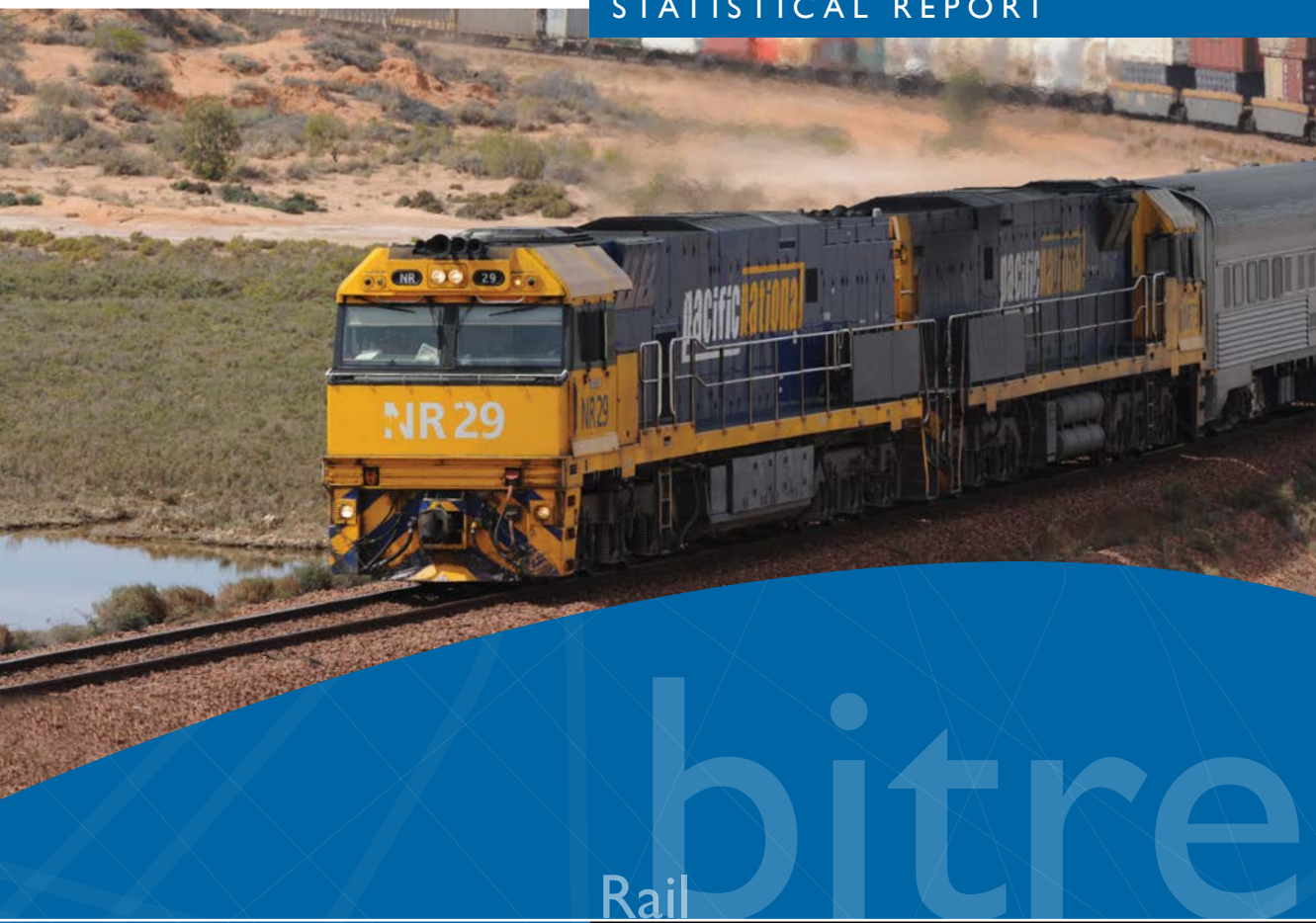
Australian Government
Department of Infrastructure and Regional Development
Bureau of Infrastructure, Transport and Regional Economics

AUSTRALASIAN RAILWAY ASSOCIATION

STATISTICAL REPORT



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Rail

Trainline 5

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

Trainline 5

Statistical Report

Department of Infrastructure and Regional Development
Canberra, Australia

ISSN: 1440-9569
ISBN: 978-1-925531-80-0
November 2017/INFRA3417

An appropriate citation for this report is:

Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2017, *Trainline 5, Statistical Report,* Canberra ACT.

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Foreword

This statistical report is a further development of the previous rail freight performance publications series Trainlines 1–4. These publications are collaborations between BITRE and the Australasian Railway Association (ARA).

Trainline 5 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. *Trainline 5* also has a case study on regional rail activity in the Albury-Wodonga region of New South Wales and Victoria, examining the Ettamogah Rail Hub and SCT Logistics Intermodal Terminal. The case studies are for informative purposes only.

We acknowledge the assistance of those organisations which (voluntarily) provided data and other information about the Australian railway industry and provided answers to follow up questions. We also acknowledge the assistance and cooperation of the Ettamogah Rail Hub and SCT Logistics in the preparation of the case study.

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November 2017

At a glance

Results

- Based on aggregated 'above rail' provided data, intermodal and bulk tonnages and net tonne kilometres grew in 2015–16, building upon growth in the previous financial year. Australian railways carried more than 1.3 billion tonnes and 413 billion net tonne kilometres (NTKs) of freight. Bulk movements continued to dominate, accounting for approximately 98 per cent of tonnages.
- Iron-ore movements in the Pilbara region of Western Australia accounted for approximately 64 per cent of total national rail freight NTKs. Queensland and New South Wales coal transport comprised approximately 20 per cent of total national NTKs.
- According to 'below rail' provided data, intermodal designated tonnages grew on sectors of the north-south interstate network, particularly between Sydney and Brisbane, while tonnages on the east-west corridor mostly declined.
- Scheduled intermodal freight train transit times on the ARTC and Arc Infrastructure interstate corridors are largely unchanged. The number of scheduled trains is also largely unchanged, except for the Melbourne–Brisbane corridor, where there has been an increase since SCT Logistics started running its own Melbourne-Brisbane trains in January 2017.
- Patronage on all urban heavy rail networks grew in 2015–16 (compared to the previous financial year), except Perth, which experienced a minor decline. Sydney had the largest growth, at approximately 10 per cent.
- In 2015–16, light rail patronage grew in all cities with light rail services. Sydney's strong and ongoing light rail patronage growth continued – at almost 60 per cent, while Gold Coast patronage grew by approximately 22 per cent.
- Non-urban rail patronage grew in all states that provide these services, except Western Australia, which had a modest decline. Victoria had the highest increase, at 20 per cent.
- Sydney still has Australia's busiest urban heavy rail passenger network, with approximately 323 million passenger journeys in 2015–16. Nationwide heavy rail urban patronage for 2015–16 was approximately 682 million passenger journeys.
- In 2016, urban heavy rail's mode share had increased in all cities except Brisbane and Perth compared to 2011. Sydney had the highest heavy rail mode share.
- Most cities exceeded their urban heavy and light rail punctuality targets, while non-urban (heavy) rail punctuality results were poorer.

- Track and receival site upgrades in New South Wales have improved rail transport of grain product's efficiency and cost effectiveness. Some grain, which previously travelled to port by road, is now travelling by rail. In Victoria, however, road became the dominant grain transport mode in the latest harvest season.
- The Office of the National Rail Safety Regulator now has nationwide management of rail safety. This will facilitate future consistent nationwide reporting on rail related safety.

Railway networks and assets

- Australia has an estimated 33 168 kilometres of operational heavy railways, approximately 10 per cent of which is electrified.
- Australia has 291 route kilometres of operational light rail/tramways.
- Melbourne has Australia's largest heavy and light urban (excluding inter-urban) passenger rail networks at an estimated 416 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 the central Queensland systems (1 979 route kilometres) and the New South Wales Hunter Valley Coal network (approximately 785 route kilometres). Grain flows run from agricultural hinterlands to ports and for domestic consumption. There are approximately 5 100 route kilometres of operational railway that are largely or exclusively used for grain haulage.
- In July 2017, there was an estimated 2025 operational locomotives in Australia. Approximately 50 per cent of the fleet was aged 13 years or less, compared to approximately 16 years or less the previous year.

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CHAPTER 1
Australia's railway industry

Trainline is a compendium of Australia's rail industry. It provides data and an analysis of the industry[1].

Australia's railways are evolving, with changes both outside and within the industry. These changes include:

- **Urban patronage.** The introduction of frequent urban rail services with high average speeds, good bus, cycling, and parking links to high amenity stations has generated strong patronage growth in some Australian cities.
- **Resurgence of light rail.** In addition to Melbourne's extensive light rail network, Sydney and the Gold Coast's light rail networks are expanding. Construction has started on the ACT's light rail network. Sydney has had exceptionally strong light rail patronage growth between 2014–15 and 2015–16.
- **Regional and inter-urban passenger service.** Regional passenger services, specifically in Victoria, have been upgraded both in rollingstock and infrastructure within the last decade.
- **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 been improved and broadened, such as with containerised grain and ores rail heads to ports.
- **Commodity flows.** Australia is a major exporter of iron ore and coal, with virtually all of this travelling by rail from mine to port. These exports have grown exponentially, enabled partly by new, expanded and upgraded railways.
- **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 in Western Australia, in-cab software that advise drivers on optimal running to maximise efficiency and fuel conservation, and shifts towards predictive and real time maintenance.

The following chapters give an overview and data on railway transport's tasks; characteristics of the railways and train operators' rolling stock; aspects of railway performance, including safety, environment and reliability; and a case study on regional rail operations in the Albury-Wodonga region of southern New South Wales – north eastern Victoria.

1 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 will be provided in BITRE's 2017 issue of the *Australian Infrastructure Statistics Yearbook*.

CHAPTER 2
Rail traffic

This chapter examines the Australian railway industry's principal tasks. It discusses the major freight commodities moved and markets served. It also discusses passenger transport—urban, intercity, and long-distance.

Overview

Railways excel in transporting large volumes of both freight and passengers. In Australia, this primarily involves moving bulk commodities (for export) and urban and intercity passenger transportation.

Weekday commuting to central city areas is the key passenger rail task. The previous surge in rail patronage in Perth commencing in 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).

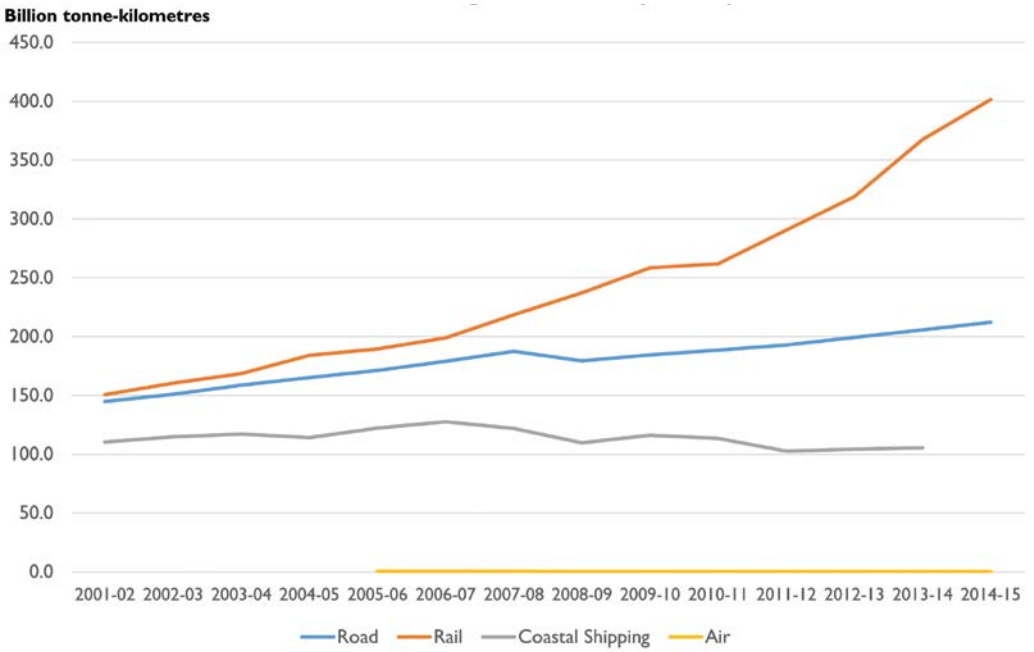
Rail transport's role in the Australian economy has increased sharply in recent years; see Figure 1. Rail now accounts for more than one-half of Australian freight transport activity, up from approximately 36 per cent at the turn of the century. Rail freight transport's strong position is primarily founded on the transportation of iron ore, coal and other bulk products such as grain primarily to ports for export. BITRE estimates Pilbara iron ore transportation accounted for approximately 64 per cent of the national NTKs in 2015–16, while combined coal transportation in Queensland and New South Wales comprised approximately 20 per cent of the national NTKs for the same period[2].

Rail is also often central to moving other bulk commodities, such as grains, sugar, and timber, especially to ports. Rail and road transport compete strongly for short haul and 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].

2 BITRE does not have an estimate of how much grain was transported by rail in Queensland and New South Wales for the same period.

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 2016, (Table T2.1b, p.54).

The recovery of rail's freight market share rose sharply, particularly from the 2007–08 financial year. This rise was 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[4].

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.

Rail's non-bulk freight performance is weaker, but there are strong performing areas. Rail accounts for the majority of inter-capital origin–destination non-bulk freight on the east-west corridor. According to the latest published estimates, rail has approximately 30 per cent market share of non-bulk freight travelling between Brisbane and Melbourne (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 This is still the latest available estimate.

National rail freight task, tonnes

The estimated total national rail freight task reported here uses aggregated data above rail train operators have provided (Table 1). BITRE measures the task in tonnes and NTK. NTK is a measure of tonnes, multiplied by the distance the freight travels[5]. The figures are conventional net tonnes, excluding tare (non-payload) weight of vehicles. Details for the 2015–16 financial year tonnages are as follows:

- Total tonnages were 1.34 billion.
- Iron-ore movements in the Pilbara region of Western Australia accounted for approximately 61 per cent of total national tonnages, 58 per cent of national bulk tonnages, and 64 per cent of total national rail freight NTKs. Bulk intrastate haulage in Queensland comprised approximately 17 per cent of total national tonnages, while in New South Wales it was approximately 14 per cent. Most of this freight was coal. Total tonnages grew by approximately nine per cent compared to the previous financial year.
- Intermodal tonnages grew by approximately five per cent, while bulk tonnages grew by approximately nine per cent.
- There was an approximate 7.5 per cent growth in Pilbara iron ore tonnages. Roy Hill's commencement of operations in December 2015 contributed partially, but not entirely, to this growth.
- Pilbara operations composed approximately 66 per cent of national bulk tonnages and 61 per cent of total national tonnages.
- Bulk intrastate haulage in Queensland comprised approximately 17 per cent of total national tonnages, while in New South Wales it was approximately 14 per cent. Most of this freight is coal.

Details for the 2015–16 financial year NTKs are as follows:

- Total NTKs were approximately 413.5 billion.
- Bulk NTKs were approximately 381 billion.
- BITRE's estimate of intermodal NTKs was approximately 32.5 billion.
- Bulk NTKs grew by approximately nine percent, while it is not yet possible for BITRE to compare the latest intermodal NTKs with previous years, due to unavailability of data.
- According to the NTK measure, while bulk still dominates, intermodal's proportion of the total is approximately eight per cent (compared to two per cent for tonnes). This is because the largest intermodal flows travel comparatively long distances.
- Pilbara operations composed approximately 58 per cent of national bulk tonnages and 61 per cent of total national tonnages
- Bulk intrastate NTKs in Queensland comprised approximately 14 per cent of total national NTKs, while in New South Wales it was approximately eight per cent.

5 A simple example of NTKs is as follows. If two tonnes of freight travels ten kilometres, the NTK is 20 (2x10).

Table 1 National rail freight task, thousand net tonnes

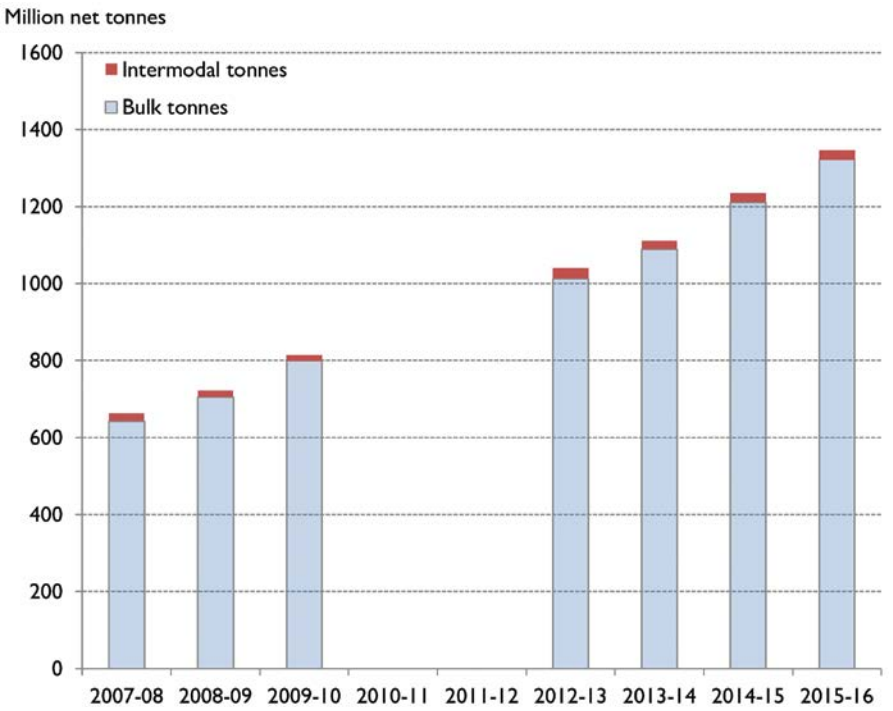
Year	Bulk	Bulk NTKs	Intermodal	Intermodal NTKs	Total	Total NTKs
2007–08	642 826	n/a	19 519	n/a	662 345	n/a
2008–09	705 039	n/a	17 481	n/a	722 520	n/a
2009–10	798 763		16 521		815 284	
2010–11	n/a	n/a	n/a	n/a	n/a	n/a
2011–12	n/a	n/a	n/a	n/a	n/a	n/a
2012–13	1 012 997	n/a	27 559	n/a	1 040 556	n/a
2013–14	1 089 566		21 891	n/a	1 111 457	n/a
2014–15	1 210 949	349 014 582	24 272	n/a	1 235 221	n/a
2015–16	1 322 085	381 125 118	25 366	32 364 817	1 347 451	413 489 935

Notes: The table 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.

Sources: BITRE estimates; Previous Trainline editions that sourced operator provided data. Pacific National, Aurizon, Fortescue Metals Group, BHP Billiton, Rio Tinto, Roy Hill Holdings, Genesee & Wyoming Australia (including Freightliner), SCT Logistics, TasRail, QUBE, Watco, and Fletcher International Exports provided the 2015–16 data.

Figure 2 National rail freight task, 2007–08 to 2015–16



Notes: 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.

Sources: BITRE estimates; BITRE 2012a; BITRE 2014; BITRE 2015; 2015–16 data was provided by Pacific National, Aurizon, Fortescue Metals Group, BHP Billiton, Rio Tinto, Roy Hill Holdings, Genesee & Wyoming Australia (including Freightliner), SCT Logistics, TasRail, QUBE, Watco, and Fletcher International Exports.

Trainline uses specific definitions for bulk and non-bulk freight. In principle, 'bulk' freight involves large quantities of homogenous product that is conveyed in wagons. Non-bulk freight is generally any containerised or unitised freight, generally placed or lifted into transport holds. However, 'non-bulk' freight is not always containerised. Conversely bulk commodities sometimes travel in containers. In this report, 'bulk' refers to anything not considered 'intermodal'. Steel may also be deemed intermodal, particularly on Pacific National trains that carry both intermodal and steel products on intermodal designated trains. Box 1 provides more insight into these definitions.

Box 1 Defining intermodal and other trains

Trainline reports 'intermodal', 'steel' and 'bulk' freight movement statistics. The definition Trainline uses for intermodal freight is 'market-based'. Defining the traffic in terms of the market served (such as relatively high priority goods for which road transport is a strong competitor) can be clearer than when defined in terms of the type of goods (notably, non-bulk) conveyed or the type of wagon used. Where data for 'intermodal' trains is reported, such trains are typically defined as trains with axle loads up to and including 21 tonnes and a maximum speed of up to 115 kilometres per hour. In terms of ARTC infrastructure charges, intermodal designated trains now include mixed trains that carry both intermodal and steel products. Because these trains carry steel products, they are subject to 80 kilometres per hour speed restrictions. These mixed trains complicate measuring tonnages for ARTC as they weigh whole trains, not components of a train. ARTC's below rail measured tonnages are the sum of intermodal and steel train volumes.

Wagon types 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. 'Intermodal' traffic consists 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 pet 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. 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.

Figure 3 Pacific National Steel Train

Note: The image above shows Pacific National steel train 7YN2 (Whyalla–Newcastle) at Stockinbingal, February 2017.
Source: Photo courtesy of Rodney Avery.

National freight task, by operator

There is some publicly available data that report national rail freight activity. Aurizon provide quarterly train-operator traffic data[6] to the Australian Stock Exchange (ASX). That material forms the basis of the data shown in Table 2, with more details in Appendix C. Pacific National (formerly part of the Asciano group that was split into three separate businesses in August 2016), no longer reports data publically as it is no longer a publically listed company, hence there is no Pacific National data after 2015–16.

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

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

Period	Pacific National				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	23.8	59.8	49.1	10.4	-	12.9	72.4	132.2
2015–16	31.8	4.4	22.4	58.6	49.7	9.6	-	12.3	71.6	130.2
2016–17	n/a	n/a	n/a	n/a	47.6	9.2	-	12.2	n/a	n/a

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

Coal continues to dominate Aurizon's operations, representing approximately 69 percent of its net tonne-kilometres.

Pacific National incorporates its steel traffic into its intermodal operations. Pacific National 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.

Traffic volumes reflect rail's competitiveness with other transport modes (particularly for intermodal traffic) and prevailing economic conditions. Variations in individual commodity flows arise from international demand for commodities as well as train operators winning or losing major contracts.

Table 3 Train operator traffic trends (TEUs (000))

Period	Pacific National	Aurizon	Combined
2014–15	771.5	372.0	1 143.5
2015–16	799.1	372.6	1 171.7
2016–17	n/a	405.2	n/a

Note: The historical Pacific National figures quoted are those which the former parent company, Asciano, reported to the ASX as a publically listed company and which BITRE reported in previous editions of *Trainline*.

Sources: Advice from Aurizon; Previous *Trainline* editions that sourced ASX data.

In addition to measuring freight transport by tonnes and NTKs, transport by twenty-foot equivalent (TEU) units of shipping containers provides another measure. This measure shows freight activity by volume rather than weight. As Table 3, above, shows, Aurizon's TEU volumes grew by almost nine per cent from 2015–16 to 2016–17.

Each year the Genesee & Wyoming parent company reports its traffic results to the New York Stock Exchange. It reports its volumes as carloads rather than tonnages and uses the American term 'railroad'. In 2017, it reported the following about its Australian (GWA) operations: "Traffic in July 2017 was 52,328 carloads, including carloads from the Glencore Rail (GRail) acquisition, which closed on December 1, 2016. On a same-railroad basis, Australian traffic increased 22.4%, primarily due to increased agricultural products and metallic ores traffic". Table 4, below, gives details of GWA's Australian carloads (Genesee & Wyoming 2017).

Table 4 GWA carloads

Period	July 2017	July 2016	Change (per cent)
Agricultural Products	5 163	2 984	+73
Coal and Coke	33 844	-	-
Intermodal	5 396	5 315	+1.5
Metallic Ores	3 287	1 942	+69.3
Minerals and Stone	4 607	4 832	-4.7
Petroleum Products	31	26	+19.2
New Railroad Carloads Subtotal[a]	**33 844**		
Same Railroad Carloads Subtotal	**18 484**	**15 099**	**+22.4**
Total Carloads	**52 328**	**15 099**	**+246**[b]

Notes: [a] This refers to new carload traffic that GWA inherited after its acquisition of Glencore.

[b] This increase largely reflects GWA's acquisition of Glencore Rail, whose traffic GWA now hauls.

Box 2 How much does it cost to ship a container by rail?

Aurizon's published superfreighter guide, effective 24 October 2016, showed an indicative base rates calculator of what it charged customers to send a 6.1 metre, 15.5 gross tonnes container from Melbourne to Brisbane and from Perth to Cairns (Aurizon 2016 p.26). For a container going from Melbourne to Brisbane the charge was as follows:

- Base charge (first five tonnes): $1032.60
- Charge per additional tonne: $399.99
- Fuel surcharge: $137.26
- **Total**: $1660.83 (including 10% GST)

For the same size container going from Perth to Cairns the charge was as follows:

- Base charge: $2228.22 ($1097.85 Perth to Brisbane, and $1130.37 Brisbane to Cairns)
- Charge per additional tonne: $649.33
- Fuel surcharge: $287.70
- **Total**: $3481.81 (including 10% GST)

These rates excluded possible additional charges such as dangerous goods charges and storage charges.

Box 3 Further freight rail operator traffic data resources

No single data source covers the entire Australian network. Data sources are train operator data, and track/infrastructure manager data.

TasRail provides information on tonnages of some commodities that it transports, such as logs and minerals. (TasRail 2016, pp. 21–26)

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.

Figure 58 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 2017; Aurizon 2017a-d);
- 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.

Traffic data and projections can also be provided to the infrastructure managers' economic regulators, which may then publish that material[7]

While explicit rail 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 2014a and BITRE 2014b, BITRE 2016a) BITRE's forthcoming *Future key commodity freight through Australian ports to 2033–34* will also include relevant information.

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

7 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); Arc Infrastructure is the Economic Regulation Authority [WA] (http://www.erawa.com.au/rail/rail-access).

Interstate network traffic

This section reports interstate traffic flows by line segment based on 'below rail' (track infrastructure manager) provided data. It only includes tonnages on the interstate network that the ARTC and Arc Infrastructure (formerly Brookfield rail) manages. Table 5 and Table 6 show intermodal and total gross tonnes by line segment, with line segments ordered from north to south and east to west. Figure 4, Figure 5, Figure 6 and Figure 7 also show the data. There are four 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. Tonnages are calculated as gross. Empty wagons and locomotive weights are therefore included.

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 higher than all other commodities carried.

ARTC and Arc Infrastructure provided tonnages are not comparable with the above rail tonnages reported because the above rail tonnages cover the whole of Australia, whereas the below rail data only measures traffic on the ARTC and Arc Infrastructure interstate networks. The two measures are therefore not 'like for like' in scope.

Interstate intermodal traffic

Table 5 and Table 6 show intermodal and total tonnage levels on line segments of the interstate network.

Table 5 Below rail gross tonnes by line segment, north-south corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2013–14	2014–15	2015–16	2013–14	2014–15	2015–16
Acacia Ridge to Casino	2.24	2.22	2.63	2.38	2.37	2.82
Casino to Acacia Ridge	3.32	3.29	4.02	3.47	3.43	4.26
Acacia Ridge – Casino	5.56	5.50	6.65	5.85	5.80	7.09
Casino to Maitland	2.29	2.26	2.65	2.86	2.86	3.53
Maitland to Casino	3.34	3.30	4.02	4.00	3.97	5.01
Casino–Maitland	5.63	5.56	6.68	6.86	6.82	8.53
Macarthur to Tahmoor	4.48	4.38	4.35	7.22	8.04	8.71
Tahmoor to Macarthur	4.27	4.24	4.56	8.36	10.87	12.79
Macarthur–Tahmoor	8.74	8.62	8.91	15.58	18.92	21.51
Tahmoor to Moss Vale	4.27	4.25	4.56	11.19	13.72	15.61
Moss Vale to Tahmoor	4.48	4.39	4.36	8.03	8.87	9.53
Tahmoor – Moss Vale	8.75	8.64	8.92	19.22	22.59	25.14
Moss Vale to Marulan	4.37	4.30	4.58	13.88	15.44	16.96
Marulan to Moss vale	4.68	4.50	4.48	9.18	9.64	10.20
Moss Vale – Marulan	9.04	8.80	9.07	23.06	25.08	27.16
Marulan to Goulburn	4.37	4.30	4.58	9.85	9.40	10.38
Goulburn to Marulan	4.68	4.50	4.48	7.85	7.64	8.08
Marulan–Goulburn	9.04	8.80	9.07	17.71	17.05	18.46
Goulburn to Cootamundra	4.36	4.30	4.58	9.04	8.75	9.19
Cootamundra to Goulburn	4.68	4.50	4.48	6.57	6.31	6.45
Goulburn–Cootamundra	9.04	8.80	9.06	15.62	15.05	15.63
Cootamundra to Junee	3.38	3.03	3.04	5.80	5.20	5.54
Junee to Cootamundra	3.16	2.80	2.72	6.21	5.76	6.08
Cootamundra–Junee	6.54	5.83	5.76	12.00	10.96	11.62
Junee to Albury	3.16	2.80	2.72	6.22	6.01	6.23
Albury to Junee	3.38	3.03	3.04	7.06	5.95	6.14
Junee–Albury	6.54	5.83	5.76	13.28	11.96	12.37
Albury to Tottenham	3.38	3.03	3.04	6.64	5.68	5.64
Tottenham to Albury	3.17	2.80	2.72	5.13	4.48	4.41
Albury–Tottenham	6.55	5.83	5.76	11.77	10.17	10.06

Notes: The ARTC has revised its tonnages calculation methodology to include steel train volumes in its intermodal tonnages calculations. As such, tonnages shown for the 2012–13 and 2013–14 financial years are revised and may differ from what was reported in *Trainline 4*. Totals are subject to rounding.

Source: Data provided by ARTC.

Table 6 Below rail gross tonnes by line segment, east-west corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2013–14	2014–15	2015–16	2013–14	2014–15	2015–16
Cootamundra to Parkes	1.32	1.48	1.45	2.80	2.71	2.51
Parkes to Cootamundra	1.22	1.51	1.87	4.75	4.12	4.24
Cootamundra–Parkes	2.55	2.99	3.33	7.55	6.83	6.75
Parkes to Broken Hill	2.24	2.50	2.64	3.54	3.74	3.59
Broken Hill to Parkes	2.32	2.50	2.40	2.83	3.00	2.85
Parkes – Broken Hill	4.55	5.00	5.04	6.37	6.74	6.44
Broken Hill to Crystal Brook	2.32	2.51	2.43	4.52	4.77	4.42
Crystal Brook to Broken Hill	2.20	2.48	2.63	2.93	3.24	3.31
Broken Hill – Crystal Brook	4.52	4.98	5.06	7.45	8.01	7.73
Tottenham to Dimboola	3.86	3.62	3.29	8.53	6.72	5.52
Dimboola to Tottenham	4.50	4.22	3.99	7.06	5.94	5.43
Tottenham–Dimboola	8.36	7.84	7.29	15.58	12.66	10.95
Dimboola to Tailem Bend	4.51	4.24	4.01	5.72	4.81	4.45
Tailem Bend to Dimboola	3.88	3.64	3.31	4.41	3.84	3.58
Dimboola – Tailem Bend	8.39	7.88	7.31	10.12	8.66	8.03
Tailem Bend to Dry Creek	3.91	3.68	3.34	4.44	3.88	3.61
Dry Creek to Tailem Bend	4.55	4.27	4.04	5.77	4.87	4.50
Tailem Bend – Dry Creek	8.46	7.95	7.37	10.21	8.75	8.11
Dry Creek to Crystal Brook	4.31	4.60	4.38	11.45	9.38	8.91
Crystal Brook to Dry Creek	5.41	5.57	5.42	8.16	7.52	7.21
Dry Creek – Crystal Brook	9.72	10.17	9.81	19.60	16.90	16.12
Crystal Brook to Port Augusta	7.70	7.56	7.33	9.72	8.92	8.83
Port Augusta to Crystal Brook	6.55	6.62	6.54	10.34	8.13	8.31
Crystal Brook – Port Augusta	14.25	14.18	13.87	20.06	17.06	17.13
Port Augusta to Tarcoola	8.14	8.07	7.73	10.46	9.35	8.05
Tarcoola to Port Augusta	6.65	6.65	6.59	14.42	11.28	7.19
Port Augusta – Tarcoola	14.79	14.72	14.33	24.88	20.63	15.25
Tarcoola to Kalgoorlie	4.50	4.49	4.44	4.93	4.95	4.98
Kalgoorlie to Tarcoola	6.16	6.08	5.78	6.47	6.28	6.07
Tarcoola – Kalgoorlie	10.66	10.58	10.22	11.40	11.23	11.05
West Kalgoorlie to Koolyanobbing East	5.10	4.96	4.86	13.73	15.89	15.97
Koolyanobbing East to West Kalgoorlie	3.74	3.61	3.63	21.71	22.12	21.65
West Kalgoorlie – Koolyanobbing East	8.84	8.58	8.49	35.44	38.01	37.62
Koolyanobbing East to West Merredin	5.10	4.96	4.86	11.46	13.39	13.66
West Merredin to Koolyanobbing East	3.74	3.61	3.63	7.53	7.70	7.75
Koolyanobbing East – West Merredin	8.84	8.58	8.49	18.99	21.09	22.90
West Merredin to Avon	5.10	4.96	4.86	13.46	15.75	15.15
Avon to West Merredin	3.74	3.61	3.63	7.79	8.05	7.75
West Merredin – Avon	8.84	8.58	8.49	21.24	23.81	22.90
Avon to Toodyay West	5.10	4.96	4.86	16.70	19.27	18.56
Toodyay West to Avon	3.74	3.61	3.63	8.54	8.93	8.59
Avon – Toodyay West	8.84	8.58	8.49	25.25	28.20	27.15

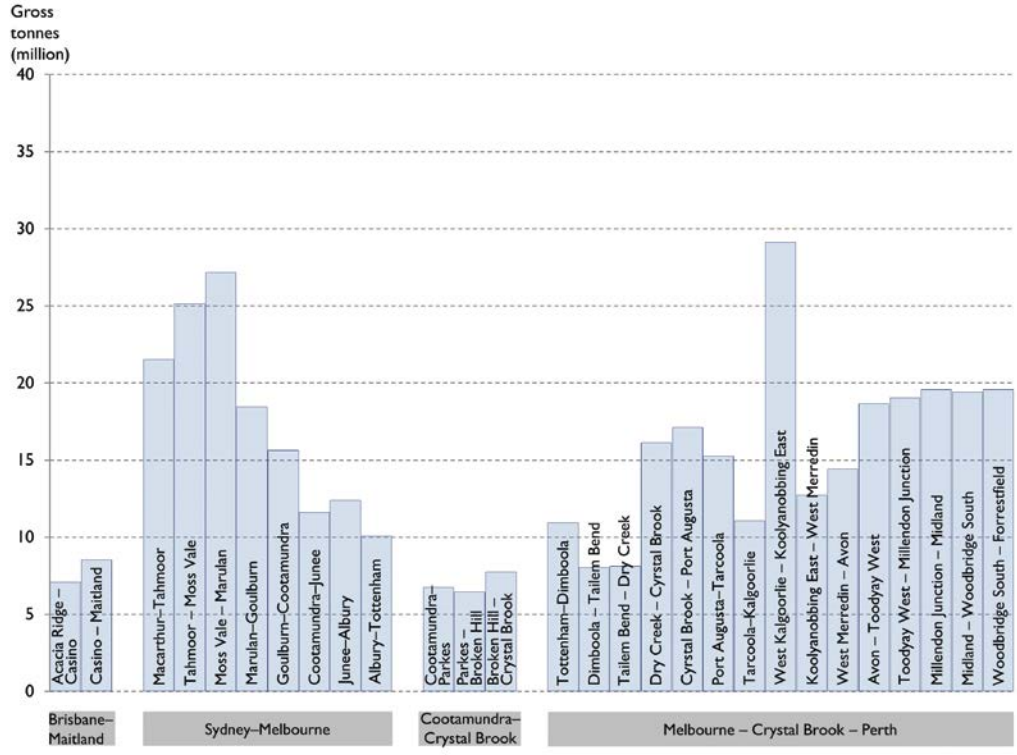
(continued)

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2013–14	2014–15	2015–16	2013–14	2014–15	2015–16
Toodyay West to Millendon Junction	5.10	4.96	4.86	17.15	19.86	18.87
Millendon Junction to Toodyay West	3.74	3.61	3.63	8.63	9.05	8.86
Toodyay West – Millendon Junction	8.84	8.58	8.49	25.78	28.91	27.53
Millendon Junction to Midland	5.10	4.96	4.86	17.68	20.40	19.29
Midland to Millendon Junction	3.74	3.61	3.63	8.77	9.21	8.77
Millendon Junction – Midland	8.84	8.58	8.49	26.45	29.62	28.06
Midland to Woodbridge South	5.11	4.97	4.86	17.67	20.32	19.22
Woodbridge South to Midland	3.74	3.62	3.64	8.72	9.14	8.70
Midland – Woodbridge South	8.85	8.59	8.50	26.38	29.46	27.92
Woodbridge South to Forrestfield	5.11	4.97	4.86	17.74	20.40	19.30
Forrestfield to Woodbridge South	3.74	3.62	3.64	8.79	9.21	8.78
Woodbridge South – Forrestfield	8.85	8.59	8.50	26.52	29.61	28.08

Notes: The ARTC has revised its tonnages calculation methodology to include steel train volumes in its intermodal tonnages calculations. As such, tonnages shown for the 2012–13 and 2013–14 financial years are revised and may differ from what was reported in Trainline 4. Totals are subject to rounding.

Sources: Data provided by ARTC and Arc Infrastructure.

Figure 4 Total below rail gross tonnes on the interstate network, by line segment, 2015–16



Sources: Data provided by ARTC and Arc Infrastructure.

The following specific flows explain variations in intermodal traffic:

- Changing intermodal train composition. ARTC provided intermodal tonnages are calculated from intermodal designated trains that operate on its network, not on the actual products each intermodal designated train carries. Some Pacific National intermodal designated trains carry steel products. This differs from the earlier practice where it carried steel products on steel designated trains only. To account for this change, ARTC reported intermodal volumes are the sum of volumes from all intermodal designated trains and steel trains. Steel is moved along 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.
- Intermodal traffic on the north-south segment between Sydney (Macarthur) and Cootamundra West includes diverging/converging traffic at Cootamundra West from the east-west corridor (via Broken Hill).
- Regional intermodal traffic travelling to the Port of Melbourne and elsewhere within Australia joins the network from terminals in the Riverina district, Ettamogah (Albury), and Barnawartha (Wodonga).
- Regional intermodal traffic from Harefield (Junee) travelling to Port Botany joins the network at Junee.
- Some intermodal rail traffic originates/terminates in terminals at Parkes/Goobang for the east-west corridor (via Broken Hill). SCT Logistics, for example, operates one intermodal train a week each direction between Goobang and Perth (two services in total).
- Intermodal traffic flows between Melbourne and western Victoria (originally at Horsham but subsequently Dooen).

Higher intermodal traffic volumes west of Crystal Brook, where the Melbourne/Adelaide and Sydney/Parkes traffic to and from Perth and Darwin shared the track.

Intermodal flows fall to the west of Tarcoola; the junction with the Darwin line.

According to ARTC's data, below rail intermodal tonnages (including steel) increased on all sectors between Maitland and Acacia ride, in both directions of travel, in 2015–16 compared to the previous financial year. Northbound tonnages between Casino and Acacia Ridge had the largest growth, at 22.3 per cent. Southbound traffic between Junee and Albury had the greatest decrease, at 2.78 per cent. Combined sector totals between Macarthur and Cootamundra recorded growth of up to approximately 3.5 per cent. All of this growth occurred with northbound traffic. Southbound traffic had minor declines – up to 7.5 per cent. All northbound sectors between Cootamundra and Tottenham had declines, while southbound traffic was relatively constant. ARTC has advised BITRE that tonnages have increased over the last two years between Acacia Ridge and Maitland partly due to containerised construction related materials being transported from Sydney to Brisbane by rail, although the future transportation of this product is in doubt.

On all sectors of the east-west corridor between Tottenham (Melbourne) and Kalgoorlie intermodal tonnages declined. The greatest decrease was eastbound traffic between Tailem Bend and Dimboola, at 9.2 per cent. According to advice from ARTC, the decline between Adelaide and Melbourne is mainly due to a reduction in export shipping container traffic between Adelaide and Melbourne.

Between Cootamundra West and Crystal Brook, eastbound tonnages on all sectors grew by up to intermodal tonnages on all eastbound sectors grew as much as 24 per cent (Parkes to Cootamundra West), while all westbound tonnages declined.

According to Arc Infrastructure's data, eastbound intermodal tonnages between Forrestfield (Perth) and Kalgoorlie grew by 0.55 per cent on all sectors, while westbound tonnages declined by approximately two per cent.

"Other" traffic on the interstate network

There is significant non-intermodal freight traffic, classified as "other" in Figure 5, Figure 6 and Figure 7[8].

Other significant non-intermodal freight flows are as follows:

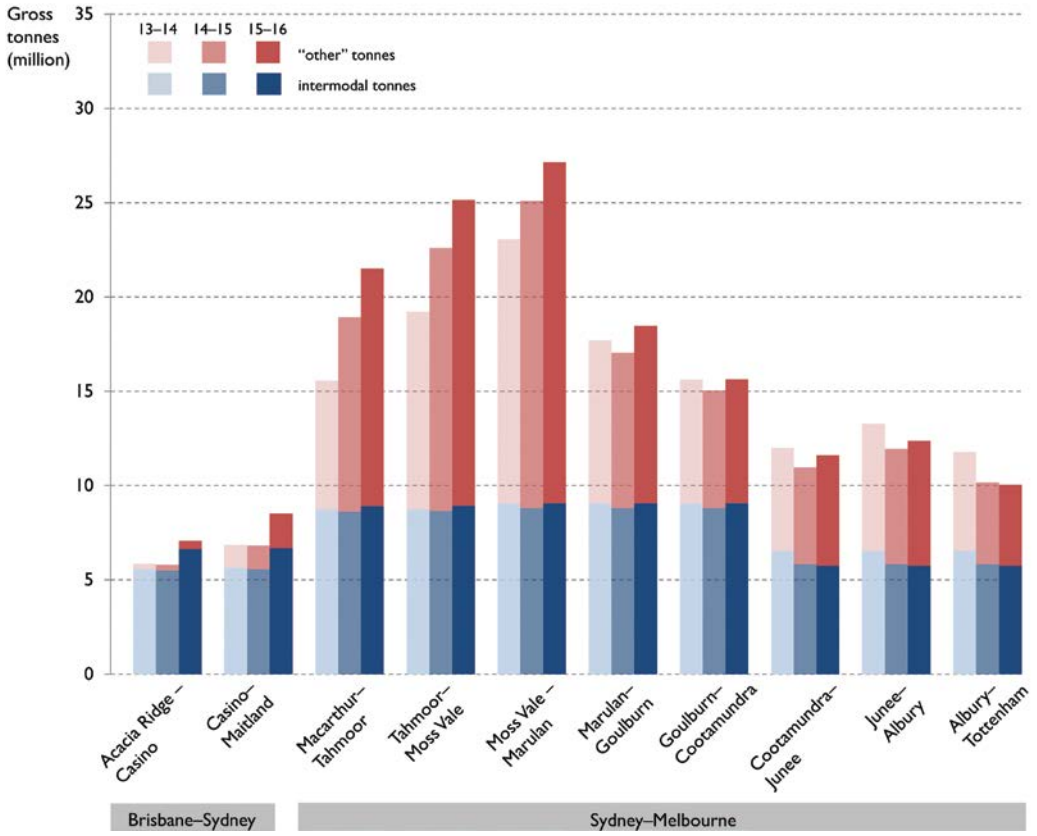
- **Grain movements** generally join the network from a web of branch and secondary lines, connecting agricultural hinterlands to the ports. Movements on the interstate network are heaviest close to Perth and in New South Wales.
- **Aggregate, sand and limestone quarries** in the southern New South Wales Southern Highlands boost tonnages between Macarthur and Goulburn. The exhaustion of quarries in Western Sydney has resulted in expansion of mining activity in the Southern Highlands. These are a significant contributor to the relatively high tonnages between Macarthur and Marulan.
- **Iron Ore** from Mount Walton from the Yilgarn Region in Western Australia contributes a major proportion of tonnages on the West Kalgoorlie – Forrestfield line segment. Iron ore is railed in two directions. It moves east from Koolyanobbing, via Kalgoorlie, to Esperance Port. It also moves west from the Mount Walton mine to Kwinana.

'Other' tonnages increased on all sectors of the north-south corridor for both directions of travel, except Albury–Tottenham (southbound), which had a 1.7 per cent decrease. On the east-west corridor the only increases in 'other' tonnages were westbound between West Kalgoorlie and Koolyanobbing East (1.65 per cent), West Merredin to Koolyanobbing East westbound Koolyanobbing East to West Merredin (4.39 per cent), and eastbound West Merredin to Koolyanobbing East (0.73 per cent). Despite the decreases, 'other' westbound tonnages progressively increase towards Forrestfield. According to advice from Arc Infrastructure, grain traffic enters the network from Southern Cross and increase steadily towards Kwinana.

Eastbound tonnages between Dry Creek and Tailem Bend grew by up to almost 36 per cent but this is based in an already small base point. Minor fluctuations therefore translate to large percentage changes. Both directions of travel between Port Augusta – Tarcoola had the largest declines – 75 per cent westbound and 87 per cent eastbound. According to advice from ARTC, the Arrium/Western Plains traffic ceased completely in 2015–16, which is the underlying cause of the reduction.

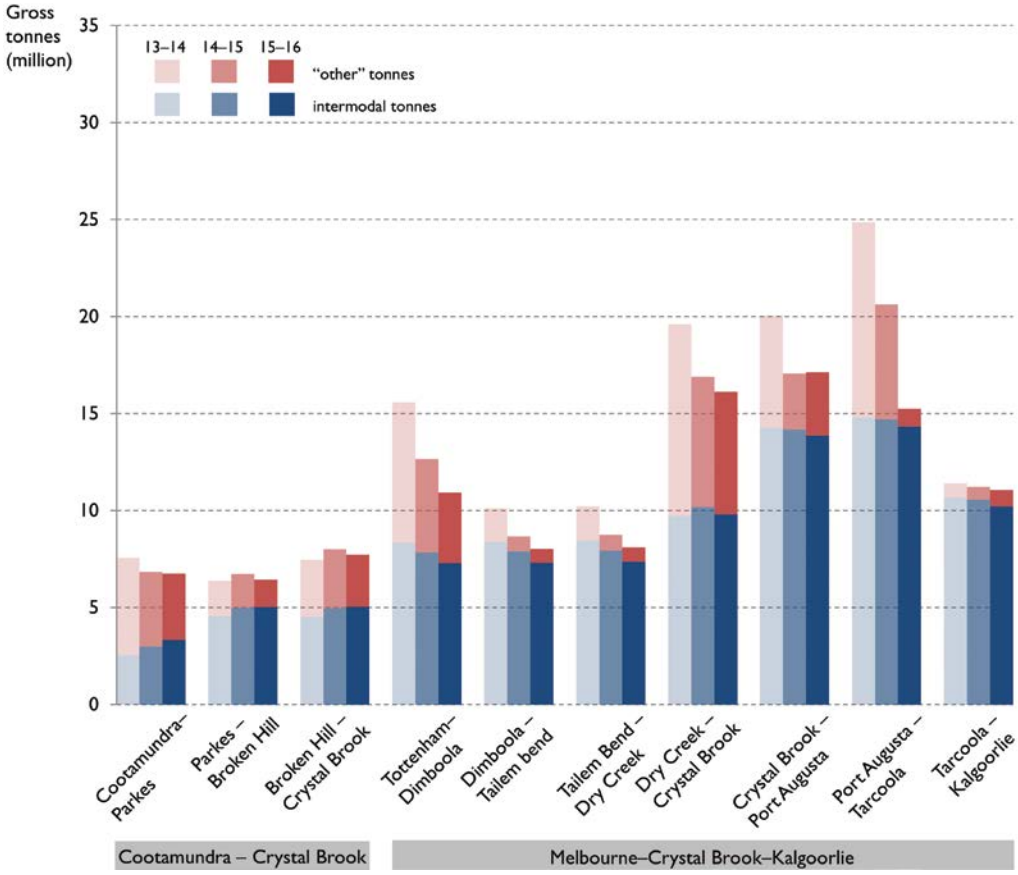
8 To obtain 'other' tonnages, deduct the intermodal component from the total figure.

Figure 5 Gross tonnage on the north-south corridor, by line segment, 2013–14 to 2015–16



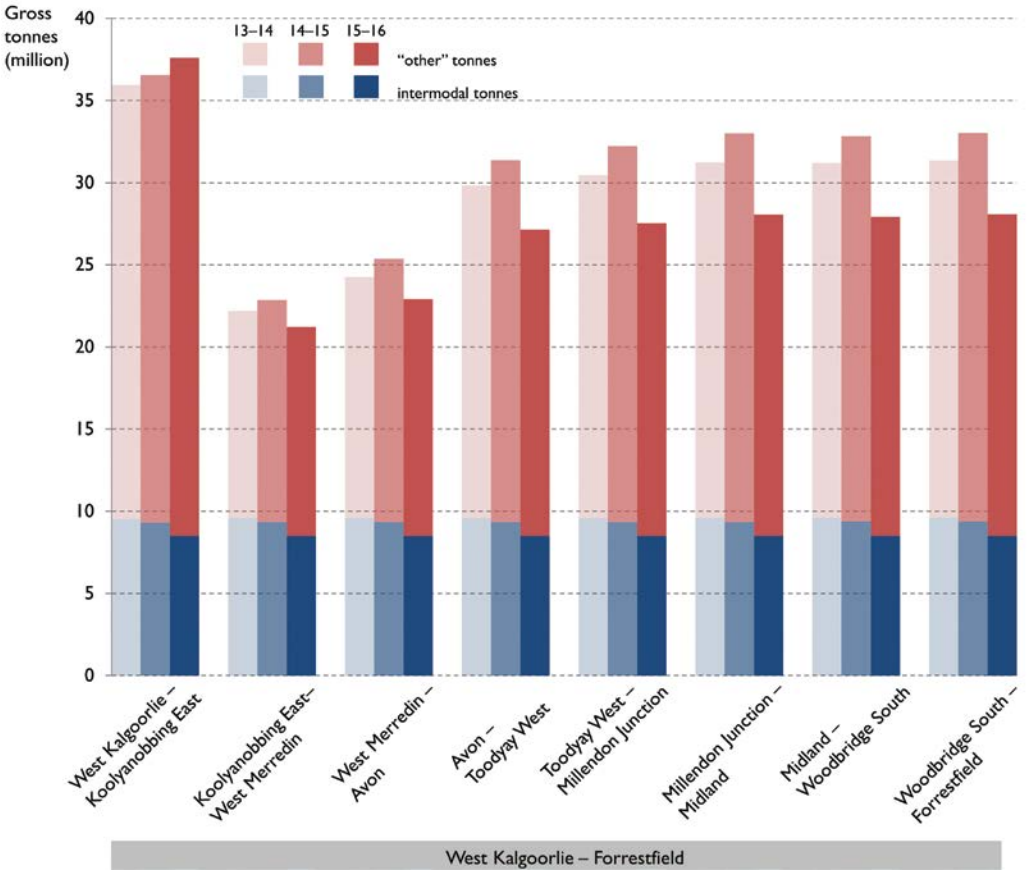
Source: Data provided by ARTC.

Figure 6 Gross tonnage on the east-west corridor, by line segment, 2013–14 to 2015–16



Source: Data provided by ARTC.

Figure 7 Gross tonnage on the east-west corridor, by line segment, 2013–14 to 2015–16

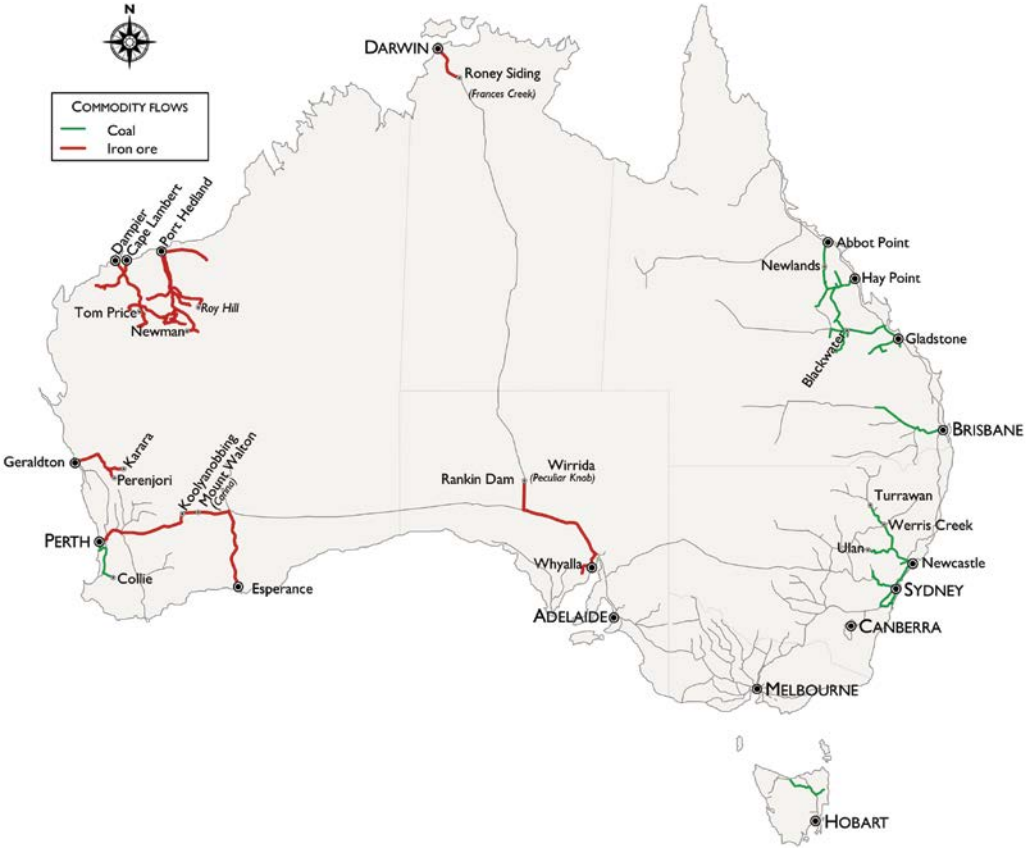


Source: Data provided by Arc Infrastructure.

Rail freight traffic, by commodity

This section discusses rail freight traffic by commodity or market. Iron ore and coal are the rail industry's two largest bulk freight flows.

Figure 8 Principal iron ore and coal flows, 2017



Iron ore traffic

Australia exports most of its iron ore,[9] almost all of which is moved to port by rail[10]. 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:

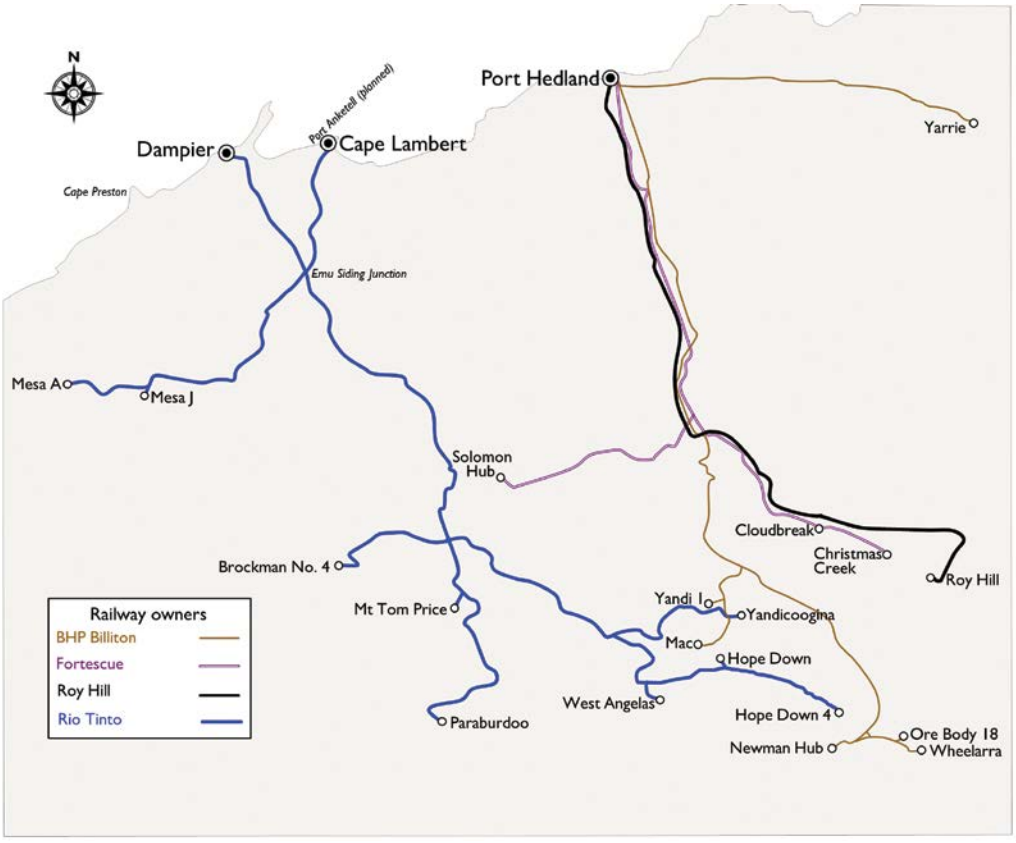
- **Rio Tinto:** The Robe River to Cape Lambert and the former Hamersley Iron's network to Port Dampier. As of 2012, trains on the Hamersley railway were approximately 2.4 kilometres long and had a capacity of 26 000 tonnes (BITRE 2013, p. 31).

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

10 Rail has an estimated 86 per cent share of the domestic iron ore freight task, with road having an estimated two 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 2014a.

- **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 344-route kilometre railway from Roy Hill to Port Hedland. These trains typically haul 232 ore cars, with a payload of more than 32 000 tonnes of ore.

Figure 9 Pilbara iron ore railways, by infrastructure owner, 2017



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, denote tonnages hauled by the iron ore railways. See Table 7.

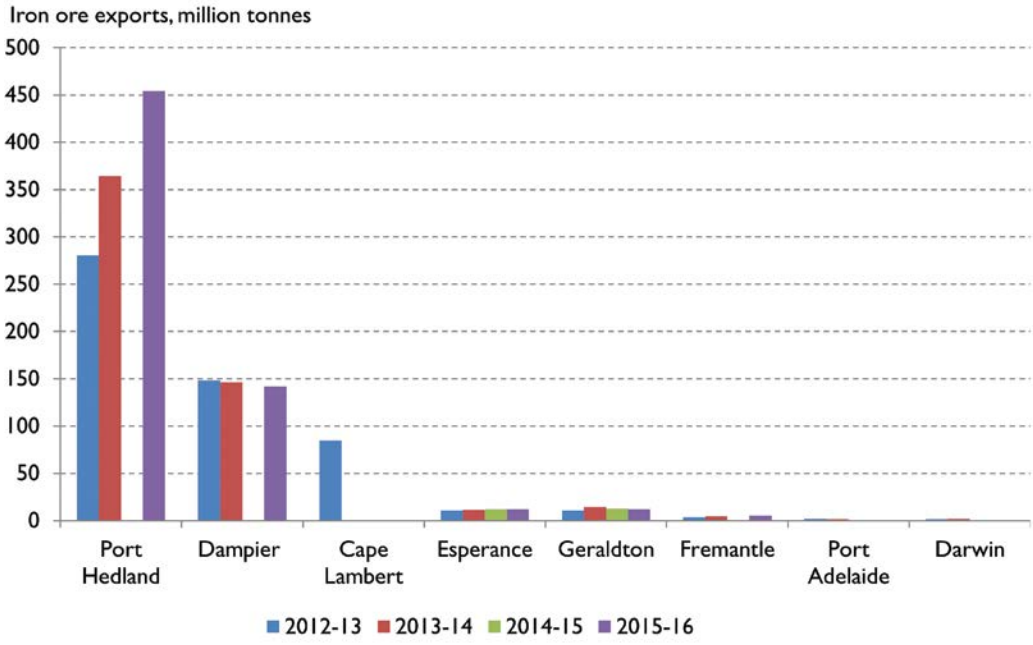
Table 7 Iron ore exports, million tonnes, 2015–16

Port Hedland	Dampier	Cape Lambert (Port Walcott)	Esperance	Geraldton	Fremantle (Perth)	Port Adelaide[a]	Darwin[b]
454.2	142.1	n/a	11.7	12.1	5.4	.27	0.04

Notes: [a] Port Adelaide's data is for the 2016 calendar year.
[b] Darwin Port only exported iron ore in September 2015

Figure 10, below, shows a comparison of iron ore exports between the latest available reporting periods.

Figure 10 Iron ore exports by financial year



Notes: The chart uses revised data. 2015–16 data for some ports is not available. Cape Lambert iron ore facilities lie within the administrative area of Port Walcott. The data for Port Walcott is not available for the reporting periods.

Segmented data for Port Hedland and Dampier for 2014–15 is not available. According to the Pilbara Ports Authority's 2014–15 annual report though, approximately 579 million tonnes of iron ore was exported through the two ports combined (Pilbara Ports Authority 2015, p.24).

Sources: Pilbara Ports Authority 2016, p.23, Southern Ports 2017, Fremantle Ports 2016, Mid West Ports 2017, Advice from Darwin Port, Flinders Ports 2017, BITRE 2014b.

Genesee & Wyoming Australia also transports Oz Minerals copper concentrates for export from Prominent Hill in northern South Australia to the Inner Harbour Port Adelaide berth #29 bulk precinct.

Figure 11 Oz Minerals copper concentrates containers at Inner Harbour, Port Adelaide

Source: Photo courtesy of Flinders Ports

Coal traffic

Similar to iron ore, rail is the best and dominant transport option from mine to port, particularly given the coalfields are mostly located well inland. Most Australian (black) coal production is 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)[11].

Australia's principal rail coal haulage is from these two states—see Figure 8. Aurizon manages the Central Queensland Coal Network, which is narrow gauge track with train axle loads of 26.5 tonnes. The network comprises five coal systems. 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. Aurizon recently linked it to the Goonyella Rail Corridor (For more details see Aurizon 2017).
- **Goonyella (Queensland).** Goonyella is an electrified system that services the Bowen Basin coal region. It primarily serves the terminals at Hay Point and Dalrymple Bay. (For more details, see Aurizon 2017a).

11 BITRE 2013 (p. 9) gives an overview of coal attributes.

- **Blackwater (Queensland).** This system services the Bowen Basin coal region. It delivers coal to the two 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. The system consists of mostly electrified duplicated lines that extend west from Rockhampton (For more details see Aurizon 2017b).
- **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 [Goonyella Abbot Point Expansion] through to and at) the port of Abbot Point.
- **Moura (Queensland).** This system is approximately 242 route kilometres and services the Boundary Hill, Dawson, and Callide mines. It is single track with passing loops and is linked to the Gladstone power station, Comalco refinery, Queensland Alumina Limited, Cement Australia and the R G Tanna and Wiggins Island coal terminals at the Port of Gladstone (For more details see Aurizon 2017c).
- **Hunter Valley (New South Wales).** Coal is transported to three coal-loading terminals in Newcastle and to domestic users. Train axle loads are up to 30 tonnes (ARTC 2017, p.22). According to ARTC, 2016 contracted export volumes are 190.9 mega tonnes per annum, remaining stable until 2024, at which time they are forecast to drop to 167.9 mega tonnes per annum, excluding new mines that may be opened (ARTC 2017, pp 4–5).

Table 8 Annual coal traffic, Queensland and New South Wales 2016–17

	Queensland					NSW
	Blackwater	Goonyella[a]	Moura	Newlands	GAPE	Hunter Valley
Net tonnes (m)	62.09	111.14	12.24	12.03	13.28	163.4
Net tonne-kilometres (b)	21.95	22.73	20.32	16.32	47.71	n/a

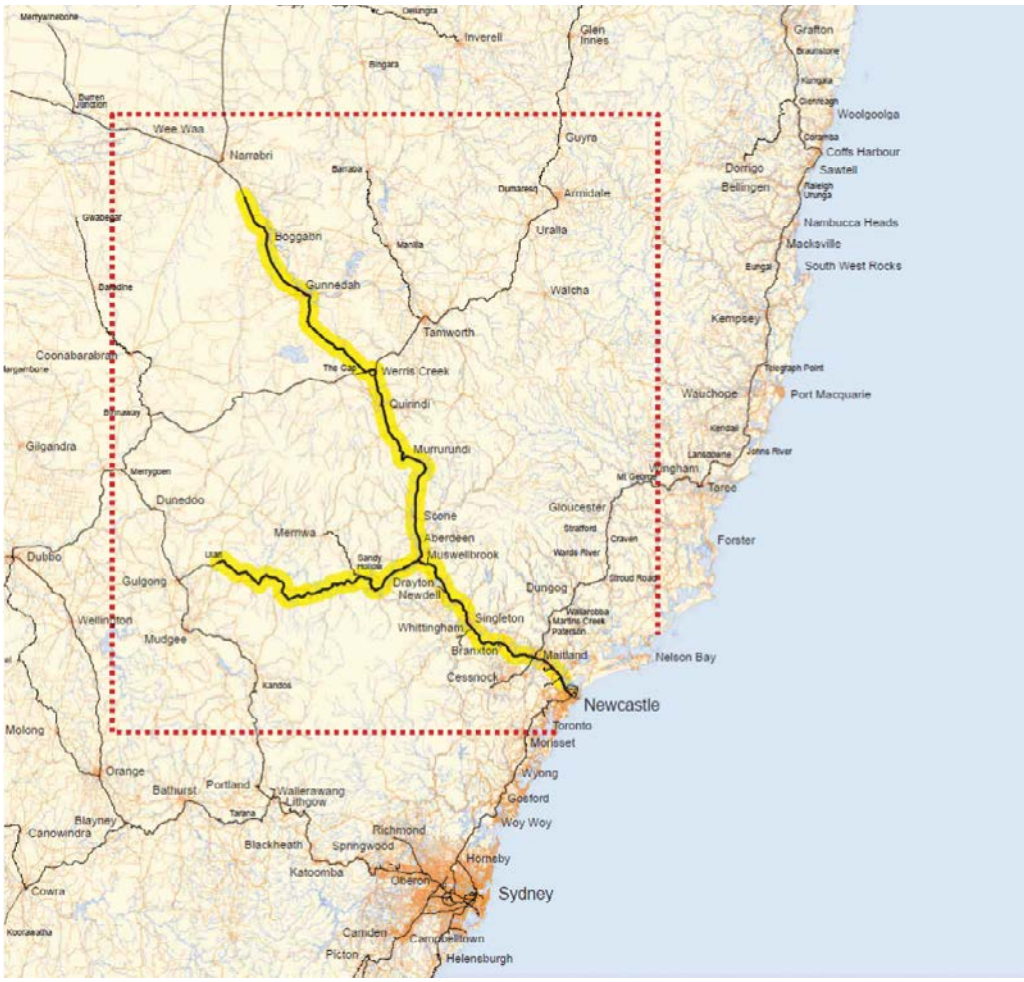
Notes: Queensland tonnages include both Aurizon and Pacific National.

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)

[a] *Trainline 4* incorrectly reported Goonyella tonnages for 2015–16 as 61.75 million tonnes. The correct figure is 121.5 million tonnes.

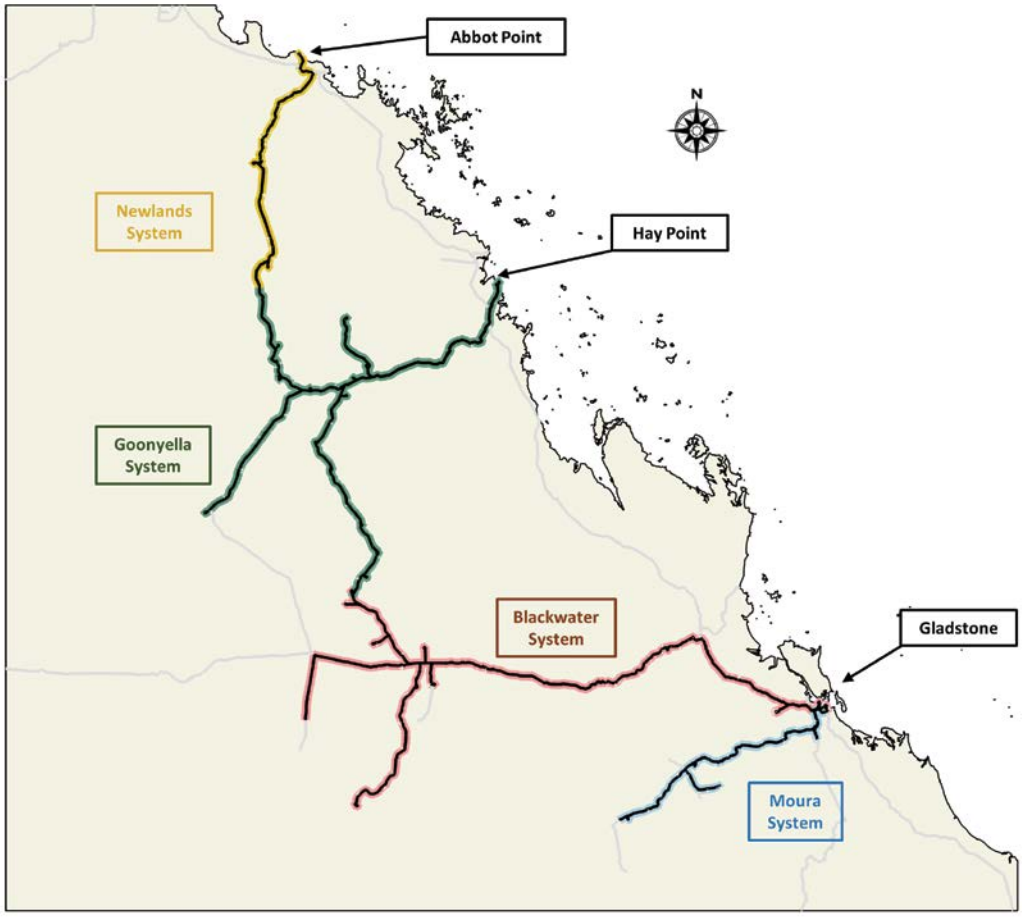
Sources: Aurizon n.d. (multiple issues), ARTC n.d. (multiple issues).

Figure 12 ARTC Hunter Valley Coal Network



Source: Map courtesy of ARTC.

Figure 13 Central Queensland Coal Network



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

- The West Moreton coal fields in southern Queensland);
- 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; and
- Fingal, in Tasmania, by TasRail.

Aurizon and Pacific National dominate coal haulage, with involvement also by Genesee & Wyoming Australia (post acquisition of Glencore Rail) and Southern Shorthaul Railroad[12]. Aurizon is the main coal train operator in Queensland. In the Hunter Valley in New South Wales, Aurizon has approximately 25 per cent market share[13].

12 Southern Shorthaul Railroad operate coal trains in New South Wales on behalf of Centennial Coal.
13 Aurizon provides fact sheets of each coal system in which it operates — see http://www.aurizon.com.au/ourservices/coal.

Table 9 Coal haulage by principal train operators

	Aurizon		Pacific National[a]	
	2015–16	2016–17	2015–16	2016–17
Tonnes (million)	206.8	198.2	158.8	n/a
Net tonne kilometres (billion)	49.7	47.6	31.8	n/a

Note: [a] Pacific National data is no longer available due to the breakup of its publically listed Asciano parent company.

Sources: Historical Asciano ASX reporting (no longer available); Advice from Aurizon.

Approximately 90 per cent of coal extracted in Queensland and 73 per cent in New South Wales is exported. Coal extracted in Tasmania is used domestically. Table 10 shows the most recent data of coal tonnages exported.

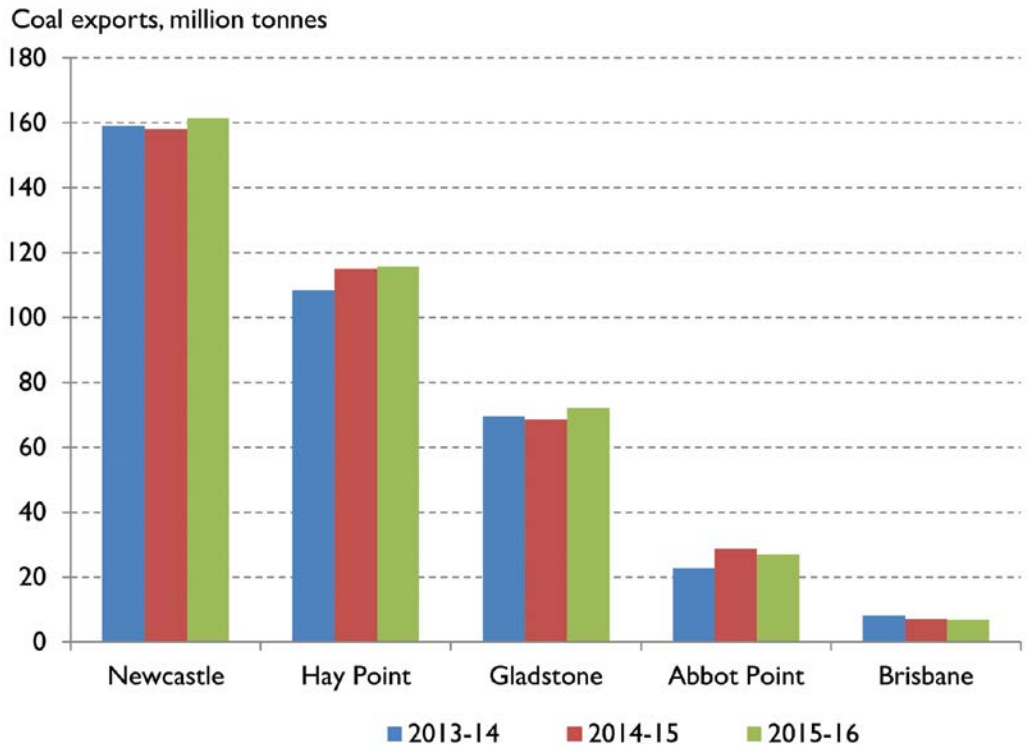
Table 10 Coal exports, by principal ports, (million tonnes), 2015–16

Newcastle	Hay Point	Gladstone	Abbot Point	Port Kembla	Brisbane
161.4[a]	115.7	72.1	27.0	n/a	6.7

Note: [a] Newcastle figures are for the 2016 calendar year.

Sources: Port of Newcastle 2016; North Queensland Bulk Ports Corporation 2016; Port of Brisbane 2017, Gladstone Ports Corporation; 2017.

Figure 14 Coal exports by port



Sources: Port of Newcastle 2015; Port of Newcastle 2016; North Queensland Bulk Ports Corporation 2016; North Queensland Bulk Ports Corporation 2014, pp. 24, 28; Port of Brisbane 2017; Advice from Port of Brisbane; Gladstone Ports Corporation, 2017.

Figure 15 Aurizon train at Mount Arthur Coal Mine, Hunter Valley

Source: Photo courtesy of Aurizon

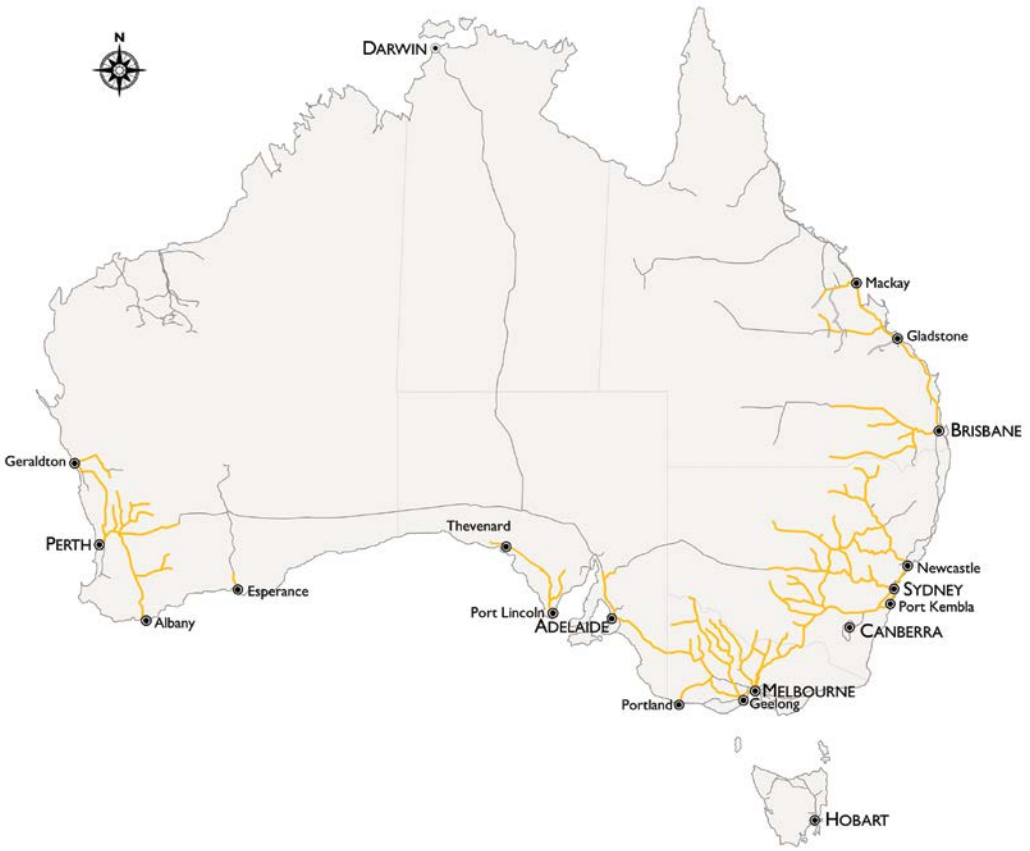
Grain traffic

A major role for Australia's railways is hauling agricultural produce from rural areas to ports for export and, to a lesser extent, domestic consumption. Grain harvests are primarily cereal grains, but also pulses, oilseed and oats. Average annual grain production between the years 2010–15 (wheat, coarse grains, pulses and oilseeds) was 45 million tonnes, 33 per cent more than average annual production levels for 2005–10. Approximately 73 per cent of the harvest over the five years 2010–15 was exported (Grain Growers 2016, p.2). According to the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), approximately 85 per cent of Australian wheat produced in 2012–13 was exported, at a value of $6.3 billion (ABARES 2015, pp.4, 13).

According to ABARES, estimated grain production for the 2016–17 winter crop was 59 524 kilo tonnes, compared to 39 608 kilo tonnes for the previous winter crop. While Western Australia had the largest total crop production at 18 041 kilo tonnes, Victoria had the greatest increase at 149 per cent (ABARES 2017, p.2). ABARES estimates national rice production for the 2016–17 season increased threefold (ABARES 2017, p.3). Graincorp has advised BITRE that its 2016–17 total harvest in Queensland, New South Wales and Victoria exceeded 12 million tonnes – almost double the harvest over each of the previous three years. On average, Graincorp had 10 trains running in constant cycles (to port and return) over a six month period, but for the 2016–17 harvest it has achieved a sustained peak of 21 constant train cycles.

Figure 16 shows grain flows by rail. This traffic largely uses dedicated grain haulage branch lines, which connect with main lines. In September 2017, there was an estimated 5 100 route-kilometres of operational railway track that was largely or exclusively used for grain haulage.

Figure 16 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"). 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. Rice and oilseed are also included.

The map shows grain flows along the railway lines that are designated as operating in September 2017. Some railways — notably in south-west Western Australia and in central New South Wales — are not shown as they are classified non-operational.

As discussed in BITRE 2013 (pp. 109–10), eighteen major ports regularly export grain.[14]

14 These rail ports are, in decreasing order of 2011–12 grain exports, Fremantle, Albany, Geraldton, Melbourne, Newcastle, Esperance, Port Adelaide, Port Lincoln, Port Kembla, Geelong, Brisbane, Portland, Port Giles, Sydney, Wallaroo, Gladstone, Mackay, Thevenard. See BITRE 2013, p. 110.

Figure 17 Southern Shorthaul Rail Grain Train

Note: The image above shows Southern Shorthaul Rail train service 5444N rolls through Curlewis in New South Wales with a load of more than 3000 tonnes of export grain from Walgett. The train consist comprises of 53 former Leigh Creek coal wagons which have been converted into grain hoppers.

Source: Photo courtesy of Charlie Harris.

Rail has traditionally dominated grain transport over long distances, while road transport becomes more competitive over shorter distances.

AEGIC (2014, p. 33) illustrated 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[15] through to the export vessel. As a major supply chain cost, therefore, the mode choice plays a major role in the overall costs.

Grain traffic trends

While rail transport has a traditional advantage for grain transportation long distances and is the preferred mode choice, this advantage is not absolute and has been partially eroded by other factors that have improved road transport's competitiveness or restricted rail transport's efficiency[16]. These include:

- Variable infrastructure quality across the networks, slower speeds, the need in places to change locomotives from mainline types to branch line types, chokepoints and short crossing loops at strategic locations[17];

15 The farm gate price is the global price the grain grower receives, minus expenses.
16 *Trainline 3* discusses in detail these changes and challenges to grain transport by rail. (See BITRE, 2015)
17 For more information on track infrastructure constraints, from a grain grower's perspective, see Grain Central 2017.

- Variable rolling stock age and capacity, which can at times be less than what the infrastructure can accommodate;
- Degrees of grain handlers' investment in grain receival sites;
- Improved roads and road transport services;
- Increased containerisation of grain;
- Deregulation of grain export marketing, which has seen smaller shipments being moved on diverse pathways for a broader range of bulk handlers and export marketers;
- Rail industry restructuring, funding and ownership changes;
- Rail transport and infrastructure availability;
- Increased domestic grain consumption of wheat produced in New South Wales, for which road transport is better suited;
- Coordinating train loading times with port receival times; and
- Weather events, including temperatures above 33 degrees Celsius, which closes tracks to rail freight operators in Victoria.

While track infrastructure may reduce rail transport's efficiency, this should be seen in the context of how much grain travels on the lower grade lines. According to advice from John Holland Rail, for example, the amount of grain traffic on these lines is already low; thus, the significance of these restrictions should be seen in that context.

For the 2016–17 season, most grain in Victoria travelled by road to ports due to the reduced availability of rail transport. Previously 60 per cent of product in the state travelled by rail, but in 2016–17 the mode share was reversed. According to Emerald Grain, the company had to pay for rail transport that they could not use while also paying for road transport (ABC, 2017). Graincorp advised BITRE that the loss of each 40 wagon train requires 45 B-Double replacement trucks. This increased road traffic includes both taking the product to port and return trips to the receival sites.

The Murray Basin Rail Project is aimed at mode shift from road to rail, including grain transport. Central to the project is conversion of the rail network from broad to standard gauge, upgrading and re-opening of the Ararat to Maryborough standard gauge line, and increasing axle loads to 21 tonnes. Gauge standardisation will boost port access for the Murray Basin rail network. Post gauge standardisation, trains originating from the Murray Basin will also have direct access to the deep sea Port of Portland, which has standard gauge access only, in addition to the Port of Geelong, which has both broad and standard gauge access[18]. The option of two ports is anticipated to stimulate competition between the two ports and the deeper water at Portland means rail freight originating from the Murray Basin region can be exported on larger bulk carriers. Project works are underway and it may be completed by the end of 2018.

18 For more information, see Public Transport Victoria 2015

Figure 18 Murray Basin Rail Project

Note: The image above shows re-sleepering of the standard gauge Ararat to Maryborough line, which is currently non-operational, as seen from a public road level crossing, September 2017.

Source: Photo courtesy of Rodney Avery.

In 2014, Graincorp commenced its Project Regeneration, whose aim, it claims, is a better network of grain storage sites in eastern Australia and more efficient rail transport of its products, which will provide higher storage capacity, more efficient turnaround times, and faster train cycle times (Graincorp 2017). Project Regeneration is expected to continue until 2020. According to Graincorp, three receival sites in Victoria and six in New South Wales have been completed, with another 10 planned or under construction in 2017, including one (Yamala) in Queensland. According to Graincorp, the completed sites have provided savings which has created some mode shift back to rail. Graincorp also claims it has $200 million in funds, which it is ready to invest should governments invest (further) in track infrastructure.

Cunningar, approximately 380 kilometres from Sydney on the Main South line, is one receival site that is currently being upgraded. The upgrade is due for completion in October 2017 and, once completed, will:

- Reduce loading times from 23.8 hours to 4.1 hours;
- Halve the cycle time for a loaded train to travel to Port Kembla and return; and
- Reduce rail transport costs by $10 per tonne (*Railway Digest* July 2017, p.5)

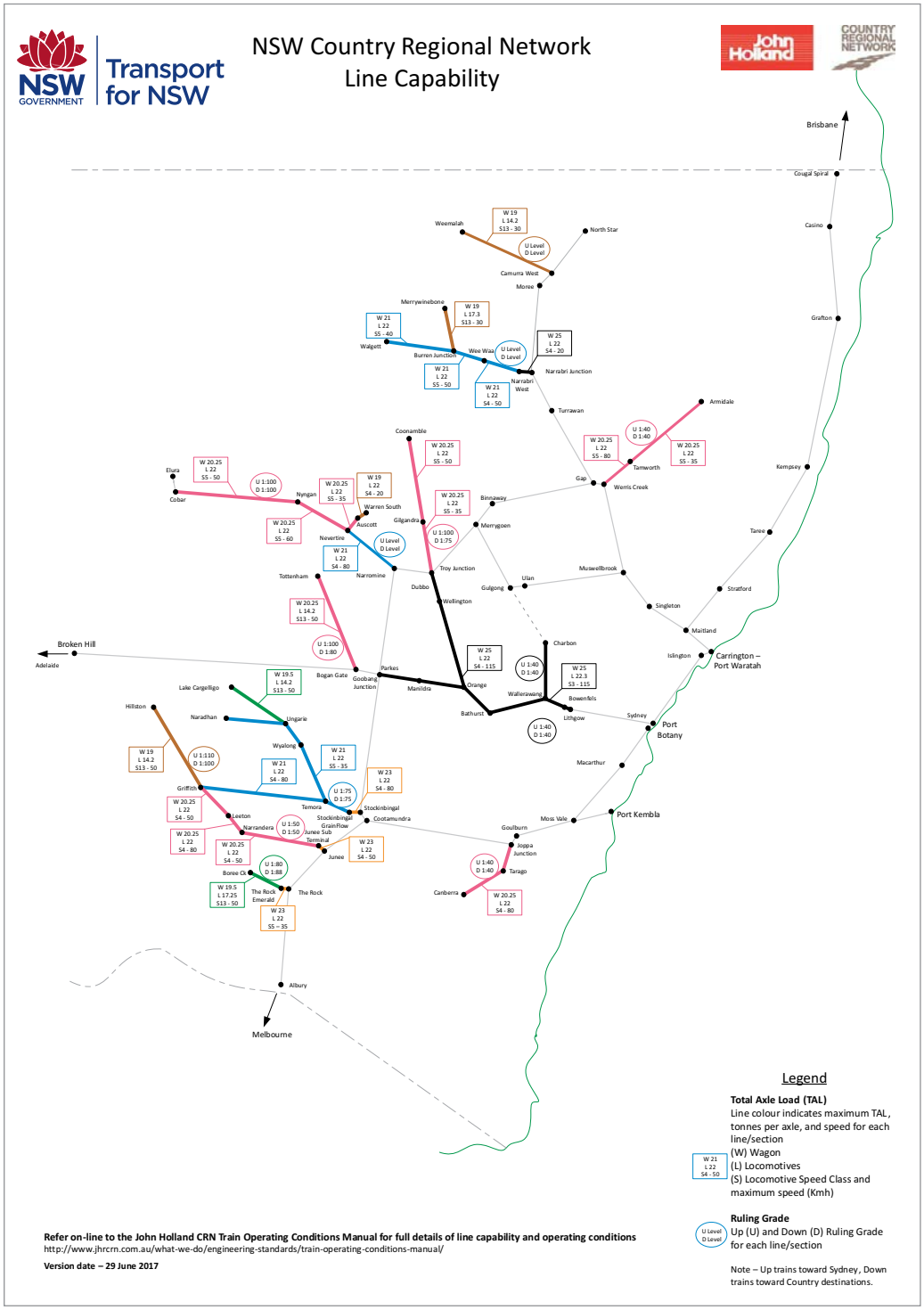
Ardlethan, also in New South Wales, is a completed Project Regeneration receival site, where the vast bulk of grain now travels to port by rail, compared to road transport's previous domination. Ardlethan includes a new 1105 metre rail siding and two new silos. Like other Project Regeneration sites, Ardlethan has increased efficiency and hence lower transport costs due to greater storage capacity, faster train loading times, faster train turnaround times, and longer individual trains[19].

Grain transport by rail in New South Wales has become more efficient and hence competitive through improvements to the state's Country Rail Network (CRN), which John Holland Rail manages under contract to Transport for NSW as part of the Annual Works Plan. Annual Works Plan expenditure is approximately $180–200 million per annum. According to advice from John Holland Rail, while the company works with and advises Transport for NSW, Transport for NSW decides what work will be done, which John Holland Rail, as track infrastructure manager in turn, implements. The works are not standalone projects but are done in conjunction with routine maintenance. Such improvements include replacement of pre-existing rail with used heavier rail and replacement of old sleepers with approximately 500,000 steel sleepers. The sleeper replacement works are expected to be completed by 2022. These track improvements enable heavier axle loads, which means heavier and more powerful locomotives can operate on sections of the CRN where they previously could not and grain hoppers can carry heavier loads. According to advice from John Holland Rail 83% of the CRN has a capability of 81 t gross or higher (which is the maximum capacity of >80% of the current bulk grain wagon fleet). This translates to reduced transport costs and improved competitiveness of rail transport in turn[20]. In August 2017, for example, Southern Shorthaul Rail operated possibly the largest grain train out of the New South Wales Riverina district; a 1000 metre train carrying 5000 tonnes of grain, using three mainline locomotives, from Coolamon to Appleton Dock in Melbourne.

19 Much of this information is what Graincorp has advised BITRE. BITRE does not currently have detailed information on Graincorp's competitors' operational capabilities. This information should not be seen as a comparison between Graincorp and its competitors.

20 For further information on Transport for NSW's CRN works see https://www.transport.nsw.gov.au/projects/current-projects/country-regional-network-crn

Figure 19 New South Wales Country Rail Network Infrastructure Standards



Note: The map above shows the New South Wales CRN network capabilities by line. Map courtesy of Transport for New South Wales.

Box 4 Further reading on railway grain handling

Overviews:

- 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, 2014), Rail freight use by the agriculture and livestock industries, Report No. 45.

New South Wales reports:

- 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).
- Pollard 2012, "Moving NSW wheat: the post deregulation experience", *Railway Digest,* reviews the logistics changes to wheat haulage in New South Wales.

Non-bulk and short-haul rail freight traffic

Non-bulk and short-haul (a distance that is shorter than that which intermodal rail transport is usually considered viable) rail freight movements are mostly containerised, although SCT Logistics, for example, typically uses louvre wagons for their palletised traffic. (See Box 1 for further discussion of defining non-bulk rail freight.) Short-haul traffic is often thought to be uncompetitive with road freight, due to the relative short distances over which the freight is moved. It can, however, be successful. To succeed, short-haul rail traffic needs:

- Minimised road drayage costs between the hinterland and intermodal terminal;
- Low line haul and high road haul costs; and
- A convergence of parties who encourage short haul and viable hinterland terminals (BITRE 2016b, pp v–vi)[21].

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), is a primary example.
- Regional export movements, from inland terminals to the port. This traffic includes agricultural commodities, such as sugar, cotton, grains, livestock, wine and logs.

21 BITRE 2016a (*Why short-haul intermodal rail services succeed*), provides an in depth discussion on the (potential) vialbility of short-haul rail transport in Australia.

- 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). These local rail services also shift empty containers.
- Export maritime activities are generally based around single commodities and/or a single company's logistics-based hub.

The New South Wales government is investing in the state's regional freight network to upgrade rail connections to ports and remove local freight pinch points on regional roads and bridges. In the state's 2016–2017 budget, for instance, $400 million was allocated for this purpose. This includes:

- Reactivating some non-operational branch lines such as Maimuru–Demondrille;
- Rail siding extensions;
- Upgrading the Canberra Freight Terminal;
- New turnouts and crossing loops; and
- Upgrades to existing operational grain branch lines.

Funding has also been allocated to enhance rail operations to Port Botany, which includes improving truck turnaround times and increasing the number of containers carried on trains. (For more details see Transport for NSW, 2016.)

The following discussion focuses on port rail flows to or from capital cities and urban shuttles, while noting other, non-capital city flows can operate.

Rail (and road) volumes of containers through the primary capital city ports are reported in BITRE's regular Waterline series. (BITRE 2017 gives the latest figures.)

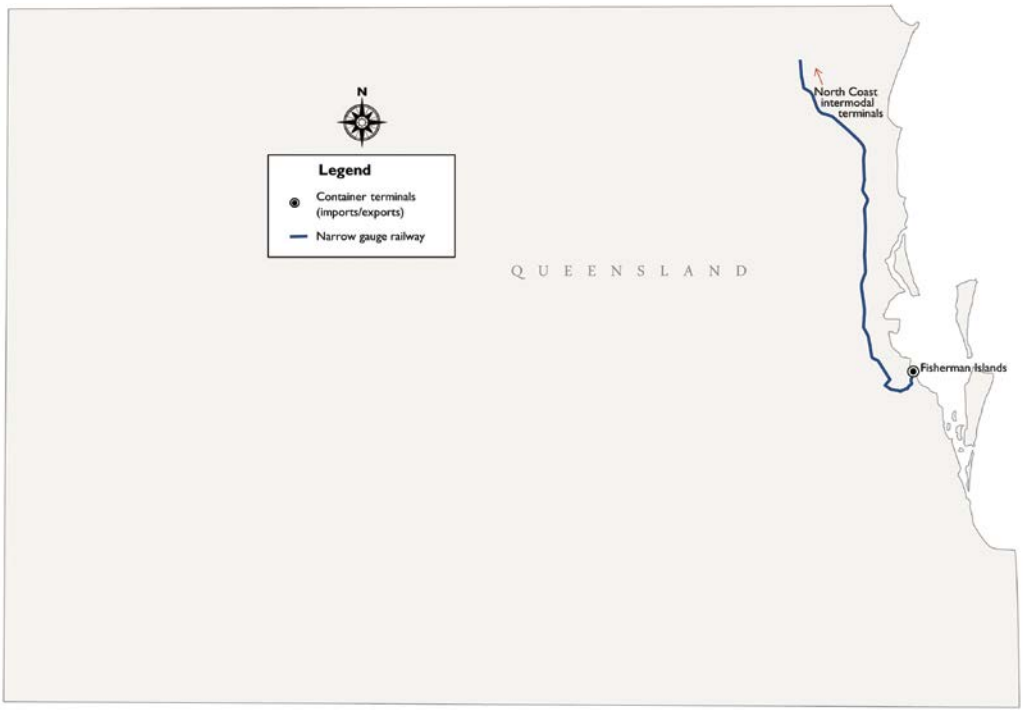
Landbridge and regional movements

The maps that follow show the regional maritime railway services to city ports.

Port of Brisbane—Fisherman Islands

Figure 20 shows the rail container flows between Queensland intermodal terminals and the Port of Brisbane (Fisherman Islands).

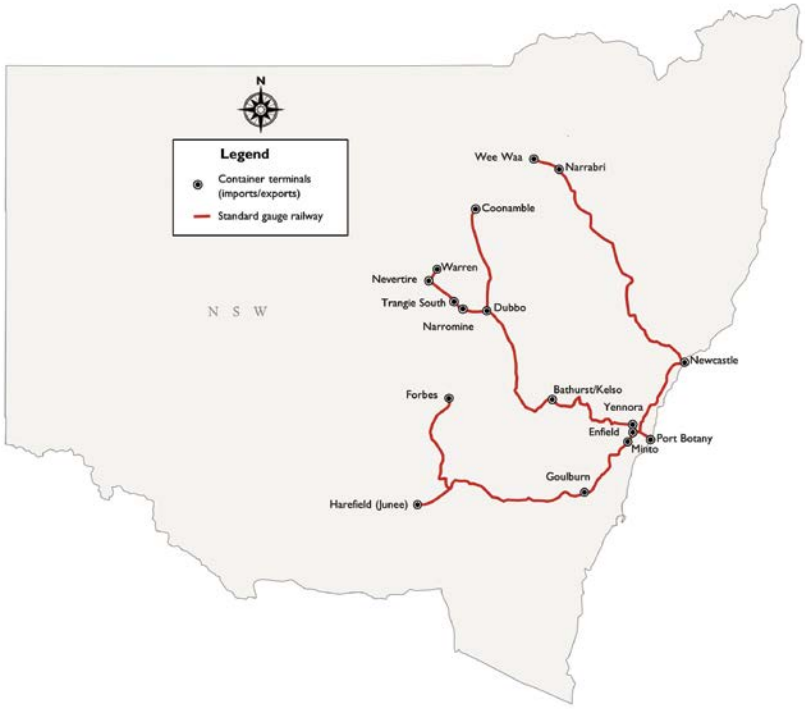
Figure 20 Rail container operations serving the Port of Brisbane (Fisherman Islands)



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.

Sydney Ports—Port Botany

Figure 21 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;
- Containerised grain and cardboard (from Visy's plant at Tumut) from Harefield (near Junee);
- Viterra pack cereals (wheat and barley), oilseeds and pulses from Narrabri;
- Cotton from Warren, Nevertire, Wee Waa, Narrabri, and Trangie South;
- Logs from Bathurst/Kelso and Newcastle (Sandgate);
- Logs from Goulburn to Port Botany and Port Kembla (commenced in 2016);
- Grain, oilseeds, pulses, and refrigerated meat from Dubbo; and
- Aluminium ingots and various agricultural produce from Newcastle.

NSW Port's estimate of rail's modal share for the Port of Botany for the calendar year to date at June 2017 was 18.8 per cent (NSW Ports 2018, p.4).

Port of Melbourne

Figure 22 shows the major regional container export flows through the Port of Melbourne. It does not show rail container flows through the port that originate or are destined for Tasmania. It is possible some of the Bass Strait traffic moves by rail along the north-south rail corridor.

Figure 22 Rail freight operations serving the Port of Melbourne

The non-urban movements can be categorised into western and eastern Victoria flows, and southern New South Wales flows. Products transported by rail are as follows.

Intrastate Victoria.

- Merbein (Mildura) – grain, wine, grapes, fruit, mineral sands;
- Donald – peas, grain;
- Westvic Container Export Services, at Warrnambool – meat and dairy products;
- Wimmera Container Line, at Dooen (near Horsham) – grain, hay, and pulses;
- Maryvale in the Latrobe Valley – containerised paper;
- Mooroopna (Shepparton) – milk products and manufactured food products; and
- SCT Logistics rail hub at Barnawartha – cotton for export to Asia.

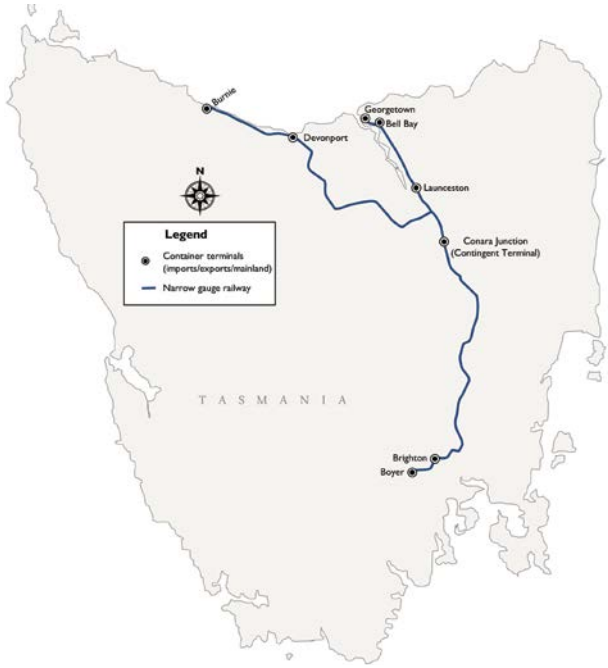
Southern New South Wales. Export flows to the Port of Melbourne, including:

- Deniliquin – containerised rice;
- Tocumwal – Grain, hay, rice, potatoes;
- Griffith and the Wumbulgal terminal – containerised wine;
- Containerised cereals, cotton and hay from Wumbulgal
- Rice and pelleted feeds for animals, from Leeton; and
- Containerised paper from the Ettamogah Rail Hub.

Tasmania

Tasmania has a growing freight rail network which is operated and maintained by TasRail, the state's fully integrated railway. With modernised terminals located at Burnie, Brighton and George Town (Bell Bay), TasRail offers freight haulage and storage services throughout the state. Containerised freight services connect major industrial areas to Tasmania's premier shipping ports where freight is moved across Bass Strait. Bulk freight services provide efficient, integrated, end to end supply chain services and the haulage of bulk commodities to storage facilities for onward export. TasRail also operates Tasmania's only publicly owned bulk handling, storage and ship loading facility for bulk mineral concentrates, which is located within the Burnie Freight Terminal precinct.

Figure 23 Rail container operations serving Tasmanian ports



Rail traffic terminals in Tasmania include:

- George Town: A multi modal-terminal with container storage area handling containerised general freight, metal ingots and bulk log freight;
- Devonport: A freight terminal handling containerised general freight;
- Burnie: An upgraded multi-modal freight terminal, which handles containerised general freight, bulk metal concentrates, paper products, and metal ingots;
- Launceston: A freight terminal handling containerised general freight;
- Brighton: A multi-modal freight terminal with container hardstand and storage area that handles containerised general freight, bulk log freight, and metal ingots; and
- Conara Junction: A contingent freight terminal handling bauxite and containerised general freight.

TasRail also hauls zinc ingots, containerised metal concentrate, bulk cement, coal, sugar, recycled metal, glass bottles, fish food, fertiliser, construction materials, consumer goods, groceries and aluminium ingots.

Figure 24 Tasrail minerals concentrates train

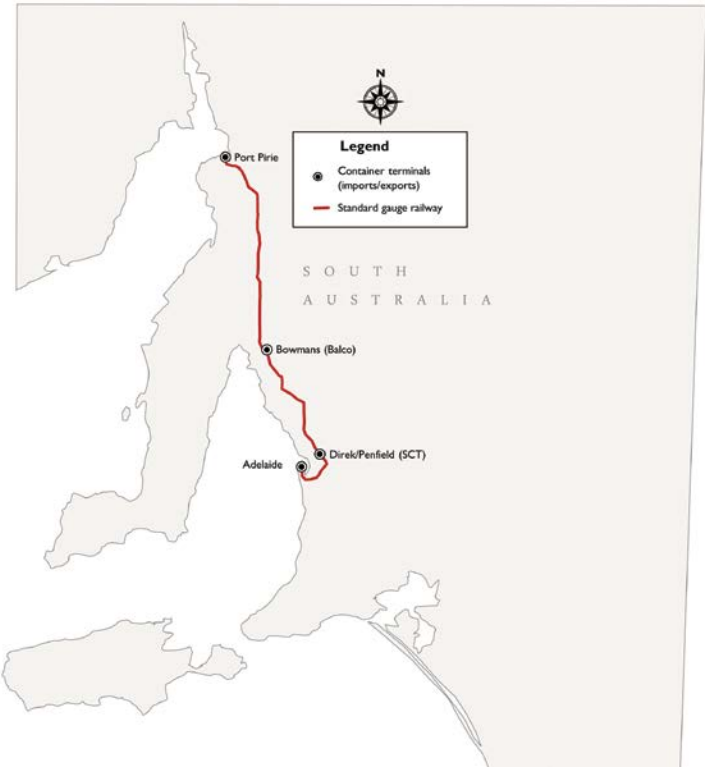
Note: The image above shows a Tasrail Burnie–Rosebery zinc, lead, and copper concentrates train at Guildford Loop, September 2017.

Source: Photo courtesy of Steven Kimpton and Tasrail.

Port Adelaide — Inner Harbor

There are regional maritime container traffic flows to Inner Harbor (Port Adelaide)—see Figure 25. 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.

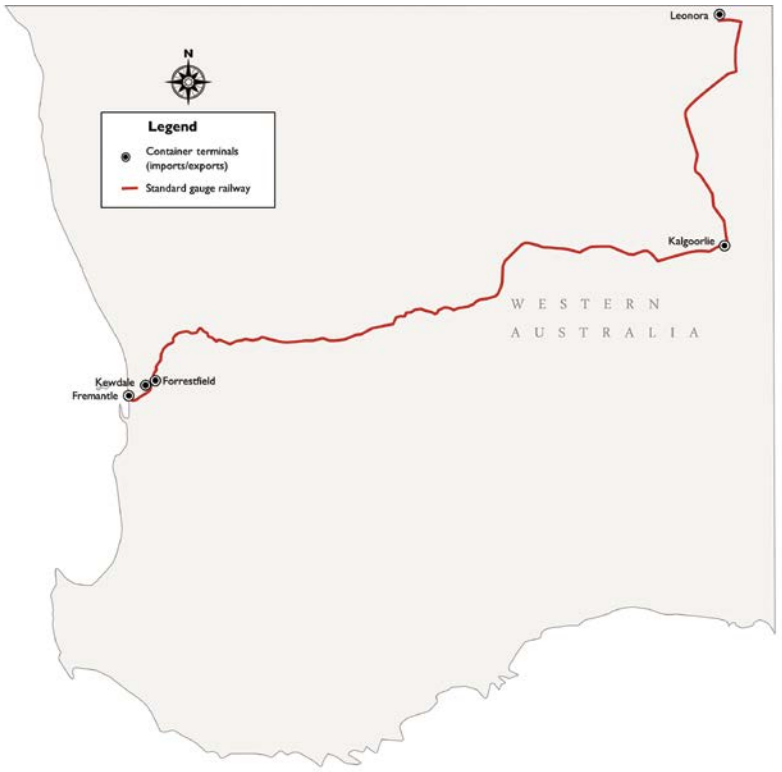
Figure 25 Rail container operations serving Port Adelaide



According to advice from Bowmans Rail, regional trains operate between the Bowmans Rail's 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 and seed. 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 Outer Harbor. 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

Figure 26 Rail container operations serving Kwinana



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

Short-haul urban shuttle trains provide a rail link from seaports to surrounding intermodal (distribution) centres. These services are advantageous by virtue of the fact they reduce road congestion into and out of the ports and connecting arterial roads. There are several flows of short-haul urban maritime container movements. These are:

- Yennora – Port Botany (approximately 40 kilometres);
- Minto – Port Botany (approximately 55 kilometres);
- Enfield – Port Botany (approximately 18 kilometres);
- Direk/Penfield – Outer Harbor, Port Adelaide (approximately 25 kilometres);
- Altona – West Swanston Dock (approximately 24 kilometres); and
- Kewdale/Forrestfield – Fremantle (Inner Harbour) (approximately 24 kilometres).

In July 2016, partners DP World and SCT Logistics commenced weekly port shuttle trains between Altona and West Swanson terminal in Melbourne following a previous trial of the service (*Railway Digest,* September 2016, p.26).

The Yennora and Minto operations handle imports and exports. The terminals conduct 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 in South Australia involves the export of wine.

The Western Australian Government subsidises container movement shuttle trains between intermodal facilities at Forrestfield/Kewdale and the Inner Harbour at Fremantle. Watco 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. Two trains of up to 600 metres operate daily in each direction. Goods are transferred from international and coastal shipping and include bulk goods, food and beverages, and construction equipment.

The federal and Victorian state governments have announced a jointly funded $58 million plan to build a series of rail lines that will provide for rail shuttle connections between the Port of Melbourne and surrounding intermodal rail facilities. It is not yet known where exactly the lines will be built or when construction will start (Herald Sun, 2017).

Box 5 Further resources on non-bulk freight activity

BITRE's *Waterline* series presents quarterly data on rail traffic volumes through the mainland state capital city ports (where traffic is measured in TEU, Twenty-foot Equivalent Unit containers).

Fremantle Ports publishes longer-run data on TEU volumes through the Fremantle Ports (Fremantle Ports 2016, pp. 27–28). 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 (Port of Brisbane 2013, pp. 10, 26).

Flinders Ports publishes monthly and yearly reporting on freight volumes (Flinders Ports 2017).

NSW Ports provides monthly and annual volumes through Port Botany (NSW Ports 2017).

Urban rail passenger traffic

Each of the mainland state capital cities operate urban passenger rail services. These services enable the mass movement of passengers to and from capital city centres. Urban passenger rail services provide an alternative to private cars, which minimises road congestion. These services also provide transport for those without cars.

Table 11 Urban rail patronage (millions of journeys), 2015–16[a]

	Brisbane[b]	Sydney[c]	Melbourne[d]	Adelaide	Perth	Gold Coast
Patronage – heavy rail	52.4	322.6	233.4	11.3	62.6	-
Patronage – light rail	-	9.7	203.8	8.9	-	7.7

Notes: [a] Methodologies for calculating patronage vary between cities.

[b] Brisbane's patronage figure is based on Queensland Rail's City Train network, whose scope is what it defines as south east Queensland. The quoted patronage also does not include the separately administered Airtrain line.

[c] According to the data source (see below), Sydney data from 2013–14 onwards is for Sydney Trains patronage only. There are two urban heavy rail operators in Sydney: Sydney Trains and NSW TrainLink, both of which were formed on 1 July 2013. Sydney Trains is the main operator, while TrainLink provides additional express services using intercity trains that stop at a small number of Sydney urban stations ('shared stations'). Future reporting may be able to include the TrainLink component of urban heavy rail patronage following the replacement of paper tickets with Opal cards.

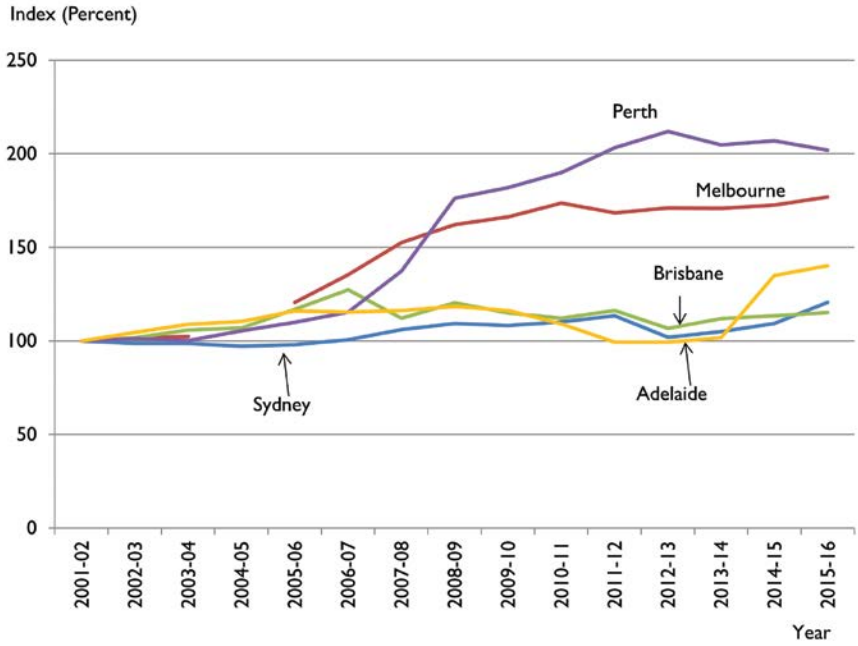
[d] Melbourne's light rail patronage includes the CBD free travel zone which commenced on 1 January 2015.

Sources: Public Transport Authority of Western Australia 2016, p.20; Public Transport Victoria 2016, pp.43–44; Department of Planning, Transport and Infrastructure 2016, p.63; Queensland Rail 2016, p.33; Department of Transport and Main Roads 2016, p.133; Data provided by NSW Bureau of Transport Statistics.

As Figure 27 shows, urban passenger traffic grew in all cities, except for Perth, whose patronage has fluctuated slightly over the past four financial years. In 2015–16, Perth's patronage decreased by 2.6 per cent. Sydney continues to have the highest levels of urban heavy rail patronage – approximately 38 per cent higher than Melbourne. In 2015–16, Sydney's patronage grew by approximately 10.5 per cent, while the other cities had minor increases.

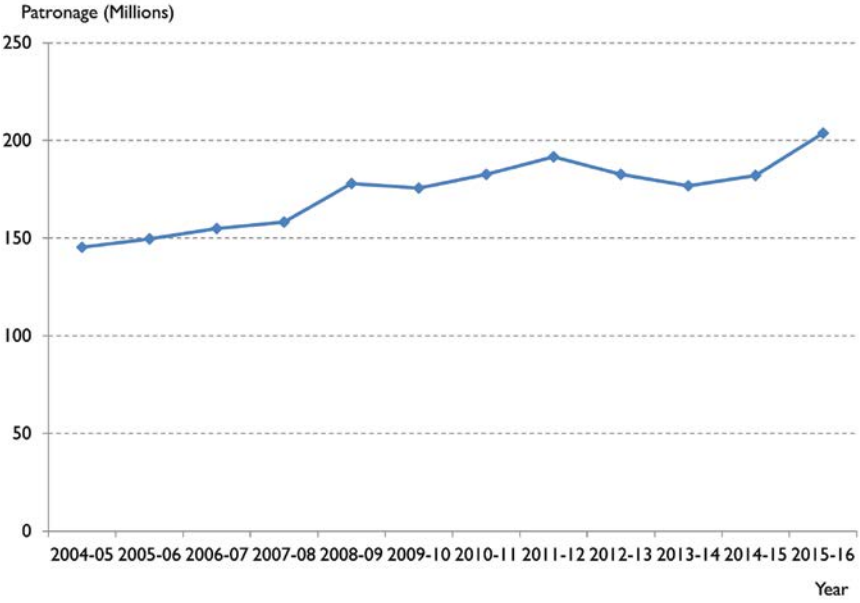
As Figure 29 and Figure 30 show, Sydney's light rail patronage continues its sharp growth. In 2015–16, its light rail patronage grew by 59 per cent compared to the previous year. Gold Coast patronage grew by approximately 22 per cent. Urban heavy rail patronage in Melbourne grew by 2.6 per cent. Melbourne's light rail patronage grew at a stronger 12 per cent. This includes free travel in the CBD zone. Adelaide's light rail patronage was effectively unchanged (0.1 per cent growth).

Figure 27 Index of urban heavy rail patronage in Australian cities



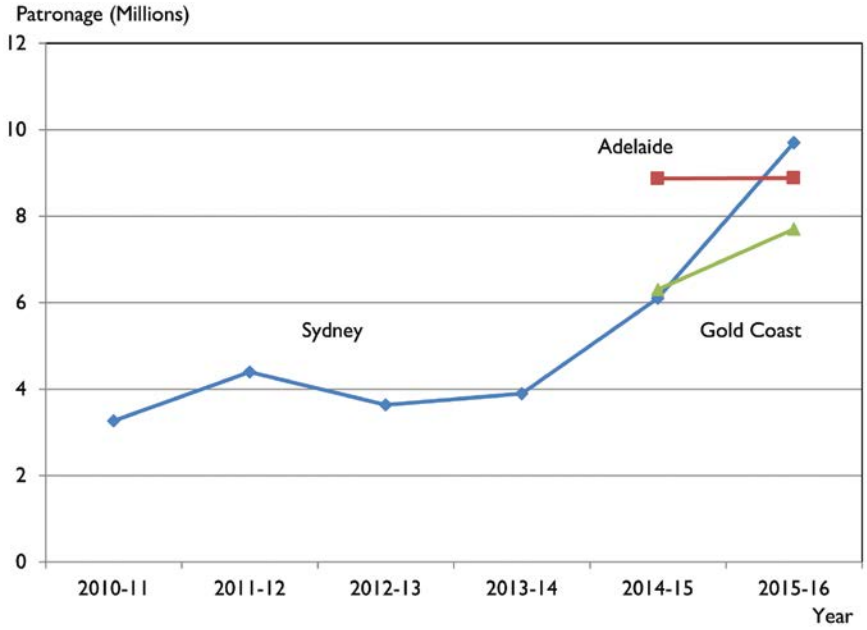
Sources: Index based on patronage data from: BITRE 2012 and previous Trainline editions; Public Transport Authority of Western Australia 2016 p.20; Public Transport Victoria 2016 pp.43–44; Department of Planning, Transport and Infrastructure 2016, p.63; Queensland Rail 2016, p.33; Data provided by NSW Bureau of Transport Statistics; and historical annual reports.

Figure 28 Melbourne light rail patronage



Source: Public Transport Victoria 2016, p.44

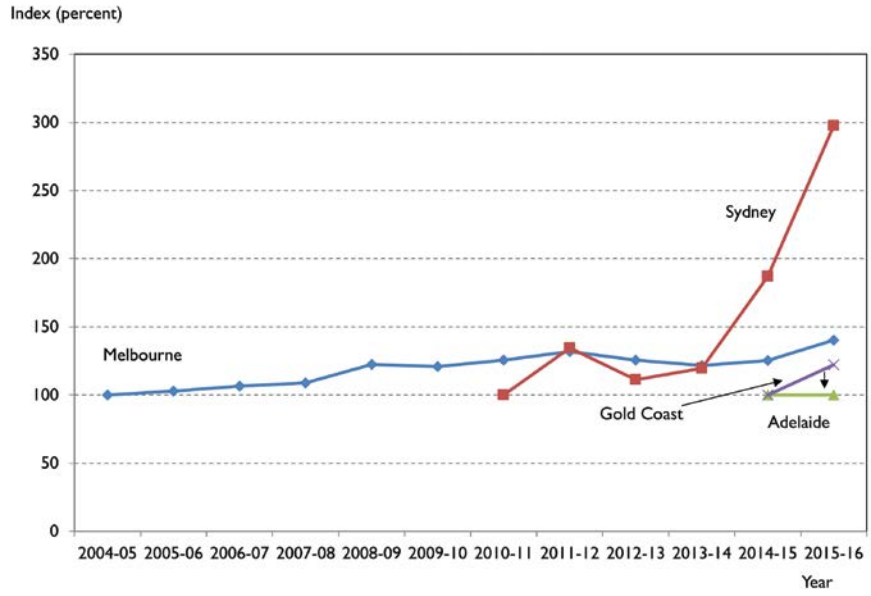
Figure 29 Sydney, Adelaide and Gold Coast light rail patronage



Note: Earlier data for Adelaide is not shown due to a patronage calculation methodology change.

Sources: Data provided by NSW Bureau of Transport Statistics; Department of Planning, Transport and Infrastructure 2016, p.63; Department of Transport and Main Roads 2016, p.133

Figure 30 Index of light rail patronage Melbourne, Sydney, Adelaide and Gold Coast



Sources: Index based on Public Transport Victoria 2016 p.44; Data provided by NSW Bureau of Transport Statistics; Department of Planning, Transport and Infrastructure 2016, p.63; Department of Transport and Main Roads 2016, p.133; and historical annual reports.

National (external) and local (network-specific) factors explain heavy and light rail patronage trends. The former includes economic activity (influencing employment and disposable income) and fuel prices. Another factor that affects mode choice 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. In the case of Gold Coast light rail patronage, Keys (2016, p.6) argues that while patronage may appear healthy and in line with forecasts, there has been a corresponding decrease in local bus patronage, thus there has been no overall mode shift from private to public transport.

Specific local factors that may have some bearing or future bearing on the city travel trends are as follows:

- **Brisbane.** Following fare decreases in January 2010, Queensland reduced fares again in December 2016 for travel within south east Queensland, in what is known as the Fairer Fares package. The package includes outright cheaper fares, reduction of travel zones from 23 to eight, extending off peak discounts, and increased eligibility for concession or free travel. (*Railway Digest*, February 2017, p.15)
- **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.** According to Public Transport Victoria, commuting to work draws the greatest urban rail patronage, and employment growth is thus linked to patronage growth. It notes employment growth for the financial year was 2.9 per cent, while patronage growth was 2.7 per cent (Public Transport Victoria 2016 p.43). Regarding light rail patronage, Public Transport Victoria attributes the growth to population growth. It notes that since 2012 more than one third of building approvals for new buildings have been near tram routes. Other factors it attributes light rail patronage growth to includes the introduction of new higher capacity trams, introduction of the free tram zone in the CBD district, and the split of former route 112 into routes 11 and 12 (Public Transport Victoria 2016 p.44.)[22].
- **Adelaide's** heavy rail patronage has continued to increase following previous declines that occurred during the period of infrastructure enhancement and the Rail Revitalisation Programme renewal works, which saw various temporary line closures.
- **Perth.** According to the Public Transport Authority of Western Australia, the 2015–16 total public transport patronage in Perth (including buses and ferries) decline occurred in fare paying boardings (thus excluding free travel for eligible patrons, for which there was a patronage increase). The Authority attributes the decline to weaker economic conditions, major arterial road improvements, a decline in the rate of population growth, and cost of living pressures that reduced discretionary travel (Public Transport Authority of Western Australia 2016 p.20).

22 Public Transport Victoria does not elaborate on how the split of the one route into two has led to increased patronage.

Commuting traffic

Urban passenger rail services are largely aligned to service weekday commuter demand to and from city centres. The task is skewed to the morning and afternoon peak periods travel. In 2016, urban heavy rail's mode share had increased in all cities except Brisbane and Perth compared to 2011. Sydney had the highest heavy rail mode share.

Table 12 Urban rail journey-to-work mode shares, 2016

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Heavy rail (%)	7.3	19.1	13.7	2.8	7.5
Light rail (%)	–	0.2	3.9	0.6	–

Notes: Cities refer to greater metropolitan areas. For the 2016 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.

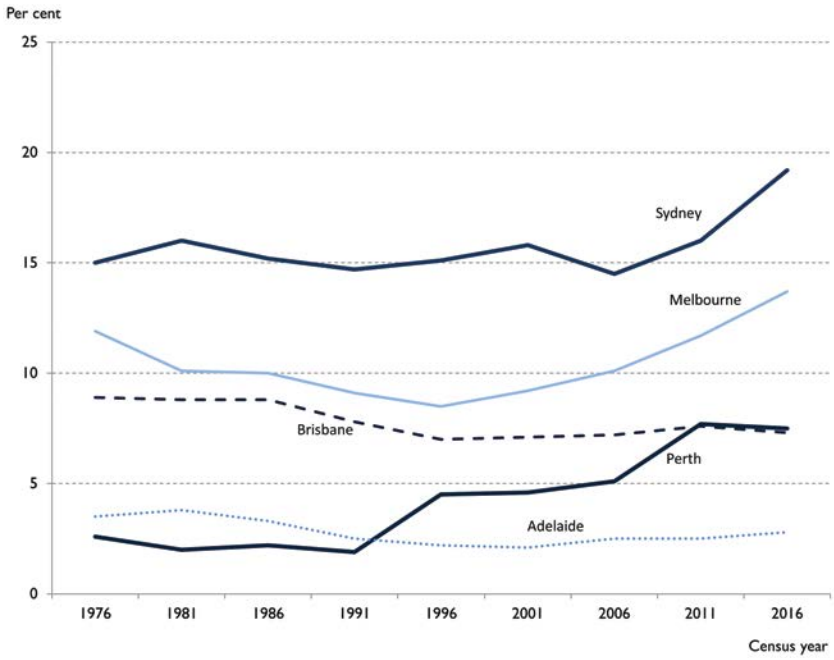
Tram/light rail census data includes respondents who: caught a tram/light rail; caught a train and tram/light rail; caught a bus and tram/light rail. The tram/light rail data is therefore an underestimate because it does not include all possibilities, for example, car and tram/light rail.

Source: ABS 2017.

Following long-term declines in urban rail patronage for all cities from the mid-1970s, ridership began recovering in the 1990s[23]. Figure 31 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.

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

Figure 31 Journey-to-work mode share, urban heavy rail 2016



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.

Box 6 Further reading

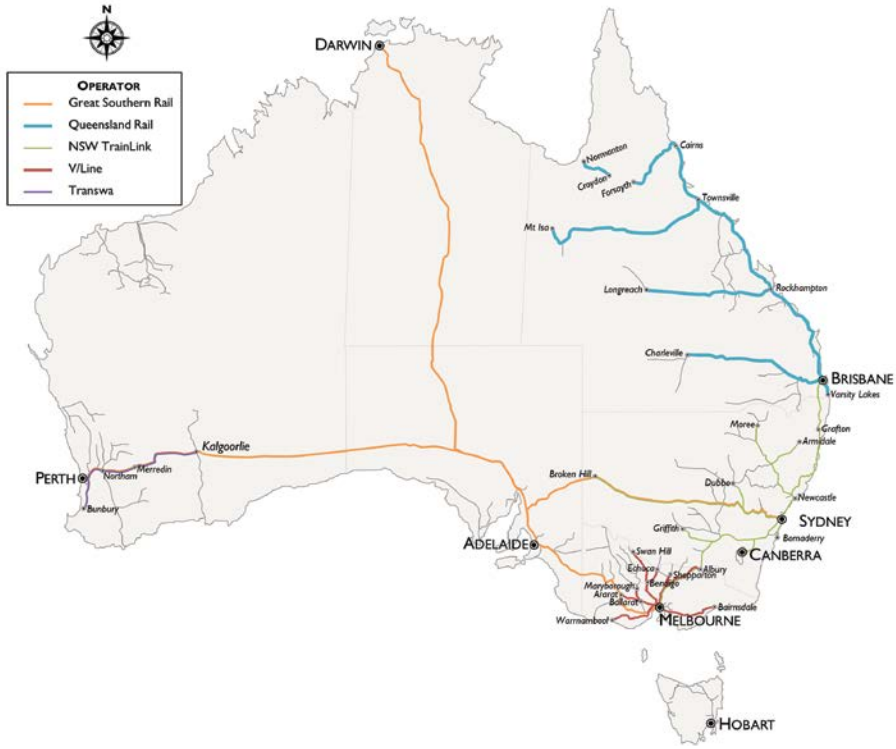
For further information on urban passenger trends, see BITRE information sheets: *Urban transport: updated passenger trends—Information Sheet 59* (BITRE 2014c); and *Long-term trends in urban passenger transport—Information Sheet 60* (BITRE 2014d).

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 services in the inter-city, regional and long-distance passenger markets. Coverage of these services is shown in Figure 32.

Figure 32 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:

- "Intercity" or "regional" travel, such as Sydney–Hamilton, 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 Melbourne–Bairnsdale 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 13 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 regional travel. The majority of passengers use intercity services on the Hamilton and Central Coast, Blue Mountains, Southern Highlands and South Coast lines.

Table 13 Non-urban rail patronage, by operator, 2015–16

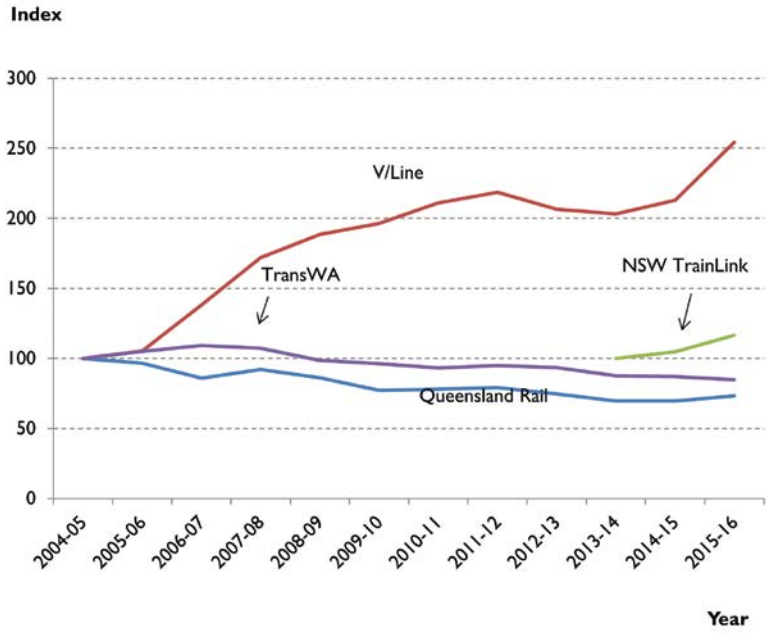
	Queensland Rail	NSW TrainLink		V/Line	Transwa
		Regional	Intercity		
Patronage (thousands)	735	1 246	38 542	16 280	212

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

Sources: NSW Trains 2016, p.17; Public Transport Authority of Western Australia, 2016, p.27; Queensland Rail 2016, p.41; V/Line 2016, p. 13.

Similar to urban patronage, non-urban patronage is influenced by broad, macroeconomic factors and local, network specific factors. Figure 33 shows patronage trends by operator. The index for NSW TrainLink is truncated to 2013–14 due to the patronage data revision.

Figure 33 Index of non-urban rail patronage, by operator



Notes: The NSW TrainLink index is the sum of regional and intercity patronage. 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, which merged regional and intercity services under one operator. 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: NSW Trains 2016, p.17; Public Transport Authority of Western Australia 2016, p.27; Queensland Rail 2016, p.41; V/Line 2016, p. 13; historic annual reports.

Some noteworthy trends are:

- **Queensland Rail** patronage, which is heavily tourism dependent, grew by five per cent, after two years of no change. The Bundaberg and Rockhampton electric Tilt Train services had the single most patronage, at approximately 25 per cent of total patronage. (Queensland Rail 2016, p.41).
- **NSW TrainLink.** It is now possible to assess meaningful patronage trends following the formation of TrainLink on 1 July 2013, which merged the former intercity and regional/long

distance services. In 2015–16, patronage grew by more than 11 per cent. Intercity patronage grew the most, at 17.25 per cent, while regional (rail) patronage increased by almost one per cent, after a previous minor decline. Services to the state's south, Canberra, and Melbourne experienced the strongest regional patronage growth. The NSW Trains annual report claims improved patronage calculation methodology following the introduction of the Opal card has contributed to the recorded overall increase (NSW Trains, 2016, p.17).

- **Transwa** patronage continued its decline from 2006–07. Compared to the previous financial year, patronage declined by approximately three per cent (Public Transport Authority of Western Australia, 2016, p.27). The Australind, which accounts for almost half of Transwa's total patronage, continued its decline in 2015–16, at eight per cent. All other services had declining patronage, except the Avonlink service, which had a growth of 26 per cent. Public Transport Authority of Western Australia attributes cancelled services due to bushfires in January 2016 and unspecified maintenance issues as contributing factors to the declining patronage for the year (Public Transport Authority of Western Australia 2016, p.27).
- **V/Line** patronage continues to grow upon already strong growth which saw a doubling of patronage in the ten years from 2004–05. This follows major upgrades between 2003 and 2006 under the Regional Fast Rail programme. (BITRE 2014 (pp. 61–70) reviews the upgrades.) The programme reduced scheduled transit times and increased frequencies. This was followed by the Regional Rail Link (RRL) programme, which separates regional trains on the Geelong, Ballarat and Bendigo corridors from urban trains in Melbourne. The RRL opened in 2015. Other contributory factors include a fare reduction of 20 per cent in March 2007, central Melbourne employment growth, and strong population growth along the rail corridors (BITRE 2014, p.69). In 2015–16, patronage grew by approximately 19.5 percent (V/Line 2016, p.13). The Geelong corridor had the strongest growth, at approximately 59 per cent, while the Bendigo and Gippsland lines had patronage declines of 0.40 and 13.73 per cent respectively. The Ballarat line had the second highest annual growth, at 12.80 percent.

According to the Victoria based Rail Futures Institute, the RRL has become 'a victim of its own success'. Its paper *Cut the Crush on Geelong Trains*! claims Melbourne's urban growth in its south west, through which the new RRL Geelong line passes has turned the line in to an urban line in itself with trains 'crammed' with regional and urban passengers. It further argues the RRL section from Sunshine to Southern Cross is already at capacity during peak periods for which longer 8-car VLocity trains sets and new tracks are needed to meet the growing demand (Rail Futures Institute 2017).

Table 14, below, compares the number of one way non-urban rail services in Victoria between 1967 and August 2017, as reported by the Rail Futures Institute (Rail Futures Institute 2017a). While the table shows very strong growth on the medium distance corridors and marginal growth on long distance services, the Institute qualifies this growth by noting there were services operating to destinations in 1967 that have since ceased and been replaced by road coach services. It should also be noted that while still a V/Line operation, the Geelong service has become an urban service for part of it journey due to urban expansion. The table also excludes interstate services.

Table 14 Comparison of weekday Victorian non-urban services 1967/August 2017

	1967	August 2017		1967	August 2017
	Number of Services			Number of Services	
Geelong	11	55	Warrnambool	2	4
Ballarat	3	24	Ararat	2	4/5
Bendigo	3	23	Maryborough	2	2
Seymour	5	20	Swan Hill	1	2
Warragul/Traralgon	8	19	Echuca	1	1
			Shepparton	2	4
			Albury	2	3
			Sale/Bairnsdale	2	3

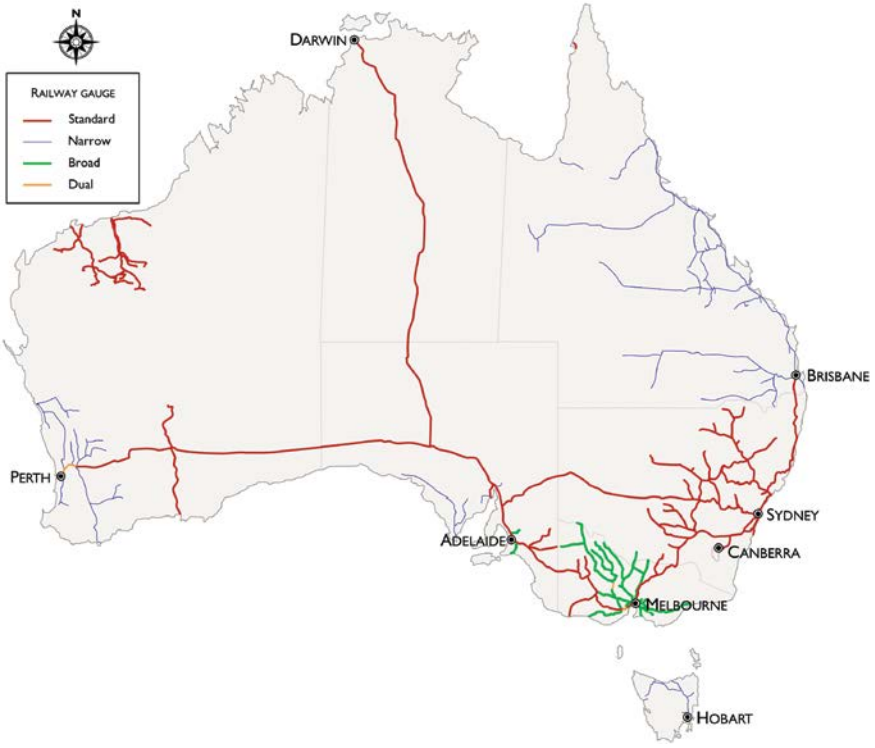
CHAPTER 3

Infrastructure and rolling stock provision

Railway network

Australia's colonies (then states in the post federation era) constructed the continent's railways, as separate networks with different gauges. The networks mostly radiated from the state (previously colonial) capitals, with cross-border links coming only after intrastate (intra-colonial) lines met at the borders. 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 aspects of the break of gauge legacy remain (Figure 34), interstate trains now operate across a continuous 1 435 mm 'standard' gauge.

Figure 34 Railway network, by track gauge, September 2017



Notes: The lines shown here are the railways that are open for traffic at August 2017. 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; and narrow ("Cape") gauge is 1 067 mm.

Table 15 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) with some exceptions, such as most urban network sections, 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 15 Estimate of route kilometres of open (operational) heavy railways in September 2017, 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		8 165	561	611	16	2 970	12 326
Standard	6	1 690	7 104	115	2 561		1 222	4 558	17 256
Other			1	4		7	30		42
Dual				36	22		32	207	297
Total	6	1 693	7 178	8 320	3 397	618	4 221	7 735	33 168
Route kilometres by electrical system									
1 500V DC			641				375		1 016
25 kV AC				2 144	44			181	2 369
33 kV AC			8						8
Total			649	2 144	44		375	181	3 393

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.

The New South Wales electrified network figures are revised, based on data which Sydney Trains provided.

The Queensland electrified network figures are revised based on BITRE's estimate of Aurizon provided data.

Does not include urban light rail and tramways. The extensive Queensland sugar tramways are also excluded.

Queensland standard gauge figures include the 19 kilometre railway at the Rio Tinto bauxite mine at Weipa.

The New South Wales standard gauge total is a revised estimate from 2016. In 2017, approximately four kilometres of the non-operational Moree–Inverell line reopened from Moree to the Broadbent Grain facility.

The electrified network route kilometres distance in Western Australia is a correction of previous editions of *Trainline*, which incorrectly stated 171 kilometres.

Sources: BITRE estimates; Data provided by Sydney Trains; Data provided by Aurizon; Rio Tinto Alcan, and TasRail; Avery (2013) p.144.

Queensland has the largest electrified network, 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 some intercity passenger services. Around 10 per cent of the Australian network route-kilometres are electrified. Appendix E 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

920 route-kilometres of freight track and 102 route-kilometres of passenger (heavy and light-rail) track have been opened since 2010.

Table 16 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	Roy Hill Holdings
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	Moranbah – Caval Ridge	Queensland	12	Caval Ridge Spur	Billiton Mitsubishi Alliance
Coal	Boggabri	NSW	17	Boggabri Rail Spur	Idemitsu
Coal	Yarwun	Queensland	13	Balloon Loop near Yarwun as part of Wiggins Island Rail Project	Aurizon
Coal	Bywerwen	Queensland	5	New branch line in GAPE System	Private and Aurizon
Intermodal	Sefton–Macarthur	NSW	36	Southern Sydney Freight Line	ARTC
Inter-Urban passenger	Deer Park – West Werribee	Victoria	27	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)	Metro Trains Melbourne
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	Petrie – Kippa-Ring	Queensland	13	Moreton Bay Railway	Queensland Rail

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 1980 is at Appendix B.

Sources: BITRE estimates, data provided by Aurizon and Gracosway.

Expansion of the mining industry in the Pilbara region of Western Australia underpins much of the recent rail infrastructure expansion and subsequent rail freight task. Development of iron ore mines in the Pilbara region 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 largest mining company in the region is Fortescue Metals Group, which opened a railway between Cloudbreak Mine and Port Hedland in 2008. In 2015, Roy Hill Holdings added 344 route kilometres of track to the network, connecting the newly developed Roy Hill Mine to the port facility in Boodarie Industrial Estate south of Port Hedland. The operation uses Roy Hill's two new berths, SP1 and SP2, at Stanley Point within the port. Enhancements to track and train specifications mean trains in the region are amongst the longest and heaviest in the world, with scope for additional axle load increases. Following construction of the Roy Hill line, there is currently an estimated 2 639 route kilometres of railway in the Pilbara region.

Since 2010, 171 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 rail transport. New lines and additional capacity have enabled a substantial expansion of exports. Such new lines and additional capacity include the Goonyella–Newlands railway in Queensland, part of the Goonyella to Abbot Point Expansion ("GAPE") project; and the Wiggins Island Rail Project (WIRP), which was completed in December 2015. Other projects have included 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 has eased rail traffic congestion through northern Sydney and at Gosford. The program included a third track between Epping and Thornleigh, construction of the North Strathfield underpass and two new passing loops at Gosford (Transport for NSW, 2017). 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. The Gawler line electrification project is currently in its preliminary stages (Government of South Australia, 2017).

Table 17 Heavy and Light Railways under construction, 2017

Traffic	Location	State	Length (route km)	Project	Infrastructure builder
Urban passenger	Epping – Cudgegong Road	NSW	23	North West Rail Link	Transport for NSW
Light rail	CBD and South East Light Rail	NSW	12	CBD and South Est Light Rail	Transport for NSW
Light rail	Gold Coast	Qld	7	Gold Coast Light Rail, Stage 2	Queensland TMR
Light rail	Canberra	ACT	12	Capital Metro	ACT Government
Urban passenger	Perth	WA	8	Forrestfield – Airport Link	PTA WA
Urban passenger	Melbourne	Vic	8	Mernda Rail Extension	Level Crossing Removal Authority
Urban passenger	Melbourne	Vic	9	Melbourne Metro	Melbourne Metro Rail Authority
Urban passenger	Chatswood–Sydenham	NSW	16	Sydney Metro City and Southwest	Transport for NSW
Light rail	Adelaide	SA	1	City Tram Extension	SA Government
Light rail	Melbourne	VIC	1	Toorak Road West Tram Diversion	Melbourne Metro Rail Authority

Infrastructure activities extend beyond new railway construction, however, with a range of enhancement projects across the country. This includes Victoria's level crossing removal and Murray Basin rail projects.

Dedicated commodity networks

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

Iron ore and coal networks

The iron ore and coal networks are shown in Figure 8. Mining companies built the iron ore railway networks in the Pilbara region 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 to accommodate the large envisaged traffic. There has been extensive subsequent capacity expansion (signalling, track and train capacity) on many of the lines.

Coal lines were developed in eastern Australia, generally being grafted onto the existing mixed-traffic networks. While the track standards are high, and include some electrified systems in Queensland, they are generally of a lower standard than the dedicated iron ore lines.

Grain railways

Grain railways usually feed into secondary or main lines. By contrast, with iron ore and many coal railways, the grain lines are generally of a lower technical and operational standard. Some are in a poor condition and traffic is seasonal.

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 standards (and, thus weight-bearing capability or train speed), their economic importance, or to their viability. The respective categories across the states[24] are outlined below.

Queensland

The "network capabilities" of railways in Queensland are classified according to the maximum permitted axle loads on a given section of track. Network information packs for access seekers provide details about track standards and permitted axle loads and train speeds[25]. Often the axle-load limits are 15 tonnes. It has been noted that rail cannot be used to haul containerised grain due to these load limits (Transport, Housing and Local Government Committee [Queensland] 2014, p. 24).

New South Wales

While the New South Wales government's grain railways are categorised by class of track – from Class 1 to Class 5, this is an engineering standard only; not an operational standard. Operationally, there is considerable variation within each standard. According to advice from John Holland Rail, for example, a Class 3 track can range in operational capability from 81 to 100 tonnes gross (See Figure 19).

Victoria

Victoria has six track standard classifications. The highest standard is Class 1, and the lowest is Class 5 (VicSig 2017). Details are as follows:

- Class 1: Sections of the Regional Fast Rail network;
- Class 2: Standard for metropolitan and country passenger lines;
- Class 2U: A modified version of Class 2 for Regional Fast Rail but of a lower standard than Class 1;
- Class 3: Passenger lines with low volumes and some grain lines;
- Class 4: Lesser branch lines; and
- Class 5: Lines that are short or have very little traffic, with minimal track maintenance.

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).

24 Most of South Australia's grain railways have been closed and the remaining four lines have not been classified.
25 An illustration of this information can be seen with the "Information pack" for South Western Queensland (Queensland Rail) [Network Access], undated.

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 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 Western Australian freight rail network, including the provision of Tier 3 railways; see the Economics and Industry Standing Committee of the WA Parliament Legislative Assembly (2014).

Urban heavy-rail passenger networks

Australia's urban heavy rail networks are extensive, even if the network coverage is not dense (see Table 18). The networks are mostly radial, reflecting the historical development of Australian cities, with lines branching from dense Central Business Districts (CBDs) into the surrounding, low density suburbs[26].

Table 18 Network characteristics of urban passenger heavy railways, 2017

	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)	n/a	212	128	126	180
Shared metropolitan freight/ passenger lines (km)	n/a	181	268	-	1
Total metropolitan route length (km)	381	416	396	126	181
Electrified metropolitan route length (km)	381	362	396	44	181
Metropolitan stations (number)	178	218	152	87	71
Average distance between stations (km)	2.1	1.9	2.6	1.4	2.5
Metropolitan passenger route length under construction (km)	23	17	-	-	8
Passenger network gauge	Standard	Broad	Narrow	Broad	Narrow

Notes: Distances are route kilometres.

Urban networks are defined by urban passenger operator boundaries. The Brisbane calculations are based on the limits of Queensland Rail's City Train network, including the privately owned Airport line.

The Sydney Trains network figures are revised, based on data which Sydney Trains provided. Due to this revision, BITRE does not currently have an estimate of dedicated passenger lines and shared passenger and freight lines.

The number of Transperth stations includes Auburn Grove, which opened in 2017.

Does not include freight only track.

Sources: BITRE estimates; Data provided by Sydney Trains; Public Transport Authority of Western Australia 2016, p. 18; Queensland Rail, 2016, p.6 Data provided by Adelaide Metro; Data provided by Aurizon.

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

The following characteristics and trends make each system distinctive:

Network expansion. Perth's system has grown significantly over the last 20 years. New lines from Perth to Joondalup / Currambine / Butler (41 km), and Mandurah (70 km), and the Thornlie branch (three km) have transformed urban transport in the city. (See Appendix B for dates of railway openings.)

Network form. Perth's system is also distinctive relative to the other Australian networks due to the nature of its new railways. Table 18 shows Perth's network is 30 per cent longer than Adelaide's, but has 16 fewer stations. This station spacing facilitates significantly higher average train speeds on Perth's Mandurah line and, to a lesser extent, the Butler line (see Figure 46). With fewer stations, good station access is inherent to station design through rail-bus interchanges, extensive park-and-ride facilities and encouragement of (nearby) Transit Oriented Development (TOD).

Shared networks. Brisbane, Melbourne, Adelaide and Perth use a different track gauge to the interstate network. This has separated most urban passenger traffic from interstate and some intrastate freight trains operating on the standard gauge. Examples of shared track 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 urban line). Sydney's network is 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 Southern Sydney Freight Line, however, provides a dedicated southern access to Sydney freight yards, which has eliminated the previous southern Sydney curfew on freight trains operations during peak passenger commuting periods and the Epping to Thornleigh third track gives additional train capacity.

Electrification. Electrified services began in Sydney and Melbourne[27] from the early inter-war period using Direct Current (DC) traction power. Cities that electrified their networks later use more advanced Alternating Current (AC) traction. 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 system electrification. Electric train operation commenced on the Seaford and Tonsley lines in 2014.

Urban light rail passenger networks

Australia has 291 route kilometres of operational light rail. The technological and operational differences between tramways, light rail and heavy rail are increasingly blurred[28]. This report refers to Australia's light rail operations as having shared characteristics with tramways, particularly in Melbourne. 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, Sydney and Adelaide (see Table 19).

27 Only Melbourne's Frankston–Stony Point line remains un-electrified.

28 Tramways generally have short spacing between stations and operate on roads, often sharing a right-of-way way with 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. Melbourne's light rail vehicles operate on former heavy rail lines to St Kilda and Port Melbourne, but most of the network shares right-of-way with road traffic.

Table 19 Network characteristics of light railways 2017

	Gold Coast	Sydney	Melbourne	Adelaide
Total route length (km)	13	12.8	250	15
Segregated right of way	segregated	largely segregated	24% segregated	largely segregated
Routes (no.)	1	1	24	1
Number of stops (no.)	16	23	1 717	29

Sources: Currie and Burke 2013; Yarra Trams 2017; Advice from Yarra Trams.

Melbourne's network is distinct, with only a small proportion of the network segregated from road traffic, and with close spacing between stops. 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.

Sydney and Adelaide once had significant tramway systems prior to 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 heavy rail corridor, with a small segment of on-road (largely segregated) operation between Haymarket and Central Railway Station. Sydney is expanding its light rail network by 12 kilometres, with 19 new stops. The extension will travel from Central Station to Circular Quay and through Surry Hills to Moore Park, Kensington, Kingsford and Randwick. Services are expected to commence in 2019.

The Gold Coast light railway, which opened in July 2014, runs between the Gold Coast University Hospital and Broadbeach. The line runs 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 Australian cities. In August 2015, the Queensland Government announced it would extend the network 7.3 kilometres from the Gold Coast University Hospital terminus to Helensvale heavy rail station and construction is now at an advanced stage.

Non-urban passenger network

The non-urban passenger services are almost entirely integrated with other rail operations through shared track access. 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. (Figure 32 shows the coverage of the non-urban passenger operations services, by operator.) Table 20 shows key network characteristics of the regional passenger services, including heritage railways.

Table 20 Network coverage of non-urban passenger rail services 2017

	Queensland Rail	NSW TrainLink	V/Line	Transwa	Great Southern Rail	Heritage operators
Electrified route kilometres	728	445	-	-	-	1
Total route kilometres	4 380	4 261	1 737	836	7 446	511 (approx.)

Notes: This is an estimate of route kilometres. Shared corridors between multiple services are only counted once. For example, TrainLink's Sydney–Brisbane estimate includes all other TrainLink services that operate anywhere on that corridor between Sydney Central and Casino.

The estimate includes the designated urban networks through which non-urban passenger rail services transit.

The Queensland Rail route lengths includes the Varsity Lakes – Brisbane service.

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 electrified urban trains (such as V/Line services on Melbourne's metropolitan network), the route is defined as not electrified.

Source: BITRE estimates.

Train operator equipment stock (excluding freight wagons)

Locomotives

BITRE estimates that in July 2017 there were 2025 operational locomotives in Australia. This excludes locomotives in storage, available for hire, or due for scrapping. Data presented here use the age of the locomotive since built new, or the age since rebuilt, whichever is the most recent[29]. The age of the fleet reflects a range of different underlying influences on rolling stock investment.

Figure 36 shows approximately 50 per cent of Australia's fleet was aged approximately 13 years or less in mid-2017, compared to approximately 16 years or less the previous year. The newest locomotives at the time of analysis were three 93 Class locomotives that belong to Pacific National. Of the youngest 50 per cent of locomotives, approximately 36 per cent are used in the Pilbara. Approximately 42 per cent of the fleet aged 13 years or less were built or rebuilt in Australia, with the remainder being built in the United States of America, China and Germany. Approximately 70 per cent operate on the standard gauge network.

The analysis is for locomotives that perform almost freight duties only. V/Line is expanding its DMU VLocity fleet. This rollingstock, by virtue of being DMU, is excluded from the age analysis and affects the broad gauge analysis as new DMU sets replace locomotive hauled passenger trains. The lesser freight task on the broad gauge compared to the standard and narrow gauges is also reflected in the relatively small broad gauge locomotive fleet numbers. To illustrate, 88 per cent of the operational broad gauge fleet is aged 13 years or older. Due to the lack of new broad gauge locomotives, operators often have to use old locomotives, some of which were built in the 1950s and 1960s. Completion of the Murray Basin Project gauge standardisation will increase locomotive fleet availability for that previously broad gauge network as standard gauge locomotives will be able to access the network.

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

The status of the locomotive fleet is highly fluid, with locomotives frequently becoming operational or going into storage. What the table and figures below also 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 or doing yard duties only. BITRE is currently unable to measure the degree of locomotive usage. While the large NR class locomotive fleet, which is the mainstay of Pacific National's intermodal services, is now more than 20 years old, Pacific National has upgraded them, including with new engines. They are arguably new locomotives.

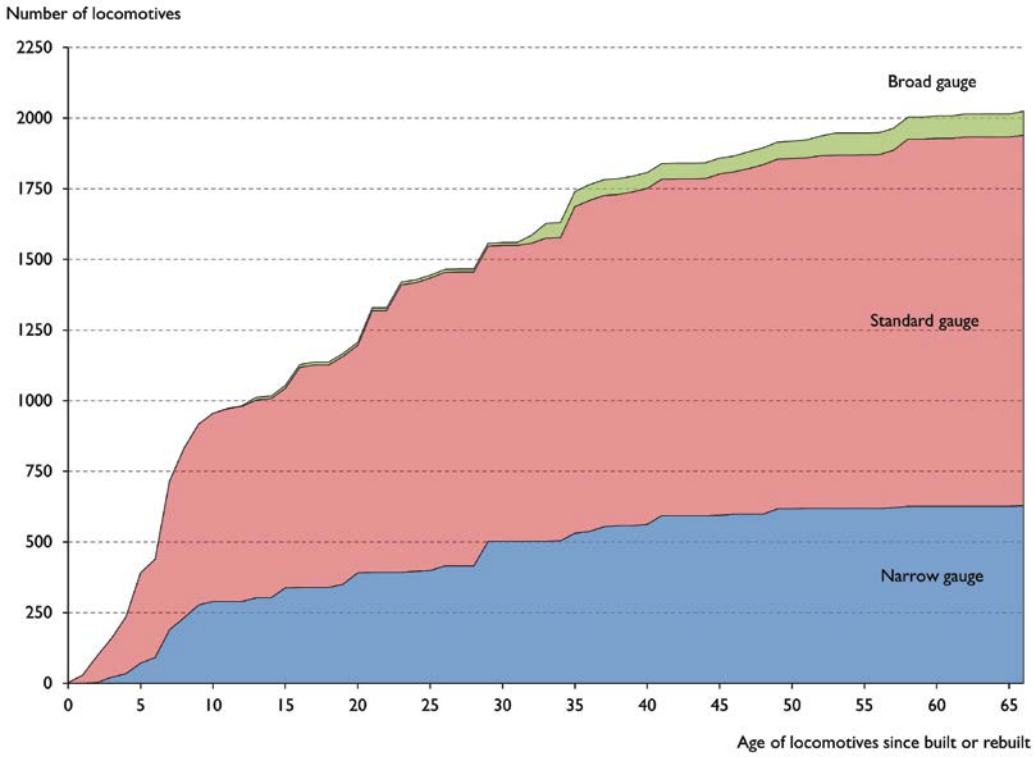
Care is also needed when comparing locomotive ages by gauge, particularly between the broad and standard gauges, where there is considerable re-gauging of the previous Victorian government owned locomotives, such as the G, T, and N classes, many of which now operate outside Victoria. For example, V/Line has converted six of the previous all broad gauge N class locomotives to standard gauge for its Melbourne–Albury passenger services. Much (originally Victorian) C class operations are now intrastate New South Wales, although there are still cross border and intrastate operations in Victoria.

Table 21 Locomotive ages

Age range (years)	Narrow Gauge	Standard Gauge	Broad Gauge	Total
0–5	92	318	0	410
6–10	198	347	0	545
11–15	48	41	10	99
16–20	53	100	0	153
21–25	8	229	0	237
26–30	103	13	0	116
30–35	29	108	43	180
36–40	62	33	3	98
41–45	2	19	0	21
46–50	23	31	5	59
51+	11	72	24	107
Total	629	1311	85	2025

Sources: Data provided by Aurizon, BHP Billiton, Pacific National, Fortesque Metals Group, Genesee & Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Fletchers International, Clark 2015, Railpage 2017.

Figure 35 Cumulative locomotive age profile, by number of locomotives



Sources: BITRE analysis of data from Aurizon, BHP Billiton, Pacific National, Fortesque Metals Group, Genesee & Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Roy Hill; Fletchers International, Clark 2015, Railpage 2017.

Figure 36 Cumulative locomotive age profile, per cent

Sources: BITRE analysis of data from Aurizon, BHP Billiton, Pacific National, Fortesque Metals Group, Genesee & Wyoming Australia, Rio Tinto, SCT, Tasrail, Queensland Rail, Roy Hill; Fletchers International, Clark 2015, Railpage 2017.

Box 7 Further resources

The monthly magazine *Railway Digest* frequently publishes a list of current and recently completed rolling stock contracts and deliveries of locomotives, wagons, permanent-way vehicles and passenger stock. Railpage.com.au also provides regularly updated and historical details of locomotives by gauge, operational status, and current operator.

Urban passenger rolling stock

The levels of rolling stock networks required are a function of factors that include the following:

- Traffic levels;
- The network size and length of individual lines;
- The range of 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).

Passenger heavy rail stock

Urban heavy rail rolling stock is generally modern, with the last of the 1970s stock being replaced. Most current rolling stock is air-conditioned, with Sydney's remaining, non-air-conditioned, S-Set trains used on low patronage lines and for stand-by services only (See Table 22).

"Multiple unit" stock using permanently coupled carriages provide most services. Sydney's fleet generally run as four car units, coupled into eight car trains. Elsewhere, most trains are three-car EMU sets, generally paired as six-car trains. Adelaide's rolling stock, with large numbers of one and two-car units, enables Adelaide Metro to cater for modest traffic levels with a broad range of configurations. There are also some two-car operations in Perth.

Table 22 Heavy rail rolling stock 2017

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Vehicles (no.)	633	1 619[a]	1 308	130[b]	294
Air-conditioned vehicles (no.)	633	1 427	1 308	130	294
Carriage format	Single-deck	Double-deck	Single-deck	Single-deck	Single-deck
Multiple-unit format	211 three car	248 four car 78 eight car	three car		48 two car 66 three car
Common train formations	EMUs coupled as six-car sets	EMUs coupled as eight-car sets	EMUs coupled as six-car sets	DMU, up to four-car; EMUs, normally as three-car sets, can couple as six car sets	EMUs coupled as six-car sets on new lines

Notes: [a] Sydney Trains is retaining its remaining S-set rollingstock until at least 2019 for stand-by services.

[b] The Adelaide vehicles includes the 4000 class, which is in fixed three car formats, namely they are permanently coupled as such.

Sources: Advice from Sydney Trains; VicSig 2017a; advice from Queensland Rail; Public Transport Authority of Western Australia 2016, p.18; advice from Adelaide Metro.

Sydney is the only system to use double-deck carriages, which it began introducing in 1964 to increase passenger capacity on the existing network. Its double deck trains may have longer dwell times, however due to passengers from the upper and lower decks meeting at the carriage doors and fewer doors per carriage than single deck trains. In August 2016, NSW TrainLink signed a $2.3 billion contract for the construction and maintenance of 512 EMU cars, to serve its intercity operations. The EMUs will be designed and built in South Korea, with UGL Ltd. support. The trains are expected to enter service between 2019–2022. (*Railway Gazette International,* September 2016, p. 17)

In February 2016, Queensland Rail received the first of 75 New Generation Rollingstock (QNGR) six car set EMUs for use in south east Queensland. These trains are still undergoing testing. While replacing existing ageing EMU sets, the QNGR fleet is expected to increase capacity by approximately 30 per cent (*Railway Digest,* April 2016 pp. 30–31).

Light rail

Melbourne's light rail fleet is much larger and more varied than the other cities; see Table 23. Melbourne's older rolling stock, such as the Z and A classes, introduced between 1975 and 1984 and 1984–1986, respectively, are comparatively short and have low passenger capacity.

Over the past 30 years, there has been a progression 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 tram, 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 is all over 30 metres in length. The new trams are a mix of imported and locally built vehicles. Bombardier manufactures the Australian built vehicles at its Dandenong plant in Victoria. These vehicles are used in Melbourne and Adelaide. In its 2017/18 budget, the Victorian Government announced it would order an additional 10 E class trams (Victoria Budget 2017).

Table 23 Light rail rolling stock 2017

City	Vehicle type	Length (metres)	No. vehicles
Gold Coast	Flexity 2	43	14
Sydney	Urbos 3	33	12
Melbourne	A1 class	15	27
	A2 class	15	42
	B1 class	23.5	2
	B2 class	23.6	130
	C class	23	36
	C2 class	32.5	5
	D1 class	20	38
	D2 Class (Combino)	29.9	21
	E Class	33.5	56
	Z3 class	16.6	114
	W6 class	14.2	1
	W7 class	14.2	1
	W8	14.2	6
	SW6 class	14.2	6
Melbourne total			485
Adelaide	100 Flexity Classic	30	15
	200 Citadis	32	6
Adelaide total			21

Notes: Fleet numbers are based on rollingstock estimated to be in service.

Adelaide retains two heritage H class trams for tourist trips and special events.

The E class estimate includes one vehicle currently under repairs.

Sources: Bombardier 2017; Transport Enthusiasts Society of South Australia 2016; Advice from Transdev NSW; Advice from Yarra Trams.

Non-urban passenger rolling stock

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 all stopping, semi-fast, and express services on a given line); and
- The average speed of services (with faster operations requiring fewer train sets).

There is a wide range of non-urban passenger services in Australia. Thus, rolling stock, designed for individual markets and service types, vary. Table 24 shows the number of individual vehicles/cars, by type and operator.

Table 24 Non-urban passenger rolling stock, by vehicle type and operator 2017

	Queensland Rail	NSW TrainLink	V/Line	Transwa
Electric multiple unit cars (no.)	150	445	-	-
Diesel multiple unit cars (no.)	27	65	216	14
Locomotives (no.)	27	19	44	-
Carriages (no.)	60	60	136	-
Total cars/vehicles	264	589	396	14

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

The above lists individual vehicles rather than sets.

Queensland Rail carriage totals excludes power cars.

V/Line diesel multiple unit totals are current on 5 May 2017.

The estimate of Victorian carriages includes those in storage or undergoing repair.

No data is available for Great Southern Rail's trains.

Sources: VicSig 2017b; Sydney Trains 2017; NSW TrainLink 2017; Advice from Transwa; Data provided by Queensland Rail

Locomotive hauled trains are primarily used for long-distance routes although V/Line uses them on some commuter route services, such as Melbourne–Seymour. Some Queensland Rail long-distance services are locomotive hauled and the temporary electric tilt train replacement service is also locomotive hauled. V/Line's N class locomotives haul long distance trains on both the broad and standard gauges. New South Wales uses both XPT trains and Xplorer DMU on its long distance services. While the XPTs are capable of travelling at 160 km/h, track conditions such as tight curves restrict their ability to travel at such speeds across much of its network. The New South Wales Government has announced plans to replace the XPT and Xplorer fleet, but without a firm date on when this will occur (Transport for NSW 2016a).

Medium-distance regional/commuter services are generally DMU operated. VLocity DMUs, that operate at speeds of up to 160km/h, are used on Victoria's Regional Fast Rail services. Transwa uses DMUs for all rail services. In its 2017/18 budget, the Victorian Government announced it will purchase an additional 39 VLocity carriages (Victoria Budget 2017). The Perth–Kalgoorlie

Prospector DMU also travels at 160km/h. All DMUs are air-conditioned and generally seat two either side of a central aisle.[30]

NSW TrainLink and Queensland Rail have large EMU fleets, which are largely used for intercity/commuter services. New South Wales, uses its EMU fleet for Sydney–Hamilton (Newcastle), 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 is Queensland Rail's tilt train (fixed-formation) sets. Queensland Rail has a fleet of electric tilt trains, used on Brisbane–Rockhampton services, and diesel tilt trains for the Brisbane–Cairns services. (BITRE 2014, p. 60 and pp. 161–162, discusses the nature of the tilt-train services and the principles of tilt trains.)

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

CHAPTER 4
Railway performance

Network indicators

Safety

In 2015, Western Australia came under Office of the National Rail Safety Regulator (ONRSR) responsibility and Queensland is expected to follow suit now its State Parliament has passed the required legislation. Following this, the ONRSR will have complete national responsibility and standard nationwide rail safety reporting should follow. Until then, standardised nationwide reporting is not possible.

ONRSR, which, in 2015–16, had regulatory safety oversight for South Australia, New South Wales, Tasmania, Northern Territory, Victoria, Western Australia[31], and the Australian Capital Territory, stated in its *Annual Safety Report 2015 to 2016* there were 83 notified fatalities on railways that the Rail Safety National Law (2012) regulates. These fatalities were:

- 71 acts of suspected suicide;
- 11 struck by train;
- 1 slip, trip or fall.

This compares to 78 fatalities for the previous financial year, excluding Western Australia.

Further 'key occurrence' category incidents include:

- 52 running line derailments;
- Six running line collisions between trains and with rollingstock;
- 27 level crossing collisions; and
- Under 'other key categories, 30 passenger train fires, 353 instances of broken rails, and 205 instances of signals passed at danger without authority. (ONRSR, 2016, p.10)

Approximately 450 people were reported to have suffered serious injuries. More than 80 per cent of these involved slips, trips, and falls. (ONRSR 2016, p.13)

There is no Western Australia data available for the period 1 July–1 November 2015.

31 Data for Western Australia is for the period 2 November 2015 to 30 June 2016.

In Queensland, where the Department of Transport and Main Roads administered rail safety during the reporting period, there were 50 Category A notifiable occurrences during that financial year, a decline of 33.3 per cent from the previous financial year (Department of Transport and Main Roads 2016a, p.21)

The department defines a Category A notifiable occurrence as:

- 'an accident or incident that caused significant property damage, serious injury or death;
- a running line derailment;
- running line collision between rolling stock;
- a collision at a railway crossing between rolling stock and either a road vehicle or a person;
- a fire or explosion on or in rail infrastructure or rolling stock that affects the safe carrying out of the railway operations or has endangered one more persons;
- a suspected terrorist attack or an act or event suspected to be a terrorist attack; or
- an accident or incident involving an inadequacy in the safety management system for the railway operations that could have caused significant property damage, serious injury or death.' (Department of Transport and Main Roads 2016, p.21)

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.

Changing requirements, such as higher performance and, for passenger rail, air-conditioning and on-board electronics, may increase emissions intensity. Table 25 shows BITRE's revised carbon dioxide equivalent emissions estimate of the rail industry since 2005. According to the current estimate, emissions have increased by approximately 31 per cent since 2005. The 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 and competitiveness. Manufacturers and operators focus on maximising energy efficiency in such ways as Aurizon using regenerative braking on its electrified Central Queensland coal network, which provides 17 per cent of the operator's energy needs on the electrified Goonyella and Blackwater systems (Aurizon 2016b). In cab real time driver assist systems such as UGL Ltd.'s EcoRun advise drivers on optimal settings for their trains, such as how much power to use, when to brake or accelerate along given sections of track and according to the specifics of a given train, and how much fuel they have saved. UGL Ltd. estimates EcoRun can provide fuel savings of between 4–15 per cent, depending on train type.

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	2015	2016
4 583	4 592	4 869	5 023	5 097	5 163	5 230	5 364	5 417	5 603	5 880	6 002

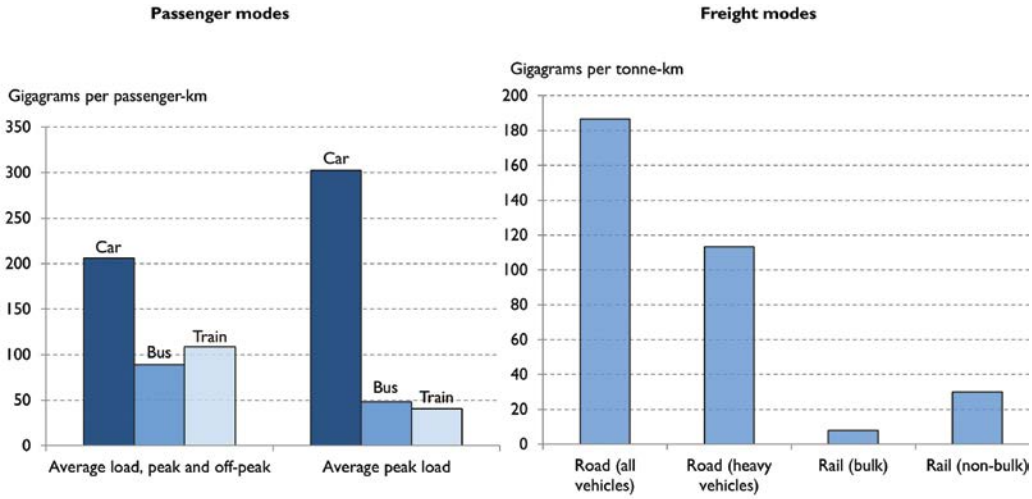
Note: Preliminary/provisional estimate.

Source: BITRE estimates.

The emissions intensity of freight rail is low relative to road freight vehicles[32]. (Figure 37).

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 services generally have lower patronage and road vehicles are less subject to congestion.

Figure 37 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.

Source: BITRE estimates.

"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.

Interstate network indicators

This section reviews indicators of the interstate network, namely the railways between the state capitals and 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 made from train operators using the railway. ARTC's access charge has two parts: 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 a train's tonnage increases, the average access charge per tonne declines.

This access charging regime encourages train operators to operate longer trains. Longer trains enable infrastructure managers to increase tonnage throughput, as there are limited train paths. However, longer trains require trackage that can accommodate the trains' lengths. Consequently, interstate network infrastructure managers have upgraded their networks to take longer trains.

The indicator below is ARTC's revised index of the maximum access yield for the interstate network it manages. The indicator measures the changes (relative to the base year) in the maximum access revenue yield per gross tonne kilometre. As the access revenue yield is calculated on a nominal reference train, this measure is essentially identifying if there have been any real access charge increases. 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 Table 26 shows, the average yield decreased slightly on all corridors from 2014–15 to 2015–16.

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

	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16
North-south corridor									
Acacia Ridge – Border Loop			100.00	99.97	100.01	100.00	100.00	99.95	99.94
Border Loop – Newcastle	100.00	99.94	100.00	99.97	100.01	100.00	100.00	99.95	99.94
Macarthur–Albury	100.04	99.95	100.00	99.99	100.03	100.00	100.00	99.98	99.97
Albury–Tottenham	107.97	99.95	100.00	99.99	100.03	100.00	100.00	99.98	99.97
East-west corridor									
Melbourne–Adelaide	96.97	99.93	100.00	99.99	100.04	100.00	100.01	99.98	99.96
Adelaide–Kalgoorlie	92.15	99.94	100.00	99.97	100.02	99.99	99.99	99.97	99.94
Cootamundra–Parkes	100.07	99.93	100.00	99.99	100.04	100.01	100.01	99.97	99.94
Parkes – Broken Hill	100.00	99.94	100.00	99.97	100.02	100.00	99.99	99.96	99.93
Broken Hill – Crystal Brook	84.71	99.94	100.00	99.97	100.02	100.00	99.99	99.96	99.93

Source: Data provided by ARTC.

Interstate network utilisation

Train frequency on the interstate network

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

The number of scheduled intermodal designated trains on the north-south corridor has increased. There is a second Sydney–Melbourne train, which Aurizon operates, although this will cease in December 2017[32]. In addition to the extra weekly Sydney–Melbourne intermodal train, and no Melbourne–Sydney intermodal trains, the number of Wollongong–Melbourne and Melbourne–Wollongong trains has remained constant at seven per week in each direction. All of these trains travel via Sydney where they load and unload intermodal freight. These trains serve as mixed intermodal and steel trains. The number of Melbourne–Brisbane trains has increased by four in each direction due to SCT Logistics' entry in to the Melbourne–Brisbane market in January 2017. These trains do not load or unload freight in Sydney, but do at SCT Logistics' newly opened Barnawartha centre in Victoria. The SCT trains do not travel all the way to/from Brisbane, but use SCT's new terminal at Bromelton in Queensland, approximately 35–45 minutes travel time from Pacific National's and Aurizon's freight terminal at Acacia Ridge in Brisbane.

On the east-west corridor, the number of scheduled intermodal trains operating Melbourne–Perth and Sydney–Perth is unchanged. The number of scheduled intermodal trains operating between Melbourne and Adelaide has decreased by one. Excluded from the Sydney-Perth train numbers are the SCT Goobang (Parkes) – Perth services, of which there is one train per direction each week. SCT bridges the gap between Goobang and Sydney by road transport, as part of its integrated logistics services.

32 On 14 August 2017 Aurizon announced it would cease all intermodal operations, both interstate and intrastate, by December 2017. See http://www.aurizon.com.au/~/media/aurizon/files/media%20releases/azj_outcomes_of_freight_review.pdf

Table 27 Number of scheduled weekly intermodal designated train services, by city pair

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
North-south corridor										
Brisbane to Sydney	1	1	1	1	2	2	2	2	5	5
Sydney to Brisbane	0	0	0	0	0	0	0	2	5	5
Sydney to Melbourne	3	0	2	2	3	2	2	1	1	2
Melbourne to Sydney	3	0	2	2	3	2	2	0	0	0
Brisbane to Melbourne	16	17	15	15	15	15	15	16	12	16
Melbourne to Brisbane	17	17	15	15	15	16	16	16	12	16
Brisbane to Adelaide	5	3	3	3	2	2	2	2	2	2
Adelaide to Brisbane	4	3	3	3	2	2	2	2	2	2
East-west corridor										
Melbourne to Adelaide	17	17	11	12	9	9	8	6	6	5
Adelaide to Melbourne	17	17	11	12	9	9	9	6	6	6
Melbourne to Perth	16	15	18	19	20	20	20	20	18	18
Perth to Melbourne	16	15	17	19	20	20	20	20	19	19
Sydney to Perth	8	7	7	7	8	9	10	8	7	7
Perth to Sydney	8	7	7	7	8	9	10	9	7	7
Adelaide to Perth	2	2	0	0	0	0	0	0	0	0
Perth to Adelaide	2	2	0	0	0	0	0	0	0	0
Central corridor										
Adelaide to Darwin	5	7	7	6	7	6	6	6	6	6
Darwin to Adelaide	5	6	6	6	7	6	6	6	6	6

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2017.

Weekly trains by interstate line segment

Table 28 shows the number of scheduled weekly interstate intermodal and steel trains on each line segment. This indicates how intensely the interstate network is used. 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, and steel trains. For example, BITRE counts a train travelling from Melbourne to Perth on all line segments on that route. Table 27 also includes interstate trains that do not travel from capital city to capital city, such as the Melbourne–Griffith trains.

Crystal Brook – Port Augusta remains the busiest segment. This segment is a convergence point for interstate intermodal trains travelling to and from Perth; intermodal trains between Adelaide and Darwin; and steel trains from Newcastle, Melbourne, Adelaide, and Perth to Port Augusta and Whyalla. The increase in the reported number of trains operating between Sydney and Cootamundra West is due to the introduction of SCT trains operating between Melbourne and Brisbane and the (new) inclusion of QUBE's Junee – Port Botany trains in the count.

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.

Table 28 Total scheduled weekly interstate intermodal and steel trains, by line segment

Line segment	2010	2015	2016	2017
North-south corridor				
1. Brisbane–Sydney	49	42	48	52
2. Sydney–Melbourne				
Sydney–Cootamundra	68	58	60	70
Cootamundra–Melbourne	53	49	49	58
East-west corridor				
3. Sydney–Crystal Brook via Broken Hill				
Sydney–Parkes via Lithgow	9	11	6	6
Cootamundra–Parkes	20	20	22	22
Parkes–Crystal Brook	29	33	30	30
4. Melbourne – Crystal Brook				
Melbourne–Adelaide	71	59	55	53
Adelaide – Crystal Brook	57	64	60	60
5. Crystal Brook – Perth				
Crystal Brook – Port Augusta	86	90	84	84
Port Augusta – Tarcoola	71	77	69	69
Tarcoola–Perth	59	65	57	57

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure, andGenesee & Wyoming Australia) as at April 2017.

Train flow patterns on the interstate network

Train flow indicators based on scheduled running times provide information about the flow of trains across the network.

Table 29, below only provides information about intermodal designated scheduled services, which share the line with other trains such as bulk goods trains, steel designated trains and passenger trains. Changes to the nature and scale of these other trains' operations may influence intermodal train flow patterns in the infrastructure managers' path planning. It is beyond the scope of this publication to assess what influence other trains' operations may have on intermodal train flow patterns. Train flow patterns are based on scheduled times. Actual times for individual trains may differ due for operational reasons.

Table 29 Scheduled inter-capital intermodal train flow patterns

Line segment/ direction	Number of weekly intermodal services		Average speed (km/h)		Average number of stops		Average scheduled transit time (mins)		Average dwell time (mins)		Percentage dwell time (per cent)		Dwell time per stop (minutes)	
Year	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
North-south corridor														
Brisbane to Sydney	17	21	54	55	7	8	1072	1063	164	154	15%	15%	22	20
Sydney to Brisbane	17	21	55	56	6	6	1060	1049	153	136	14%	13%	24	22
Sydney to Melbourne	13	18	66	66	2	3	872	875	74	81	9%	9%	31	28
Melbourne to Sydney	12	16	72	70	2	3	801	828	22	43	3%	5%	11	13
Brisbane to Melbourne	12	16	59	58	10	11	1971	2002	277	299	14%	15%	27	28
Melbourne to Brisbane	12	16	62	61	9	10	1885	1912	214	227	11%	12%	25	22
East-west corridor														
Melbourne to Adelaide	24	23	67	67	3	3	749	748	63	54	8%	7%	19	17
Adelaide to Melbourne	25	24	58	57	6	5	861	874	149	167	17%	19%	27	34
Adelaide to Perth	18	18	66	65	14	12	2400	2462	355	350	15%	14%	26	28
Perth to Adelaide	19	18	57	58	18	17	2802	2764	731	652	26%	24%	40	39
Cootamundra to Crystal Brook	3	3	64	67	4	5	1192	1138	321	263	27%	23%	74	53
Crystal Brook to Cootamundra	7	7	66	61	5	5	1152	1248	321	382	28%	31%	66	79
Brisbane to Adelaide	2	2	52	52	15	14	3230	3230	921	918	29%	28%	61	63
Adelaide to Brisbane	2	2	51	51	16	14	3292	3292	986	916	25%	28%	73	65
Central corridor														
Tarcoola to Darwin	6	6	71	71	4	4	1897	1906	225	262	12%	14%	56	68
Darwin to Tarcoola	6	6	70	68	4	4	1939	1986	222	297	11%	15%	56	71

Notes: 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 Cootamundra to Crystal Brook figures exclude the two weekly Brisbane–Adelaide trains that run in each direction as the ARTC timetable does not have an arrival/departure time for these trains at Crystal Brook.

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2017.

(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/lanes and sidings for others to pass or overtake.

North-south corridor

The average number of scheduled stops has increased slightly since to 2016. A contributing factor to this is the commencement of SCT train operations between Melbourne and Brisbane, whose trains dwell at the company's Barnawartha facility, in addition to other routine stops. Previously no trains stopped at Barnawartha.

Sydney is a major market served by the Brisbane–Melbourne and Brisbane–Adelaide trains, where freight is loaded and unloaded. This increases the corridors' average dwell times. Some dwell times are therefore of the train operators' volition, while some are externally imposed. It is important to consider this when measuring dwell and travel times to assess rail transport's performance.

Average dwell times on the north-south corridor have decreased for trains travelling in both directions between Sydney and Brisbane, while they have increased for trains travelling in both directions between Sydney and Melbourne. This may also be due to SCT trains stopping at Barnawartha, whose dwell is between 50–60 minutes. When measuring the whole Melbourne to Brisbane corridor, average dwell times have increased slightly for trains travelling in both directions.

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 and diverge for those travelling in the opposite direction. Sydney–Perth and Perth–Sydney train calculations do not include Sydney – Cootamundra West (part of the north-south corridor) and the alternative Sydney–Parkes via Lithgow route. Rather, BITRE calculates times from Cootamundra West, where westbound trains travel north to Goobang Junction (Parkes), then west to Broken Hill and Crystal Brook. The reverse applies for eastbound trains[33].

The average number of stops has reduced or remain unchanged on all corridors, except for Cootamundra West to Crystal Brook, which has increased by one. There is no clear pattern in changes to average dwell times. On some corridors it has increased while in others it has decreased. There is also no clear correlation between changes to average numbers of stops and average dwell times. On the Cootamundra West to Crystal Brook section, for instance, the average number of scheduled stops has increased by one, but average dwell times have reduced by almost an hour.

33 Sydney–Perth trains take either the more direct but steeper route via Lithgow or the longer but flatter route via Cootamundra West. All Perth–Sydney trains travel via Cootamundra West.

Adelaide is the largest intermediate city on the corridor. Pacific National 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 (Parkes) in New South Wales.

Two other 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.

Central corridor

Dwell times have increased but the number of stops is unchanged. Genesee & Wyoming Australia, which is the sole freight train operator on the corridor have the following characteristics:

Trains originate/terminate at the intermodal terminals at Berrimah (Darwin) and the Islington terminal (Adelaide);

Trains stop at intermodal terminals in Katherine, Tenant Creek and Alice Springs; and

Operational stops at Spencer Junction are common.

(b) Average speed

Average train speed is a measure of a train's in motion speed plus its dwell time. The measure can be used to assess 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 remained largely unchanged on all corridors.

Track indicators for the interstate network

The indicators 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 38 and Figure 39 show the average scheduled intermodal transit time for trains travelling in both directions on nine city pairs, for the north-south, central and east-west corridors respectively. Table 29 shows the scheduled transit time figures.

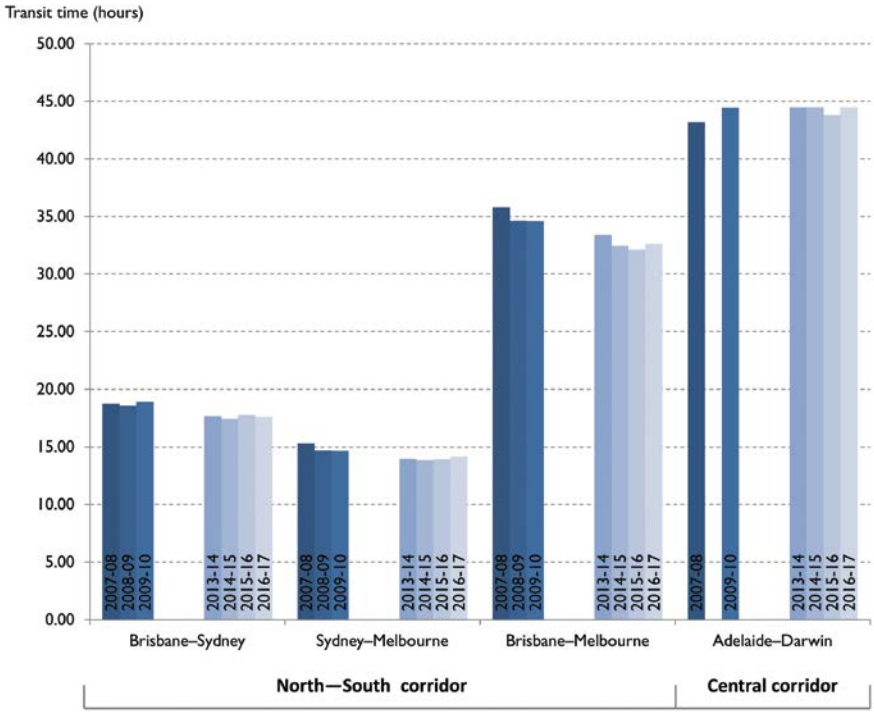
Scheduled transit times are influenced by factors including line speed; the number of stops en route; the number and type of other trains on the line (particularly when the route has single track or in shared urban and intercity networks); operator-dependent factors such as time spent in intermediate cities; and, for Sydney–Perth trains, the route used.

Average scheduled transit times between Sydney and Brisbane have reduced slightly, while transit times between Melbourne and Sydney and Melbourne and Brisbane have increased, due possibly to the SCT trains dwelling at Barnawartha.

Scheduled transit times on the east-west corridor are largely unchanged, except for Brisbane-–Adelaide trains, whose scheduled transit times have increased by almost five per cent.

Scheduled transit times on the central corridor have increased by less than two per cent.

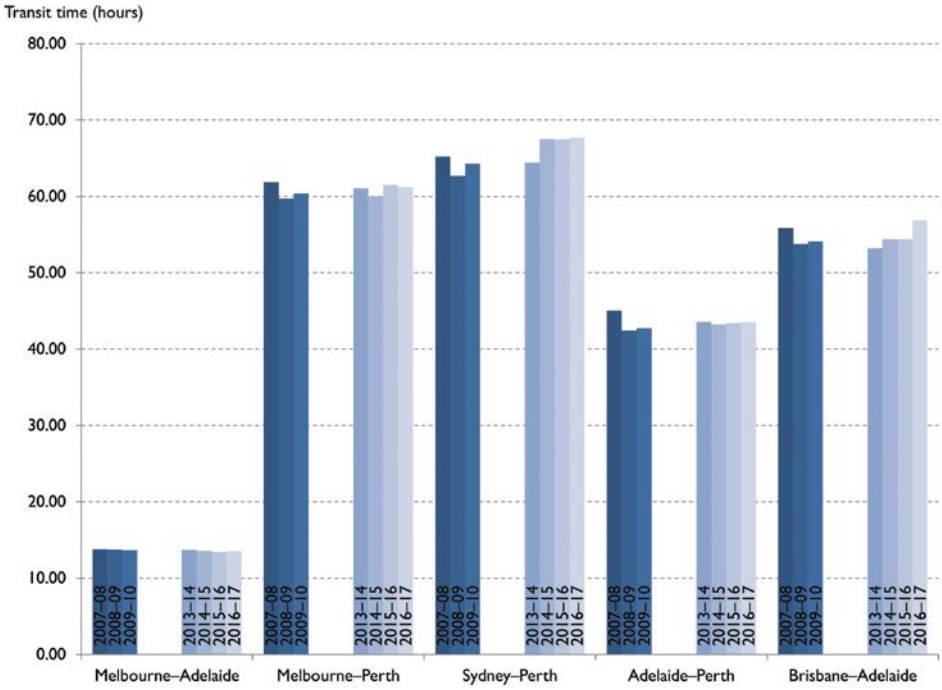
Figure 38 Average scheduled transit times, north-south and central corridors, 2006–07 to 2016–17



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

Sources: Infrastructure managers' working timetables (ARTC, Sydney Trains, Arc Infrastructure, and Genesee & Wyoming Australia) as at April 2017.

Figure 39 Average scheduled transit times, east-west corridors, 2006–07 to 2016–17



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

Calculations for westbound Sydney–Perth trains are based on both the via Cootamundra West and Lithgow routes.

For 2005–06 to 2009–10, BITRE calculated average scheduled transit times from infrastructure managers (ARTC, RailCorp and Arc Infrastructure) 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. Arc Infrastructure provided their timetable used in the week beginning 6 April 2014. In 2014–15, ARTC timetables effective from 19 April 2015 were used. Arc Infrastructure 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.

The Sydney–Perth calculations are revised for the years 2013–14 to 2015–16.

Sources: Infrastructure managers' working timetables (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2017.

Train reliability on the interstate network

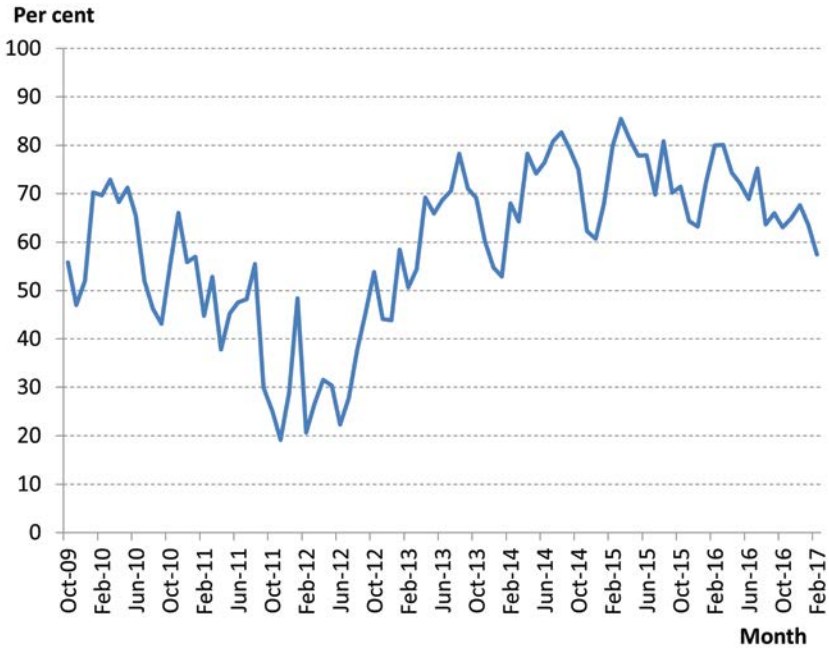
The ARTC publishes performance indicators relating to key service quality areas including reliability. Detailed information regarding reliability by city pair is available on ARTC's website.

Train and track issues affect reliability. 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 trespass and vandalism. These problems can cause significant delays across the network and for trains entering the network. This requires infrastructure managers to allocate train paths without compromising their obligations to other operators.

Infrastructure issues also affect reliability. Track quality problems can result in (temporary) speed restrictions and track closures. Signalling failures also cause delays. Infrastructure maintenance and renewal, as well as weather conditions, are important aspects in infrastructure reliability.

Figure 40 and Figure 41 show the percentage of intermodal trains that left the ARTC network within 30 minutes of schedule. The data are collected monthly and are subject to significant variation due to the impact of individual events.

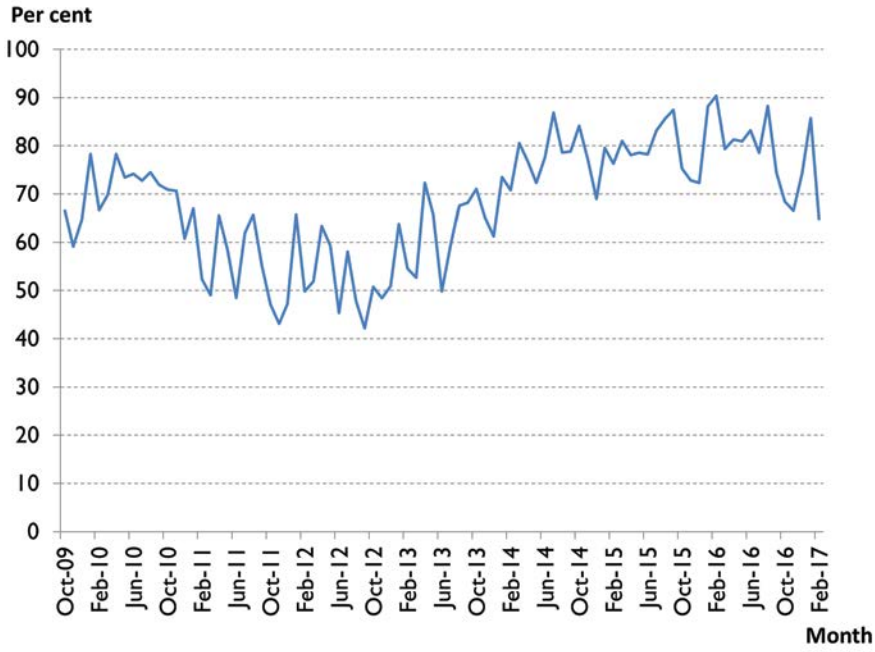
Figure 40 North-south corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



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 commenced 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. Between June 2016 to February 2017, an average of 66 per cent of intermodal trains departed the network within 30 minutes of schedule.

Figure 41 East-west corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Data provided by ARTC.

Reliability on the east-west corridor (Cootamundra West/Parkes–Kalgoorlie and Melbourne–Kalgoorlie) has remained approximately 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[34] on the Crystal Brook–Tarcoola section had limited opportunities to recover. Reliability has since improved due to the installation of Centralised Train Control (CTC) signalling. Between June 2016 and February 2017, an average of 76 per cent of intermodal trains departed the network within 30 minutes of schedule.

Permitted train lengths on the interstate network

Permitted train lengths are important to 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 built longer crossing loops and passing lanes (approximately 6–8 kilometres in length) across the interstate network. Track alignment and gradients can also determine permitted train lengths.

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

- 1 500 metres Brisbane–Sydney;

34 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 Melbourne–Adelaide (1 800 metres restricted[35]); and
- 1 800 metres Sydney–Melbourne, Cootamundra–Crystal Brook, Adelaide–Kalgoorlie, Tarcoola–Darwin.

The 'unrestricted' train length is the maximum length operators can operate any scheduled service without reference to the infrastructure manager. The length is shorter than the 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 the unrestricted use of 1 800 metre trains.

Double stacking capability on the interstate network

Double stacking containers on wagons is also 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 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 travel in 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 trains' operating performances. The permitted track speed and the smoothness of the wagons' ride are strongly influenced by the infrastructure quality, the maintenance regime and the underlying economic life of the infrastructure.

Figures 35 to 38 illustrate engineers' physical measures of average track condition by line segment. These indicators use a 'track quality index' (TQI). A lower the index numbers equates to higher 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 are comparable. Box 8 provides explains how each infrastructure manager calculates the indices.

35 The Melbourne–Adelaide corridor will be able to accommodate unrestricted 1 800 metre trains by late 2017. See https://www.artc.com.au/2017/09/22/big-boost-for-adelaide-melbourne-rail-freight-productivity/

Box 8 Calculating track quality indices

For safety, maintenance, planning and regulatory reasons, infrastructure managers regularly measure the condition of their track. Managers measure the extent to which the railway track deviates from the 'designated' (or 'true') alignment. Infrastructure managers can report a global indicator of track condition on a given line segment. 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.

Infrastructure managers regularly operate a train with a 'track geometry measuring car'. The carriage is equipped to measure and record a range of geometric parameters. There is a variety of track geometry measuring cars in Australia and hence a variety 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.

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

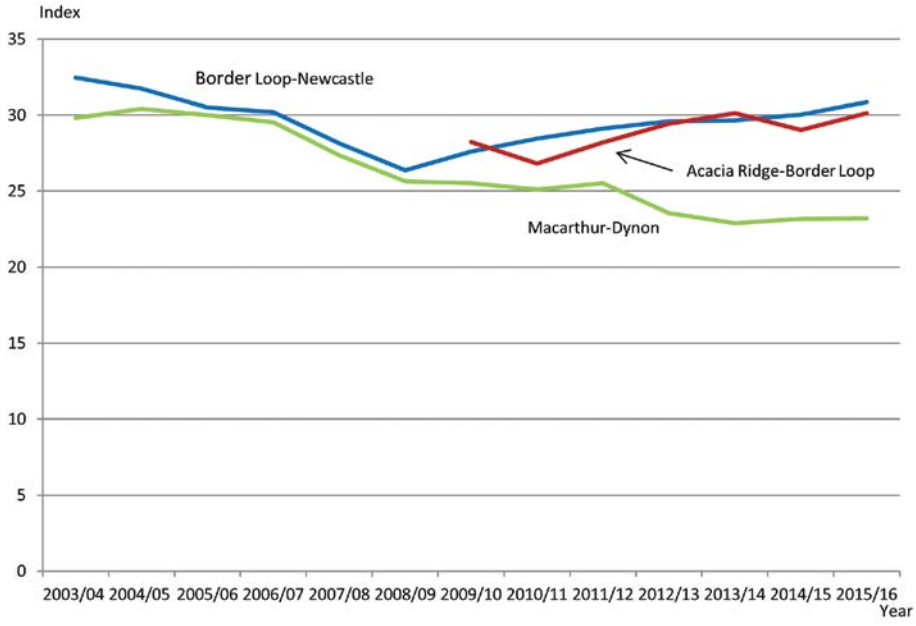
- Gauge;
- Twist (short), measured over two metres;
- Vertical irregularities ('top'), deviation over a 20 metre inertial reading (average of left and right rail); and
- Horizontal line irregularities ('versine'), 5/10 metre chord emulation (average of left and right rail).

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

The charts show trends in track condition for given line segments. The rate of track quality decline is influenced by such factors as 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.

As the figures below show, ARTC's TQI has increased on the Newcastle to Acacia Ridge corridor, while remaining relatively steady between Macarthur and Dynon. On the east-west corridor it has increased on two of the three corridors except for Dynon to Dry Creek. Genesee & Wyoming Australia's TQI has fluctuated on most corridors. The Tennant Creek to Katherine section has had a continual improvement since February 2016. The break in the Katherine – Union Reef and Union Reef Darwin corridors in the first half of 2012 was due to the Edith Bridge derailment.

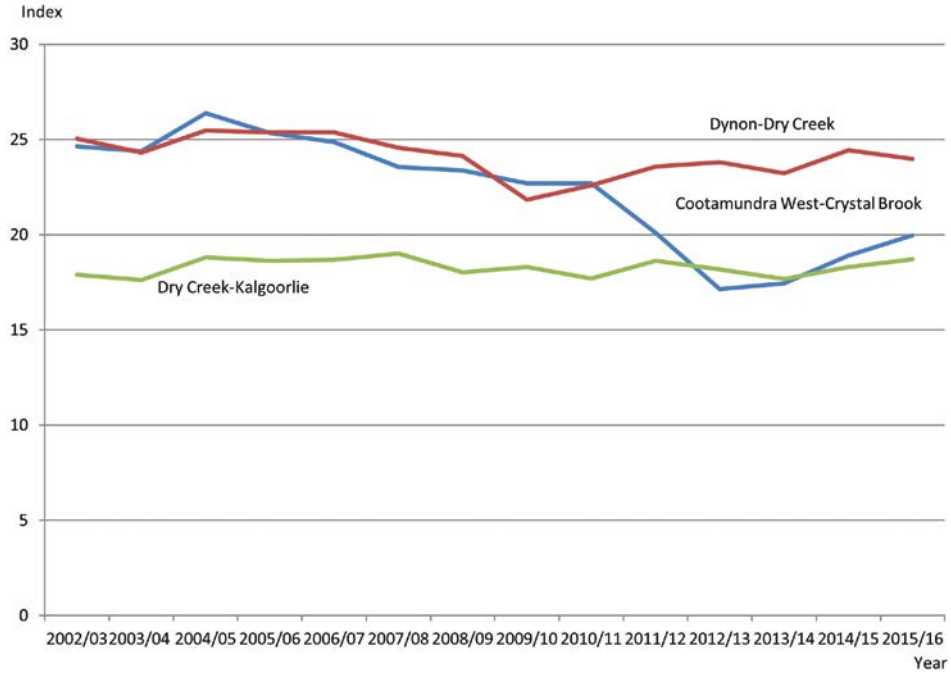
Figure 42 ARTC track quality index, north-south corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

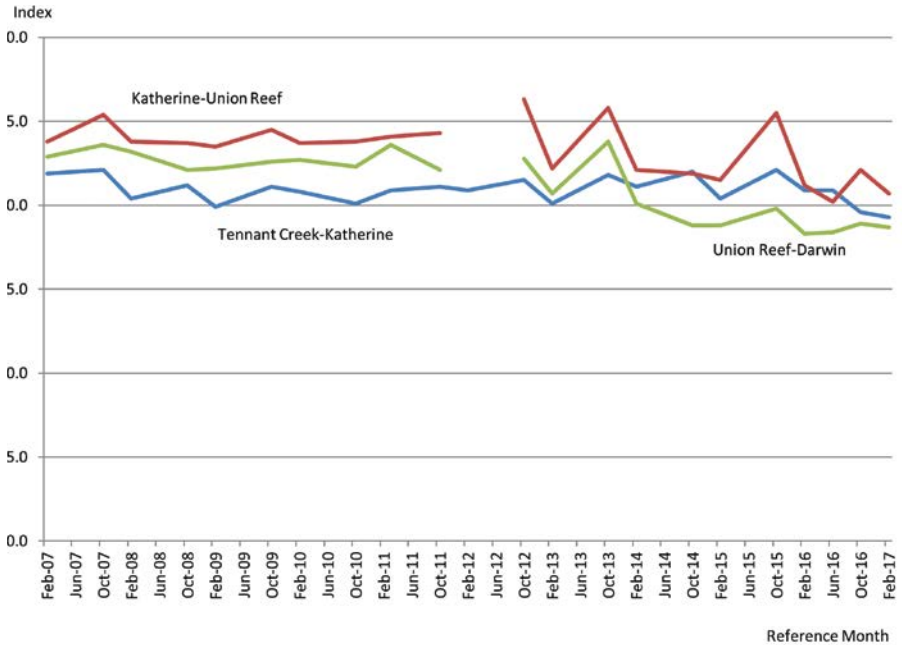
Figure 43 ARTC track quality index, east-west corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

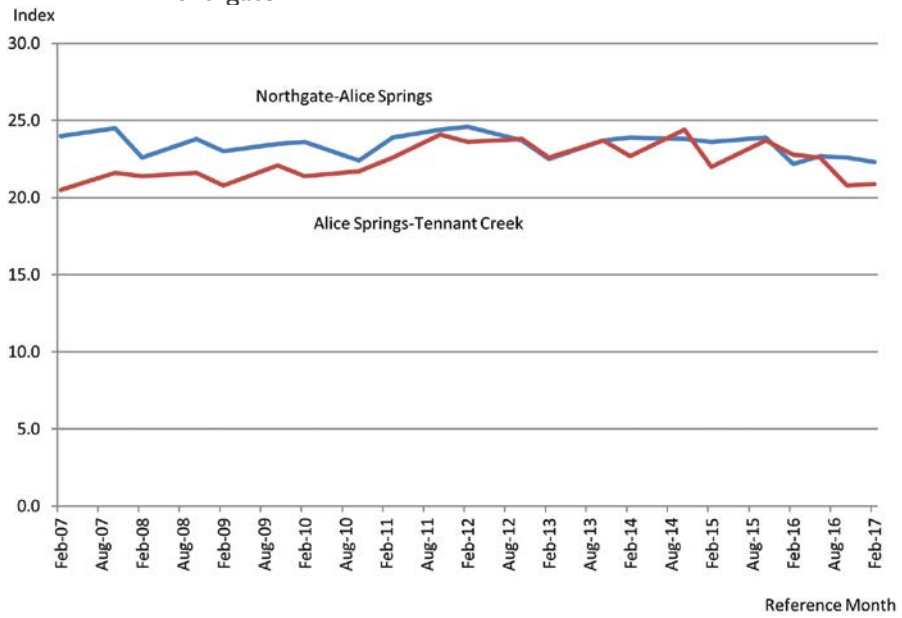
Figure 44 Genesee & Wyoming Australia track quality index, Darwin – Tennant Creek



Note: Lower indices indicate higher track quality.

Source: Data Provided by Genesee & Wyoming Australia.

Figure 45 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 is important to rail's competitiveness. 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. Punctuality is therefore part of a journey's perceived time. Punctuality is less significant for frequent "turn up and go" services[36]. 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", which varies between operators. Table 30 shows operators punctuality targets and results. In 2015–16, all operators which published their results met their punctuality targets.

Table 30 Urban heavy and light rail punctuality, on time performance, 2015–16

	Sydney[a b]	Melbourne	Perth	Brisbane	Adelaide
Heavy rail punctuality (%)	94.2	92.5	95.48	97.16	n/a
Heavy rail target (%)	92	92.5	95	95	
Heavy rail measure	Arriving within 5 minutes of schedule at peak times	Arriving at destination no later than 4 minutes 59 seconds late.	Arriving within 4 minutes of schedule	Arriving within 3 minutes 59 seconds of scheduled time	n/a
Light rail punctuality (%)	-	83.7	-	-	n/a
Light rail target (%)	-	82.9	-	-	n/a
Light rail measure	-	Departing no more than 59 seconds early or 4 minutes 59 seconds after scheduled time in the timetable.	-	-	n/a

Notes: [a] Sydney and Gold Coast light rail operators do not publish timetables as they operate on a 'turn up and go' basis.

[b] Sydney heavy rail is "urban lines". It does not include inter-city services that also use the Sydney urban network. Skipped stops are not counted as being punctual.

Sources: Public Transport Victoria 2016, pp. 43–44; Public Transport Authority of Western Australia 2016, p. 95; Advice from Department of Planning, Transport and Infrastructure; Sydney Trains 2015; Queensland Rail 2017.

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

Non-urban rail punctuality

Table 31 shows non-urban operators' punctuality targets and results. Punctuality targets are generally higher for markets which are likely to have a higher value-of-time. For example, trains which service intercity 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 75 per cent.

The punctuality results indicate long-distance services are generally less punctual than shorter distance services. Of note is Transwa's *Prospector*, whose punctuality was 48 per cent. According to the Public Transport Authority of Western Australia's annual report, this result was due to infrastructure works along the line (Public Transport Authority of Western Australia 2016, p. 96). 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).

Table 31 Non-urban rail punctuality, on time performance, 2015–16

	Service type	Punctuality 2015–16 (%)	Punctuality target (%)	Measurement
Queensland Rail	QR Traveltrain	85.5	75	Arriving within 15 minutes
NSW TrainLink	Intercity	89.4	>92	Arriving within 6 minutes
	Regional & interstate	78.6	>78	Arriving within 10 minutes
V/Line	Commuter	86.3	92	Arriving within 5 minutes
	Long distance	87.9	92	Arriving within 10 minutes
Transwa	*Australind*	94	90	Arriving within 10 minutes
	Prospector	48	80	Arriving within 15 minutes
	MerridinLink	62	95	Arriving within 10 minutes
	AvonLink	83	97	Arriving within 10 minutes

Sources: V/Line 2016, p11; V/Line 2017; NSW Trains 2016, p.14; Queensland Rail 2017; advice from Queensland Rail; Public Transport Authority of Western Australia 2016, pp.96–97.

(b) Service attributes

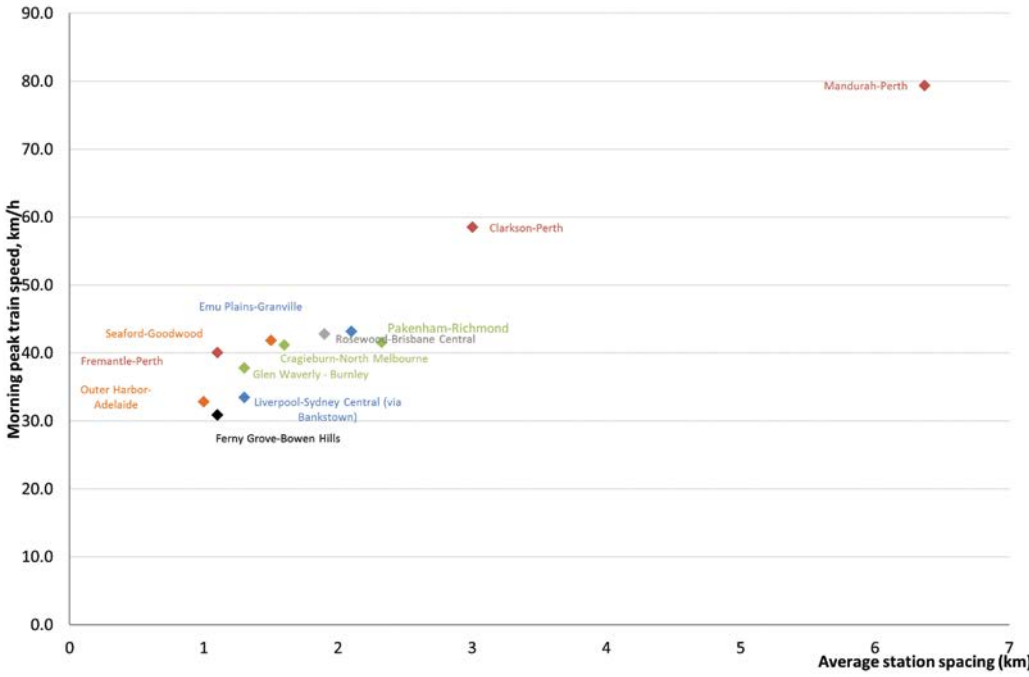
Train speeds

Australia's older passenger lines have relatively short station spacing. Mees and Dodson (2011) observed that Australian lines were often built as a way of supporting urban expansion with consequent short distances between stations[37]. A consequence of this, however, is the regular stops cause slower speeds.

In contrast, newer lines, such as Mandurah–Perth and, to a lesser extent, Clarkson–Butler have wider station spacing, which allows higher average speeds. In addition to speed, wider station spacing allows for simpler train schedules because there is little need for express services. Figure 46 shows stopping services. Express services help overcome short station spacing.

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

Figure 46 Station spacing and illustrative train speeds



Source: Derived from operator timetables, April 2017.

Wide station spacing reduces the capacity for patrons to access railway stations 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 also 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)	812	556	254	535
Average scheduled speed (km/h)	23	21.3	16	17.3

Note: Sydney, Adelaide and Gold Coast 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 mixed infrastructure type. Sydney's light rail, for example, operates largely on a segregated line. Between Haymarket and Central Station, however, it travels "on-road" (albeit largely separated from vehicles) through areas of significant pedestrian activity near Paddy's Market and George Street.

Frequency

The graphs below show urban heavy rail service frequency as measured from arrival at the point of destination (end of line) from the point of departure and from major centres and junctions. All cities provide express and all stops services, to varying degrees.

Frequency is important to service quality and, therefore, mode choice. Frequency also influences overall travel times. It determines how long passengers wait for a train and how closely the train departure (or arrival) time is to a 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).

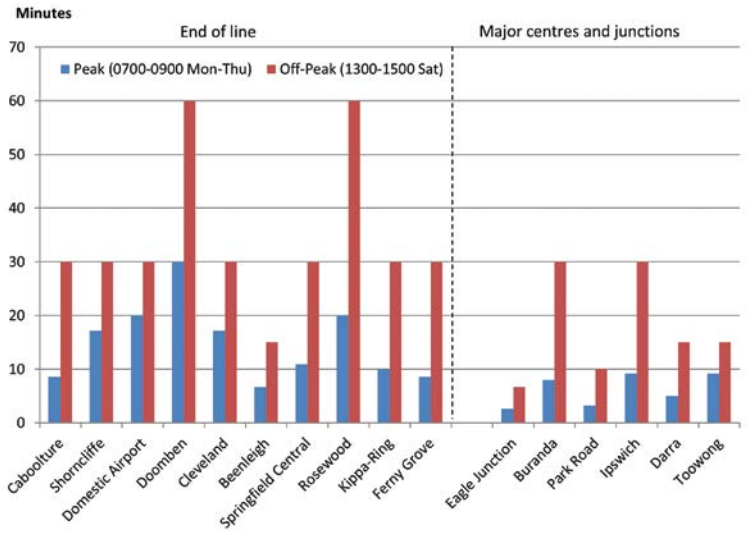
Frequency is also important in integrating rail services both with other rail lines and other transport modes. Services may have coordinated arrival and departure times for passenger interchanges between services. However, the scale of large urban networks can make coordination unfeasible. In these cases, frequency is crucial in reducing passengers' interchange waiting times. Major centres and junction stations generally have high frequencies due to service densification. As the graphs below show, all Australian capital cities with urban heavy rail services have higher service frequency during peak periods.

Service frequency in 2017 is largely the same as the previous year. There have been some minor decreases and increases across the times of day periods measured, although this should not be interpreted to mean there are fewer services overall. A train that arrives at its destination at 0901 hours on a weekday, for example, would be excluded as it is outside the peak period scope.

Brisbane heavy rail

Figure 47 shows average times between trains for arrivals at Roma Street Station in peak and off-peak times, from stations that are at the end of lines or at major centres and junctions. The peak period service frequency is for Monday–Thursday, as trains run to a separate timetable on Fridays.

Figure 47 Average time between trains for services arriving at Brisbane Central



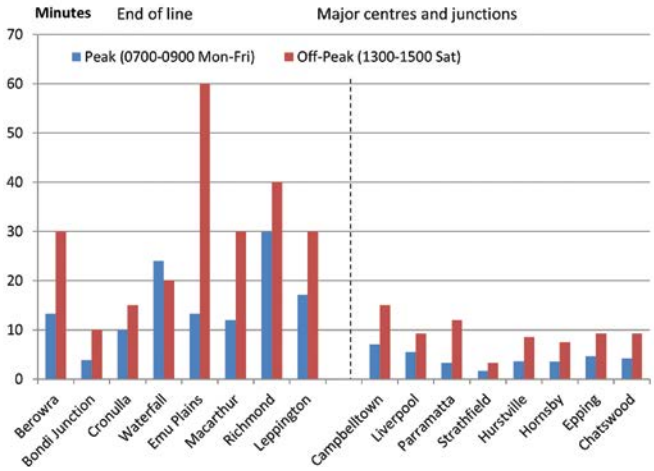
Source: Translink, 2017.

Sydney heavy rail

Sydney Trains frequency depends on the time of day, service demand and network capacity. The Bondi Junction line has the most services, at an average arrival at Sydney Central every four minutes, while the Carlingford line has only one direct peak hour service. There is less discrepancy in peak hour wait times at major centres and junctions. The average wait time is four minutes.

Off-peak service frequencies similarly vary significantly across the network from both points of origin and major centres and junctions.

Figure 48 Average time between trains for services arriving at Sydney Central



Notes: The Carlingford line has only one direct service that arrives at Sydney Central during the designated peak hour period, thus is it is not applicable to show times between the single service. The Carlingford line also has no direct off peak services to Sydney Central.

Source: Sydney Trains 2017a.

Figure 48 includes a number of stations listed in The New South Wales Government's Long Term Transport Master Plan as being "Regional Cities" (Parramatta and Liverpool) and "Major Centres" (Hornsby, Chatswood, Bondi Juncion, Hurstville, Campbelltown, Macarthur)[38]. 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.

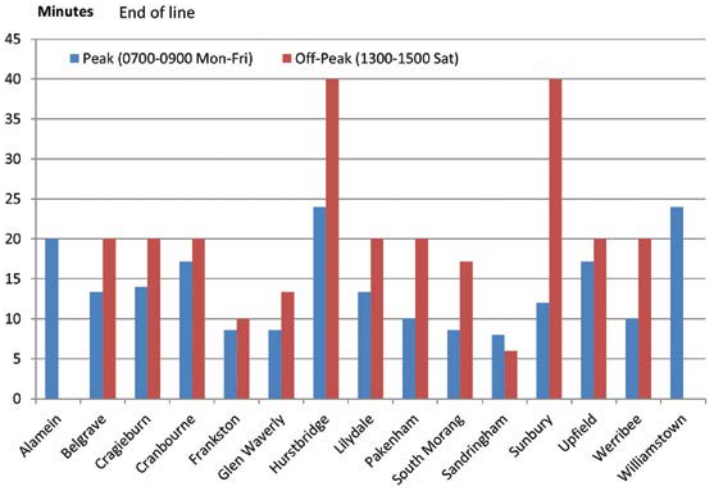
Melbourne heavy rail

Melbourne's urban heavy rail timetables are currently subject to frequent change, possibly due to level crossing removal works. Peak frequencies are measured from the timetable that was current on 24 April 2017 and the off peak frequencies are measured from the timetable that was current on 29 April 2017. Peak frequencies similarly vary considerably across services, with smaller branch lines running fewer trains. For end of line services, Alamein and Williamstown have the fewest through running peak time services, at intervals of 20 and 24 minutes respectively. Average off peak services vary from 10 minutes on the Frankston line to 40 minutes on the Hurstbridge and

38 The full list of "Regional Cities" is: Paramatta, Liverpool, Penrith. Major centres are: Hornsby, Dee Why, Brookvale, Chatswood, Bondi Junction, Burwood, Bankstown, Kogarah, Hurstville, Campbelltown, Macarthur, Blacktown, Castle Hill. See New South Wales Government 2012, p.46.

Sunbury lines. The Alamein and Williamstown lines have no direct services to Flinders Street station in the off peak period. Rather, shuttle trains run to Camberwell and Newport, where passengers change trains for ongoing travel.

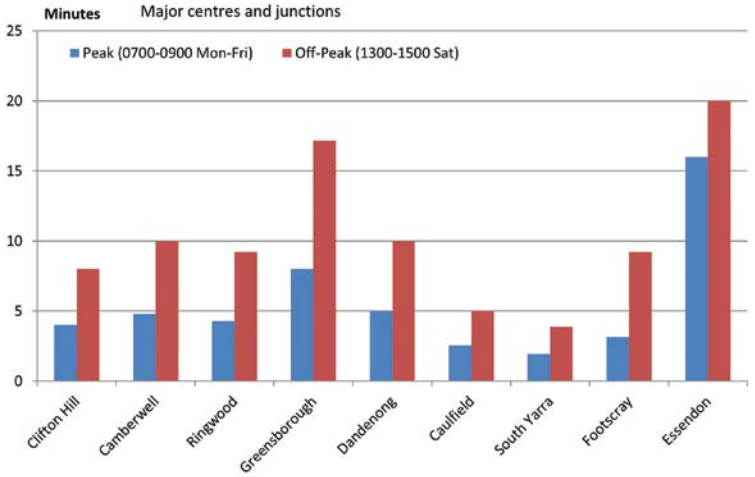
Figure 49 Average time between trains for services arriving at Flinders Street from end of line



Source: Public Transport Victoria 2017

There is less variation between peak hour service frequency at major centres and junctions. South Yarra is the busiest, with an average departure every two minutes. This is because it is one of Melbourne's busiest junctions, with trains from the Cranbourne, Pakenham, Frankston and Sandringham lines passing through the station. During off peak periods, service frequency at most of the major centres and junctions as shown in the graph is approximately half that of peak hour services.

Figure 50 Average time between trains arriving at Flinders Street Station from major centres and junctions

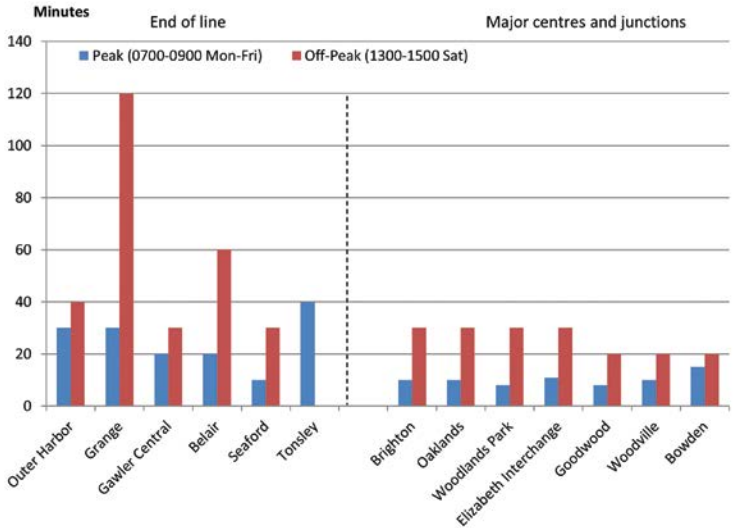


Source: Public Transport Victoria 2017

Adelaide heavy rail

While average frequencies are relatively consistent across the Adelaide network for both end of line services and trains departing from major centres and junctions, they are comparatively long. Service patterns are strongly geared to peak-period commuting to Adelaide Railway Station. Average times between trains in peak periods are often less than one-half of those in off-peak periods. Adelaide's lower service levels reflect its modest patronage compared to the other networks.

Figure 51 Average time between trains for services arriving at Adelaide Railway Station



Note: The Tonsley line does not run weekend services.

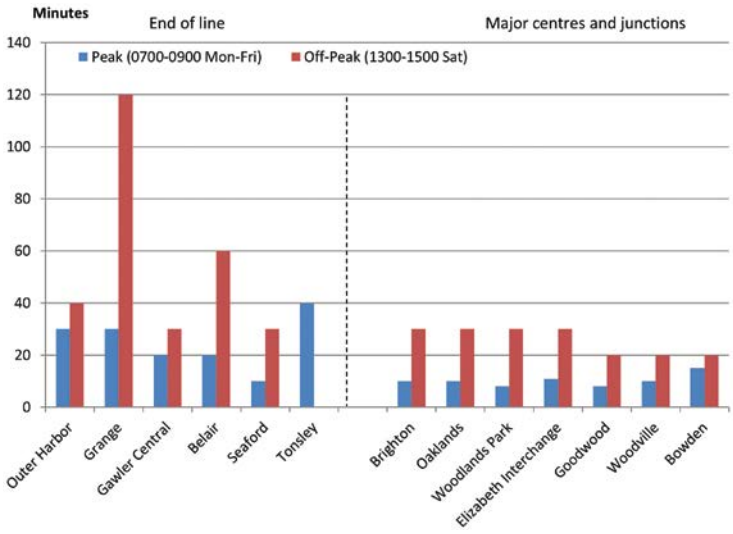
Source: Adelaide Metro 2017

Perth heavy rail

There have been no changes to Transperth's service frequency since publication of *Trainline 4*. Transperth's trains mostly stop at all stations. Its focus on maintaining low dwell times and long distances between stations on its Mandurah and Joondalup lines enables relatively high average line speeds. Consequently, there are no express services on these two lines, unlike the city's 'heritage' lines that have closer station spacing.

Each end of line service has a train departing every 15 minutes during the assessed off peak periods (eight services each). The difference in service levels between major centres and junctions and end of line services is less significant than in Brisbane, Sydney and Melbourne. This is partly due to the lack of express services. Having only two junctions outside the city centre reduces the service densification seen in other cities where lines merge, such as South Yarra in Melbourne.

Figure 52 Average time between trains for services arriving at Perth Central



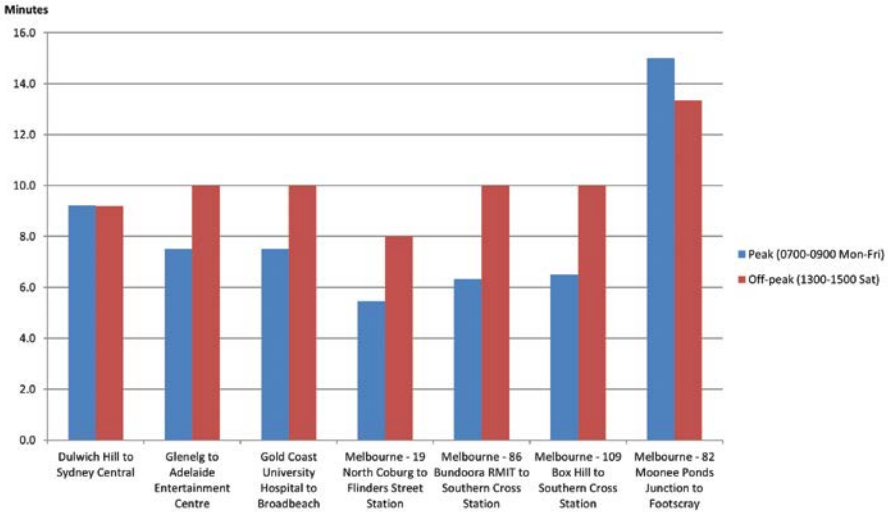
Source: Transperth 2017

Light rail

Light rail frequencies in Australia vary (see Figure 53). Off peak waiting times are 15 minutes or less. Compared to the previous financial year, the greatest change is Sydney light rail's off peak frequency, which now equals peak hour frequency. Care is needed when comparing the single route Sydney, Gold Coast and Adelaide operations with Melbourne. Many Melbourne routes share tracks, meaning a passenger may have more than one tram route option, thus increasing frequency on shared tracks.

The selected routes for Melbourne provide an indicator of transit times across the network's 23 routes. Routes 19 (Flinders Street Station to North Coburg) and 82 (Moonee Ponds Junction to Footscray) have the shortest and longest peak hour intervals on the network, respectively.

Figure 53 Average time between trams, by route and direction



Notes: Gold Coast operations do not run to timetables. Melbourne tram services have a separate timetable for Fridays. As such, calculated peak hour frequency as shown above is based on the published Monday–Thursday timetables. Peak hour calculations are based on peak hour directions of travel.

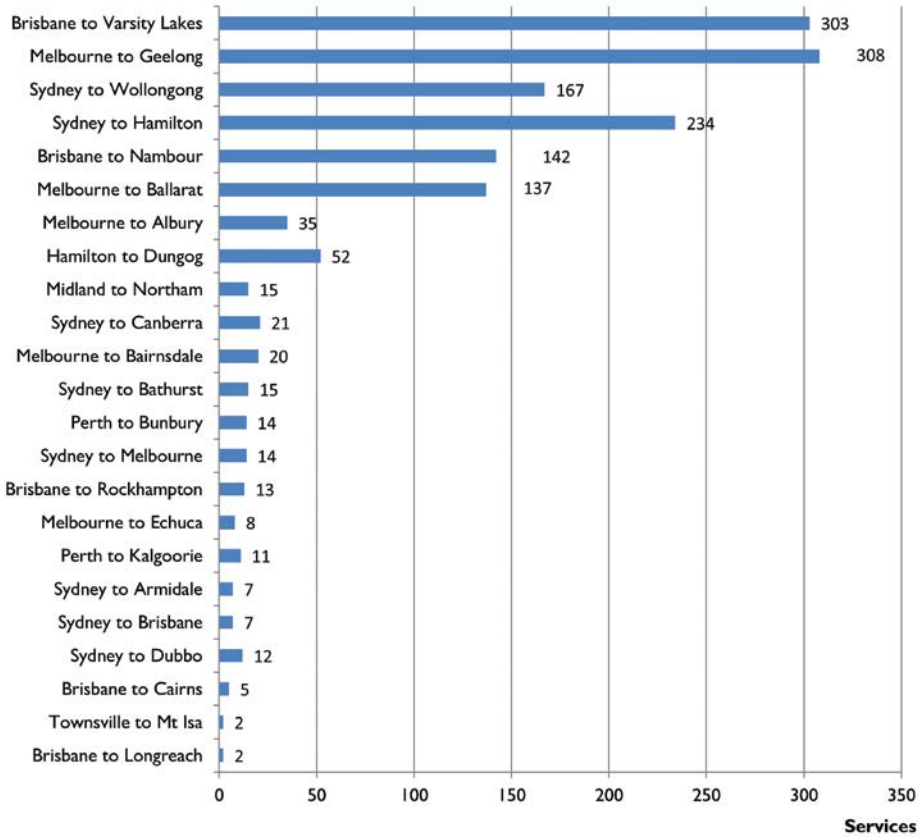
Sources: Transport for NSW 2017; G:link 2017; Public Transport Victoria 2017; Adelaide Metro 2017a.

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 and its generalised cost.

Figure 54 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 intercity and regional centre-capital city commuter markets generally have the highest service frequency.

Figure 54 Non-urban passenger rail services per week



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

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

The Sydney–Hamilton figures now include services that stop at nearby Broadmeadow and bypass Hamilton.

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.

The Brisbane–Rockhampton figures include the (temporary) locomotive hauled Tilt Train replacement service and now excludes Brisbane–Bundaberg services. Brisbane to Bundaberg services were included in the count for previous *Trainline* editions.

Sources: NSW TrainLink 2017a; Queensland Rail 2017; Transwa 2017; V/Line 2017.

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 intercity rail commuter corridors.

Victoria, in particular, has high levels of service between Melbourne and major regional cities, which increased further in 2015–2016. According to the 2015–2016 V/Line annual report, the number of 'commuter' services run increased by approximately 22.5 per cent from the previous financial year (V/Line 2016 p.11).

In Western Australia, the average number of Midland to Northam services has dropped from 2.8 services per day to 1.6 and the cessation of the single weekend service. This follows the completion of a three year trial which expired in June 2017, during which the average weekday patronage occupancy was 21 per cent (*Railway Digest*, July 2017a, p. 29).

Transit times — non-urban

Transit times are important for commuter travel 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. Time rich tourist travellers are likely to value comfort ahead of time. The *Indian Pacific, Ghan,* and *Kuranda Scenic Railway* are cases in point. Conversely, the opposite would likely apply to commuters 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/intercity 3 hour 59 minutes or less							
Brisbane to Nambour	QR (TransLink)	Narrow	105	Yes	1h 52m	56	20
Brisbane to Varsity Lakes			89	Yes	1h 15m	71	11
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	8
Sydney to Bathurst			238	No	3h 43m	64	6
Melbourne to Ballarat	V/Line	Broad	118	No	1h 6m	107	4
Melbourne to Echuca			250	No	3h 24m	74	4
Melbourne to Bairnsdale			275	No	3h 53m	70	13
Melbourne to Geelong			81.5	No	55m	88	5
Melbourne to Albury		Standard	305	No	3h 55m	77	11
Midland to Northam	Transwa	Standard	102	No	1h 20m	80	1
Perth to Bunbury		Narrow	183	No	2h 25m	76	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 20 m	69	26
Brisbane to Rockhampton (electric Tilt Train)			639	Yes	7h 45m	82	11
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	17
Adelaide to Darwin	GSR	Standard	2 971	No	53h 15m	56	3

Notes: The Adelaide to Darwin service includes extended stops for sightseeing at Alice Springs and Katherine. This affects the train's average speed.

Sources: Great Southern Rail 2017; NSW TrainLink 2017a; Queensland Rail 2017; Transwa 2017; V/Liine 2017; Rail Geelong 2016.

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;
- Station spacing and stopping patterns, determined largely by the function of the service; and
- Scheduled extended stops en route for passengers to do off train tours (such as the Ghan stopping at Alice Springs for more than four hours).

The Brisbane–Nambour, Sydney–Hamilton, and Sydney–Wollongong services have similar, relatively low average train speeds. These services are medium-distance, intercity, 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 urban areas of Brisbane and Sydney respectively. In addition, the Sydney–Hamilton 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 (completed by 2006) and the Regional Rail Link (opened in June 2015), included a number of measures that improved average speed, including:

Upgraded track condition and separation from urban 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, which affects transit times.

There is a wide dispersion of transit times across V/Line services, caused by different stopping patterns that cater for different market segments. The Melbourne–Ballarat service cited above, for instance, is based on an express peak hour service with only three stops. This enables a relatively high average speed. For more information on V/Line's Regional Fast Rail Project; see BITRE, 2014f.

Long-distance passenger trains in Australia have uncompetitive transit times compared to air and some road coach travel[39]. 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. Queensland Rail's Tilt Trains similarly have their speed restricted north of Rockhampton due to track conditions that do not allow 160 kilometres per hour travel.

39 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.

CHAPTER 5

Case Study: Albury-Wodonga Regional Freight

There are two regional rail hubs/intermodal terminals in the Albury-Wodonga region – the Ettamogah Rail Hub, owned and operated by the Colin Rees Group, and the SCT Logistics Logic Estate at Wodonga. The Rail Hub is located approximately 15 kilometres north of Albury and the Logic Estate approximately 20 kilometres south of Albury.

The Ettamogah Rail Hub is an independent operation which contracts Pacific National to haul its products. These Pacific National trains are typically the Melbourne–Griffith services which pick up and drop off containerised freight. SCT services its estate with its own Brisbane–Melbourne trains, which pick and drop off primarily louvre wagons en route between Melbourne and Brisbane. The Ettamogah Rail Hub opened in 2008, while the SCT estate opened in late 2016.

The main product throughput at Ettamogah is:

- Paper for export;
- Imported consumables;
- Imported agricultural equipment;
- Received components for local production.

The Ettamogah facility sends and receives freight on six trains to/from Melbourne, three to/from Adelaide and Perth, and three to/from Brisbane per week. It does not ship to Sydney on the grounds it is not economically viable for the company.

The SCT estate is a greenfield rail operation that uses an existing customer base previously served by road transport. Products that the facility handles includes outbound:

- Mars Petfoods;
- Uncle Tobys;
- Bottled water;
- Locally produced water bottles;
- Wine;
- Timber products from Benalla;
- Canned foods from the SPC facility at Shepparton; and
- Containerised cotton, for export.

While it exports cotton, this is a new initiative of secondary importance when SCT set up its core business at the terminal.

The Ettamogah Rail Hub is a typical intermodal rail facility where Reach Stackers lift containers on to and off wagons stabled in the facility. Road trucks, which act as a local feeder service, drop off and pick up the containerised freight. SCT, which specialises in using louvre wagons, shunts its wagons in to an enclosed warehouse, where several forklifts transfer the palletised freight between the wagons and local feeder road trucks which use loading bays connected to the warehouse.

Figure 55 External view of Barnawartha intermodal terminal

Source: Photo courtesy of SCT Logistics.

Figure 56 Internal view of Barnawartha intermodal terminal

Source: Photo courtesy of Rodney Avery.

APPENDIX A
Significant railway events

Date	Event	Description
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
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

(continued)

Date	Event	Description
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
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

(continued)

Date	Event	Description
18 December 2006	Pacific National wins 7-year steel contract	PN wins a contract extension, with Bluescope and OnesSteel 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
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

(continued)

Date	Event	Description
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
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 per annum)
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 Aug 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
Dec 2009	Track upgrade	Completion of concrete sleepering of the Cootamundra–Parkes line

(continued)

Date	Event	Description
17 Jan 2010	ARTC track	ARTC commenced a 60-year lease of the Brisbane–NSW border standard gauge track
22 Feb 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
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 Jan–27 Feb 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

(continued)

Date	Event	Description
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
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
27 March 2014	Sydney Inner West Light Rail	Sydney light rail extension from Lilyfield to Dulwich Hill opened.
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
20 July 2014	Gold Coast Light Rail	Gold Coast Light Rail commences operations
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 June 2015	Regional Rail Link	Opening of the Wyndham Vale – Tarneit section of the Regional Rail Link in Victoria

(continued)

Date	Event	Description
August 2015	Murray Basin Rail Project	Victorian government commits to implementing the project, following the release of the project's business case. The project involves standardising the rail gauge and increasing axle load capacities in the state's Murray Basin region. Associated critical maintenance works commence in October.
October 2015	Sydney CBD and South East Light Rail	Major construction works commence
December 2015	Wiggins Island Rail Project	Completion of (Stage One) of Wiggins Island Rail Project
10 December 2015	Roy Hill Holdings	First shipment loaded, using ore transported on the newly opened rail link from the mine sites to Port Hedland
June 2016	Northern Sydney Freight Corridor Programme	Epping to Thornleigh Third Track line opened
2 July 2016	New Melbourne port shuttle service	SCT Logistics and DP World commence weekly shuttle services from Altona to West Swanston terminal
12 July 2016	ACT Light Rail	Construction commences on ACT Light Rail. Initial work involves construction of the Mitchell depot and maintenance centre
19 August 2016	Asciano Acquisition	Asciano acquisition complete, with business split into three distinct businesses – Patrick, Pacific National, and Bulk and Automotive Port Services (BAPS)
30 August 2016	Aurizon shuttle trains	Aurizon commences freight shuttle trains between Port of Botany and Enfield Intermodal Terminal
3 October 2016	Petrie – Kippa-Ring line	Petrie – Kippa-Ring line officially opened
14 August 2017	Aurizon announcement	Aurizon announces it will cease all intermodal rail operations from December 2017

APPENDIX B

Significant network route additions from 1980

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
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

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
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	Coal
	Moss Vale Triangle Loop	NSW	Standard	0.4	Mainline/rural freight
	Abbot Point – Kaili	Queensland	Narrow	16.0	Coal
	Annandale – Boundary Hill Mine	Queensland	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

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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	Grain
	Fork at Rocklands	Qld	Narrow	0.8	Freight/ non urban passenger
	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	Grain
	Yarrowlea–Ebenezer	Qld	Narrow	8.4	Coal
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	Line deviations
	Mackay – Point "X"	Qld	Narrow	4.3	Line deviations
	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	Woodchips

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
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	Uurban 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	Limestone
	Fishermans Landing – Mount Miller	Qld	Narrow	8.3	Coal and Limestone
	Fisherman Islands – Dutton Park	Qld	Narrow/ Standard	20.4	Urban freight (dual gauge)
	Helensvale–Nerang	Qld	Narrow	7.7	Urban passenger

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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	South Walker Junction – South Walker	Qld	Narrow	8.7	Coal
2003	Bidgerley Junction to Hail Creek	Qld	Narrow	46.7	Coal
2004	Darwin – Alice Springs	NT	Standard	1 418	Interstate
	Mt Miller– 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
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

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
	Deer Park – West Werribee (Regional Rail Link)	VIC	Broad	27	Intercity passenger
	Roy Hill	WA	Standard	344	Iron ore
2016	Boggabri Coal Mine Expansion	NSW	Standard	17	Coal
	Petrie – Kippa-Ring	Qld	Narrow	13	Urban passenger
2017	Moree – Broadbent Grain facility Byerwen branch line	NSW Qld	Standard Narrow	3.5 5	Grain Coal

Note: Does not include light rail/tramways.

Sources: Quinlan and Newland 2000; BITRE 2016c; Data provided by Aurizon.

APPENDIX C

Train operator traffic Asciano and Aurizon 2007–08 to 2015–16

ASX train operator traffic trends (billion net tonne-kilometres)									
	Asciano				Aurizon				
Period	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)

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

	Asciano				Aurizon				
Period	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 2014–2015	30.9	5.1	20.9	56.9	49.1	10.4	-	12.9	72.4
Sep-15	-	-	-		-	-	-	-	-
Dec-15	-	-	-		-	-	-	-	-
1HY-16	16.2	2.3	10.2	28.7	25.0	5.0	-	6.5	36.5
Mar-16	-	-	-		-	-	-	-	-
Jun-16	-	-	-		-	-	-	-	-
2HY-16	15.6	2.1	9.4	27.1	24.7	4.6	-	5.8	35.1
Full year 2015–2016	31.8	4.4	19.6	55.8	49.7	9.6	-	12.3	71.6

Sources: QR National 2010, pp. 98–99; Asciano web site (Australian Stock Exchange [ASX] Announcements – no longer published, following August 2016 division of Asciano. Saved copies available from BITRE); Aurizon website (ASX Announcements).

APPENDIX D
Aurizon Traffic 2016–17

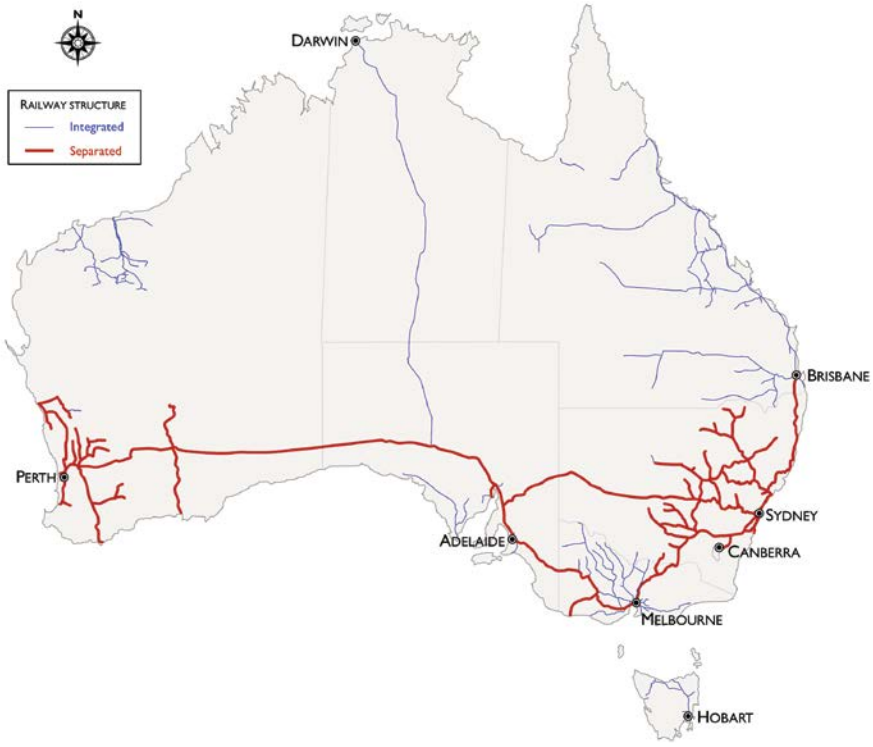
ASX train operator traffic trends (billion net tonne-kilometres)				
		Aurizon		
Period	Coal	Iron Ore	Freight	Total
Sep-16	12.3	2.2	3.2	17.7
Dec-16	12.5	2.5	3.4	18.4
1HY-16	**24.8**	**4.7**	**6.6**	**36.1**
Mar-17	11.7	2.2	2.8	16.7
Jun-17	11.1	2.3	2.8	16.2
2HY-17	**22.8**	**4.5**	**5.6**	**32.9**
Full year 2016–17	**47.6**	**9.2**	**12.2**	**69**

Sources: Aurizon website (ASX Announcements). Advice from Aurizon.

APPENDIX E
Industry structure

The industry structure consists of vertically separated and vertically integrated railways. In vertically separated railways, the railway infrastructure manager does not operate revenue earning trains. Instead it sells track access to train operators under an "open access" regime. 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.

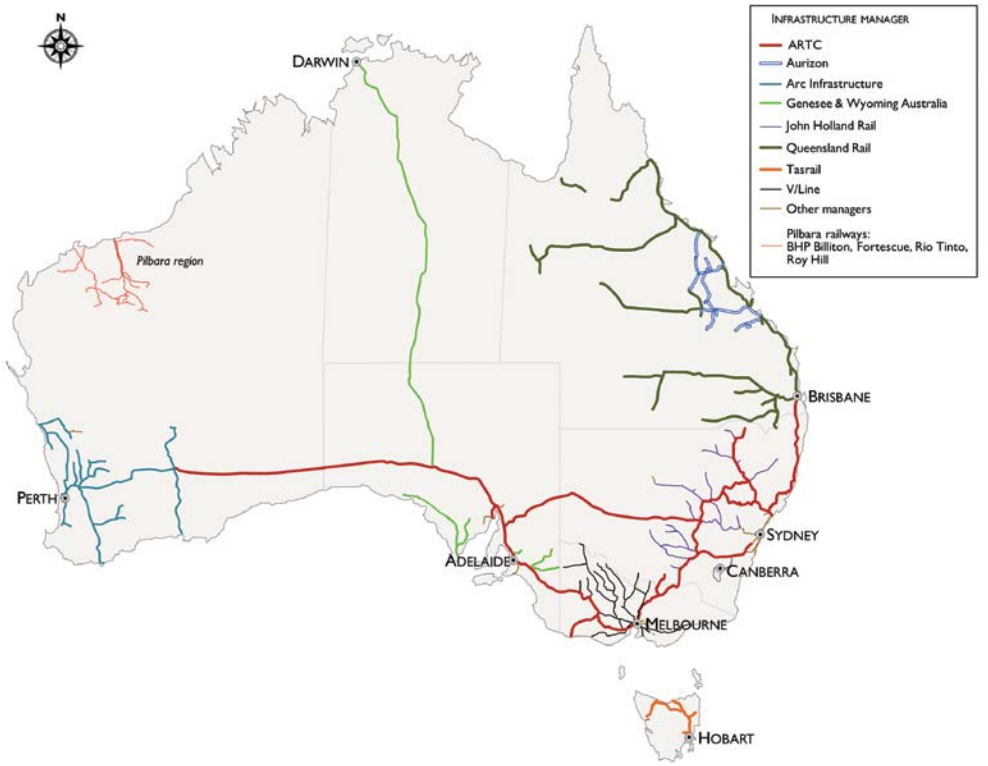
Figure 57 Australian rail industry structure



Infrastructure management

Australia's infrastructure managers are diverse in structure and operation. Figure 58 shows Australia's railway system by network manager.

Figure 58 Australian railways, by network manager, 2017



Notes: The lines shown here are the railways that were open for traffic at July 2017. The BHP Goldsworthy line in the Pilbara is shown but it was mothballed in 2014.

The pattern of the network management is, by traffic type:

- **Interstate.** ARTC and Arc Infrastructure manage most of the interstate network. Genesee & Wyoming Australia owns (long lease) the Tarcoola–Darwin line as a vertically integrated railway. Sydney–Perth trains which travel via Lithgow use John Holland Rail managed track between Marrangaroo (Lithgow) and Parkes.
- **Iron ore — Pilbara.** These lines are vertically integrated operations, with lines owned by BHP Billiton, Rio Tinto, Fortescue Metals Group and Roy Hill.
- **Coal.** Coal railways in Central Queensland are vertically integrated. 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 are vertically separated, with the ARTC managing the Hunter Valley coal network and with some coal trains also operating over rail infrastructure that John Holland Rail or RailCorp manages.
- **Mixed.** Tasmania's railways are vertically integrated. TasRail manages the system and operates the trains.

(continued)

- **Grain.** Grain railways are vertically separated in Queensland, New South Wales (ARTC, John Holland Rail and RailCorp), Victoria (V/Line)[40] and Western Australia (Arc Infrastructure). Genesee & Wyoming Australia operates as a vertically integrated operator in South Australia.
- **Passenger.** Urban systems have integrated management structures, except for Sydney where Sydney Trains operates as a vertically integrated operator, with TrainLink operating additional limited stops urban services as a vertically separated operator. Non-urban passenger operations are a mix of vertical integration and separation.

Table 34 Principal infrastructure managers of Australian railways, 2016

Infrastructure manager	Structure	Primary usage
Interstate		
Australian Rail Track Corporation (ARTC)	Separated	Intermodal, grain, ores, steel, passenger
Arc Infrastructure	Separated	Intermodal, grain, ores, steel, passenger
Genesee & Wyoming Australia (GWA)	Integrated	Intermodal, ores, passenger
Intrastate		
Aurizon	Integrated	Coal
Queensland Rail	Integrated and Separated	Passenger (integrated), grain, coal, cattle, ores, intermodal (separated)
John Holland	Separated	Intermodal, grain, ores, cotton, passenger
ARTC (New South Wales regional and Hunter Valley)	Separated	Intermodal, coal, grain, cotton, passenger
V/Line	Integrated (passenger); Separated (freight)	Passenger, grains, mineral sands, intermodal
ARTC (Portland, Benalla–Yarrawonga)	Separated	Grain, mineral sands
TasRail	Integrated	Intermodal, coal, ores, timber
GWA (intrastate South Australia)	Integrated	Grain, gypsum, ores
Arc Infrastructure Rail (intrastate Western Australia)	Separated	Grain, ores
BHP Billiton	Integrated	Iron ore
Rio Tinto	Integrated	Iron ore
Fortescue Metals Group	Integrated	Iron ore
Roy Hill Holdings	Integrated	Iron ore
MTM (Metro Trains Melbourne)	Separated	Passenger, freight, steel
Sydney Trains	Separated	Passenger, freight
Urban		
Queensland Rail (Brisbane, Gold Coast)	Integrated	Passenger
Airtrain CityLink Limited	Integrated	Passenger
Sydney Trains	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 an estimated 511 route-kilometres.

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

Above rail operators

Numerous organisations provide train operation services.

- **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 511 route-kilometres.
- National rail freight operators. Two largest national rail freight train operators are Aurizon and Pacific National; 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. Pacific National operates intermodal services on the open access interstate network[41].
- **Regional rail freight operators.** Genesee & Wyoming Australia is a major train operator in South Australia and the Northern Territory, including running intermodal trains from Adelaide to Darwin. Other significant players include Southern Shorthaul Railroad and Freightliner Australia (a subsidiary of Genesee & Wyoming Australia). TasRail provides all rail freight services in Tasmania while CBH contracts Watco WA Rail to provide grain haulage in Western Australia.
- **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. 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 product 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 Roy Hill operate trains on their own railways.

41 Aurizon is due to cease all intermodal services in December 2017.

Table 35 Principal train operators in Australia, 2017[42]

Train operator	Infrastructure network used	Primary tasks
Aurizon	Aurizon, Queensland Rail, ARTC, Arc Infrastructure, Sydney Trains	Coal, iron ore, intermodal, minerals, cattle, grain, mixed bulk
Pacific National	Aurizon, Queensland Rail, ARTC, V/Line, John Holland Rail, Sydney Trains, Arc Infrastructure, Metro Trains Melbourne	Coal, ores, intermodal, steel, grain, mixed bulk
Genesee & Wyoming Australia (including Freightliner and Glencore)	Genesee & Wyoming Australia ARTC, Sydney Trains, John Holland Rail	Intermodal, ores, agricultural produce, coal
SCT Logistics/Specialised Bulk Rail	ARTC, Arc Infrastructure,	Intermodal, grain, iron ore
Qube Holdings	ARTC, V/Line, Sydney Trains, John Holland Rail, MTM Melbourne	Intermodal, grain, mixed bulk
Watco	Arc Infrastructure	Grain, urban freight
Southern Shorthaul Railroad	ARTC, Sydney Trains, John Holland Rail, V/Line	Coal, grain, intermodal, infrastructure works
TasRail	TasRail	Intermodal, coal, ores, timber
Rio Tinto	Rio Tinto	Iron ore
BHP Billiton	BHP Billiton	Iron ore
Fortescue Metals Group	Fortescue Metals Group	Iron ore
Roy Hill Holdings	Roy Hill Holdings	Iron Ore
Queensland Rail	Queensland Rail, AirTrain CityLink Limited	Heavy Rail Passenger
NSW TrainLink (long distance, interstate, intrastate, urban intercity)	Sydney Trains, ARTC, John Holland Rail, V/Line, Queensland Rail	Heavy Rail Passenger
V/Line	V/Line, ARTC, Metro Trains Melbourne	Heavy Rail Passenger
Transwa	Transperth, Arc Infrastructure	Heavy Rail Passenger
Great Southern Railway	Sydney Trains, John Holland Rail, ARTC, Arc Infrastructure, Genesee & Wyoming Australia	Heavy Rail Passenger
Sydney Trains	Sydney Trains	Heavy Rail Passenger
Metro Trains Melbourne	Metro Trains Melbourne	Passenger
Adelaide Metro	Adelaide Metro	Heavy Rail Passenger
Transperth	Transperth	Heavy Rail Passenger
GoldLinQ	GoldLinQ	Light Rail Passenger
Transdev	Transport for NSW	Light Rail Passenger
Yarra trams	Yarra trams (Keolis Downer EDI Rail)	Light Rail Passenger
Adelaide Metro	Adelaide Metro	Light Rail Passenger

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

APPENDIX F

Urban heavy rail network maps – April 2017

Figure 59 Adelaide

Figure 60 Brisbane

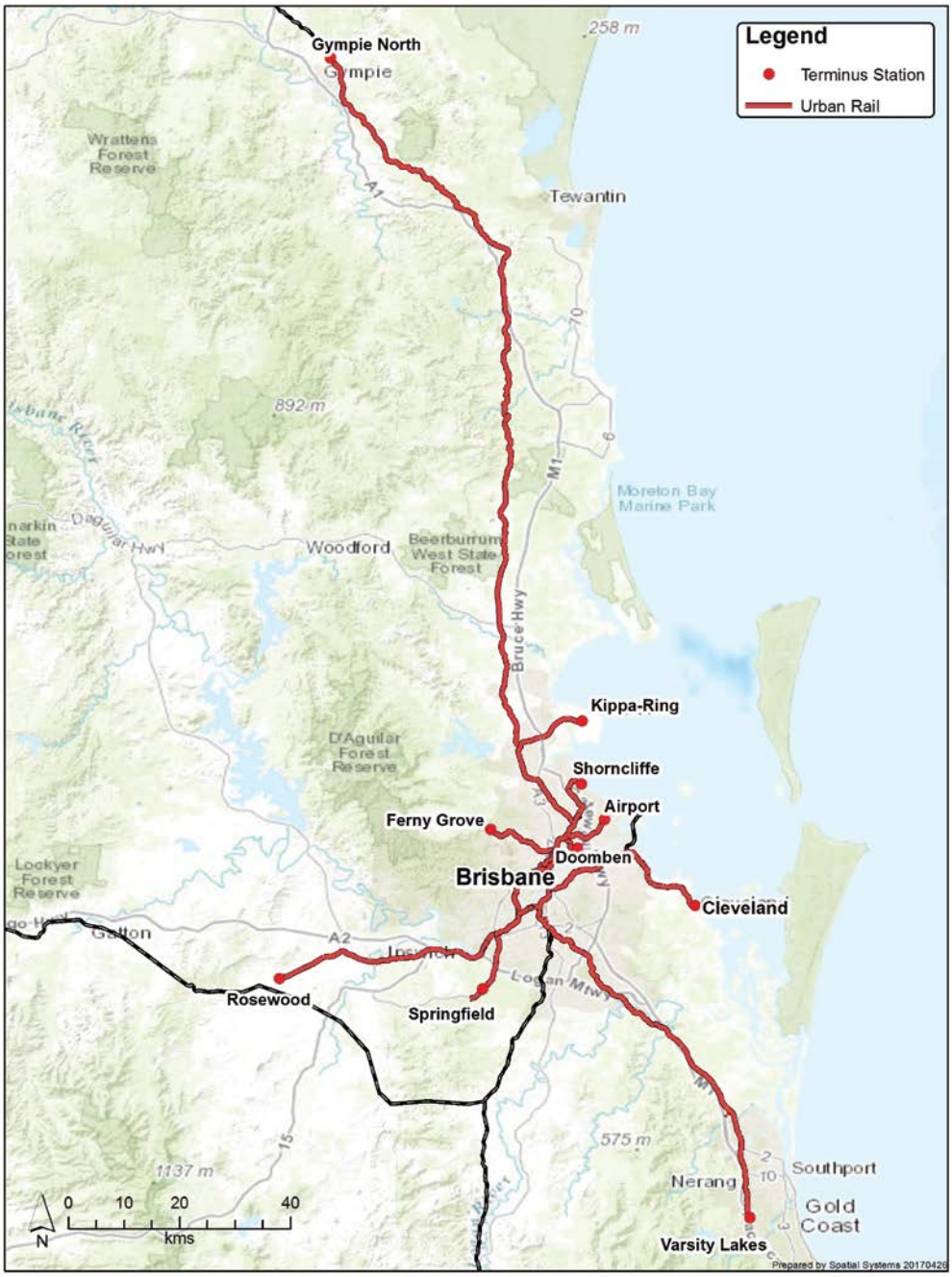


Figure 61 Melbourne

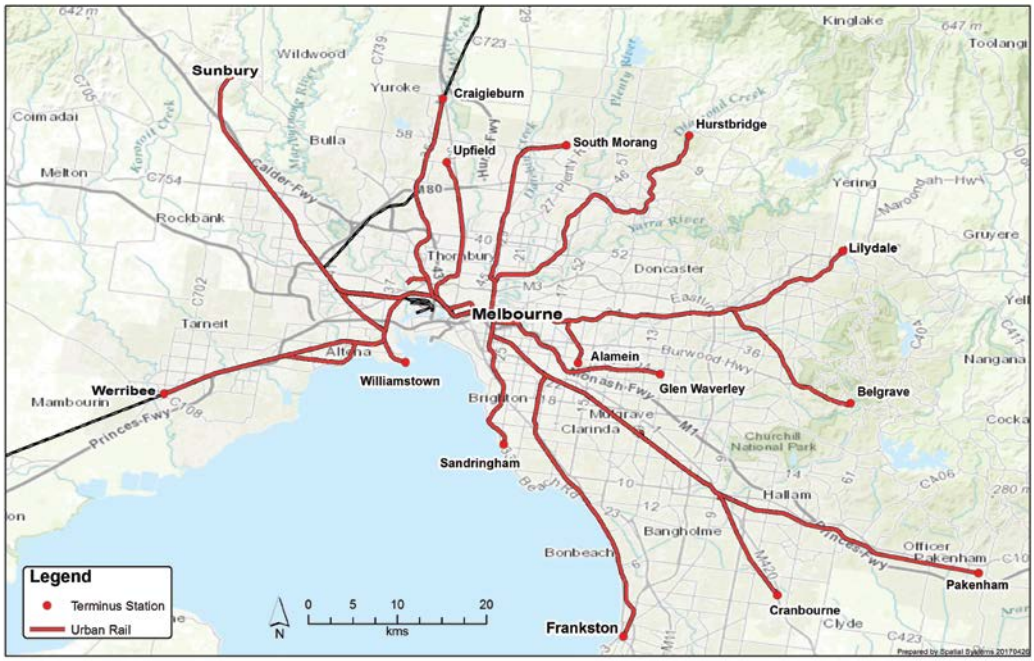
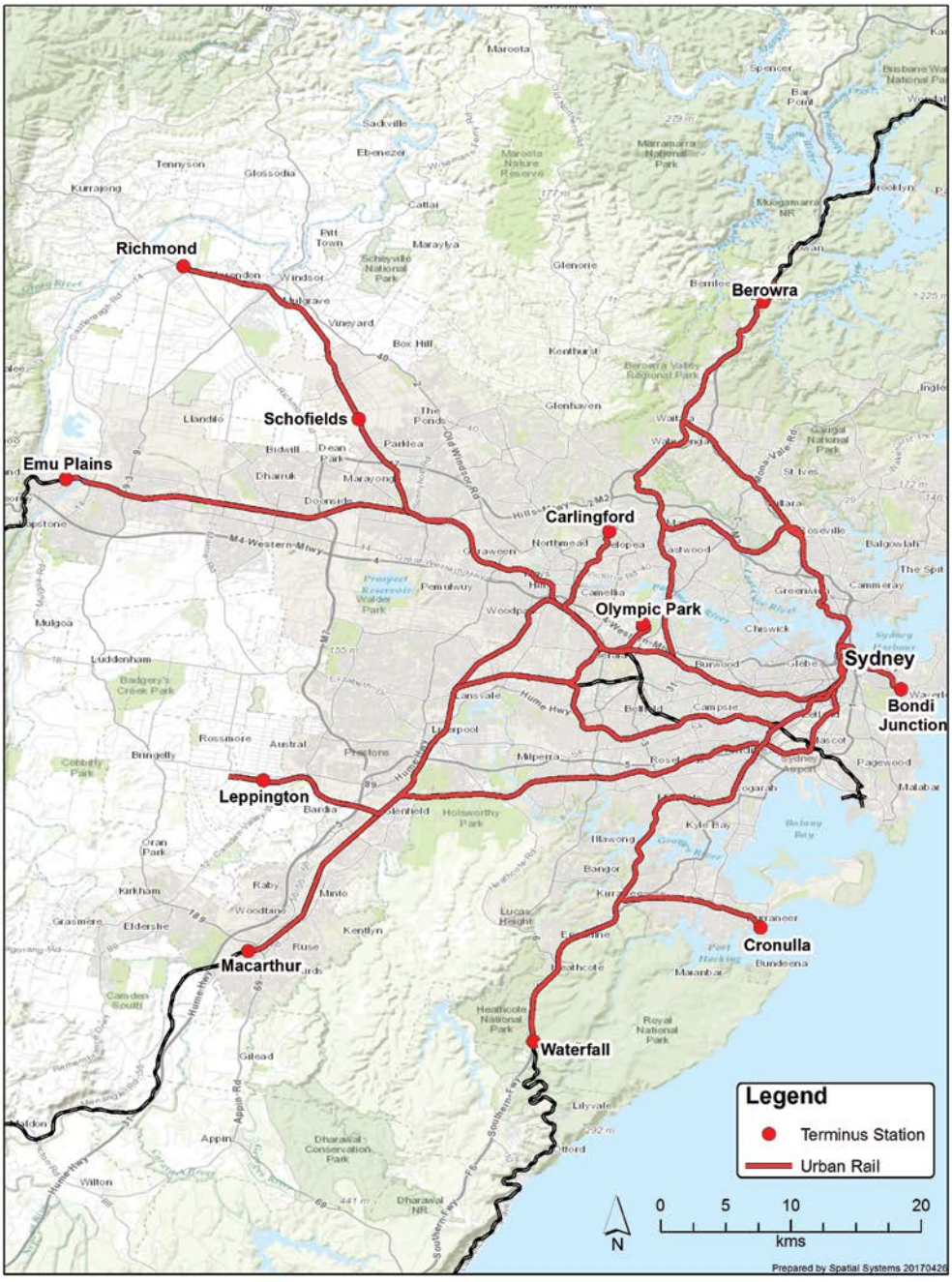


Figure 62 Perth

Figure 63 Sydney



References

ABARES – see Australian Bureau of Agricultural and Resource Economics and Sciences

ABC – see Australian Broadcasting Corporation

ABS – see Australian Bureau of Statistics

Adelaide Metro, 2017, Train Timetables, <https://www.adelaidemetro.com.au/timetables/trains>

Adelaide Metro, 2017a, Tram Timetable, < https://www.adelaidemetro.com.au/timetables/trams>

ARTC – See Australian Rail Track Corporation

ATSB—see Australian Transport Safety Bureau

Aurizon n.d., Australian Stock Exchange announcements, <http://www.aurizon.com.au/Investors-site/Pages/Financial-Results.aspx>

Aurizon 2016, *Aurizon Superfreighter Guide* <https://www.aurizon.com.au/~/media/aurizon/files/what%20we%20do/services/intermodal%20freight/guides/aurizon%20superfreighter%20guide%20october%202016.ashx>

Aurizon 2016a, *15/16 Annual Report* p.14, < https://www.aurizon.com.au/~/media/aurizon/files/investors/documents%20and%20webcasts/2016/full%20year%20results/annual%20report%202016.ashx>

Aurizon 2016b, Heavy Haul Operations at Aurizon – Integrated Solutions for Efficiency presentation at 2016 ARA Heavy Haul Rail Conference

Aurizon, n.d, <http://www.aurizon.com.au/Investors-site/Pages/Financial-Results.aspx>

Aurizon 2017, *Newlands system information pack* <https://www.aurizon.com.au/~/media/aurizon/files/what%20we%20do/network/network%20downloads/cqcn%20info%20packs/auz014_infopack_newlands_ia.pdf >

Aurizon 2017a, *Goonyella system information pack*, <https://www.aurizon.com.au/~/media/aurizon/files/what%20we%20do/network/network%20downloads/cqcn%20info%20packs/auz014_infopack_goonyella_ia_r1.pdf >

Aurizon 2017b, *Blackwater system information pack,* < http://www.aurizon.com.au/~/media/aurizon/files/what%20we%20do/network/network%20downloads/cqcn%20info%20packs/auz014_infopack_blackwater_ia.pdf>

Aurizon 2017c, *Moura system information pack*, <http://www.aurizon.com.au/~/media/aurizon/files/what%20we%20do/network/network%20downloads/cqcn%20info%20packs/auz014_infopack_moura_ia_r1.pdf>

Aurizon 2017d, *Aurizon 16/17 Annual Report*, < http://www.aurizon.com.au/~/media/aurizon/files/investors/documents%20and%20webcasts/2017/full%20year%20results/annual%20report%202017.pdf>

Australian Broadcasting Corporation 2017, *Road deliveries to Victorian ports exceed rail deliveries, and it's costing the grain industry* <http://www.abc.net.au/news/rural/2017-07-05/road-deliveries-to-victorian-ports-exceed-rail/8679808>

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2015, *Australia's what supply chains Infrastructure issues and implications* <http://data.daff.gov.au/data/warehouse/9aaw/2015/awscfd9aaw20150305/AustWheatSC_InfrstrctIssuesImplctns_20150305_V1.1.0.pdf>

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2017, *Australian Crop Report No. 182*, <http://data.daff.gov.au/data/warehouse/aucrpd9abcc003/aucrpd9aba_20170614_uPOax/AustCropRrt20170614_v1.0.0.pdf>

Australian Bureau of Statistics 2016, Census of population and housing – journey to work, <http://www.abs.gov.au/websitedbs/D3310114.nsf/Home/2016%20Census%20Community%20Profiles>

Australian Export Grains Innovation Centre 2014, *The cost of Australia's bulk grain export supply chains. An information paper,* <Online version no longer available>

Australian Export Grains Innovation Centre 2014a, *The cost of Australia's bulk grain export supply chains. Postscript Version 2014.1,* <Online version no longer available>

Australian Rail Track Corporation n.d., (search 'Hunter Valley Network Key Performance Indicator Report'

Australian Rail Track Corporation, 2014. Performance indicators 2007 interstate access undertaking – reliability, Adelaide, <https://www.artc.com.au/library/Reliability.pdf?260416>

Australian Rail Track Corporation, 2017, *Route Access Standard General Information*, <https://www.artc.com.au/uploads/RAS_General-Information.pdf?080617>

Australian Transport Safety Bureau 2013, Canberra, *Safety of rail operations on the interstate rail line between Melbourne and Sydney* <https://www.atsb.gov.au/media/4182477/ri-2011-015_final.pdf>

Avery, Rodney, *Great Rail Journeys of Australia,* Acacia Press, Brisbane, 2013

BITRE—see Bureau of Infrastructure, Transport and Regional Economics

BTRE—see Bureau of Transport and Regional Economics

Bombardier 2017, FLEXITY 2 Light Rail System – Gold Coast, Australia < http://www.bombardier.com/en/transportation/projects/project.flexity2-gold-coast-australia.html?f-region=all&f-country=fr&f-segment=all&f-name=all>

Bureau of Transport and Regional Economics 2006, *Optimising harmonisation in the Australian railway industry, Report 114*, <www.bitre.gov.au/publications/2006/files/report_114.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2009, *Road and rail freight: competitors or complements? Information sheet 34,* <http://www.bitre.gov.au/publications/2009/files/is_034.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2012, *Understanding Australia's urban railways, Research report 131,* <http://www.bitre.gov.au/publications/2012/files/report_131.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2012a, *Trainline 1,* Statistical report, <http://www.bitre.gov.au/publications/2012/train_001.aspx>

Bureau of Infrastructure, Transport and Regional Economics 2012b, *Population growth, jobs growth and commuting flows in Sydney,* Research report 132, <http://www.bitre.gov.au/publications/2012/report_132.aspx>

Bureau of Infrastructure, Transport and Regional Economics 2013, *Australia's bulk ports, Research Report 135,* <http://www.bitre.gov.au/publications/2013/files/report_135.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2014, *Improving regional passenger rail services, Research report 137*, <http://www.bitre.gov.au/publications/2014/files/report_137_Regional_Rail.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2014a, *Freightline 1 — Australian Freight Transport Overview,* <http://www.bitre.gov.au/publications/2014/files/Freightline_01.pdf>, Canberra

Bureau of Infrastructure, Transport and Regional Economics 2014b, *Freightline 2 — Australian Iron Ore Freight Transport,* <http://www.bitre.gov.au/publications/2014/files/Freightline_02.pdf>, Canberra

Bureau of Infrastructure, Transport and Regional Economics 2014c, *Urban transport: updated passenger trends, Information Sheet 59* < http://bitre.gov.au/publications/2014/files/is_059.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2014d, *Long-term trends in urban passenger transport—Information Sheet 60,* Canberra < https://bitre.gov.au/publications/2014/files/is_060.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2015, *Trainline 3*, <http://bitre.gov.au/publications/2015/files/trainline_003.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2016, *Australian Infrastructure Statistics Yearbook 2016,* https://bitre.gov.au/publications/2016/files/BITRE_yearbook_2016_statistics_full_report.pdf

Bureau of Infrastructure, Transport and Regional Economics 2016a, *Freightline 4,* <http://bitre.gov.au/publications/2016/Freightline_04.aspx>

Bureau of Infrastructure, Transport and Regional Economics 2016b, *Why short-haul intermodal rail services succeed* <http://bitre.gov.au/publications/2016/files/rr_139.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2016c, *Trainline 4*, <https://bitre.gov.au/publications/2016/files/train_004.pdf>

Bureau of Infrastructure, Transport and Regional Economics 2017, *Waterline 60* <https://bitre.gov.au/publications/2017/files/water_060.pdf>

Bureau of Transport and Regional Economics 2007, *Filling a gap in rail data: an investigation of the Gheringhap Loop train sightings* <http://www.bitre.gov.au/publications/2007/files/ip_057.pdf>

Clark, Peter, 2015, *An Australian Locomotive Guide Second Edition*, Rosenberg Publishing Pty. Ltd., Kenthurst

Currie, G and Burke, M 2013, *Light Rail in Australia - Performance and Prospects. Australasian Transport Research Forum,* <http://www.atrf.info/papers/2013/2013_currie_burke.pdf>

Department of Economic Development, Jobs, Transport and Resources, 2015 <http://economicdevelopment.vic.gov.au/__data/assets/pdf_file/0009/1191429/Murray-Basin-Rail-Project-Summary-Brochure.pdf>

Department of Planning, Transport and Infrastructure 2016, *Annual report 2015–16*, < https://dpti.sa.gov.au/__data/assets/pdf_file/0005/283973/DPTI_Annual_Report_2015–16_-_Final_version_without_Financial_Statements.PDF>

Department of Transport and Main Roads 2016, *Annual Report 2015-2016*, https://publications.qld.gov.au/dataset/2aa1d450-da8b-4432-9125-c8a775a973fb/resource/612b10db-51aa-4aa8-a4a3-661f09fcff92/download/annual-report-2015–16part1.pdf>

Department of Transport and Main Roads 2016a, *Rail Regulator's Report 2015–16*, < http://www.tmr.qld.gov.au/Safety/Rail-safety/Safety-reports>

Economics and Industry Standing Committee, WA Parliament Legislative Assembly, 2014, Inquiry into the management of Western Australia's freight rail network. <http://www.parliament.wa.gov.au/ publications/tabledpapers.nsf/displaypaper/3912300ad02cbe5f14cd9d0848257d74000d77af/$fi le/2300.pdf>

Fitzgerald, M 2014, "Container exports open market opportunities", *Grain business,* July, pp. 22–24, http://www.glencoregrain.com.au/uploads/Magazine/Glencore_026_GBM_Winter_2014_FINAL_LR.pdf

Flinders Ports 2017, <https://www.flindersports.com.au/ports-facilities/port-statistics/>

Fremantle Ports 2016, *Performance Management Framework,* <http://www.fremantleports.com.au/News/Publications/AnnualReport/Documents/2016%20Annual%Report%202%20-%20Performance.pdf>

Genesee & Wyoming 2017, *Genesee & Wyoming Reports Traffic for July 2017.* < http://ir.gwrr.com/press-release/carloads/genesee-wyoming-reports-traffic-july-2017>

Gladstone Ports Corporation 2017, < http://content1.gpcl.com.au/viewcontent/CargoComparisonsSelection/CargoOriginDestination.aspx?View=G&Durat=F&Key=2016>

Government of South Australia, 2017, < https://www.premier.sa.gov.au/index.php/stephen-mullighan-news-releases/7465-gawler-rail-electrification-project-underway-with-first-stage-of-tender-process>

G:link 2017, All Stations, <http://ridetheg.com.au/ riding-the-g/time-table/>

Grain Central 2017, *Eliminating choke points to build NSW grain rail capacity,* <https://www.graincentral.com/cropping/grains/eliminating-choke-points-to-build-nsw-grain-rail-capacity/>

Graincorp 2017, *Project Regeneration Building a better network* <http://www.graincorp.com.au/regeneration>

Grain Growers 2016, *State of the Australian Grains Industry 2016,* < http://www.graingrowers.com.au/media-centre/media-releases/685-new-report-reveals-a-largely-positive-story-of-the-australian-grains-industry>

Great Southern Rail 2017, <https://www.greatsouthernrail.com.au/fares-and-timetables/timetables>

HunterValley Coal Chain Coordinator < https://www.hvccc.com.au/DailyPlanning/Throughput%20Reports/Monthly%20Performance%20Report%202015-08-31%20NM.pdf>

Independent Pricing and Regulatory Tribunal 2012, *Review of access pricing on the NSW grain line network. Transport — Final Report,* <http://www.ipart.nsw.gov.au/files/0e7ce937-257b-4cbf-be52-a0d700fae160/Final_Report_-_Review_of_access_pricing_on_the_NSW_grain_line_network_-_April_2012.pdf>

Keys, E, 2016 *Light Rail Development in Australia 2012-2016,* <http://atrf.info/papers/2016/files/ATRF2016_Full_papers_resubmission_40.pdf>

International Transport Forum 2010, *Improving Reliability on Surface Transport Networks,* Paris, OECD

Mees, P and Groenhart, L 2012, *Transport policy at the crossroads: travel to work in Australian capital cities 1976–2011,* RMIT, Melbourne

Mid West Ports 2017, < https://www.midwestports.com.au/Assets/Documents/Document%20Centre/CompTradeStats/2017/Comparative-Trade-Report-June-2017.pdf>

New South Wales Government 2012, NSW Long Term Master Train Plan < https://www.transport.nsw.gov.au/sites/default/files/media/documents/2017/nsw-transport-masterplan-final.pdf>

New South Wales *Grain Freight Review 2009*, <http://investment.infrastructure.gov.au/publications/reports/pdf/NSW_Grain_Freight_Review_Final_report.pdf>

North Queensland Bulk Ports Corporation 2014, <http://nqbp.com.au/wp-content/uploads/2017/04/NQBP-Annual-Report-2013-2014.pdf>

North Queensland Bulk Ports Corporation 2016, <https://nqbpannualreport.com.au/port-logistics/#section-4>

NSW Ports 2017, <http://www.nswportsbotany.com.au/trade/trade-results/>

NSW Ports 2018, < https://www.nswports.com.au/assets/Uploads/CFC-Final-Minutes-June-2018.pdf>

NSW Trains 2016, 2015–16 *Annual Report Volume 1,* < https://www.transport.nsw.gov.au/sites/default/files/b2b/publications/annual_reports/nsw-trains-annual-report-2015–16-volume-1.pdf>

NSW TrainLink 2017, Our fleet, <http://www.nswtrainlink.info/your_journey/on_board/fleet>

NSW TrainLink 2017a, <http://www.nswtrainlink.info/timetables>

Oberg, Leon, 2016, "NSW budget's strong freight emphasis, *Track and Signal,* October-December 2016

Office of the National Rail Safety Regulator 2016, *Rail Safety Report 2015-2016*, <http://www.onrsr.com.au/__data/assets/pdf_file/0017/18800/Rail-Safety-Report-2015-2016-Web-Digital.pdf>

Pilbara Ports Authority, 2015 *Annual Report 2014-2015* < https://www.pilbaraports.com.au/PilbaraPortsAuthority/media/Documents/ABOUT%20THE%20PORT/Corporate%20Governance/Annual%20Reports/Pilbara-Ports-Authority-web.pdf>

Pilbara Ports Authority, *Annual Report 2015-2016,* <https://www.pilbaraports.com.au/PilbaraPortsAuthority/media/Documents/ANNUAL%20REPORTS/PPA%202015–16/PPA-AR-2016-reduced-size.pdf>

Pollard N 2012,"Moving NSW wheat: the post deregulation experience. Part one", *Railway Digest,* July, pp. 34–43; and "Moving NSW wheat: the post deregulation experience. Part two", Railway Digest, August, pp. 28–33

Port of Brisbane 2013, *Import/export logistics chain study. Summary report,* <http://www.qtlc.com.au/wp-content/uploads/2013/10/IMEX-Study.pdf>

Port of Brisbane 2016, *Monthly Trade Report June 2016,* <https://www.portbris.com.au/trade-logistics/trade-statistics>

Port of Newcastle 2015, *2015 Annual Trade Report,* <http://www.portofnewcastle.com.au/Resources/Documents/Trade-Report-2015---FINAL.pdf>

Port of Newcastle 2016, *Port of Newcastle 2016 Trade Report,* <http://www.portofnewcastle.com.au/Resources/Documents/Trade-Report-2016---Version-1---low-res.pdf>

Public Transport Authority of Western Australia 2014, *Annual Report 2013–14*, < http://www.pta.wa.gov.au/portals/0/annualreports/2014/docs/annual-report-sections-1-2.pdf>

Public Transport Authority of Western Australia 2016, *Annual Report 2015–16*, < http://www.pta.wa.gov.au/Portals/15/annualreports/2016/pdfs/PTA%20Annual_Report_2015–16_Full_Report.pdf>

Public Transport Victoria 2015, Murray Basin Project < http://ptv.vic.gov.au/assets/PTV/PTV%20docs/Projects/Murray-Basin-Rail-Project-Summary-Brochure.pdf>

Public Transport Victoria 2016, *Annual Report 2015–16* < https://static.ptv.vic.gov.au/PTV/PTV%20docs/AnnualReport/1477349157/PTV-Annual-Report-2016.pdf>

Public Transport Victoria 2017, Timetables, <http://ptv.vic.gov.au/timetables/standard>

Queensland Rail 2016, *Annual and Financial Report 2015-2016,* < https://www.queenslandrail.com.au/about%20us/Documents/Queensland%20Rail%20FY2015–16%20Annual%20and%20Financial%20Report%20-%20FINAL%20-%20LR.pdf>

Queensland Rail 2017, <http://jp.translink.com.au/travel-information/network-information/trains/all-timetables>, and <http://www.queenslandrailtravel.com.au/plan-your-trip/Rail%20Information/Timetables>

Queensland Rail 2017, Service punctuality and reliability, < http://www.queenslandrail.com.au/aboutus/ourperformance/service-punctuality-and-reliability>

Quinlan, H and Newland, J, 2000, *Australian railway routes: 1854 to 2000*, Australian Railway Historical Society (New South Wales Division), Redfern.

Rail Futures Institute 2017, *Cut the Crush on Geelong Trains!,* < http://www.railfutures.org.au/2017/08/cut-the-crush-on-geelong-trains/>

Rail Futures Institute 2017a, *What a Difference a Year Makes – Well 50 of them!!,* <http://www.railfutures.org.au/wp-content/uploads/2017/08/1708 18-Future-Rail-Newspost-3-v3b.pdf>

Rail Geelong 2016, <http://www.railgeelong.com/lineguide/geelong/diagram/page-1>

Railpage 2017, www.railpage.com.au

Railway Digest, April 2016

Railway Digest, September 2016

Railway Digest, February 2017

Railway Digest, July 2017

Railway Digest 2017a

Railway Gazette, 31 August 2016, <http://www.railwaygazette.com/news/freight/single-view/view/aurizon-launches-sydney-port-shuttle.html>

Railway Gazette International, September 2016

Salt, B 2013, "GFC to blame as city-flickers play follow the jobs" *The Australian,* 18 July 2013

Securities and Exchange Commission (USA), web site for Genesee & Wyoming filings, <http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=0001012620&owner=include&count=40&hidefilings=0>

Southern Ports, 2017, <http://www.epsl.com.au/statistics.asp >

Strategic Design and Development 2009, *Report prepared for Freight and Logistics Council of Western Australia on behalf of the Strategic Grain Network Committee,* <www.transport.wa.gov.au/mediaFiles/rail-freight/freight_Strategic_Grain_Network_Report.pdf>

Sydney Trains 2016, Our Performance, <http://www.sydneytrains.info/about/our_performance/otr_year.jsp>

Sydney Trains 2017 Our Fleet, <http://www.sydneytrains.info/about/fleet/>

Sydney Trains 2017a, Timetables <http://www.sydneytrains.info/timetables/#landingPoint>

TasRail 2016, *Annual report 2015/16,* <https://www.tasrail.com.au/client-assets/downloads/annual_reports/2016_Annual_Report_(no_financials).pdf>

The Age, 2015 <http://www.theage.com.au/victoria/labor-puts-brakes-on-port-rail-project-that-would-take-3500-trucks-off-road-20150916-gjo7c3.html>

Translink 2017, <http://jp.translink.com.au/travel-information/network-information/trains/all-timetables>

Transperth 2017, <http://www.transperth.wa.gov.au/Timetables>

Transport Enthusiasts Society of South Australia 2016, <http://www.users.on.net/~wisp/TESSA/AdelaideTrams.html> (link no longer available)

Transport for NSW 2016, < https://www.transport.nsw.gov.au/newsroom-and-events/media-releases/budget-focuses-on-freight>

Transport for NSW 2016a, <https://www.transport.nsw.gov.au/newsroom/media-releases/new-country-train-program-accelerated>

Transport for NSW 2017, Northern Sydney Freight Corridor Program, <https://www.transport.nsw.gov.au/projects/programs/northern-sydney-freight-corridor-program>

Transport for NSW 2017, Light Rail Services, <https://transportnsw.info/documents/timetables/L1-Dulwich-Hill-Line-20170123.pdf>

Transport, Housing and Local Government Committee (Queensland) 2014, *Rail freight use by the agriculture and livestock industries, Report No. 45,* < http://www.parliament.qld.gov.au/documents/committees/THLGC/2014/INQ-RAIL/rpt_rail_16June2014.pdf>

Transwa 2017, <https://www.transwa.wa.gov.au/Bookings/Timetables>

Victoria Budget 2017, <https://www.budget.vic.gov.au/priority/public-transport>

VicSig 2017, Track Class < http://vicsig.net/index.php?page=infrastructure&article=track-class>

VicSig 2017a, Suburban rolling stock, <http://vicsig.net/suburban/fleet>

VicSig 2017b, Passenger <http://vicsig.net/index.php?page=passenger>

V/Line 2016, *Annual Report 2015-2016,* < https://corporate.vline.com.au/getattachment/6ad4 1cbe-17f6-489c-9fac-d65a 1a627 13 1/Annual-Report-2015–16>

V/Line 2017, <https://www.vline.com.au/About-V-Line/Performance>

V/Line 2017a, <https://www.vline.com.au/Timetables/Train-coach-timetables/>

Yarra Trams 2017, <http://yarratrams.com.au/about-us/who-we-are/facts-figures/>

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ISBN: 978-1-925531-80-0