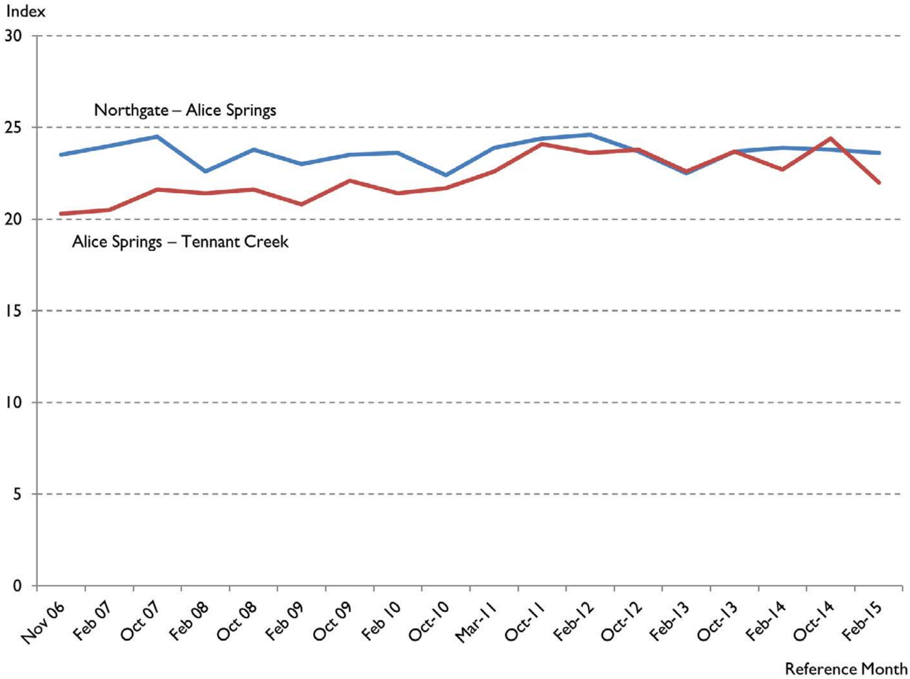
Note: Lower indices indicate higher track quality.
Source: Data Provided by ARTC.

Figure 36 Genesee & Wyoming Australia track quality index, Darwin – Tennant Creek



Note: Lower indices indicate higher track quality.
Source: Data Provided by Genesee & Wyoming Australia.

Figure 37 Genesee & Wyoming Australia Track Quality Index, Tennant Creek – Northgate



Notes: Northgate is the start of the Genesee & Wyoming Australia track. It is located shortly north of Tarcoola, where it separates from the ARTC track.

Lower indices indicate higher track quality.

Source: Data Provided by Genesee & Wyoming Australia.

Passenger train indicators

(a) Punctuality

Punctuality—often called reliability—is important to rail's competitiveness, including the uptake of services. The International Transport Forum (2010, p. 5) notes poor punctuality not only worsens the transport "experience" but can affect the commercial (work) and personal activities of those that depend on reliable transport services.

Urban rail punctuality

For infrequent services, in particular, customers rely on timetables for trip planning. Punctuality is therefore part of a journey's perceived time. Punctuality is less significant for frequent "turn up and go" services.[48] Real-time information at railway stations, light rail stops, online and through smart phone applications are playing a growing trip planning role.

Measures of punctuality are largely determined by the definitions of "on time". The punctuality of operators is presented in Table 30. In 2013–14, most operators met their punctuality targets.

Table 30 Urban rail punctuality, on time performance, 2013–14

	Sydney [b]	Melbourne	Perth	Brisbane	Adelaide[c]
Heavy rail punctuality (%)	94.1	93.1	94.9	97.03	90.8
Heavy rail target (%)	92	91.5	95	94.17	-
Heavy rail measure	Arriving within 5 minutes of schedule at peak times	Arriving no later than 4 minutes 59 seconds late.	Arriving within 4 minutes of schedule	Arriving within 4 minutes of schedule	Departing 1 minute early to 5 minutes 59 seconds late
Light rail punctuality (%)[a]	-	82.9 (average over route)	-	-	99.3
Light rail target (%)[a]	-	82.5	-	-	-
Light rail measure[a]	-	Arriving no earlier than 59 seconds before and no later than 4 minutes 59 seconds after scheduled time.	-	-	Departing 1 minute early to 5 minutes 59 seconds late

Notes: [a] Sydney and Gold Coast light rail opeartors do not publish timetables.
[b] Sydney heavy rail is "suburban lines". It does not include inter-city services that also use the Sydney suburban network. Skipped stops are not counted as being punctual.
[c] Adelaide's data are for the fourth quarter 2013–14.

Sources: Public Transport Victoria 2014; Public Transport Authority WA 2014; Adelaide Metro 2015; Sydney Trains 2015a; Queensland Rail 2014.

48 The light rail operators in Sydney and the Gold Coast, for example, do not publish timetables.

Non-urban rail punctuality

Table 31 shows punctuality results and targets by operator. Punctuality targets are generally higher for markets which are likely to have a higher value-of-time. For example, trains which service interurban commuter corridors, such as NSW TrainLink's intercity services and V/line have targets of 92 per cent. In contrast, QR Travel, which operates numerous long-distance services, have a punctuality target of only 60 per cent.

The punctuality results indicate long-distance services are generally less punctual than shorter distance. This difference is recognised in the punctuality targets and measurement. Of note is TransWA's Prospector. While its recorded punctuality increased from 77 to 84 percent, the target decreased from 90 to 80 percent. According to page 54 of the Western Australia Public Transport Authority 2013–14 Annual Report: *"On the basis of historical data, the Prospector goal was adjusted in 2013–14 from 90 per cent of services to 80 per cent, to reflect a more achievable target."* (Public Transport Authority of Western Australia 2014). QR Traveltrain's target measurement has also increased, from 10 minutes to 15 minutes.

Table 31 Non-urban rail punctuality, on time performance, 2013–14

	Service type	Punctuality 2013–14 (%)	Punctuality target (%)	Measurement
Queensland Rail	QR Traveltrain	89.07	75	Arriving within 15 minutes
NSW TrainLink	Intercity	93.6	92	Arriving within 6 minutes
	Regional and interstate	73.5	78	Arriving within 10 minutes
V/Line	All	87.5	92	Arriving within 5 minutes on commuter services, 10 minutes on long services
TransWA	Australind	92	90	Arriving within 10 minutes
	Prospector	81	80	Arriving within 15 minutes
	MerridinLink	90	95	Arriving within 10 minutes
	AvonLink	98	95	Arriving within 10 minutes

Note: For intercity Queensland Rail services on the TransLink network, see Chapter 3 – Urban passenger rail – Reliability.

Sources: Public Transport Victoria 2014, p. 31; NSW Trains 2014, p. 12; Queensland Rail 2014, p. 13; Public Transport Authority of Western Australia 2014.

(b) Service attributes

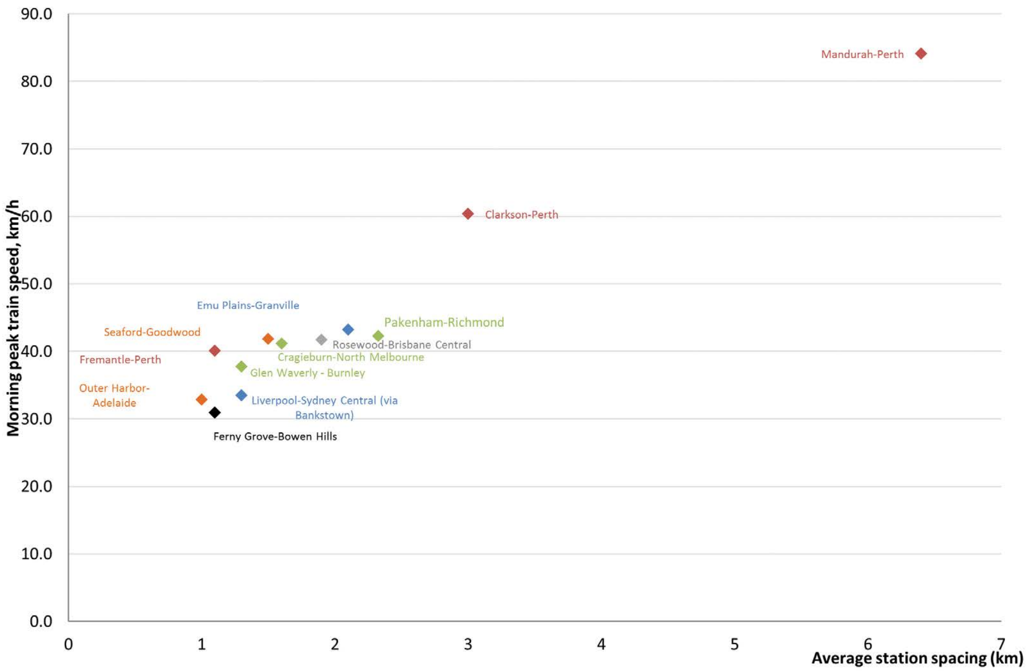
Train speeds

Australia's older passenger lines have relatively short station spacing. Mees and Dodson (2011) have observed that Australian lines were often built as a way of supporting urban expansion with consequent short distances between stations.[49] A consequence, however, of this spacing is the regular stops contribute to slower speeds on older lines.

In contrast, newer lines, such as Mandurah–Perth and, to a lesser extent, Clarkson–Butler have wider station spacing, allowing for higher average speeds. In addition to speed, wider station spacing allows for simpler train schedules because there is little need for express services. Figure 38 shows stopping services. Express services are a common way of overcoming short station spacing.

49 Mees and Dodson cite Davison as observing the role of urban railways in urban development (Mees & Dodson 2011, p. 5).

Figure 38 Station spacing and illustrative train speeds



Source: Derived from operator timetables, August 2015.

Wide station spacing reduces the capacity for patrons to access the railway station by walking. Integration of the railway with other modes of transport, such as the provision of feeder bus or tram services and park and ride facilities therefore becomes crucial.

Average scheduled light rail speeds generally correlate to stop spacing (see Table 32). Caution is needed when comparing Melbourne with other networks due to the wide variation in speeds that exist in that city. Currie and Burke (2013) analysed designated stop spacing and average speeds by line on Melbourne's network. Designated stop spacing varies from 100 metres on the East Brunswick – St Kilda Beach line to 317 metres on the Bundoora RMIT – Water Front City Docklands line. Across the entire Melbourne network, average stop spacing is 254 metres.

Table 32 Light rail station spacing and speeds

	Gold Coast	Sydney	Melbourne	Adelaide
Average station spacing (metres)	813	557	254	517
Average scheduled speed (km/h)	23	19.35	16	16.4

Note: Sydney and Adelaide average speeds derived from scheduled transit time and route kilometres.

Sources: Currie and Burke 2013; BITRE analysis.

Speeds depend largely on a light railway's function and its operating environment. A line designed to operate in a dense pedestrianised zone has lower speeds than vehicles operating in a segregated corridor. Sometimes a single line will have a mix of functions—Sydney's light rail, for example, operates largely on a segregated former goods line, however, between Haymarket and Central Station, it travels "on-road" (albeit largely separated from vehicles) through areas of significant pedestrian activity near Paddy's Market and George Street.

Frequency

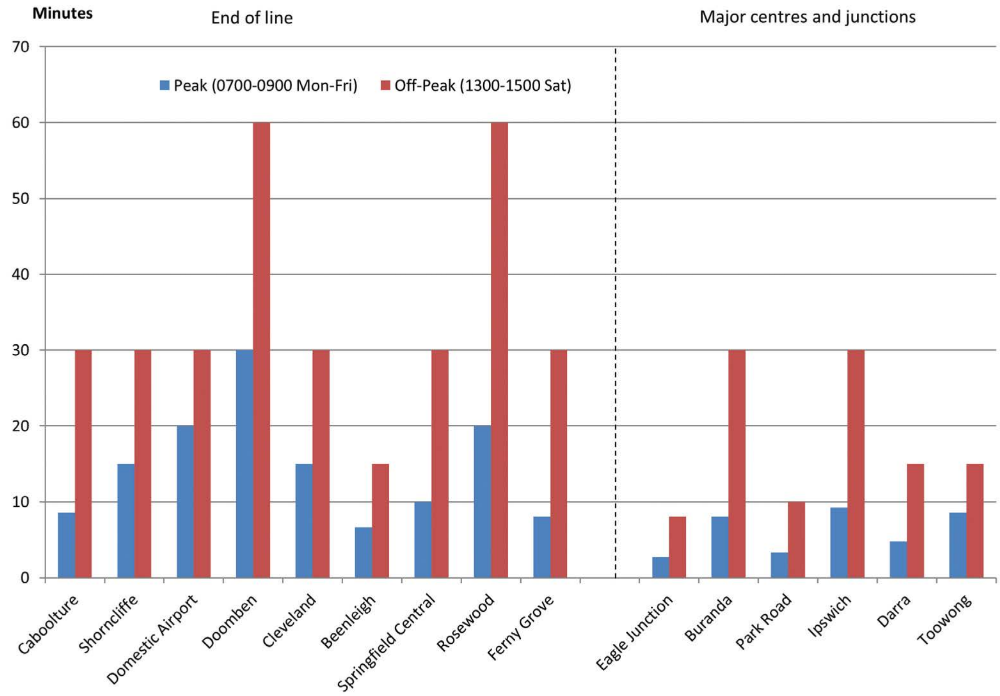
Frequency is important to service quality and, therefore, competitiveness with other transport modes. Frequency is closely connected to travel time. It determines how long passengers wait for a train and how closely the train departure (or arrival) time is to the passenger's preferred time. Passengers' perceptions of service frequency are therefore closely related to their perception of total journey times (including waiting time, in-vehicle journey time and transfer time).

Frequency is also important in integrating rail services both with other rail lines and other transport modes. Services may have coordinated arrival and departure times for passenger interchanges between services. However, the scale of large urban networks can make coordination unfeasible. In these cases, frequency is crucial in reducing passengers' interchange waiting times.

Brisbane heavy rail

Queensland Rail operates all-stops and express trains. Figure 39 illustrates average times between trains for arrivals at Brisbane Central in peak and off-peak times, from stations that are at the end of lines or at major centres and junctions.

Figure 39 Average time between trains for services arriving at Brisbane Central



Source: Queensland Rail 2015.

Junction railway stations generally have high frequencies due to service densification. The Brisbane system is generally geared towards the commuting task, with significantly higher frequencies in peak periods. All the selected centres and junctions and many of the smaller stations have peak frequencies of a train every ten minutes. In off-peak periods, thirty minute train intervals are common.

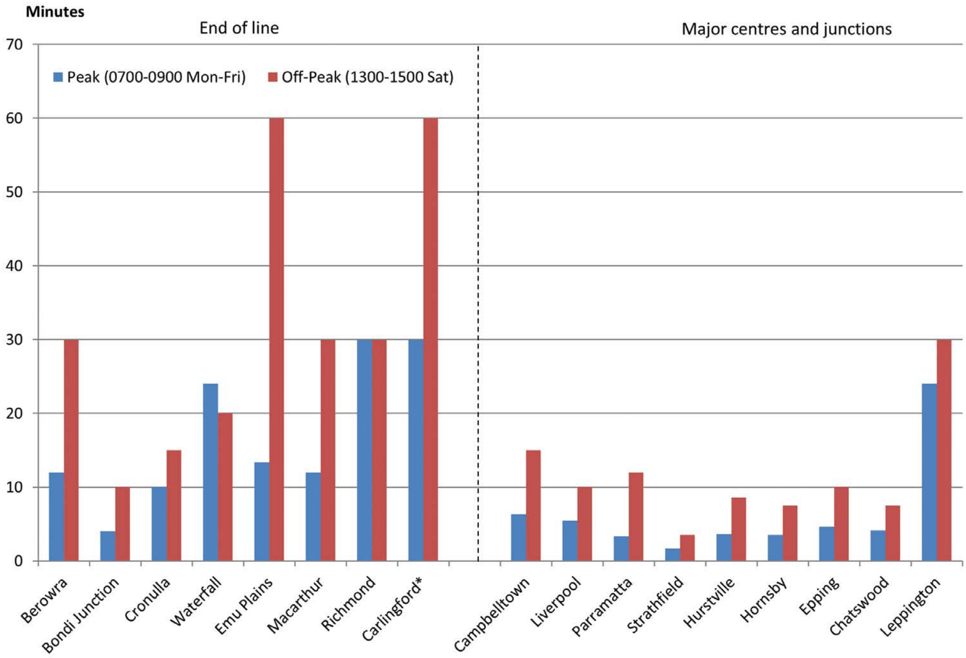
All the selected centres and junctions and many of the smaller stations have peak frequencies of a train every ten minutes. In the off-peak, thirty minute train intervals are common.

Sydney heavy rail

Sydney Trains frequency depends on the time of day, service demand and varying network capacity constraints. The average peak time frequency is a train approximately every 10 minutes or less; see Figure 40.

Off-peak service frequencies vary significantly across the network. Major centres and junctions retain sub-10 minute "turn-up-and-go" frequencies. However, average waiting times are is significantly higher at smaller stations and on the Carlingford line.

Figure 40 Average time between trains for services arriving at Sydney Central



Source: Sydney Trains 2015b.

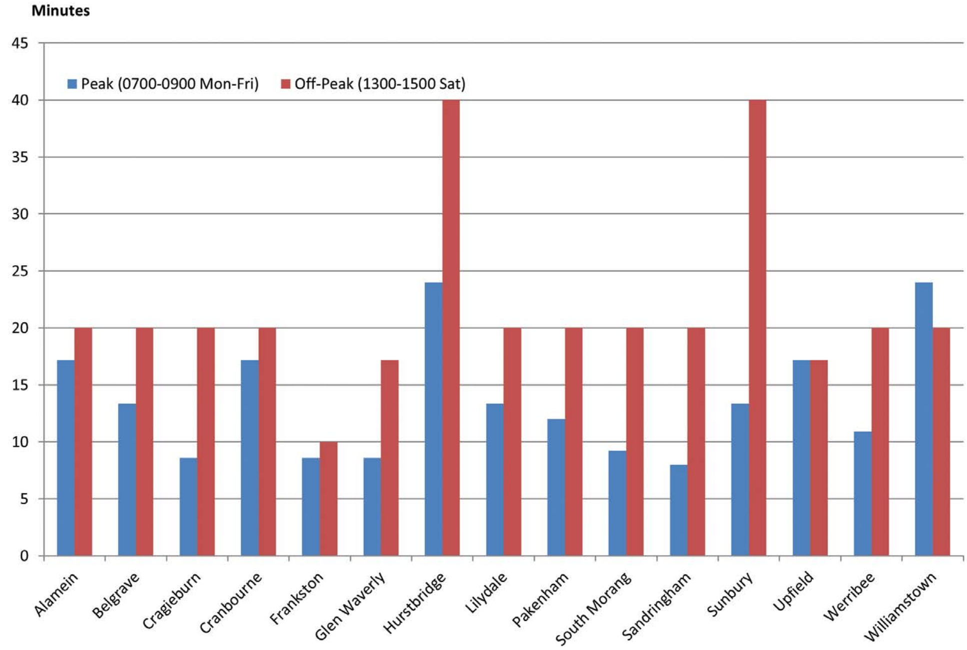
Figure 40 includes a number of stations listed in the New South Wales Government's Transport Master Plan as being "Regional Cities" (Parramatta and Liverpool) and "Major Centres" (Hornsby, Chatswood, Bondi Junction Hurstville, Campbelltown, Macarthur).[50] These locations are significant transport interchanges and destinations. Frequencies through these locations provide an important indicator of the value of the network in providing transport services other than radial-based commuting.

Melbourne heavy rail

Melbourne's services consist of express and all-station services. Figure 41 illustrates the average time between trains arriving at Melbourne's Flinders Street station, from stations at the end of each line. Peak frequencies vary considerably across services, with smaller branch lines generally running fewer trains. Hurstbridge and Williamstown have the highest average peak time periods between services, at 24 minutes. For most lines, the peak average time between trains is much better than the off-peak, with service frequency being primarily geared to commuters. Most off-peak services are based on 20 minute train interval averages.

50 The full list of "Regional Cities" is: Paramatta, Liverpool, Penrith. Major centres are: Hornsby, Dee Why, Brookvale, Chatswood, Bondi Junction, Burwood, Bankstown, Kogarah, Hurstville, Cambelltown, Macarthur, Blacktown, Castle Hill.

Figure 41 Average time between trains for services arriving at Flinders Street from end of line

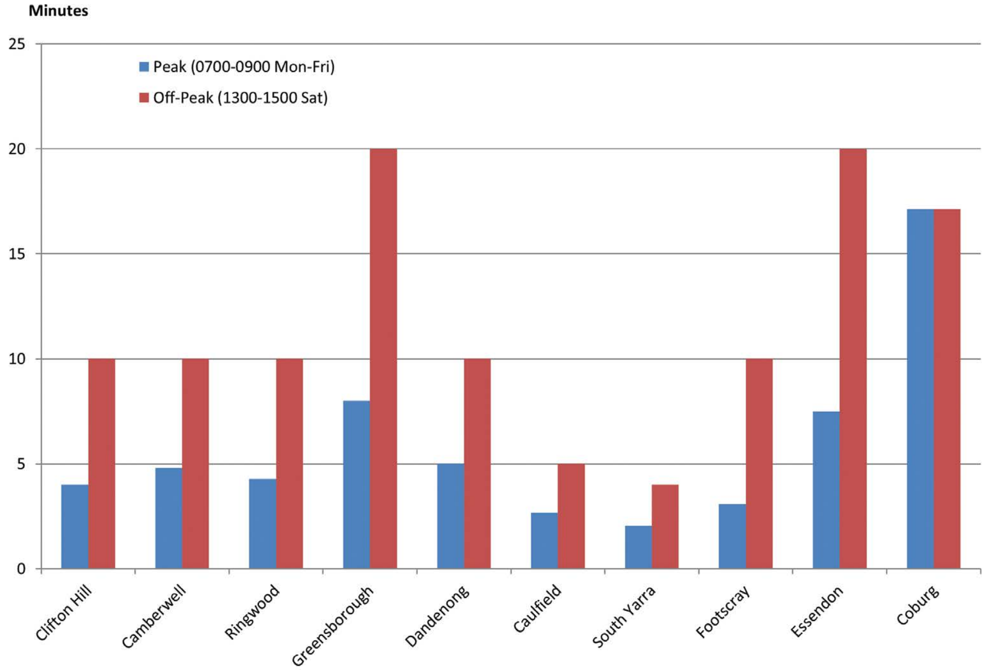


Source: Public Transport Victoria 2015.

The pattern of high-frequency peak services and lower off-peak frequencies is repeated for major centres and junctions (see Figure 42). The structure of the network into branch lines means that stations closer to the city loop will generally have higher frequencies. Although the network is designed as a radial system, centred on the city loop, the densification of services at junctions provides high frequencies at some centres outside the CBD. Also, some non-peak Alamein line services do not travel to or from Flinders Street Station but run as shuttles from Camberwell Station. Passengers on these services must interchange with Belgrave or Lilydale line trains which also service Camberwell station.

South Yarra station has the lowest average wait time, at two minutes in the peak period and four in the off-peak. The station is located close to the City loop, at the junction of the Sandringham and Pakenham, Cranbourne and Frankston lines.

Figure 42 Average time between trains arriving at Flinders Street Station from major centres and junctions



Source: Public Transport Victoria 2015.

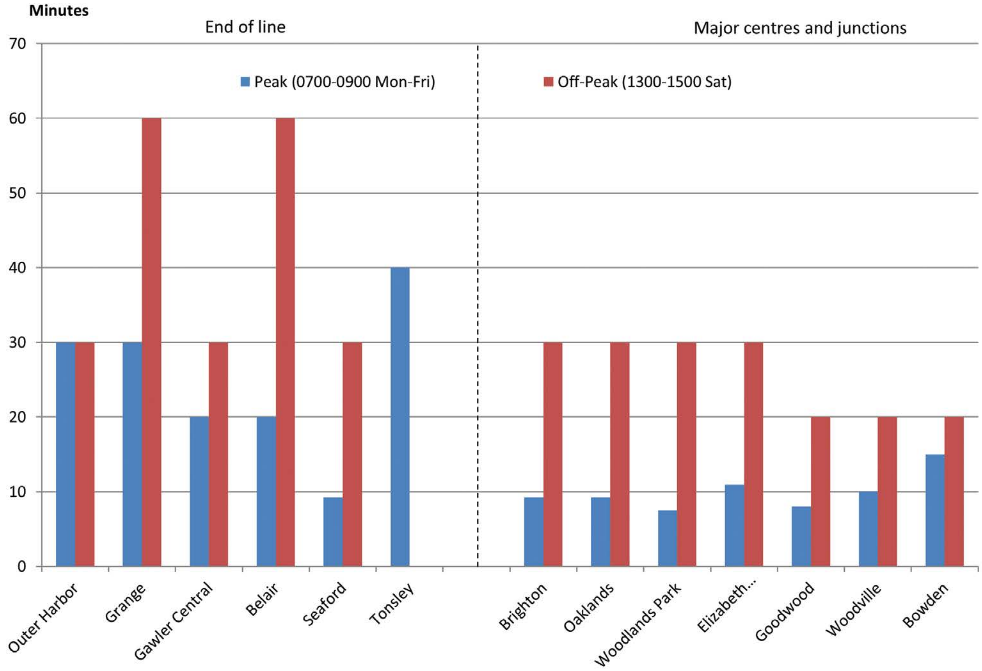
Adelaide heavy rail

Adelaide Metro runs express and all-stops services on a radial network. Figure 43 compares train frequencies from the end of railway lines to major centres and junctions.

While average frequencies are relatively consistent across the network, they are also comparatively long. Service patterns are strongly geared to the peak-period commuting task to Adelaide Railway Station. In most cases, average times between trains in peak periods is less than one-half of those in off-peak periods. The Tonsley line has no weekend services.

Adelaide's lower service levels reflect its modest ridership compared to the other networks. Recent infrastructure enhancement, as part of the Rail Revitalisation Programme, includes electrification, the acquisition of new rolling stock and track renewal. The revitalisation should enable higher speeds, increased frequencies, and greater passenger comfort, which may increase passenger demand.

Figure 43 Average time between trains for services arriving at Adelaide Railway Station



Note: The Tonsley line does not run services on the weekend.

Source: Adelaide Metro 2015a.

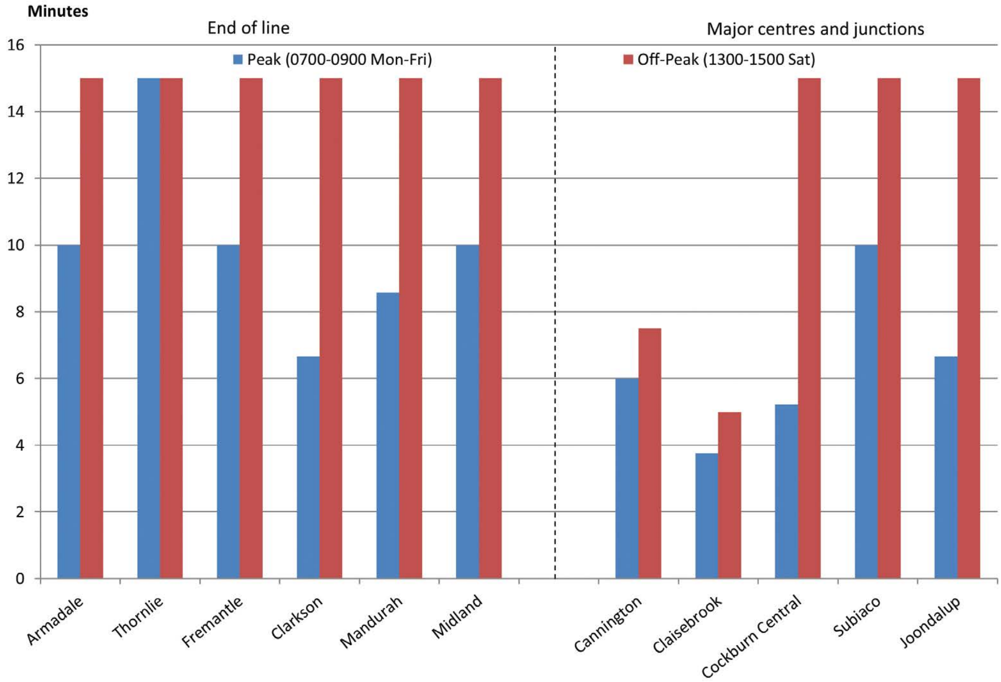
Perth heavy rail

Transperth mostly runs all-station trains. Transperth's focus on maintaining low dwell times and relatively long distances between stations, enables relatively high average line speeds; see Figure 38. Consequently, there is little need to provide express services when compared with Sydney and Melbourne—two networks spread over large areas but with closer average station spacing.

Figure 44 compares train frequencies from stations located at the end of lines with stations at major centres and junctions. This reveals two notable aspects of Transperth's rail services. First, service standards are relatively consistent both across and within lines. The difference in service levels between major centres and junctions and stations located at the end of lines is less significant than in Brisbane, Sydney and Melbourne. This is partly due to the lack of express services. Additionally, the low number of junction stations—with only two junctions outside the city centre—reduces the service densification seen in other cities when different lines merge.

Secondly, except at the extreme ends of operating hours, the maximum time between trains is 15 minutes in the off-peak. In peak times, all selected stations except for Thornlie record average train intervals of 10 minutes or less. The consistent and high service frequencies on the network allow for easier integration with Transperth's bus network, which in turn broadens the railways' catchment beyond walking distance.

Figure 44 Average time between trains for services arriving at Perth Central



Note: The Butler extension was not yet open at the time of this publication's timetable analysis, but has since opened, on 21 September 2015.

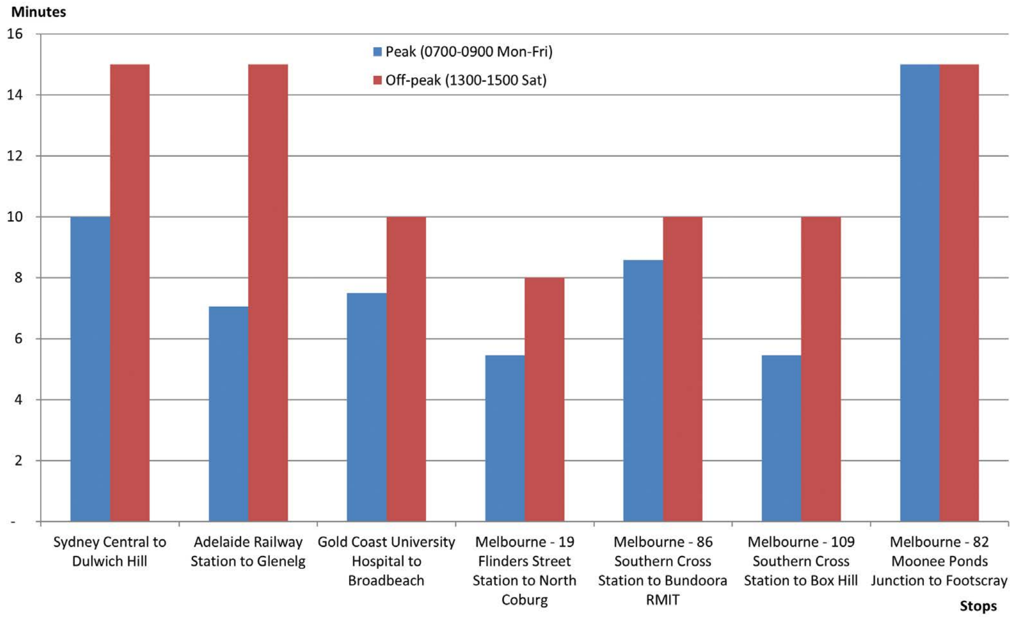
Source: Transperth 2015.

Light rail

Light rail frequencies in Australia vary across networks (see Figure 45). In off-peak periods, average waiting times are 15 minutes or less. In peak periods, waiting times are generally less than 10 minutes. Care should be taken when comparing the single route Sydney, Gold Coast and Adelaide operations with Melbourne. Many Melbourne routes share tracks, meaning a customer may be able to take more than one tram to his/her destination, thus increasing frequency.

The selected routes for Melbourne provide an indicator of transit times across the network's 24 routes. Routes 19 (Flinders Street Station to North Coburg) and 82 (Monee Ponds Junction to Footscray) have the shortest and longest peak hour intervals on the network, respectively.

Figure 45 Average time between trams, by route and direction



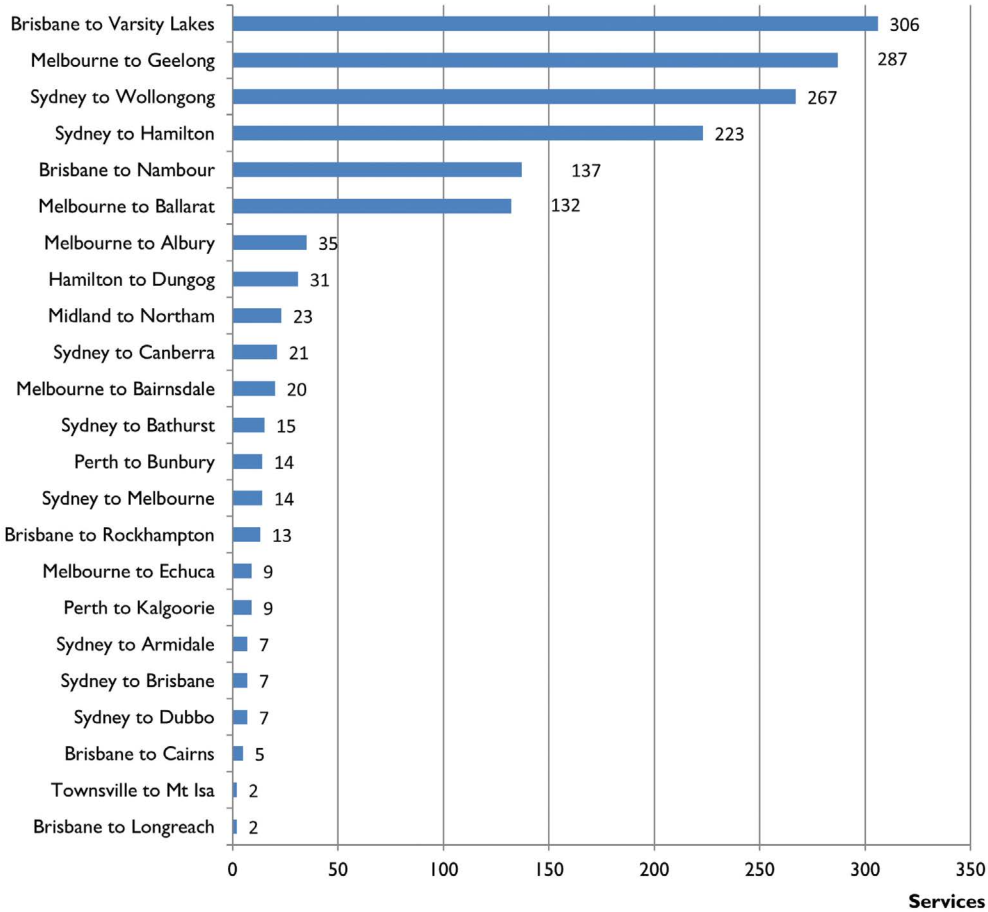
Note: Sydney and Gold Coast operations do not run to timetables. Service frequencies are on their websites.
Sources: Transport for NSW 2015; G:link 2015; Public Transport Victoria 2015; Adelaide Metro 2015b.

Non-urban rail

Frequency is important for non-urban services because it determines how closely a train departure and arrival is to a passenger's preferred time. Service frequencies can also determine the amount of time a passenger waits for a train and, therefore, is closely aligned with perceptions of total travel time.

Figure 46 shows services per week on selected non-urban routes. Frequencies align with the function of each railway, the distance of the corridor and the size of the populations they serve. Railways that serve inter-city and regional centre – capital city commuter markets generally have the highest service frequency.

Figure 46 Non-urban passenger rail services per week



Notes: Based on calculation of outbound 'down' services. Does not include return services.

As of January 2015 train services to Newcastle terminate at Hamilton as a result of a new transport interchange being constructed.

The Sydney–Wollongong figures include truncated services that depart from Waterfall.

Services include trains that arrive at but do not terminate at destination, for example, NSW TrainLink services from Melbourne to Albury that continue on to Sydney.

Sources: BITRE correspondence with NSW TrainLink; NSW TrainLink 2015a; Queensland Rail 2015; Transwa 2015; yarra.

An analysis of Census 2011 data by Bernard Salt (2013) found Sunshine Coast – Brisbane, Brisbane – Gold Coast, Newcastle–Sydney (via the Central Coast), Sydney–Wollongong, Melbourne–Geelong and Perth–Mandurah are among Australia's largest inter-city commuter corridors.

Victoria, in particular, has high levels of service between Melbourne and major regional cities. Frequency increases was one of the key upgrades in Victoria's Regional Fast Rail project. The programme increased weekly services between Melbourne and regional cities by the following levels: Geelong (+13%), Ballarat (+83%), Bendigo (+71%) and Traralgon (+59%) (BITRE, 2014d, p. 65).

Frequencies are approximately similar except for the following:

- Brisbane – Varsity Lakes services have reduced from 398 per week to 306 per week;
- Melbourne–Geelong services have increased from 191 to 287 per week; and
- Melbourne–Ballarat services have increased from 112 to 132 per week.

The Melbourne–Albury figure has increased from 21 to 30 as this year's figures include the two daily Melbourne–Sydney NSW TrainLink XPT services that passengers can also use for Melbourne–Albury travel and which appeared on the published V/Line Melbourne–Albury timetable.

Transit times—non-urban

For commuter travel transit times are important in determining rail's competitiveness against other transport modes. Commuter travellers may consider comparative door-to-door transit times rather than the top speed of a service, when making transport mode choices. For non-urban services, the value of transit time varies according to the market. Tourist travellers are likely to value comfort over time. The *Indian Pacific*, *Ghan*, and Kuranda Scenic Railway are cases in point. Conversely, the opposite would likely apply to regional travellers who are time poor. Rail travel also provides a social service to those who do not have access to other transport modes.

Table 33 shows the key characteristics of selected regional/commuter and long-distance services. The speed shown is an average over the length of the service, including stops.

Table 33 Key characteristics of selected non-urban passenger services

	Operator	Track gauge	Route length (km)	Electrified	Indicative transit time	Indicative average speed (km/h)	Stopping stations (no.)
Regional/commuter *3 hour 59 minutes or less*							
Brisbane to Nambour	QR (TransLink)	Narrow	105	Yes	1h 53m	56	18
Brisbane to Varsity Lakes			89	Yes	1h 23m	64	12
Hamilton to Dungog	NSW TrainLink	Standard	81	No	1h 17m	63	14
Sydney to Hamilton			165	Yes	2h 35m	64	14
Sydney to Wollongong			82	Yes	1h 28m	56	7
Sydney to Bathurst			238	No	3h 43m	64	6
Melbourne to Ballarat	V/line	Broad	118	No	1h 6m	107	3
Melbourne to Ecucha			250	No	3h 23m	74	4
Melbourne to Bairnsdale			275	No	3h 44m	74	15
Melbourne to Geelong			81.5a	No	55m	89	6
Melbourne to Albury		Standard	305	No	3h 58m	77	13
Midland to Northam	TransWA	Standard	102	No	1h 20m	117	1
Perth to Bunbury		Narrow	183	No	2h 30m	72	11
Long-distance *4 hours or more*							
Townsville to Mount Isa	QR Travel	Narrow	977	No	20h 55m	47	8
Brisbane to Longreach			1 325	No	25h 5m	53	19
Brisbane to Cairns			1681	No	24h	70	26
Brisbane to Rockhampton (electric Tilt Train)			639	Yes	6h 30m	82	9
Sydney to Canberra	NSW TrainLink	Standard	330	No	4h 18m	77	9
Sydney to Dubbo			462	No	6h 27m	72	14
Sydney to Armadale			579	No	8h 6m	71	19
Sydney to Brisbane			987	No	14h 12m	70	21
Sydney to Melbourne			951	No	10h 58m	87	17
Perth to Kalgoorlie	TransWA	Standard	653	No	6h 50m	96	16
Adelaide to Darwin	GSR	Standard	2 971	No	54h 15m	55	3

Note: The Melbourne–Geelong distance has been adjusted to account for the new route via Tarneit, which was constructed as part of the Regional Rail Link.

Sources: Great Southern Rail 2015; NSW TrainLink 2015a; Queensland Rail 2015; Transwa 2015; V/Line 2015a; Rail Geelong; BITRE 2015.

Average train speeds are a function of:

- The quality of the track, including condition, curves, level crossings and capacity;
- The standard of rolling stock, influenced by its power, propulsion, in-cab signalling and the existence of a tilting mechanism;
- Railway procedures, including crew changes, loading and unloading passengers/luggage and right-of-way priority relative to other trains; and
- The station spacing and stopping pattern, determined largely by the function and policy objective of the service.

The Brisbane–Nambour; Brisbane–Varsity Lakes; Sydney–Newcastle; and Sydney–Wollongong services have similar, relatively low average train speeds; see Table 33. These services are medium-distance, inter-city, commuter railways. The services stop at a large number of stations relative to distance travelled. This is because they function as limited-stop and stopping commuter trains in the peri-urban coastal regions and metropolitan areas of Brisbane and Sydney, respectively. In addition, the Newcastle–Sydney and Sydney–Wollongong rail corridors are slow and circuitous due to the 'steam era' alignments through the mountainous terrain in which they operate.

V/Line's medium-distance regional services are relatively fast. The Victorian Government's Regional Fast Rail Project (largely completed by 2006) and the Regional Rail Link (opened in June 2015), included a number of measures that improved average speed:

- upgraded track condition and separation from suburban trains in metropolitan Melbourne;
- improved track alignment;
- upgrading or elimination of level crossings;
- improved signalling and communications; and
- enhanced rolling stock.

While the Regional Rail Link has enhanced the Regional Fast Rail Project for services between Melbourne and Bendigo, Ballarat, and Geelong, Melbourne–Traralgon services still lack a dedicated corridor through the more expansive south eastern suburbs of Melbourne.

It is important to note there is a wide dispersion of transit times across V/Line services—caused by different stopping patterns—largely to cater for different market segments. For more information on V/Line's Regional Fast Rail Project; see BITRE, *Improving regional passenger rail services,* 2014f.

Long-distance passenger trains in Australia generally have uncompetitive transit times compared to air travel.[51] While NSW TrainLink's XPT trains can cruise at 160 kilometres per hour, their speed is restricted in much of New South Wales due to the tight curves that typify much of the state's railway alignment.

51 Long-distance trains can provide services for centres along their route, thus acting as medium-distance services along numerous route segments. For example, the Sydney–Melbourne and Sydney–Canberra trains serve regional centres such as Goulburn and Moss Vale.

Case Study—Sydney Metro Northwest

Australia's urban rail systems will undertake a step-change over coming years, with the completion of Stage 1 of the Sydney Metro project – the $8.3 billion Sydney Metro Northwest (formerly the North West Rail Link). Unlike the proposed Melbourne Metro project which is an underground extension of an existing suburban railway, Sydney Metro is an example of 'metro' rail technology previously unseen in Australia, but used in many international cities. Metros provide a level of rail service with the following features (from Vuchic, 2007, pp. 51–2):

- high levels of safety-dedicated grade-separated alignments, automated train and signalling control systems and platform screen doors at stations; and
- high frequency, high capacity, fully-automated trains.

Why Sydney Metro is important is that it may mark a turning point in the construction of urban railways in Australia. International evidence tends to show that once cities open metro-style urban railways, all future new urban rail lines will be subsequently built to the metro standard.[52]

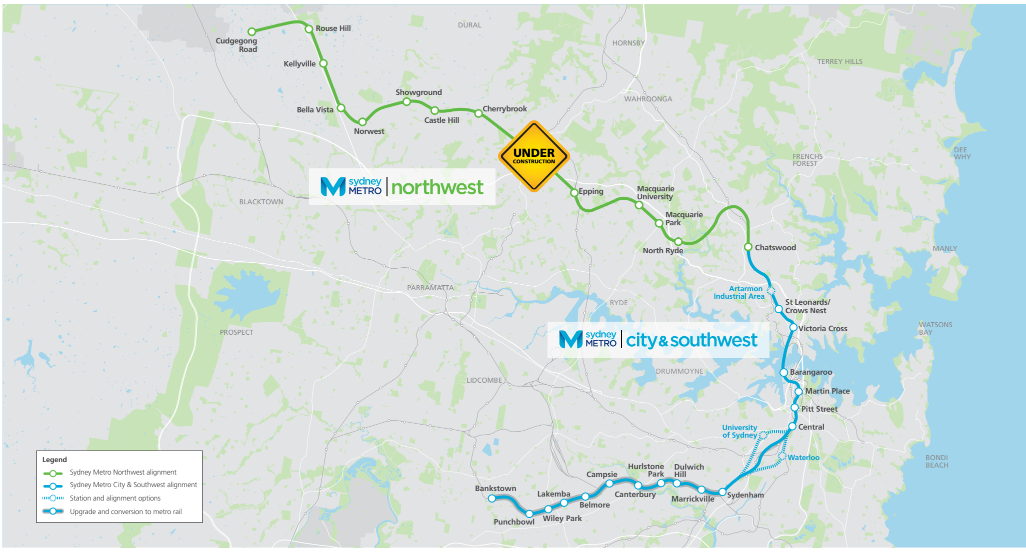
Sydney Metro is Australia's biggest public transport project and will provide regular automated rail transport services to the north western Sydney suburbs (an area with Australia's highest car ownership rates). Sydney Metro Northwest will open to customers in the first half of 2019. The 36 kilometre metro rail project from Rouse Hill to Chatswood includes eight new railway stations, 4,000 commuter car spaces and five existing stations upgraded to metro standards. The $8.3 billion project includes 15 kilometre twin tunnels between Bella Vista and Epping – Australia's longest – and a four kilometre elevated skytrain viaduct. It will be Australia's first fully automated rail system, which will also provide regular services without timetables. Trains will operate every four minutes during peak periods and every 10 minutes outside the peaks.

Stage 2 of Sydney Metro – Sydney Metro City and Southwest – extends metro rail from Chatswood, under Sydney Harbour, through new underground CBD stations and southwest to Bankstown. It is expected to open in 2024. According to Sydney Metro Northwest, safety and security is paramount to the system's design:

- The trains are being designed, built and will be operated to the highest safety standards, with more than 300 Australian and international safety standards stipulated in the operations contract for the trains and the equipment on the trains.
- Rail controllers will monitor the entire system from an Operations Control Centre.
- High levels of security will prevent trespasser access, such as platform screen doors which keep people and objects away from the tracks and allow trains to enter and depart stations faster.
- Obstruction detectors will prevent trains departing stations if any door is not fully closed.
- In an emergency, passengers can leave the train when directed by using either tunnel walkways or the wide built-in ramps which fold out from the front and back of the trains.
- There will be extensive use of surveillance cameras, both on board the trains and in the tunnels.
- A modern communications system will control the trains, the tunnels, tracks, platforms, platform screen doors and skytrain.
- While the trains are fully automated, customer service assistants will be at every station and on board the trains[53].

52 R. Malla (2014), 'Automation sets a new benchmark', *Metro Report International,* March 2014, p. 3.
53 Sources: Sydney Metro Northwest; BITRE Liaison with Sydney Metro Northwest. Photo courtesy of Sydney Metro.

Figure 47 Sydney Metro Northwest Stage 1 Map



APPENDIX A

Significant railway events

Date	Event	Description
30 July 1991	National Rail Corporation (Agreement) Act	Agreement between Federal Government and states of Queensland, NSW, Victoria and WA for National Rail Corporation to take over operation of interstate rail services from states.
3 April 1993	Commencement of National Rail third-party access	National Rail began third-party access freight operations on interstate track
1995	Port of Brisbane	Connection of Port of Brisbane to standard gauge network, opening in 1997
1995	Trans Australia Railway	Traffic on Trans Australia Railway disrupted for six weeks due to flooding
June 1995	Melbourne–Adelaide gauge standardisation	Completion of standardisation of Melbourne–Adelaide broad gauge with new standard gauge line via North Geelong – Cressy – Ararat (bypassing former main line through Ballarat).
July 1995	First private train on national network	SCT commenced first private train service on national network, Melbourne–Perth
June 1996	TNT (Toll) trains commenced	TNT (later Toll) began operating freight trains between Melbourne and Perth
1 July 1996	Vertical separation in NSW	State Rail Authority split, with Rail Access Corporation managing infrastructure, Rail Services Australia undertaking track maintenance, FreightCorp operating freight trains and residual State Rail Authority operating passenger trains
1 July 1996	National Rail Safety agreement	Inter-governmental Agreement to legislate terms for national safety and accreditation processes
26 October 1996	NR class locomotives enter service	The first of 120 of National Rail's new 4000 hp locomotives entered service
May 1997	Patrick Rail operations	Patrick Corporation commences land bridging container train service between Port Adelaide and the Port of Melbourne.
30 October 1997	Privatisation of AN's passenger business	Great Southern Railway consortium purchased Australian National Railways' passenger business ("Pax Rail") for $16 million, effective from 7 November 1998
14 November 1997	Privatisation of AN's Tasmanian network	Australian Transport Network purchased Australian National Railways' Tasmanian operations ("Tasrail") for $22 million, effective from 14 November 1997
31 October 1997	Privatisation of AN's SA intrastate network	Genesee & Wyoming purchased Australian National Railways' SA intrastate network ("SA Rail") for $57.4 million, effective from 31 October 1997

(continued)

Date	Event	Description
1 July 1998	Vertical separation of Commonwealth railway infrastructure	ARTC commenced management of Australian National's infrastructure (assets of AN's Track Access Unit) following incorporation of ARTC on 25 February 1998
February 1999	V/Line freight service sold and track leased	V/Line freight business sold and intrastate country track leased for 45 years to Rail America for $163 million trading as Freight Australia.
August 1999	Victorian franchising	Victorian passenger rail and tram services franchised to National Express, Connex and Yarra Trams
1 July 1999	Lease of Victorian interstate rail network	The Australian Rail Track Corporation is given 15 year lease of Victorian interstate rail network from SA border through Melbourne to Albury.
2 December 1999	Glenbrook accident	Train collision at Glenbrook, NSW
November 2000	NSW rail industry restructure	Merger of Rail Services Australia and Rail Access Corporation in NSW into Rail Infrastructure Corporation
18 December 2000	Privatisation of Westrail	Consortium of Wesfarmers and Genesee & Wyoming purchased Westrail for $585 million
May 2001	Opening of intermodal terminal	Bowports, in conjunction with FreightCorp, developed an intermodal terminal at Minto, with port shuttle trains commencing in May 2001.
30 January 2002	Sale of National Rail and FreightCorp	Consortium of Patrick Corporation and Toll Holdings purchased National Rail Corporation for and FreightCorp for $1.2 billion, forming Pacific National
17 December 2002	National Express abandons franchises	National Express walked away from its V/Line Passenger and Melbourne passenger contracts
31 January 2003	Waterfall accident	Passenger train derailment at Waterfall, NSW
27 March 2003	Bridge closure	Temporary closure, until 23 April, of Menangle Rail Bridge, on Sydney–Melbourne railway line. Interstate trains had to move along alternative circuitous routes
May 2003	Freight competition between Sydney and Melbourne	Freight Australia commenced a daily freight service between Sydney and Melbourne
1 January 2004	NSW RailCorp	Creation of Rail Corporation New South Wales (RailCorp) as the merged entity of the State Rail Authority of New South Wales and the metropolitan functions of the Rail Infrastructure Corporation.
16 January 2004	Darwin line opened	First freight train arrived in Darwin
February 2004	Takeover of ATN-Tasrail	Pacific National purchased ATN-Tasrail
April 2004	QRN commences North–South intermodal service	QR National commences intermodal freight service between Brisbane, Sydney and Melbourne
1 September 2004	Takeover of Freight Australia	Pacific National purchased Freight Australia business and track lease for $285 million.
5 September 2004	ARTC lease in NSW	ARTC commences 60 year lease of interstate rail network in NSW and management contract of country rail network

(continued)

Date	Event	Description
1 July 2005	QRN operating in Hunter Valley	QR National commences operating in Hunter Valley (Mount Arthur–Port Waratah)
September 2005	Tasmanian rail freight	Pacific National announced that it intended to withdraw most of its rail freight services in Tasmania leaving only two bulk haul operations.
14 February 2006	Sale of WA and SA rail freight operations and track	In a complex sale worth $970 million, Queensland Rail purchased ARG's WA freight business; Babcock & Brown purchases ARG's WestNet infrastructure; and Genesee & Wyoming takes full control of ARG's SA operations
11 March 2006	Toll takeover of Patrick	ACCC approves Toll takeover of Patrick
March 2006	South Maitland Railway	30 km of the South Maitland Railway reopens to service the Austar Coal Mine in the Hunter Valley
17 August 2006	Linfox buys FCL	Linfox buys FCL, a major rail-based freight forwarding company.
September 2006	Victorian regional fast trains commence	The start of the first Regional Fast Train service begins. Faster services are introduced from Geelong, Ararat/Ballarat, Bendigo and the Latrobe Valley.
October 2006	End of Sydney–Perth coastal shipping service	Boomerang coastal shipping service, operating between Sydney and Perth since June, ended after financial failure.
20 October 2006	SCT commence Parkes service	SCT Logistics commenced freight service between Parkes and Perth
November 2006	Sandgate Flyover	Opening of main line flyover of coal lines, to enable unimpeded movement of coal trains, between Hunter Valley and Kooragang Island
18 December 2006	Pacific National wins 7-year steel contract	PN wins a contract extension, with Bluescope and OnsSteel for 7 years, to shift steel products around the country.
1 January 2007	Tasmanian government takes back rail infrastructure	Tasmanian government resumes financial responsibility for the State's commercial railways; day-to-day infrastructure management remains with Pacific National
3 January 2007	North–South Corridor upgrading	On this date the new Wagga Wagga bridge was opened The construction is a first major milestone in the $1.8 billion North–South Corridor upgrade
15 February 2007	ACCC approval of SCT acquisition	ACCC approved SCT Logistics' purchase of train assets (including 9 locomotives) from Pacific National, as part of Toll's takeover of Patrick
18 February 2007	CRT ceases Melbourne port shuttle	CRT ceased its Altona North–Port of Melbourne shuttle.
15 March 2007	Tasrail funding	Australian Government announced $78 funding of remedial work on AusLink section of Tasmanian railway system with $40 million more from the Tasmanian Government and commitment by Pacific National to spend $38 million on locomotive and wagon upgrades.
18 April 2007	ACCC approves Toll restructuring, formation of Asciano	ACCC approves Toll Holdings restructure, with new company Asciano, which will include the Pacific National and Patrick Portlink assets
18 April 2007	Toll restructuring	Toll announces split of Toll Holdings, with Asciano Ltd controlling the Patrick and Pacific National assets
4 May 2007	Re-acquisition of Victorian track lease	Victorian government bought back leased intrastate track from Pacific National giving control of the network to V/Line Passenger, the State's regional rail operator.

(continued)

Date	Event	Description
October 2007	Lang Hancock Railway opens	58km Lang Hancock Railway opens between Hope Downs and existing Rio Tinto railway
November 2007	Asciano announces end of rail services in southern Australia	Asciano announces end of grain and intrastate intermodal services in Tasmania, Victoria and NSW, to take effect from early 2008.
16 November 2007	QRN commences Melbourne–Perth service	QRN commences new thrice-weekly Melbourne–Perth service, incorporating the weekday P&O Melbourne–Adelaide train
23 December 2007	Opening of Mandurah railway in Perth	Opening of 70km Perth–Mandurah passenger railway
18 January 2008	Rail competition begins in Victoria	El Zorro begins broad gauge grain train competition in Victoria, the first in that State
March 2008	Opening of Lang Hancock Railway	Opening of 58km Lang Hancock Railway in the Pilbara, linking Hope Down iron ore deposits with Pilbara Rail network
March 2008	Pacific National begins withdrawal from Victoria	Pacific National begins withdrawal of freight services in Victoria, following earlier (Nov. 2007) announcement of closure of operations. El Zorro announces it will take over Warrnambool–Melbourne container operation.
15 May 2008	Opening of Fortescue railway	Opening of Fortescue Metals Group's 260 km Cloudbreak railway in the Pilbara
13 June 2008	Cessation of Tasmanian train operations	Pacific National announced cessation of its Tasmanian train operations, later indicating it would sell the business
25 July 2008	Extension of double-stacking network	Commencement of standard double-stacking operations between Parkes and Perth following ARTC investment
5 August 2008	Pacific National wins Queensland coal haulage contracts	Asciano announces it has signed 10-year contracts with Rio Tinto and Xstrata for coal haulage in Queensland from early 2010
May–September 2008	Grain contracts awarded	GrainCorp, AWB, ABB sign contracts with train operators for grain haulage
15 September 2008	New Portland freight traffic	Commencement of movement of mineral sands between Portland and Melbourne
24 September 2008	Investment in Tasmanian tracks	Announcement by Tasmanian government of upgrading of its railway tracks
2 October 2008	Additional east–west train service	Pacific National adds a third "Express" freight train to its Melbourne–Perth service
27 October 2008	Pilbara railway access decision	The Treasurer, Mr Swan, announces that Fortescue Metals Group has the right to use Pilbara railways built by BHP-Billiton and Rio Tinto
November 2008	Closure of grain lines	NSW Government announces closure of 5 grain railways in the west of State
November 2008	Construction of Southern Sydney Freight Line	Construction of the 36 km Southern Sydney Freight Line commenced
6 November 2008	Darwin railway operator in administration	FreightLink placed in administration

(continued)

Date	Event	Description
26 November 2008	Suspension of railway construction	Suspension of work on Fortescue's Cloudbreak–Christmas Creek railway
1 December 2008	Gauge conversion	End of Albury-Wodonga–Seymour broad gauge services marked the commencement of conversion of railway to standard gauge
12 December 2008	Infrastructure investment announcement	Australian Government announces $1.2 billion funding for ARTC for rail projects on interstate and Hunter Valley networks
23 February 2009	Chatswood–Epping	Opening of Sydney's Chatswood–Epping passenger line
3 March 2009	Extra Parkes–Perth service	SCT Logistics commenced second freight service between Parkes and Perth
23 March 2009 8 April 2009	Grade separation in Melbourne	Opening of Melbourne's Footscray Road rail underpass, as part of Dynon Port Rail Link; opening of Tottenham–Dynon rail link.
5 May 2009	PN coal contract in Queensland	Asciano wins 9-year coal-haulage contract with Macarthur Coal (3.7 million tonnes pa)
15 May 2009– 23 June 2009	Temporary mainline closure in Tasmania	Following a derailment, Tasmanian railway was closed to enable significant track renewal task to be brought forward and expedited
29 May 2009	GrainCorp trains	GrainCorp commences train operations in NSW, taking grain trains from NSW government.
2 June 2009	QR above-rail privatisation	Queensland Premier announced plan to part-privatise QR, namely, the freight businesses (but not passenger services); and to explore the sale or lease of the regional intrastate infrastructure to ARTC
23 June 2009	Announcement that Tasmanian railways will be nationalised	Asciano agrees the transfer of Tasmanian train operations to Tasmanian government, effective from 30 November 2009.
30 June 2009	New train operator	Freightliner Australia, a subsidiary of a major UK freight operator, commenced operating in Australia
June 2009	GrainCorp trains	GrainCorp takes over 18 48-class locomotives and 180 wagons from NSW government; grain trains to be run by Pacific National
22 July 2009	Asciano contract	Asciano signed 10-year contract with Xstrata Coal for moving coal in Hunter Valley
22 August 2009	Mildura railway	Completion of upgrade of Mildura railway
October 2009	ARTC lease	ARTC commenced lease of the Benalla–Oaklands railway, from V/Line
30 Nov 2009	Formation of TasRail	Tasmanian government took control of railways, from Asciano, establishing TasRail on 1 December
December 2009	Track upgrade	Completion of concrete sleepering of the Cootamundra–Parkes line
17 January 2010	ARTC track	ARTC commenced a 60-year lease of the Brisbane–NSW border standard gauge track
22 February 2010	Rio Tinto line opens	Opening of 49-kilometre Rio Tinto railway in Pilbara, between Pannawonica and Mesa A
May 2010	Goonyella-Newlands	Commencement of construction of 69 km Northern Missing Link railway linking the Goonyella and Newlands coal systems in Queensland
May 2010	Asciano wins contract from Toll	Toll and Asciano signed a five-year contract for intermodal and car transport

(continued)

Date	Event	Description
May 2010	Interstate track re-railing	Commonwealth announced programme to re-rail interstate track, Cootamundra–Parkes, Broken Hill–Whyalla, Albury–Melbourne–Geelong, Kalgoorlie–Koolyanobbing
9 June 2010	Freightlink sold	Genesee & Wyoming Australia buys Freightlink, the Darwin line operator. The transaction is expected to take 3 months for completion.
30 June 2010	Camellia closed	Asciano closed its Patrick-subsidiary Camellia intermodal terminal in Sydney, along with its Dubbo and Port Botany services.
1 July 2010	QR split	QR split into passenger train and non-coal intrastate infrastructure (Queensland Rail); and freight train and coal infrastructure network (QR National).
October 2010	SBR	Commencement of Specialised Bulk Rail services between siding west of Cairn Hill and Outer Harbour (Adelaide). SBR is a subsidiary of SCT Logistics. The service is for IMX Resources.
22 November 2010	QR National float	QR National was floated, while leaving around 25–40 percent of the shares with the Government
January 2011	Widespread flooding	Severe flooding in eastern Australia, especially in Queensland, where train services and coal exports were severely disrupted
January 2011	New Fortescue line	Fortescue commenced commissioning of new 50 km railway between Cloudbreak and Christmas Creek, WA
February 2011	Cyclone Yasi disruption	Cyclone Yasi crossed the north Queensland coast around Cairns, causing disruption to freight, notably coal exports
Late February 2011	Trans Australia Railway	Flooding cut the Trans Australia Railway for a number of days
26 June 2011	V/Line services to Albury–Wodonga	Resumption of V/Line passenger services to Albury–Wodonga, following conversion of broad gauge track between Albury and Seymour
20 July 2011	Roy Hill Holdings	Roy Hill Holdings received permission to build 342 km Roy Hill–Port Hedland railway
19 December 2011	Northern Missing Link	Opening of 68 km "Northern Missing Link", Newlands – North Goonyella, Queensland
27 December 2011 to 29 February 2012	Darwin Line cut	The Darwin line was broken near Katherine after flood waters washed away part of the track/bridge work. Goods between Darwin and Katherine were conveyed by road during this period
15 January 2012	NSW regional rail	John Holland took over management of NSW's Country Regional Network from ARTC, under contract from NSW Government.
15 January 2012	Karara railway	QR National commenced contract with Karara Mining to haul iron ore over new railway, to Geraldton
30 January– 27 February 2012	Port Botany works	DP World's Port Botany rail yards were closed to enable expansion of the rail facilities
April 2012	South Morang	Opening of Epping – South Morang railway in Melbourne
7 June 2012	Sale of Independent Railways	Qube announced that it was purchasing Independent Railways of Australia, including the Macarthur Intermodal Shipping Terminal at Minto, Sydney
5 August 2012	ARTC lease in Sydney	Enfield West – Port Botany section (19 km) of Metropolitan Freight Network leased by NSW to ARTC until 2064
14 September 2012	Trans Australian Railway	Centenary of the commencement of construction of the Trans Australian Railway.
14 November 2012	MidWest Rail Upgrade	Formal completion of $550 million upgrade of the Morawa–Mullewa–Geraldton Port railway, including installing dual-gauge sleepers
1 December 2012	Aurizon	QR National changed its name to Aurizon

(continued)

Date	Event	Description
1 December 2012	Fortescue Hamersley Line	First train on the Fortescue Hamersley Line in the Pilbara, serving the Firetail iron ore deposits at Solomon
December 2012	Geraldton upgrade	Completion of substantial track upgrade and capacity expansion of tracks into Geraldton
21 January 2013	Southern Sydney Freight Line	Formal opening of the Southern Sydney Freight Line
29 January–February 2013	Queensland coal disruptions	Queensland's Blackwater and Moura coal systems disrupted by Cyclone Oswald
21 April 2013	Hope Down 4	Opening of Hope Down 4 railway in the Pilbara
June 2013	El Zorro	South–east Australian train operator, El Zorro, ceased operations
1 July 2013	Sydney Trains/ NSW Trains	Establishment of Sydney Trains and NSW Trains, from CityRail and RailCorp
October 2013	Roy Hill Railway	Commencement of construction of Roy Hill Railway
1 December 2013	Springfield Railway	Opening of the Springfield urban railway in Brisbane
2 December 2013	Enfield Staging Facility	First train to use the Enfield Staging Facility in Sydney
23 February 2014	Seaford Railway and Adelaide electrification	Opening of the Seaford urban railway extension from Noarlunga, coinciding with first public operation of electric trains in the city on the Adelaide–Seaford line
2 May 2014	Tonsley Railway electrification	The Tonsley railway electrification was commissioned.
22 June 2014	Hobart/Brighton Hub	Intermodal freight services shifted from Hobart to Brighton Hub (to the north of the city), leading to closure of the Hobart–Bridgewater Junction line.
27 July 2014	Regional Rail Link	V/Line regional passenger services commenced using new dedicated tracks between Sunshine and Melbourne Southern Cross railway stations, as part of the Regional Rail Link project
5 August 2014	Port Botany Terminal	Opening of the Hutchison rail terminal at Port Botany.
21 September 2014	Butler Railway, Perth	Opening of the 9 km Butler urban railway extension from Clarkson
12 November 2014	North Quay Rail Terminal, Fremantle	Opening of extended North Quay Rail Terminal at Fremantle's Inner Harbour
25 December 2014	Newcastle Station Closure	Heavy rail line from Wickham to Newcastle closed
8 February 2015	South West Rail Link	Opening of Sydney's South West Rail Link, between Glenfield and Leppington
23 February 2015	Canberra freight	Resumption of rail freight services on Canberra railway, with containerised scrap metal being shifted by Espee Railroad Services to Port Botany for export
25 March 2015	Sale of Freightliner	Genesee & Wyoming completed its acquisition of 94 per cent of Freightliner Group
30 March 2015	Great Southern Rail	Allegro Funds acquired Great Southern Rail from Serco
21 May 2015	Viterra	Grain handling group Viterra announced it would no longer be using rail to transport grain on the Pinaroo and Loxton lines in SA
21 June 2015	Regional Rail Link	Opening of the Wyndham Vale – Tarneit section of the Regional Rail Link in Victoria

(continued)

APPENDIX B

Significant network route additions from 1970

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
1970	Midland–Forrestfield Forrestfield – Kenwick Junction	WA	Narrow	8.0 10.0	Urban freight
	Kenwick Junction – Kenwick	WA	Narrow	1.0	Urban freight
	Bunbury Power House – Bunbury Inner Harbour	WA	Narrow	1.5	Urban freight
	Broken Hill – SA/NSW border SA/NSW border – Peterborough Peterborough – Port Pirie	SA/NSW	Standard	48.7 253.8 114.4	Interstate standardisation
	Blackwater–Laleham	Qld	Narrow	41.1	Coal
1971	Hay Point – Yukan Yukan–Goonyella Goonyella Mine Balloon Loop	Qld	Narrow	30.2 196.9 5.1	Coal
1972	Shay Gap – Goldsworthy	WA	Standard	65.0	Iron ore
	Tom Price – Paraburdoo	WA	Standard	110.0	Iron ore
	Kooragang Junction Triangle Loop	NSW	Standard	0.9	Coal
	Coppabella – Peak Downs Peak Downs Mine Balloon Loop	Qld	Narrow	42.6 5.6	Coal
	Cape Lambert – Pannawonica (Mesa J)	WA	Standard	203	Iron ore
	Spencer Junction – Whyalla	SA	Standard	74.0	Steel
	East Swanson Dock	VIC	Broad	1.4	Urban freight
1973	Longreach Junction – Coldwater Creek Longreach Junction – Longreach	TAS	Narrow	27.0 2.8	Mixed freight
	Redmine–Kambala	WA	Standard	8.0	Mixed freight
	Taurus–Koorilgah	Qld	Narrow	5.9	Coal
	Cockburn South – Kwinana	WA	Narrow	12.0	Urban freight
	West Kalgoorlie – Kambalda	WA	Standard	54.0	Gauge standardisation

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
1974	Leonora–Kalgoorlie Kambalda–Esperance	WA	Standard	259.0 332.3	Gauge standardisation
	Bell Bay Wharf – Longreach Junction	TAS	Narrow	17.8	Freight
	Coldwater Creek Junction – East Tamar Junction	TAS	Narrow	12.5	Freight
	Peak Downs – Saraji Saraji Mine Balloon Loop	Qld	Narrow	21.1 5.5	Coal
	Cobarra Balloon Loop Junction – Greenvale	Qld	Narrow	216.5	Nickel ore
1975	Callemondah Yard – Powerhouse Loop – Fork at Callemondah	Qld	Narrow	3.6	Coal
	Boorgoon Mine Balloon Loop	Qld	Narrow	4.2	Coal
	Box Flat – Swanbank Powerhouse	Qld	Narrow	4.6	Coal
1975–1988	Bottom Points – Clarence	NSW	Narrow	7.0	Heritage passenger
1976	Pt Stanvac – Christie Downs	SA	Broad	2.9	Urban passenger
	Pinjarra East – Pinjarra South	WA	Narrow	1.1	Passenger and freight
	Dongara–Eneabba – South Mine	WA	Narrow	93.5	Mineral sands
	Osborne Power Station – Container Terminal	SA	Broad	4.2	Port–intermodal
	Flynn – Phosphate Hill	Qld	Narrow	66.1	Phosphate
1978	Kenwick Junction – Canning Vale	WA	Narrow	5.0	Urban freight
	Picton Junction – Picton East – Point V	WA	Narrow	5.1	Freight
	Christie Downs – Noarlunga Centre	SA	Broad	1.3	Urban passenger
	Whittingham Junction – Mount Thorley Balloon Loop	NSW	Standard	14.8	Coal
	Roma Street – South Brisbane	Qld	Narrow	1.8	Urban passenger
1979	Norwich Park Mine Balloon Loop	Qld	Narrow	5.4	Coal
	Bondi Junction – Erskineville Junction	NSW	Standard	10.1	Urban passenger
	Saraji – Norwich Park	Qld	Narrow	43.2	Coal
	Port Botany – Botany ANL (now Patrick) Terminal – Port Botany	NSW	Standard	0.8 1.4	Port–intermodal
1980	Alice Springs – Kulgera Kulgera – SA/NT border SA/NT border – Tarcoola	NT/SA	Standard	256.0 15.7 562.5	Interstate
	Vales Point Balloon Loop – Vales Point Junction	NSW	Standard	2.7	Coal
	Golding – Callemondah Yard	Qld	Narrow	8.5	Coal
	Fork at Gladstone	Qld	Narrow	0.5	Port
	Fisherman Islands – Ampol Refinery Junction	Qld	Narrow	3.0	Port
	Fisherman Islands Balloon Loop	Qld	Narrow	1.7	Port
	Gregory Mine – Burngrove Gregory Mine balloon loop and fork	Qld	Narrow	61.1 7.6	Coal

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
1981	Tahmoor Colliery Junction – Tahmoor Colliery Balloon Loop	NSW	Standard	1.3	Coal
	Kwinana CBH	WA	Narrow	8.0	Grain/port
	Boonal (Yarrabee)	Qld	Narrow	3.5	Coal
	Inner Harbour Balloon Loop	NSW	Standard	2.0	Port
1982	Container Terminal – Outer Harbor	SA	Broad	1.3	Port
	Dry Creek North Junction – Dry Creek East Junction	SA	Broad	0.5	Port
	Lota–Thornside	Qld	Narrow	1.9	Re-opening/ urban passenger
	Elura Mine – Elura (CSA) Junction	NSW	Standard	33.6	Ore
	Glanville – Grand Junction Road Container Terminal – Glanville Container Terminal – Outer Harbor Dry Creek North – Dry Creek East Junction Cavan – Dry Creek East Junction Dry Creek – Gillman Junction Gillman Junction – Port Adelaide Junction Port Adelaide Flat – Gillman Junction	SA	Standard	2.7 10.9 1.3 0.5 1.1 4.7 2.4 3.1	Interstate standardisation
	Saxonvale Junction – Saxonvale Balloon Loop (Bulga Mine)	NSW	Standard	8.0	Coal
	Ulan Junction – Ulan Balloon Loop Sandy Hollow – Ulan	NSW	Standard	2.0 105.2	Coal
	German Creek – Gregory Mine Junction	Qld	Narrow	36.1	Coal
	Snowtown–Kadina Kadina–Wallaroo	SA	Standard	74.4 9.9	Gauge conversion (dual gauge)
	Crystal Brook East Fork	SA	Standard	1.2	Interstate standardisation
	Crystal Brook – Salisbury–Islington	SA	Standard	189.1	Interstate standardisation

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
1983	Hamilton–Worsley Worsley North – Worsley East	WA	Narrow	11.0 1.0	Alumina/rural freight
	Norwich Park – German Creek Fork at German Creek	Qld	Narrow	21.7 1.3	Coal
	Oaky Creek Mine Balloon Loop Fork at Oaky Creek Mine balloon Loop	Qld	Narrow	6.1 0.5	Coal
	Riverside Mine Balloon Loop Riverside–Goonyella	Qld	Narrow	7.4 5.2	Coal
	Teralba Colliery Junction – Teralba Colliery Balloon Loop	NSW	Standard	3	Coal
	Watonga – Blair Athol Mine Blair Athol Balloon loop	Qld	Narrow	108.2 6.9	Coal
	Drayton Junction – Drayton Balloon Loop	NSW	Standard	8.0	Coal
	Curragh–Saggitarius	Qld	Narrow	14.0	
	Moss Vale Triangle Loop	NSW	Standard	0.4	Mainline/rural freight
	Abbot Point – Kaili	Qld	Narrow	16.0	Coal
	Annandale – Boundary Hill Mine	Qld	Narrow	5.6	Coal
	Torrens Bridge Junction – Mile End Junction Mile End Junction – Mile End Goods Yard	SA	Standard	0.9 2.3	Interstate standardisation
1984	Collinsville – Newlands Mine	Qld	Narrow	75.6	Coal
	Canning Vale – Cockburn South	WA	Narrow	13.0	Urban freight
	Cockburn North – Cockburn East	WA	Narrow	1.0	Urban freight
	Kooragang Island Balloon Loop	NSW	Standard	5.0	Coal
1981–1985	Flagstaff – Flinders Street (City Loop)	Victoria	Broad	3.0	Urban passenger
1985	Altona – Laverton Junction	Victoria	Broad	4.6	Freight/ passenger
	Ulan–Gulgong	NSW	Standard	23.8	Coal
1986	Blair Athol Mine – Claremont	Qld	Narrow	22.0	Coal
	Fork at Rocklands	Qld	Narrow	0.8	Coal
	Roma Street – South Brisbane	Qld	Standard	1.8	Interstate passenger
	Melbourne Yard – Webb Dock	VIC	Broad	7.8	Port
1987	Wellington Point – Cleveland	Qld	Narrow	4.4	Urban passenger
	East Hills – Glenfield	NSW	Standard	8.3	Urban passenger
1987–1988	Blue Cow – Perisher – Bullocks Flat	NSW	Standard	8.5	Rural passenger
1989	Hellyer Mine – Moory Junction	TAS	Narrow	11.5	Zinc ore
1989	Jimblebar – Jimblebar Junction	WA	Standard	32.0	Iron ore
1990	Glenlee Triangle Fork	NSW	Standard	0.3	Mainline Freight
	Mount McLaren Balloon Loop	Qld	Narrow	1.0	Coal
	Yarrowlea–Ebenezer	Qld	Narrow	8.4	Coal

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
1991	Camberwell Balloon Loop – Camberwell junction	NSW	Standard	4.0	Coal
	Rosella – Brockman 2	WA	Standard	44.0	Iron ore
	Thornton Junction – Bloomfield Colliery Balloon Loop	NSW	Standard	7.5	Coal
1992	Gidgy Junction – Yandicoogina	WA	Standard	32.0	Iron ore
	Stanwell Power House Balloon Loop	Qld	Narrow	5.1	Coal
	Eraring Junction – Eraring Balloon Loop	NSW	Standard	1.8	Coal
	Gordonstone Junction – Gordonstone Balloon Loop	Qld	Narrow	12.8	Coal
	Joondalup–Perth	WA	Narrow	26	Urban passenger
1993	Currambine–Joondalup	WA	Narrow	3.0	Urban passenger
	Shay Gap – Yarrie	WA	Standard	32.0	Iron ore
	Riverside – North Goonyella	Qld	Narrow	18.8	Coal
	Point "V" – Bowen Junction	Qld	Narrow	0.9	Coal
	Mackay – Point "X"	Qld	Narrow	4.3	Coal
	Gunnedah Junction – Gunnedah Balloon Loop	NSW	Standard	2.0	Coal
1994	Marandoo–Rosella	WA	Standard	59.0	Iron ore
	Moura Mine Balloon Loop	Qld	Narrow	5.6	Coal
	Owanyilla Balloon Loop	Qld	Narrow	0.2	Coal
1995	Apamurra–Monarto	SA	Standard	34.4	Gauge conversion
	Fork at Blackwater	Qld	Narrow	0.6	Coal
	Tottenham Junction – VIC/SA border (via Cressy) VIC/SA border – Goodwood – Mile End Goods	SA/Vic	Standard/ dual	520 309.0	Interstate standardisation
	Hopetoun–Murtoa	VIC	Standard	111.3	Gauge conversion
	Rainbow–Dimboola	VIC	Standard	64.0	Gauge conversion
	Yaapeet–Rainbow	VIC	Standard	17.0	Gauge conversion
	Maroona–Portland	VIC	Standard	171.0	Gauge conversion
	Dartbrook Junction – Dartbrook Balloon Loop	NSW	Standard	4.0	Coal
	Stratford Balloon Loop – Stratford Junction	NSW	Standard	3.2	Coal

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
1996	Islington Workshops – Kilburn Junction	SA	Standard	0.3	Interstate standardisation
	Fork at Coppabella	Qld	Narrow	1.4	Coal
	Ewington Branch	WA	Narrow	3.0	Coal
	Burton Mine Balloon Loop	Qld	Narrow	5.0	Coal
	Beenleigh–Helensvale	Qld	Narrow	28.0	Urban passenger
	Maryborough–Ararat	VIC	Standard	81	Gauge conversion
	Dunolly–Maryborough	VIC	Standard	15	Gauge conversion (dual)
	Loxton–Tookayerta Tookayerta – Tailem Bend	SA	Standard	8.1 151.2	Gauge conversion
	Granville Triangle Loop	NSW	Standard	0.9	Urban passenger
	Mount Owen Balloon Loop – Glennies Creek Junction	NSW	Standard	6.5	Coal
	Liddell Junction – Ravensworth Washery Balloon Loop	NSW	Standard	3.0	Coal
1997	Mackenzie – Ensham Mine Balloon Loop	Qld	Narrow	14.9	Coal
	South Walker Branch	Qld	Narrow	2.3	Coal
	Aldoga – East End	Qld	Narrow	11.9	Coal
	Fishermans Landing – Mount Miller	Qld	Narrow	8.3	Coal/port
	Fisherman Islands – Dutton Park	Qld	Narrow/ Standard	20.4	Urban freight (dual gauge)
	Helensvale–Nerang	Qld	Narrow	7.7	Urban passenger
1998	Arriga Junction – Arriga Junction Fork – Arriga	Qld	Narrow	4.1	Rural freight
	Nerang–Robina	Qld	Narrow	9.5	Urban passenger
	Moranbah North Balloon Loop	Qld	Narrow	7.3	Coal
	Pinnaroo – Tailem Bend	SA	Standard	144.5	Gauge conversion
	Olympic Park Flemington – Goods Junction	NSW	Standard	3.9	Urban passenger
1999	Macarthur Junction – Macarthur Balloon Loop	Qld	Narrow	5.1	Coal
	Yandi–Marandoo	WA	Standard	147.0	Iron ore
	Parkes Y-Link	NSW	Standard	0.4	Rural freight
	Mount Thorley Junction – Wambo Balloon Loop	NSW	Standard	16.0	Coal
2000	Sydney Central – Turrella (Airport line)	NSW	Standard	7.3	Urban passenger
2001	Brisbane Airport – Eagle Junction	Qld	Narrow	8.5	Urban passenger
2002	Mindi–South Walker	Qld	Narrow	8.7	Coal
2003	Hail Creek – South Walker	Qld	Narrow	46.7	Coal
2004	Darwin – Alice Springs	NT	Standard	1 418	Interstate
	Mt Millar – Comalco Balloon Loop	Qld	Narrow	2.4	Coal
	Clarkson–Currambine	WA	Narrow	4.0	Urban passenger
2005	Beckenham–Thornlie	WA	Narrow	3.0	Urban passenger

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
2006	South Maitland Railway	NSW	Standard	30.0	Coal (re-opened line)
	Kinrola–Rolleston	Qld	Narrow	110.0	Coal
2007	Hancock Junction – Hope Downs	WA	Standard	58.0	Iron ore
	Perth–Mandurah	WA	Narrow	70.0	Urban passenger
2008	Port Hedland – Cloudbreak Mine	WA	Standard	260.0	Iron ore
	Port River Rail Bridge	SA	Standard	0.3	Port
2009	Lake Vermont – Dysart	Qld	Narrow	18.0	Coal
	Chatswood–Epping	NSW	Standard	15	Urban passenger
	Robina – Varsity Lakes	Qld	Narrow	4.1	Urban passenger
	Oaklands–Benalla	NSW	Standard	125	Gauge conversion
2010	Cameby Downs Loop	Qld	Narrow	7.0	Coal
	Brooklyn Triangle	VIC	Standard	0.5	Interstate
	Mesa K – Warramboo (Mesa A)	WA	Standard	49.0	Iron ore
	Darra–Richlands	Qld	Narrow	4.5	Urban passenger
2011	Cloudbreak Mine – Christmas Creek	WA	Standard	50.0	Iron ore
	Newlands – North Goonyella	Qld	Narrow	69.0	Coal
	Middlemount Rail Spur	Qld	Narrow	16.5	Coal
2012	Brockman 2 – Brockman 4	WA	Standard	41.0	Iron ore
	Tilley Siding (Morawa) – Karara	WA	Narrow	79	Iron ore
	Solomon Junction – Solomon	WA	Standard	130.0	Iron ore
	South Morang – Epping	VIC	Broad	3.5	Urban passenger (re-opened line)
2012–13	Sefton–Macarthur (Southern Sydney Freight Line)	NSW	Standard	36	Interstate freight
2013	Hope Downs 4 railway	WA	Standard	53.0	Iron ore
	Richlands–Springfield	Qld	Narrow	9.5	Urban passenger
2014	Noarlunga–Seaford	SA	Broad	5.7	Urban passenger
	Clarkson–Butler	WA	Narrow	8.0	Urban passenger
2015	Glenfield–Leppington	NSW	Standard	12	Urban passenger
2015	Deer Park – West Werribee (Regional Rail Link)	VIC	Broad	27	Inter-urban passenger

Note: Does not include light rail/tramways. Does not include the Roy Hill-Port Hedland Railway that was due for opening in late 2015 but had not yet opened at the time of writing.

Sources: Quinlan and Newland 2000; BITRE 2015; Data provided by Aurizon.

APPENDIX C

Train operator traffic

Table 34 ASX train operator traffic trends (billion net tonne-kilometres)

Period	Asciano				Aurizon				
	Coal	Other bulk	Intermodal (including steel)	Total	Coal	Iron ore	Bulk	Non-bulk —plus residual bulk from 2011–12	Total
Sep-07	3.0	0.7	6.7	10.4	-	-	-	-	-
Dec-07	3.1	0.6	6.7	10.5	-	-	-	-	-
1HY-08	6.2	1.4	13.4	21.0	-	-	-	-	-
Mar-08	3.1	0.7	6.0	9.8	-	-	-	-	-
Jun-08	3.4	0.7	6.5	10.6	-	-	-	-	-
2HY-08	6.5	1.4	12.5	20.4	-	-	-	-	-
Full year 2007–08	12.7	2.8	25.9	41.4	42.8	-	13.6	4.8	61.2
Sep-08	3.4	0.8	6.7	10.8	-	-	-	-	-
Dec-08	3.5	0.8	5.9	10.2	-	-	-	-	-
1HY-09	6.9	1.6	12.6	21.1	-	-	-	-	-
Mar-09	3.3	1.0	4.8	9.1	-	-	-	-	-
Jun-09	3.7	1.1	5.1	9.8	-	-	-	-	-
2HY-09	7.0	2.0	9.9	18.9	-	-	-	-	-
Full year 2008–09	13.9	3.6	22.5	40.0	43.5	-	14.3	4.2	62.0
Sep-09	4.2	0.9	5.7	10.8	-	-	-	-	-
Dec-09	4.2	0.8	5.9	10.9	-	-	-	-	-
1HY-10	8.4	1.7	11.6	21.7	-	-	-	-	-
Mar-10	4.4	0.8	5.3	10.5	-	-	-	-	-
Jun-10	5.2	0.9	5.4	11.5	-	-	-	-	-
2HY-10	9.7	1.7	10.7	22.0	-	-	-	-	-
Full year 2009–10	18.1	3.4	22.2	43.7	45.3	-	15.2	3.7	64.2
Sep-10	5.3	0.9	5.7	11.9	-	-	-	-	-
Dec-10	4.2	0.8	5.6	10.6	-	-	-	-	-
1HY-11	9.6	1.6	11.3	22.5	22.6	-	-	10	32.6
Mar-11	4.1	1.2	5.0	10.3	-	-	-	-	-
Jun-11	4.6	1.2	5.5	11.4	-	-	-	-	-
2HY-11	8.7	2.4	10.5	21.6	18.3	-	-	8.9	27.2
Full year 2010–11	18.3	4.0	21.8	44.2	40.9	-	-	18.9	59.8

(continued)

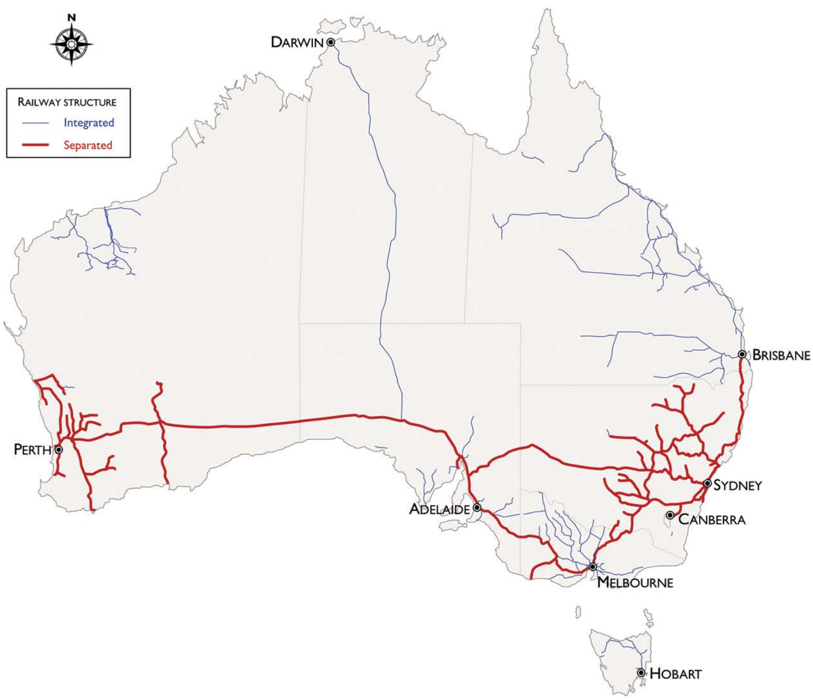
Period	Asciano				Aurizon				
	Coal	Other bulk	Intermodal (including steel)	Total	Coal	Iron ore	Bulk	Non-bulk—plus residual bulk from 2011–12	Total
Sep-11	4.9	1.3	5.8	12.0	-	-	-	-	-
Dec-11	4.8	1.4	5.9	12.0	-	-	-	-	-
1HY-12	9.6	2.7	11.7	24.0	22	-	9.9	-	31.9
Mar-12	4.7	1.4	5.6	11.8	-	-	-	-	-
Jun-12	5.7	1.6	5.7	12.9	-	-	-	-	-
2HY-12	10.3	3.0	11.3	24.6	19.9	-	-	11.1	31.0
Full year 2011–12	20.0	5.6	23.0	48.6	41.9	6.7	-	14.3	62.9
Sep-12	5.3	1.6	5.8	12.7	-	-	-	-	-
Dec-12	6.1	1.3	6.0	13.4	-	-	-	-	-
1HY-13	11.5	2.9	11.7	26.1	21.9	4.8	-	6.8	33.5
Mar-13	6.0	1.5	5.4	12.9	-	-	-	-	-
Jun-13	6.6	1.6	5.5	13.7	-	-	-	-	-
2HY-13	12.6	3.1	10.9	26.6	-	-	-	-	-
Full year 2012–13	24.0	6.0	22.7	52.7	43.6	10.3	-	13.2	67.1
Sep-13	7.1	1.3	5.6	14.0	12.4	3	-	3.3	18.7
Dec-13	7.4	1.2	5.6	14.3	13.1	3.1	-	3.3	19.5
1HY-14	14.5	2.5	11.2	28.2	25.5	6.1	-	6.6	38.2
Mar-14	7.3	1.4	5.1	13.8	11.4	3	-	3	17.4
Jun-14	7.4	1.3	5.1	13.8	12.3	3.1	-	2.9	18.3
2HY-14	14.7	2.7	10.2	27.6	23.7	6.1	-	5.9	35.7
Full year 2013–14	29.2	5.1	21.5	55.8	49.2	12.2	-	12.5	73.9
Sep-14	7.4	1.1	5.5	14	12.6	2.8		3.5	18.9
Dec-14	7.8	1.3	5.7	14.8	12.6	2.5		3.3	18.4
1HY-15	15.2	2.4	11.2	28.8	25.2	5.3		6.8	37.3
Mar-15	7.6	1.4	5.0	14	11.5	2.4		2.9	16.8
Jun-15	8.1	1.3	4.7	14.1	12.4	2.7		3.2	18.3
2HY-15	15.7	2.7	9.7	28.1	23.9	5.1		6.1	35.1
Full year 2014–15	30.9	5.1	20.9	56.9	49.1	10.4		12.9	72.4

Sources: QR National 2010, pp. 98–99; Asciano web site (Australian Stock Exchange [ASX] Announcements); Aurizon website (ASX Announcements).

APPENDIX D
Industry structure

The industry structure consists of both vertically-separated and vertically-integrated railways. In vertically-separated railways, the railway infrastructure manager does not operate revenue-earning trains; the "open access" manager sells track access to train operators. Integrated railways manage the network's infrastructure and access and also operate trains on the track. Integrated railway owners may provide "third-party access" to (other) train operators.

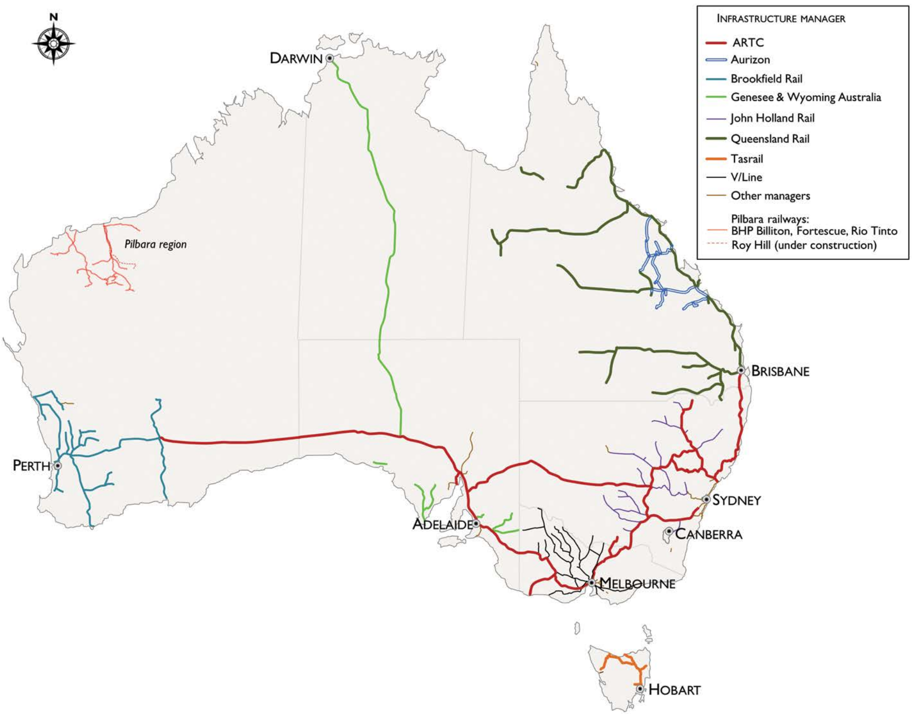
Figure 48 Australian rail industry structure



Infrastructure management

Australia's infrastructure managers are diverse in structure and operation. Figure 49 presents Australia's railway system by network manager.

Figure 49 Australian railways, by network manager, 2015



Note: The lines shown here are the railways that were open for traffic at July 2015.
The BHP Goldsworthy line in the Pilbara is shown on the map but it was mothballed in 2014.

The pattern of the network management can be described thus, by traffic type:

- **Interstate**. The interstate network is managed by the ARTC and Brookfield Rail infrastructure managers. The Tarcoola–Darwin line is owned (long-leased) as an integrated railway company, by Genesee & Wyoming Australia. Sydney–Perth trains which travel via Lithgow use John Holland Rail managed track between Marrangaroo (Lithgow) and Parkes.
- **Iron ore – Pilbara.** These lines have integrated infrastructure management and train operation, with lines owned by BHP Billiton, Rio Tinto, and Fortescue Metals Group.
- **Coal**. Coal railways in Queensland have an integrated structure. Aurizon manages infrastructure and operates trains in Central Queensland and uses Queensland Rail infrastructure elsewhere. Third-party access is provided to these lines. Coal railways in New South Wales have a vertically-separated structure, with the ARTC managing the Hunter Valley coal network and with some coal trains also operating over rail infrastructure managed by John Holland Rail or RailCorp.
- **Mixed.** Tasmania's network of mixed bulk and non-bulk traffic is vertically-integrated, with TasRail managing the system and operating the trains.

- **Grain**. Grain railways are vertically integrated in Queensland (Queensland Rail), and South Australia (Genesee & Wyoming Australia) and separated in New South Wales (ARTC, John Holland Rail and RailCorp), Victoria (V/Line)[54] and Western Australia (Brookfield Rail).
- **Passenger**. Urban systems have integrated management structures.

Table 35 Principal infrastructure managers of Australian railways, 2014

Infrastructure manager	Structure	Primary usage
Interstate		
Australian Rail Track Corporation (ARTC)	Separated	Intermodal, grain, ores, steel
Brookfield Rail	Separated	Intermodal, grain, ores, steel
Genesee & Wyoming Australia (GWA)	Integrated	Intermodal, ores
Intrastate		
Aurizon	Integrated	Coal
Queensland Rail	Integrated and Separated	Passenger (integrated), grain, coal, cattle, ores, intermodal (separated)
John Holland	Separated	Grain, ores, cotton
ARTC (New South Wales regional and Hunter Valley)	Separated	Coal, grain, cotton
V/Line	Integrated (passenger); Separated (freight)	Passenger, grains, mineral sands, intermodal
ARTC (Portland, Benalla–Yarrawonga)	Separated	Grain, mineral sands
TasRail	Integrated	Intermodal, coal, ores
GWA (intra-state South Australia)	Integrated	Grain, gypsum, ores
Brookfield Rail (intra-state Western Australia)	Separated	Grain, ores
BHP Billiton	Integrated	Iron ore
Rio Tinto	Integrated	Iron ore
Fortescue Metals Group	Integrated	Iron ore
MTM (Metro Trains Melbourne)	Separated	Freight
Sydney Trains	Separated	Freight
Urban		
Queensland Rail (Brisbane, Gold Coast)	Integrated	Passenger
Airtrain CityLink Limited	Integrated	Passenger
Sydney Trains	Integrated	Passenger
NSW TrainLink (Intercity)	Integrated	Passenger
MTM (Metro Trains Melbourne)	Integrated	Passenger
Adelaide Metro (Department of Planning, Transport and Infrastructure)	Integrated	Passenger
Transperth	Integrated	Passenger

Note: There are a number of other, smaller, infrastructure managers, including heritage railways, totalling approxiametly 555 route-kilometres.

54 Also in Victoria, the ARTC manages the Maroona–Portland and Benalla (Victoria)–Oaklands (New South Wales) lines.

Above rail operators

Train operation is undertaken by numerous organisations.

- **Heavy rail urban passenger** operators are largely integrated organisations, that is, they manage the tracks on which their trains run. Most are publically-owned entities, with the exception of Metro Trains Melbourne, which is a privately owned joint venture that operates trains and manages the network on behalf of the Victorian Government under a franchise agreement.
- **Non-urban passenger services** are largely government operated with a few exceptions, including Great Southern Rail, which operates the long-distance *Ghan*, *Indian Pacific* and *Overland* trains.
- **Heritage passenger railways.** Around 40 heritage volunteer-based organisations manage and operate railways, totalling approximately 500 route-kilometres.
- **National rail freight operators.** Two largest national rail freight train operators are Aurizon and Asciano (operating under the subsidiary names Pacific National and Patrick); see p. 8 for further details of their traffic. The companies' core activity is coal haulage in Queensland and New South Wales, with other important ancillary bulk-haulage activities. Both companies also operate intermodal services on the open access interstate network.
- **Regional rail freight operators.** Genesee & Wyoming Australia is a major train operator in South Australia and the Northern Territory. Other significant players include Southern Shorthaul Railroad and Freightliner Australia. TasRail provides the rail freight services in Tasmania while Watco WA Rail is contracted by CBH to provide grain haulage in Western Australia—see page 9 for further details[55].
- **Logistics companies**—notably SCT Logistics, and Qube Holdings—operate intermodal services for their own logistics chains. They also operate a small number of bulk services. SCT Logistics has a diverse portfolio of rail and road activities, including intercity intermodal operations. Qube Holdings also has a diverse intermodal and bulk portfolio, with a primary focus on local and regional port-based operations. Fletcher International is a new player in the rail transport industry. It provides agricultural products rail services from Dubbo to Port Botany in New South Wales. (Other logistics companies—such as Toll, Sadliers Logistics and Ettamogah Rail Hub—use rail freight operators to undertake their rail haulage.)
- **Mining companies,** such as Rio Tinto, BHP Billiton, Fortescue Metals Group and Karara Mining operate trains on their own railways.

55 In March 2015, the New York Stock Exchange listed Genesee & Wyoming (G&W) announced it had completed the acquisition of the United Kingdom based Freightliner Group. As a consequence, G&W now operates in Australia through Genesee & Wyoming Australia and Freightliner Australia. Watco WA Rail is a subsidiary of Kansas-headquartered Watco Companies (a transport-based operation).

Table 36 Principal train operators in Australia, 2015[56]

Train operator	Infrastructure network used	Primary tasks
Freight		
Aurizon	Aurizon, Queensland Rail, ARTC, Brookfield, NSW TrainLink, Sydney Trains	Coal, iron ore, intermodal, cattle, grain, mixed bulk
Asciano (Pacific National, Patrick)	Aurizon, Queensland Rail, ARTC, V/Line, John Holland, Sydney Trains, NSW TrainLink, Brookfield, GWA, MTM Melbourne	Coal, ores, intermodal, steel, grain, mixed bulk
Genesee & Wyoming Australia (GWA)	GWA, ARTC	Intermodal, ores
SCT Logistics/Specialised Bulk Rail	ARTC, Brookfield Rail, GWA, V/Line	Intermodal, grain, iron ore
Qube Holdings	ARTC, Brookfield Rail, V/Line, Sydney Trains, NSW TrainLink, John Holland MTM Melbourne	Intermodal, grain, mixed bulk
Watco	Brookfield	Grain
Southern Shorthaul Railroad	ARTC, Sydney Trains, NSW TrainLink, John Holland	Coal, grain, intermodal, infrastructure works
Freightliner Australia	ARTC, Sydney Trains, NSW TrainLink, John Holland	Coal, grain, cotton
TasRail	TasRail	Intermodal, coal, ores
Rio Tinto	Rio Tinto	Iron ore
BHP Billiton	BHP Billiton	Iron ore
Fortescue Metals Group	Fortescue Metals Group	Iron ore
Non-urban passenger		
Queensland Rail	Queensland Rail	Passenger
NSW TrainLink (long distance, interstate, intrastate, and inter-urban)	NSW TrainLink, Sydney Trains, ARTC, John Holland, V/Line, Queensland Rail	
V/Line	V/Line, ARTC, MTM Melbourne	
TransWA	Transperth, Brookfield Rail	
Great Southern Railway	Sydney Trains, NSW TrainLink, John Holland, ARTC, Brookfield Rail, GWA	
Heavy urban rail passenger		
Queensland Rail	Queensland Rail, AirTrain CityLink Limited	Passenger
Sydney Trains	Sydney Trains	
MTM Melbourne	MTM Melbourne	
Adelaide Metro (Department of Planning, Transport and Infrastructure)	Adelaide Metro (Department of Planning, Transport and Infrastructure)	
Transperth	Transperth	
Light urban rail passenger		
GoldLinQ	GoldLinQ	Passenger
Transdev	Transport for NSW	
Yarra trams	Yarra trams (Keolis Downer EDI Rail)	
Adelaide Metro (Department of Planning, Transport and Infrastructure)	Adelaide Metro (Department of Planning, Transport and Infrastructure)	

56 Chicago Freight Car Leasing Australia (CFCLA) is a major rail operator in Australia through the leasing of locomotives and other rail rollingstock.

APPENDIX E
Bulk rail freight task

Table 37 Bulk rail freight, by origin and destination (thousand net tonnes), 2013–14

Origin	Destination								
	QLD	NSW	ACT	Vic	Tas	SA	NT	WA	Total
QLD	197 017	3	-	-	-	-	-	1	**197 021**
NSW	593	70 732	-	801	-	52	1	202	**72 381**
ACT	-	-	-	-	-	-	-	-	**-**
Vic	56	31	-	62		112	-	117	**378**
Tas	-	-	-	-	1 680	-	-	-	**1 680**
SA	65	735	-	78	-	22 383	7	57	**23 325**
NT	-	-	-	-	-	-	2 566	-	**2 566**
WA	1	-	-	-	-	-	-	913 900	**913 901**
Total	**197 732**	**71 501**	**-**	**941**	**1 680**	**22 547**	**2 574**	**914 277**	**1 211 252**

Note: Sub-totals are rounded to the nearest 1 000 tonnes, thereby excluding some flows. Sub-totals do not add to total due to rounding.

The table excludes traffic data for some of the smaller train operators, such as Southern Shorthaul Railroad and Sydney Rail Services.

The data used to compile this matrix are provided by train operators. The operators typically use billing information and goods dispatch records to compile their data. A deficiency in this data arises when goods are trans-shipped. For example, interstate tonnages originating in Tasmania will be recorded as intrastate.

Sources: Data provided by Asciano, Aurizon, Fortescue Metals Group, BHP Billiton, Rio Tinto, Freightliner Australia, Genesee & Wyoming Australia, Qube, SCT Logistics, and TasRail.

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