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Bureau of Infrastructure, Transport and Regional Economics

AUSTRALASIAN RAILWAY ASSOCIATION

STATISTICAL REPORT

Rail bitre

Trainline 7

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

Trainline 7

Statistical Report

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Foreword

Trainline 7 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 7* also has a case study on light rail in Canberra.

The *Trainline* series are a collaboration between BITRE and the Australasian Railway Association (ARA).

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 Canberra Metro and Transport Canberra in preparing this year's case study.

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December 2019

At a glance

Results

- In 2017–18, freight tonnages reported by infrastructure managers ('below-rail') tonnages declined on most sectors of the interstate network, both intermodal and other freight. This occurred on both the North—South and East—West corridors.
- National level tonnages reported by train operators ('above-rail') are no longer available due to a lack of data provision.
- Scheduled intermodal freight train transit times on the ARTC and Arc Infrastructure interstate corridors in 2019 were largely unchanged from 2018.
- There has been a decline in the number of scheduled Melbourne to Perth and Perth to Melbourne services. There has been a significant decline in the number of Melbourne to Brisbane and Brisbane to Melbourne services but there has been an introduction of Melbourne to Sydney services (where previously there were none) and an increased number of Sydney to Melbourne services.
- Total urban heavy rail patronage for 2017–18 was 726.4 million passenger journeys, while for light rail there was 235.4 million passenger journeys.
- Patronage grew on all urban heavy rail networks in 2017–18 (compared to the previous financial year), except Perth, which had a minor ongoing decline. Brisbane had the greatest patronage growth, at five per cent. Growth in Sydney, Melbourne, and Adelaide was below two per cent each.
- Sydney still has Australia's busiest urban heavy rail passenger network, with approximately 359.2 million passenger journeys in 2017–18.
- There was modest growth in light rail patronage in all cities that had light rail services in 2017–18.
- In 2019, Sydney's Northwest Metro opened to revenue services, as did light rail services in Canberra and Newcastle.
- Non-urban rail patronage grew in all states that provide these services, except Western Australia, where patronage continued to decline, and Queensland, that had a minor decline. New South Wales (Trainlink) intercity services had the highest increase, at almost 10 per cent, while regional and interstate Trainlink services had a small patronage decline.
- Most cities exceeded their urban heavy and light rail punctuality targets, while non-urban punctuality results were poorer.
- There were 104 notified fatalities on Australian railways that the Office of the National Rail Safety Regulator regulates.
- Approximately 45.6 thousand people work in the Australian rail industry.

Railway networks and assets

- Australia has an estimated 32 900 route-kilometres of operational heavy railways, approximately 10 per cent of which is electrified.
- Almost the entire Eyre Peninsula (narrow gauge) network became non-operational in May 2019.
- Australia has 314 route-kilometres of operational light rail/tramways.
- Melbourne has Australia's largest heavy and light rail urban passenger networks at an estimated 413 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 for export and to cities for domestic consumption. There are approximately 4 700 route-kilometres of operational railway that are largely or exclusively used for grain haulage.
- In September 2019, there was an estimated 2005 operational locomotives in Australia, which is roughly the same as 2018. Approximately 50 per cent of the fleet is aged 12 years or less, compared to approximately 11 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. This includes:

- **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 tram/light rail network, Sydney, Adelaide, and the Gold Coast's light rail networks are expanding. Light rail services have commenced in Canberra and Newcastle.
- **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 movement from rail heads to ports.
- **Commodity flows.** Australia is a major exporter of iron ore and coal, with virtually all of this being transported 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, the introduction of driverless metro trains in Sydney, improvements in vehicle design and performance, 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 Canberra's light rail network and services.

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 is provided in BITRE's annual *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 summarises passenger transport.

Overview

Railways excel at 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).

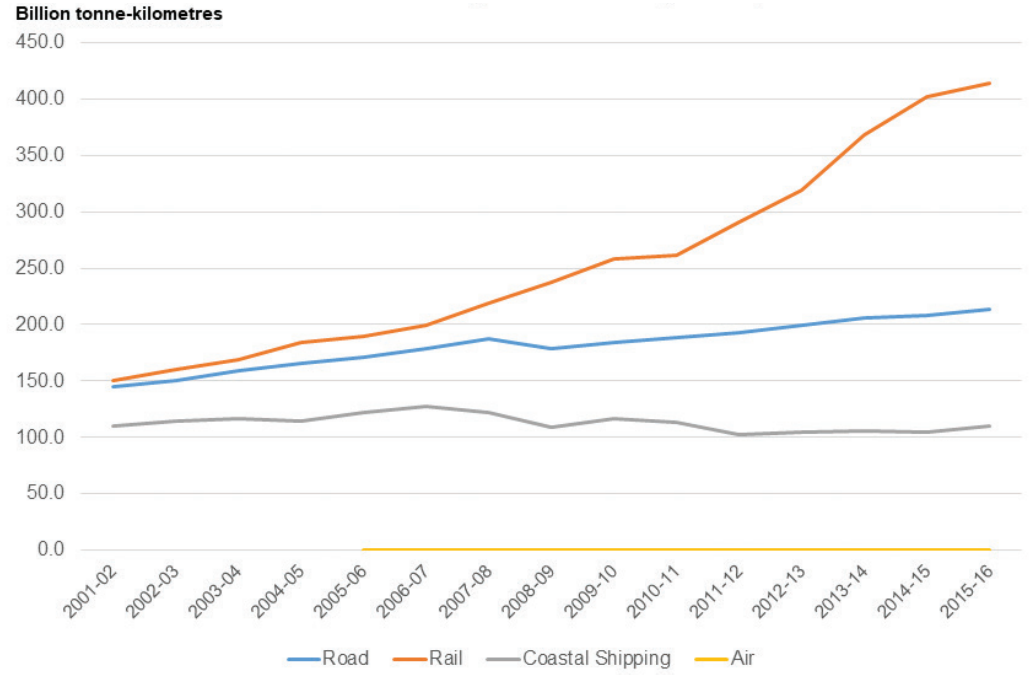
Rail transport's role in the Australian economy has increased sharply in recent years; see Figure 1. Rail now accounts for more than one-half of Australian freight transport activity, up from approximately 36 per cent at the turn of the century. Rail freight transport's strong position is primarily founded 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 net tonne kilometres (NTK) 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 sugar and timber, especially to ports, as well as containerised export agricultural commodities. 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 (2017), (Table T2.1c, p.55).

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 faces greater competition from road transport, 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. The Murrumbidgee Irrigation Area (Griffith and south-west New South Wales) to Melbourne is one example.

4 This is still the latest available estimate.

National rail freight task, tonnes

Due to an ongoing data shortage following one major operator's decision not to provide BITRE and the ARA with details of its annual tonnages5, Trainline is unable to report the national rail freight task. Table 1, below, shows reported tonnages until 2015–16.

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
2011–12	-	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	1 347 451 934	413 489 935

Notes: The table excludes traffic data for some of the smaller train operators, such as Sydney Rail Services.
Data for 2010–11, 2011–12, and 2016–17 are not available.

Sources: BITRE estimates; Previous Trainline editions that sourced operator provided data.

5 BITRE and ARA are only able to obtain operators' data by voluntarily contribution.

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, 2011–12, and 2016–17 are not available.

Sources: BITRE estimates; (BITRE 2012a; 2014; 2015); 2015–16 data was provided by Pacific National, Aurizon, Fortescue Metals Group, BHP, Rio Tinto, Roy Hill Holdings, Genesee & Wyoming Australia (including r), 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 either placed on container wagons, transported in an enclosed wagon (for example, SCT Logistics) or transported on a wagon with a secure fastening capability. 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', where 'intermodal' is generally considered to be containerised freight or freight in a louvre wagon. Steel may also be deemed intermodal, particularly on Pacific National trains that carry both intermodal and steel products on intermodal designated trains.

National freight task, by operator

There is some publicly-available data that reports national rail freight activity. Aurizon provides 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), does not publish data publicly as it is not a publicly listed company, hence there is no Pacific National data after 2015–16.

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 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		15.4[a]	12.2	n/a	n/a
2017–18	n/a	n/a	n/a	n/a	50.4		13.4		63.8	n/a
2018–19	n/a	n/a	n/a	n/a	50.5		8.5		59	n/a

Sources: Aurizon (2019, pp.15, 17); Previous *Trainline* editions that sourced ASX data.

Note: [a] Bulk for the 2016–17 and 2017–18 financial years includes iron ore. For the 2018–19 year bulk comprised agricultural products, and mining and industrial inputs.

Since 2017–18, Aurizon has reported its above rail results as coal and bulk only.

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

In addition to measuring freight transport by tonnes and NTKs, transport by twenty-foot equivalent (TEU) units of shipping containers provides another measure, where available. This measure shows freight activity by volume rather than weight. As Table 3 shows, *Trainline* has reported Pacific National and Aurizon's TEU results. As Pacific National no longer reports to the ASX and Aurizon has ceased intermodal operations, this and future editions of Trainline cannot report this metric.

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 3 Train operator traffic trends (TEUs (000))

Period	Pacific National[a]	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
2017–18	n/a	266.0[b]	n/a

Note: [a] The historical Pacific National figures 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.

[b] Aurizon ceased interstate intermodal operations in December 2017.

Sources: Aurizon (2018 p.21); previous *Trainline* editions that sourced ASX data.

The Genesee and Wyoming parent company reports its results to the New York Stock Exchange. It reports its volumes as carloads rather than tonnages (Table 4).

Table 4 Genesee and Wyoming Australia (carloads)

Period	2017 calendar year	2018 calendar year	Change (per cent)
Agricultural Products	51 909	37 348	-28.05%
Coal and Coke	359 791	393 664	9.41%
Intermodal	58 848	55 716	-5.32%
Metallic Ores	29 458	23 737	-19.42%
Minerals and Stone	51 872	66 176	27.58%
Petroleum Products	277	284	2.53%
Total Carloads	**552 155**	**576 925**	**4.49%**

Source: (Genesee and Wyoming 2019).

Tasrail reports its freight task in its annual report. Table 5, below, shows and compares Tasrail's freight task for the 2016–17 and 2017–18 financial years.

Table 5 Tasrail freight task (net tonne kilometres)

Period	2016/17	2017/18	Change (per cent)
Coal	44 863 564	42 601 177	-5.04%
Cement	28 136 132	25 976 894	-7.67%
Mineral concentrates	22 923 272	22 810 917	-0.49%
Logs	19 285 427	23 989 688	24.39%
Intermodal general	229 820 283	246 889 952	7.43%
Intermodal paper	127 867 540	126 246 955	-1.27%
Total	**472 896 217[7]**	**488 515 583**	**3.3%**

Source: Tasrail 2018, p.20.1

7 The total does not balance due to rounding of decimals.

Box 1 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 2018, pp. 20–22)

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 62 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 2019; Aurizon 2019a;
- 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[8].

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 also presents freight flows by commodity (BITRE 2014a and BITRE 2014b, BITRE 2016, BITRE 2018).

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).

8 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).

Intermodal freight rail operator feedback

In September 2019, BITRE contacted the following intermodal freight rail operators, seeking their feedback on the challenges and opportunities facing intermodal freight rail operations in Australia:

- Pacific National;
- QUBE Holdings;
- Southern Shorthaul Railroad;
- SCT Logistics;
- Crawfords Freightlines; and
- Genesee and Wyoming Australia.

Two operators gave feedback[9], which is reported below:

- Red tape. While accepting the need for regulation, the feedback stated it was to such a depth that it erodes operational efficiencies and dissuades investment. One respondent noted that red tape is not a problem rail transport alone faces. Such red tape is mostly at the state and local government levels. The degree of red tape is such that it can require several staff members to manage it full time, as their sole duties. According to the feedback, while an operator is already complying with existing regulations, regulatory bodies (appear to) apply new regulations or interpretation of existing regulations that the operators could not have reasonably foreseen and to which they must respond. The following examples given in the feedback illustrate:
  - How much noise bogies make in a freight terminal on weekends;
  - Having development applications to local government rejected because of the applicant's choice of font used in the application, and their choice of cover photos.
- Development applications. The feedback indicated there are problems particularly at local government level, which frequently hampers construction of new rail facilities, such as freight terminals. To obtain approval for development (of a freight terminal) to proceed, some local councils impose such conditions that it makes a planned development unviable. The time taken for an application to be determined in NSW blows out further when an application must be referred to the NSW Independent Planning Commission, which routinely happens, for determination[10]. The time taken for the Commission to make a determination can be lengthy, which protracts matters further. One respondent stated investment funds tend to follow the path of least resistance. Red tape and the difficulty of having development applications approved creates such resistance, with the result some investors choose to invest their funds elsewhere.
- Restrictions on using old locomotives due to emissions requirements in NSW. This restricts the use of old but light locomotives on branch lines. Because only the older (and lighter) locomotives are capable of operating on such branch lines, this effectively means no trains can operate on such branch lines. The newer locomotives are too heavy, while the older locomotives are too polluting.
- Road transport competition. Both respondents noted the growing freight task by trucks, due both to road access reform and new road infrastructure. This has allowed increasingly large trucks to operate between Melbourne and Sydney. Progressive duplication of the Pacific

9 The feedback reported here is entirely that which the operators provided. These comments are not BITRE advocacy.
10 The criteria for referral to the Commission is: there have been 25 or more public objections to the application, or the local council has objected, or a reportable political donation has been made, the local council has objected.

Highway, between Sydney and Brisbane, is reducing road transit times. These changes have reduced rail's market share on the Melbourne-Sydney corridor. Disparate user charges heavily favour road transport, enabling them to provide transport at a much lower rate than rail transport. One respondent claimed intermodal transport by rail between Melbourne and Sydney is 'almost dead', with a claimed mode share of less than one per cent.

- Substandard infrastructure and poorly executed projects not only fail to achieve their planned benefits but can actually make the original problem worse. One respondent cited the Victorian Murray Basin Project as an example. While the Ararat to Maryborough line has been re-built to high quality standards, the choice to use 100 year old recycled rail cancelled out the benefits that would otherwise be obtained.
- Sydney port access and track congestion means rail freight operators only have a narrow window to get their trains through suburban Sydney and into Port Botany. If they miss that window they can be delayed many hours. The worst case consequence of such delays is a ship that was to take the freight leaves port before the train can arrive. Duplicating the 2.9 kilometre section of single line between Mascot and Botany would help ease the problem.
- Track access fees vary significantly between some infrastructure managers, to the point in one location where some capital city to capital city freight is offloaded from trains and placed onto trucks for the remaining distance.
- One respondent said the commenced but not finished Maldon—Dombarton line needs completing as passenger traffic between Sydney and Wollongong is growing and it is increasingly difficult to move freight to Nowra.
- One respondent wanted to see the scope of the Office of National Rail Safety Regulator (ONRSR) expanded to give it a wider range of consistent regulatory powers, similar to the National Heavy Vehicle Regulator. This would remove the inefficiencies of having to comply with multiple regulations on a state by state basis.

Interstate network traffic

This section reports interstate freight traffic flows by line segment based on below-rail (infrastructure manager) provided data. It only includes tonnages on the interstate network that ARTC and Arc Infrastructure each manage. Table 6 and Table 7 shows intermodal and total gross tonnes by line segment, with line segments ordered from north to south and east to west. Figure 3, Figure 5, Figure 6 and Figure 7 also show the data. ARTC's data excludes regional import/export trains that join the network at such locations as Harefield (Junee), but includes regional/export traffic that is attached/detached to/from interstate intermodal trains en route. Wimmera Container Line export agricultural produce from Doen (near Horsham) in Victoria is an example.

There are four factors to note when reviewing the tonnages. Where freight 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 6 Below-rail gross tonnes by line segment, North-south corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2015–16	2016–17	2017–18	2015–16	2016–17	2017–18
Acacia Ridge to Casino	2.63	2.94	3.00	2.82	3.09	3.01
Casino to Acacia Ridge	4.02	4.48	4.63	4.26	4.63	4.65
Acacia Ridge – Casino	6.65	7.43	7.63	7.09	7.72	7.66
Casino to Maitland	2.65	2.96	3.02	3.53	3.64	3.29
Maitland to Casino	4.02	4.50	4.64	5.01	5.22	4.96
Casino–Maitland	6.68	7.46	7.66	8.53	8.86	8.25
Macarthur to Tahmoor	4.35	4.73	4.75	8.71	9.44	9.33
Tahmoor to Macarthur	4.56	4.92	4.86	12.79	14.45	14.61
Macarthur–Tahmoor	8.91	9.66	9.61	21.51	23.88	23.94
Moss Vale to Tahmoor	4.56	4.92	4.85	15.61	17.61	17.71
Tahmoor to Moss Vale	4.36	4.73	4.73	9.53	10.48	10.37
Tahmoor – Moss Vale	8.92	9.65	9.58	25.14	28.09	28.08
Moss Vale to Marulan	4.48	4.89	4.85	10.20	12.13	11.11
Marulan to Moss vale	4.58	4.96	4.89	16.96	21.34	18.67
Moss Vale – Marulan	9.07	9.85	9.74	27.16	33.47	29.77
Marulan to Goulburn	4.48	4.89	4.89	8.08	9.72	8.70
Goulburn to Marulan	4.58	4.96	4.85	10.38	13.85	10.96
Marulan–Goulburn	9.07	9.85	9.74	18.46	23.58	19.66
Goulburn to Cootamundra	4.48	4.89	4.89	6.45	7.44	6.18
Cootamundra to Goulburn	4.58	4.96	4.86	9.19	11.35	8.14
Goulburn–Cootamundra	9.06	9.85	9.74	15.63	18.80	14.32
Cootamundra to Junee	3.04	3.64	3.70	5.54	6.87	5.22
Junee to Cootamundra	2.72	3.16	3.13	6.08	7.28	5.53
Cootamundra–Junee	5.76	6.80	6.83	11.62	14.15	10.75
Junee to Albury	3.04	3.64	3.70	6.14	7.32	6.59
Albury to Junee	2.72	3.16	3.14	6.23	7.23	6.52
Junee–Albury	5.76	6.80	6.84	12.37	14.55	13.11
Albury to Tottenham	3.04	3.64	3.70	5.64	7.22	6.35
Tottenham to Albury	2.72	3.13	3.07	4.41	5.17	4.50
Albury–Tottenham	5.76	6.77	6.77	10.06	12.39	10.85

Notes: Totals are subject to rounding.

Source: Data provided by ARTC.

Table 7 Below-rail gross tonnes by line segment, East-West corridor

	Intermodal			Total		
	2015–16	2016–17	2017–18	2015–16	2016–17	2017–18
Cootamundra to Parkes	1.45	1.26	1.21	2.51	2.91	2.18
Parkes to Cootamundra	1.87	1.81	1.74	4.24	5.93	3.55
Cootamundra–Parkes	3.33	3.07	2.95	6.75	8.85	5.72
Parkes to Broken Hill	2.40	2.27	2.22	2.85	2.79	2.78
Broken Hill to Parkes	2.64	2.46	2.37	3.59	3.68	3.36
Parkes – Broken Hill	5.04	4.73	4.59	6.44	6.47	6.14
Broken Hill to Crystal Brook	2.43	2.26	2.19	4.42	4.05	4.32
Crystal Brook to Broken Hill	2.63	2.45	2.38	3.31	3.07	3.18
Broken Hill – Crystal Brook	5.06	4.71	4.57	7.73	7.12	7.50
Tottenham to Dimboola	3.29	4.27	4.55	5.43	6.77	6.80
Dimboola to Tottenham	3.99	3.37	3.98	5.52	7.92	8.91
Tottenham–Dimboola	7.29	7.64	8.53	10.95	14.69	15.71
Dimboola to Tailem Bend	4.01	4.13	4.08	4.45	4.88	4.82
Tailem Bend to Dimboola	3.31	3.24	3.46	3.58	3.72	3.78
Dimboola – Tailem Bend	7.31	7.38	7.54	8.03	8.60	8.60
Tailem Bend to Dry Creek	4.04	4.17	4.13	4.50	4.93	4.91
Dry Creek to Tailem Bend	3.34	3.27	3.50	3.61	3.75	3.82
Tailem Bend – Dry Creek	7.37	7.44	7.64	8.11	8.68	8.73
Dry Creek to Crystal Brook	5.42	5.55	5.23	7.21	7.49	7.10
Crystal Brook to Dry Creek	4.38	4.55	4.62	8.91	10.00	9.42
Dry Creek – Crystal Brook	9.81	10.10	9.85	16.12	17.49	16.52
Crystal Brook to Port Augusta	7.33	7.29	7.19	8.83	8.96	8.43
Port Augusta to Crystal Brook	6.54	6.48	6.76	8.31	9.30	8.42
Crystal Brook – Port Augusta	13.87	13.77	13.95	17.13	18.25	16.85
Port Augusta to Tarcoola	7.73	7.71	7.52	8.05	8.15	7.52
Tarcoola to Port Augusta	6.59	6.65	6.82	7.19	8.26	7.39
Port Augusta – Tarcoola	14.33	14.36	14.34	15.25	16.41	14.91
Tarcoola to Kalgoorlie	5.78	5.85	5.81	6.07	5.99	5.75
Kalgoorlie to Tarcoola	4.44	4.48	4.52	4.98	5.04	5.01
Tarcoola – Kalgoorlie	10.22	10.33	10.32	11.05	11.02	10.75
Kalgoorlie to West Kalgoorlie	n/a	5.55	5.01	n/a	7.15	7.07
West Kalgoorlie to Kalgoorlie	n/a	4.45	4.15	n/a	6.06	6.23
Kalgoorlie – West Kalgoorlie	n/a	10.00	9.16	n/a	13.21	13.30
West Kalgoorlie to Koolyanobbing East	n/a	5.48	4.94	n/a	16.00	13.58
Koolyanobbing East to West Kalgoorlie	n/a	4.42	4.10	n/a	21.96	17.82
West Kalgoorlie – Koolyanobbing East	n/a	9.90	9.04	n/a	37.97	31.39
Koolyanobbing East to West Merredin	n/a	5.47	4.94	n/a	13.02	11.48
West Merredin to Koolyanobbing East	n/a	4.41	4.10	n/a	7.97	7.87
Koolyanobbing East – West Merredin	n/a	9.89	9.04	n/a	20.99	19.35
West Merredin to Avon	n/a	5.48	4.94	n/a	14.95	13.03
Avon to West Merredin	n/a	4.42	4.10	n/a	8.52	8.29
West Merredin – Avon	n/a	9.90	9.04	n/a	23.47	21.32
Avon to Toodyay West	n/a	5.48	4.94	n/a	19.71	15.90
Toodyay West to Avon	n/a	4.40	4.10	n/a	9.77	9.07

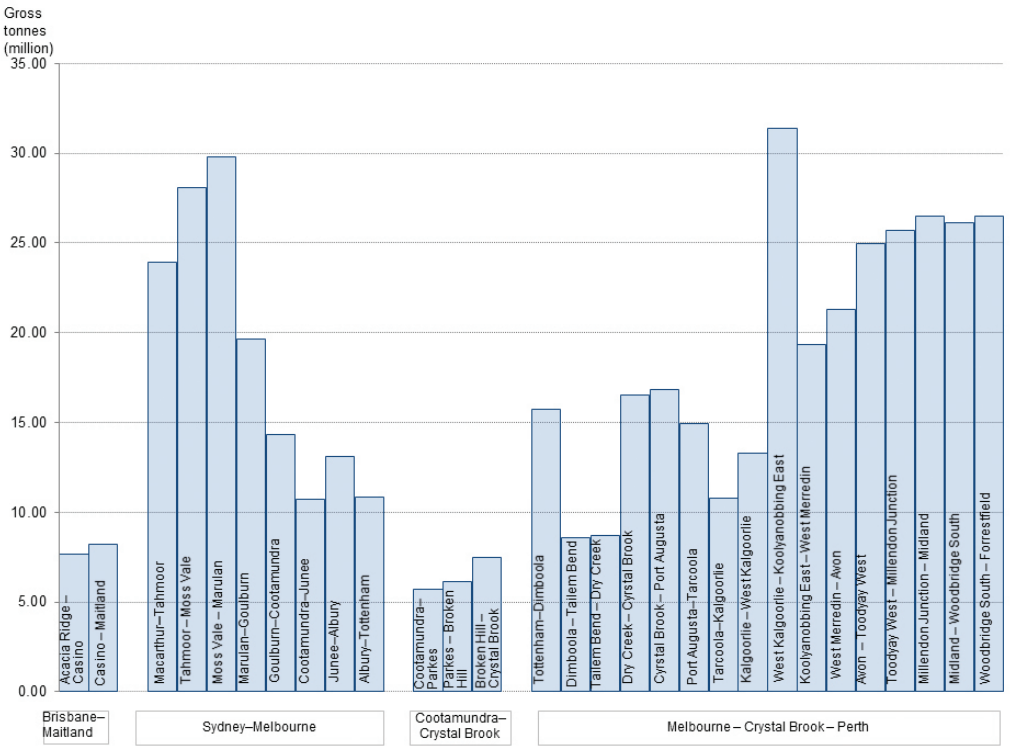
(Continued)

	Intermodal			Total		
	2015–16	2016–17	2017–18	2015–16	2016–17	2017–18
Avon – Toodyay West	n/a	9.88	9.04	n/a	29.49	24.97
Toodyay West to Millendon Junction	n/a	5.48	4.94	n/a	20.21	16.45
Millendon Junction to Toodyay West	n/a	4.41	4.10	n/a	9.93	9.24
Toodyay West – Millendon Junction	n/a	9.89	9.04	n/a	30.15	25.69
Millendon Junction to Midland	n/a	5.48	4.94	n/a	20.94	17.09
Midland to Millendon Junction	n/a	4.41	4.10	n/a	10.16	9.43
Millendon Junction – Midland	n/a	9.89	9.03	n/a	31.10	26.52
Midland to Woodbridge South	n/a	5.48	4.94	n/a	20.74	16.90
Woodbridge South to Midland	n/a	4.42	4.11	n/a	9.95	9.25
Midland – Woodbridge South	n/a	9.92	9.05	n/a	30.69	26.14
Woodbridge South to Forrestfield	n/a	5.51	4.95	n/a	20.90	17.06
Forrestfield to Woodbridge South	n/a	4.43	4.12	n/a	10.11	9.41
Woodbridge South – Forrestfield	n/a	9.94	9.07	n/a	31.01	26.47

Notes: Totals are subject to rounding. Arc Infrastructure has revised its calculation methodology and now includes Kalgoorlie – West Kalgoorlie. This new methodology applies from 2016–17 data.

Sources: Data provided by ARTC and Arc Infrastructure.

Figure 3 Total below rail gross tonnes on the interstate network, by line segment, 2017–18



Sources: Data provided by ARTC and Arc Infrastructure.

The following explains some variations in intermodal traffic, in addition to market factors:

- Changing intermodal train composition. ARTC-provided intermodal tonnages are calculated from train type designations (for example 'intermodal' or 'steel') that trains use, not on the actual products each train carries. Some Pacific National intermodal designated trains also 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). Steel trains also operate between Melbourne and Port Augusta and Perth. On the North-South corridor, there are also steel movements 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).
- Some intermodal rail traffic originates/terminates in terminals at Parkes/Goobang for the East–West Corridor (via Broken Hill). SCT Logistics, for example, generally operate one Goobang—Crystal Brook train per week in each direction.
- Higher intermodal traffic volumes west of Crystal Brook, where the Melbourne/Adelaide and Sydney/Parkes traffic to and from Perth and Darwin share the track.
- Intermodal flows fall to the west of Tarcoola; the junction with the Darwin line.
- Interstate capital city to capital city intermodal trains sometimes pick up and drop off freight at regional locations en route (for example the Logic terminal at Barnawartha in Victoria and Ettamogah in New South Wales).

Figure 4 Pacific National steel train

Note: The image above shows a Wollongong to Melbourne steel train at the 378 kilometre post mark from Sydney, near Harden, NSW. Photo courtesy of Rodney Avery.

According to ARTC's data, below-rail intermodal tonnages on the North—South corridor increased slightly on the Brisbane—Sydney sectors, in both directions of travel. According to advice from ARTC, these increases were partly driven by increased construction related material volumes. Between Sydney and Melbourne, changes were more benign. Some sectors had small increases, while others sectors had minor decreases.

On the East-West Corridor, intermodal freight volumes grew on some sectors and declined on others in 2016–17. Between Parkes and Crystal Brook, intermodal tonnages declined on all sectors in both directions of travel. Most Melbourne—Adelaide sectors had growth, up to 18 per cent for Dimboola to Tottenham. Dimboola to Tailem Bend and Tailem Bend to Dry Creek had minor decreases.

All eastbound sectors from Kalgoorlie to Dry Creek had increases, of up to 4.4 per cent (Port August to Crystal Brook). All westbound sectors had decreases, of up to 5.8 per cent (Dry Creek to Crystal Brook). According to Arc Infrastructure data, intermodal tonnages were down on all sectors between Kalgoorlie and Perth, for both directions of travel. Woodbridge South to Forrestfield had that greatest decrease, at 10.2 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[11].

Other significant non-intermodal freight flows are as follows:

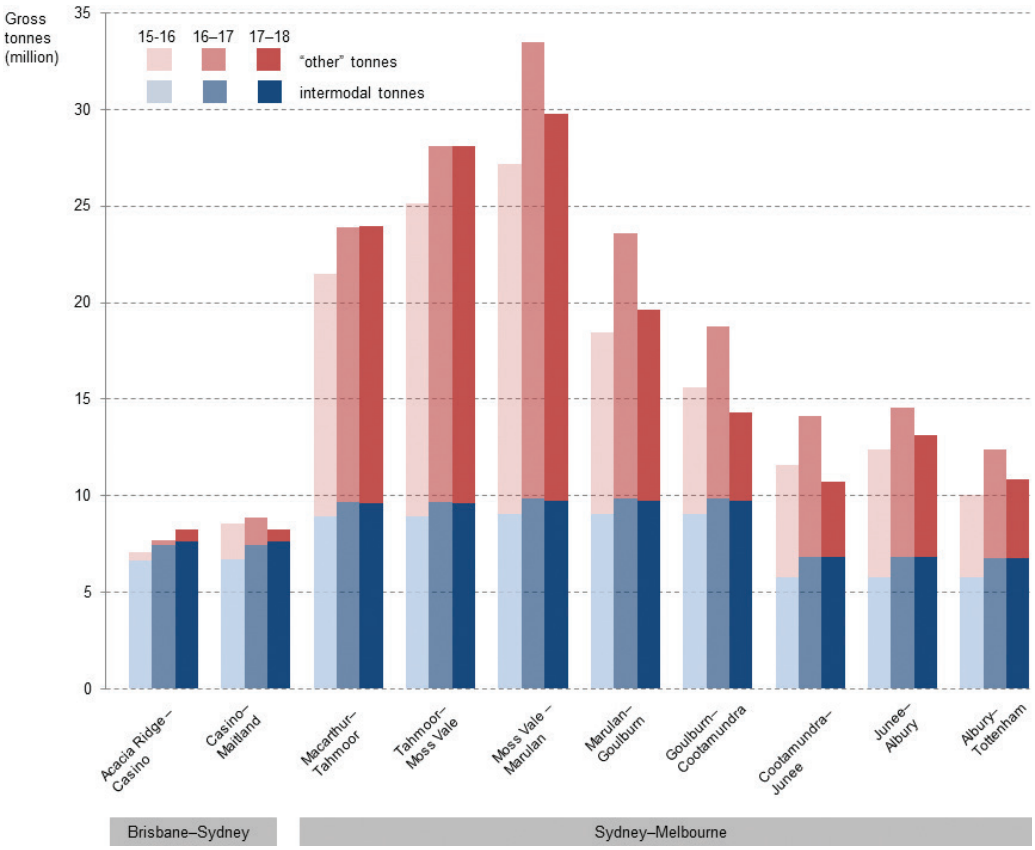
- **Grain movements** generally join the network from a web of branch and secondary lines, connecting agricultural hinterlands to the ports. Movements on the interstate network are heaviest close to Perth and in New South Wales.
- **Aggregate, sand and limestone quarries** in the southern New South Wales 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—Koolyanobbing East line segment, due to iron ore being railed east from Koolyanobbing, via Kalgoorlie, to Esperance Port.
- Grain comprises the majority share of all 'other' tonnages between Kalgoorlie and Koolyanobbing.

'Other' tonnages decreased or were approximately static (growth of less than 0.5 per cent) on all sectors of both the North—South and East—West corridors except:

- Acacia Ridge (Brisbane) to Casino (3.02 per cent)
- Casino to Acacia Ridge (8.58 per cent);
- Islington to Casino (1.33 per cent);
- Kalgoorlie to West Kalgoorlie (28.75 per cent);
- West Kalgoorlie to Kalgoorlie (29.19 per cent);
- West Merredin to Koolyanobbing East (5.90 per cent); and
- Avon to West Merredin (2.20 per cent).

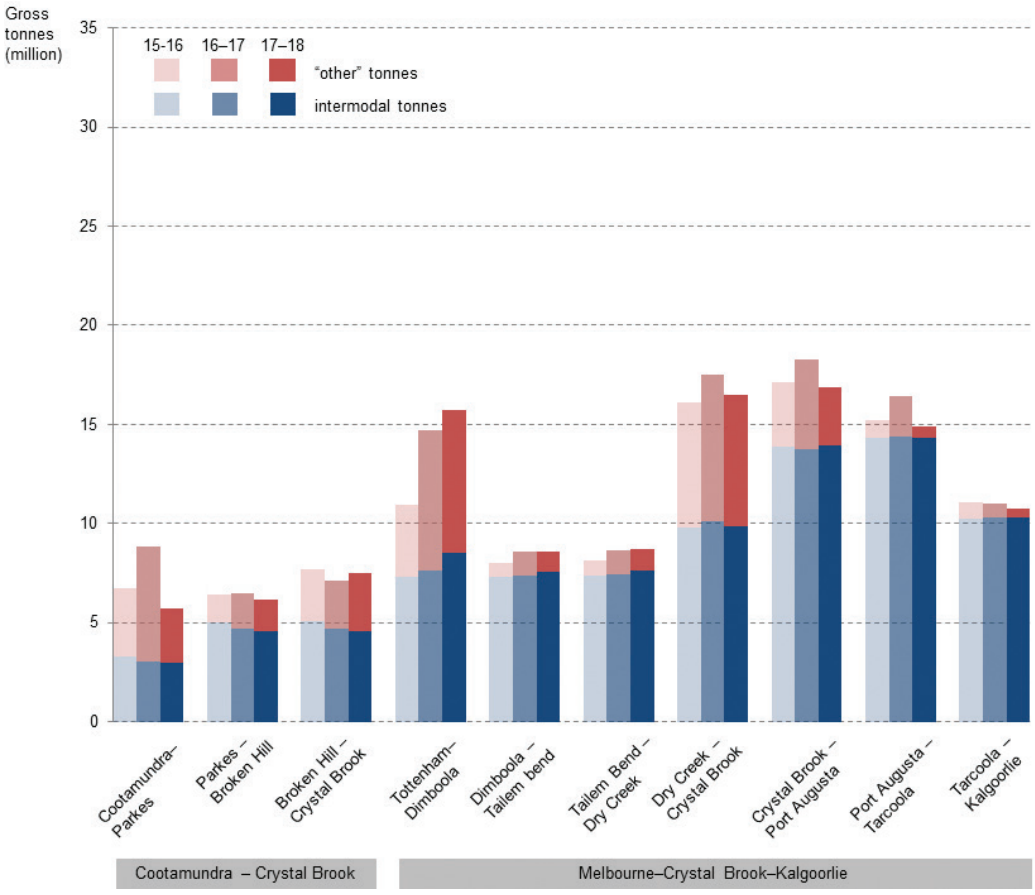
11 To obtain 'other tonnages, deduct the intermodal component from the total figure.

Figure 5 Gross tonnage on the North–South corridor, by line segment, 2015–16 to 2017–18



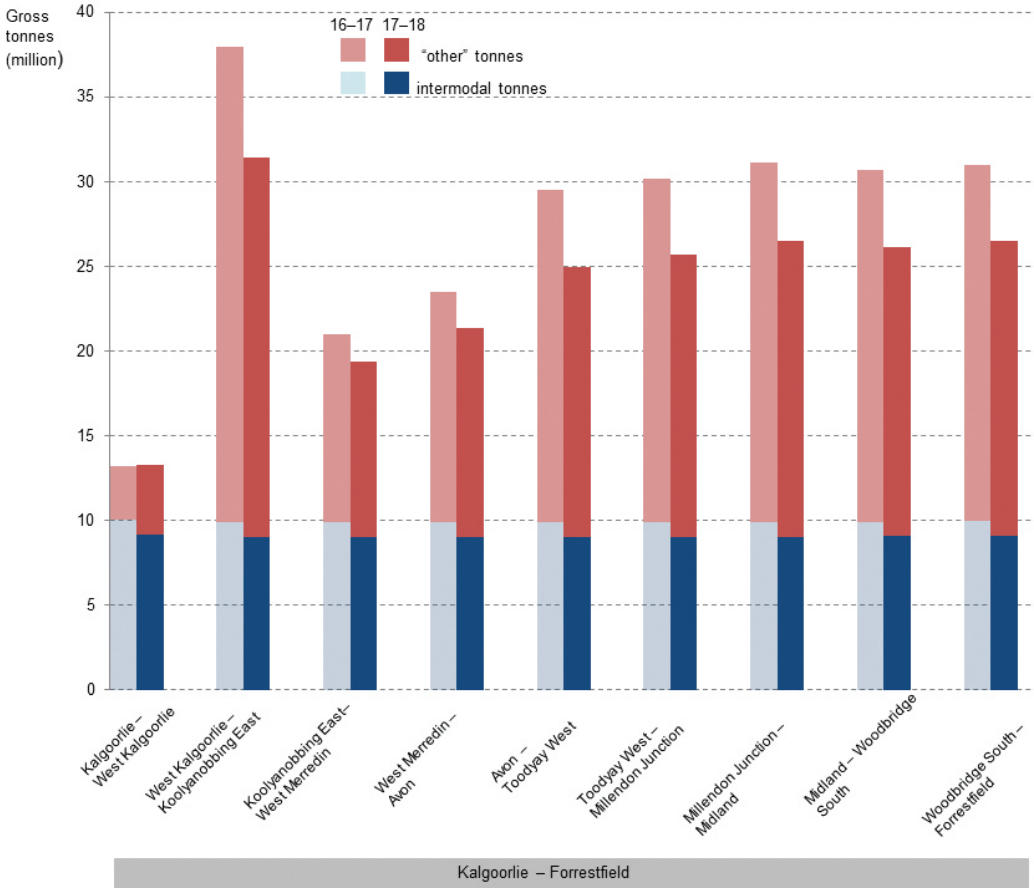
Source: Data provided by ARTC.

Figure 6 Gross tonnage on the East–West corridor, by line segment, 2015–16 to 2017–18



Source: Data provided by ARTC.

Figure 7 Gross tonnage on the East–West corridor, by line segment, 2016–17 to 2017–18



Source: Data provided by Arc Infrastructure.

National Freight and Supply Chain Strategy and Action Plan

In August 2019, the Australian Transport and Infrastructure Council (TISOC) released the National Freight and Supply Chain Strategy and accompanying National Action Plan (Transport and Infrastructure Council, 2019). According to the action plan, "It sets a national vision for freight systems and supply chains to contribute to a strong and prosperous Australia through achieving the following goals:

- Improved efficiency and international competitiveness;
- Safe, secure, and sustainable operations;
- A fit for purpose regulatory environment;
- Innovative solutions to meet freight demand;
- A skilled and adaptable workforce;
- An informed understanding and acceptance of freight operations." (National Action Plan (Transport and Infrastructure Council, 2019, p.6).

The Action Plan further states that these goals will be achieved through action across the following four areas:

- Smarter and targeted infrastructure investment;
- Enabling improved supply chain efficiency;
- Better planning, coordination, and regulation; and
- Better freight location and performance data.

The strategy has a 20 year outlook, and will be reviewed every five years (National Action Plan (Transport and Infrastructure Council), 2019, p.27).[12]

The National Action Plan (released August 2019), which sits alongside the Strategy, informs how the Strategy will be implemented (TISOC 2019b, p.4)). The Action Plan has the following 13 Actions:

- Ensure that domestic and international supply chains are serviced by resilient and efficient key freight corridors, precincts and assets;
- Provide regional and remote Australia with infrastructure capable of connecting regions and communities to major gateways, through land links, regional airports or coastal shipping;
- Identify and support digital infrastructure and communication services necessary for improved and innovative supply chains;
- Advance heavy vehicle road reform to facilitate efficient investment in infrastructure;
- Adopt and implement national and global standards, and support common platforms, to reduce transaction costs and support interoperability along supply chains;
- Promote training and re-skilling of industry and government workforces appropriate to current and future needs;

12 TISOC was formed to advise and assist the Transport and Infrastructure Council. According to its terms of reference TISOC "….will play a key role in delivering national reforms to improve the efficiency and productivity of Australia's infrastructure and transport systems, and ensure these systems drive economic growth, increase employment opportunities, support social connectivity and enhance quality of life for all Australians." (Transport and Infrastructure Council, 2019a). For more information about TISOC see https://www.transportinfrastructurecouncil.gov.au/.

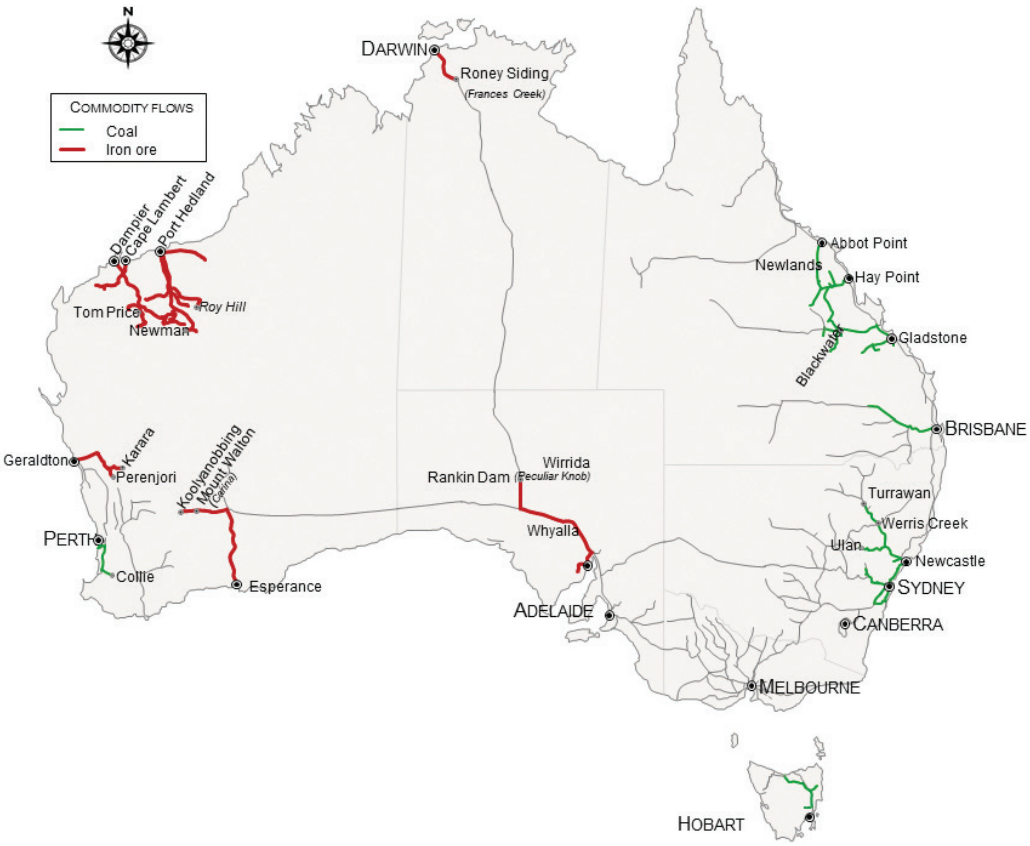
- Facilitate new and innovative technologies that improve freight outcomes and understand the deployment, skills and workforce requirements for operators and infrastructure;
- Build community acceptance of freight operations;
- Ensure freight demand is integrated in transport and land use planning across and between jurisdiction boundaries and freight modes;
- Strengthen the consideration of freight in all other government planning and decision-making;
- Investigate policy, planning and operational solutions to improve freight access and movement along domestic and international supply chains;
- Improve regulation to be more outcomes focused and risk-based to support innovation and reduce regulatory burden whilst maintaining safety, security and sustainability; and
- Develop an evidence-based view of key freight flows and supply chains and their comparative performance to drive improved government and industry decision-making, investment and operations.

Aspects of the Action Plan that directly pertain to rail include:

- Developing:
- Moorebank Intermodal Terminal in New South Wales;
- Kenwick Intermodal Terminal in Western Australia;
- Katherine Agribusiness and Logistics Hub in the Northern Territory;
- Port Botany rail line duplication;
- Melbourne port rail shuttle;
- Inland Rail, including corridor preservation, corridor surveying, and terminals planning;
- Murray Basin Project;
- Standardisation and interoperability across rail networks;
- Advanced Train Management System pilot;
- Townsville eastern access rail corridor and Port of Brisbane rail access corridor identification and protection; and
- Scheduling and operating procedures to improve rail freight access and flows through metropolitan areas.

Rail freight traffic, by commodity

Figure 8 Principal iron ore and coal flows



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

Iron ore traffic

Australia exports most of its iron ore,[13] almost all of which is moved to port by rail[14] 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, are:

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

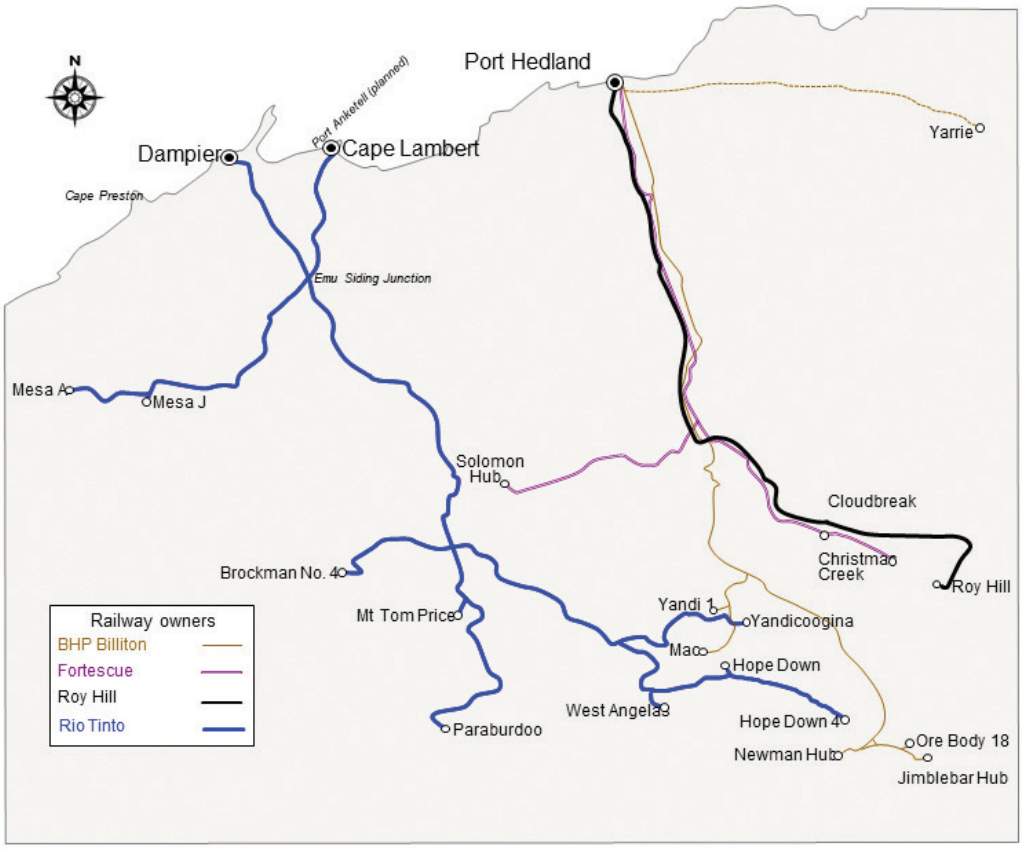
13 There are two domestic manufacturers of steel, Arrium and BlueScope Steel, with a blast furnace at Whyalla and Port Kembla, respectively. Arrium has sourced its iron ore mostly from the Middleback Ranges in South Australia. BlueScope Steel uses iron ore from Mount Newman (Western Australia) and Savage River (Tasmania). See BITRE 2014a.

14 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 2014b, p.21.

inaugurated its first driverless train revenue service on 10 July 2018. The train carried 28 000 tonnes of iron ore over 280 kilometres from Tom Price to Cape Lambert (Rio Tinto, 2018).

- BHP: 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: A 344 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

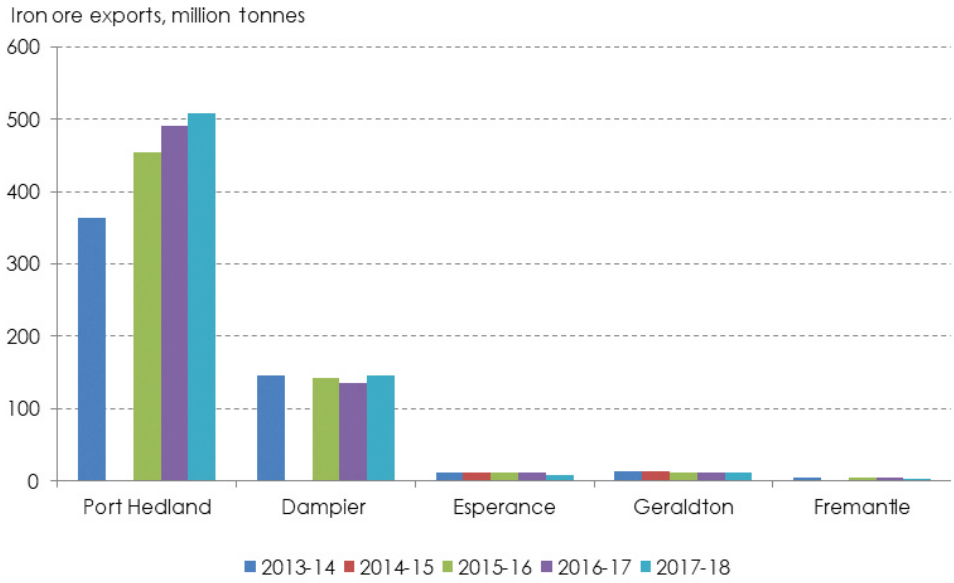


The scale of the task means rail is the most efficient means for transporting iron ore from mine to port. Tonnages exported, by principal port, denote tonnages hauled by the iron ore railways. See Table 8.

Table 8 Iron ore exports, million tonnes, 2017–18

Port Hedland[15]	Dampier	Cape Lambert (Port Walcott)	Esperance	Geraldton	Fremantle (Perth)	Total
509.0	145.6	n/a	8.2	11.9	3.1	677.8

Figure 10 Iron ore exports by financial year



Notes: 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 (2019); Pilbara Ports Authority (2019a); Southern Ports (2018, p.48); Fremantle Ports (2019); Mid West Ports (2018, p.22); BITRE (2014b).

Coal traffic

Similar to iron ore, rail is the best and dominant mode for hauling coal from mine to port, particularly given Australia's coalfields are mostly located inland. Most Australian (black) coal extraction 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)[16].

Most of Australia's coal haulage by rail is in these two states. 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 manages the New South Wales (standard gauge) Hunter Valley system. The systems are:

15 The Pilbara Ports Authority source document reports total throughput, itemised by commodity type as a percentage of the total. The totals listed here for Port Hedland and Dampier are what BITRE has calculated according to the iron ore percentage of the total.

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

- **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 2019b).
- **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 2019b.)
- **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 2019b.)
- **Goonyella to Abbot Point (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 2019b.)
- **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, with scope for increases, at speeds of up to 80 kilometres per hour (ARTC 2019, p.14). Maximum train lengths are approximately 1500 metres (ARTC 2019, p.13). According to ARTC, 2017 contracted export volumes were 192.5 million tonnes per annum, which will remain stable until 2024, at which time ARTC forecasts it to drop to 152 million tonnes per annum by 2027 (ARTC 2018, p 4). In 2019, based on contracted volumes and train sizes, an average of 66 trains on average need to be operated each day. This translates to one train every 22 minutes. ARTC's capacity planning provides for a maximum of 87 trains per day (ARTC 2019, p.12).

Table 9 Annual coal traffic, Queensland and New South Wales, 2018–19

	Queensland					NSW
	Blackwater	Goonyella	Moura	Newlands	Southeast Qld	Hunter Valley
Net tonnes (m)	58.9	61.0	13.6	18.8	7.4	164.2

Notes: Queensland tonnages include all above rail operators.

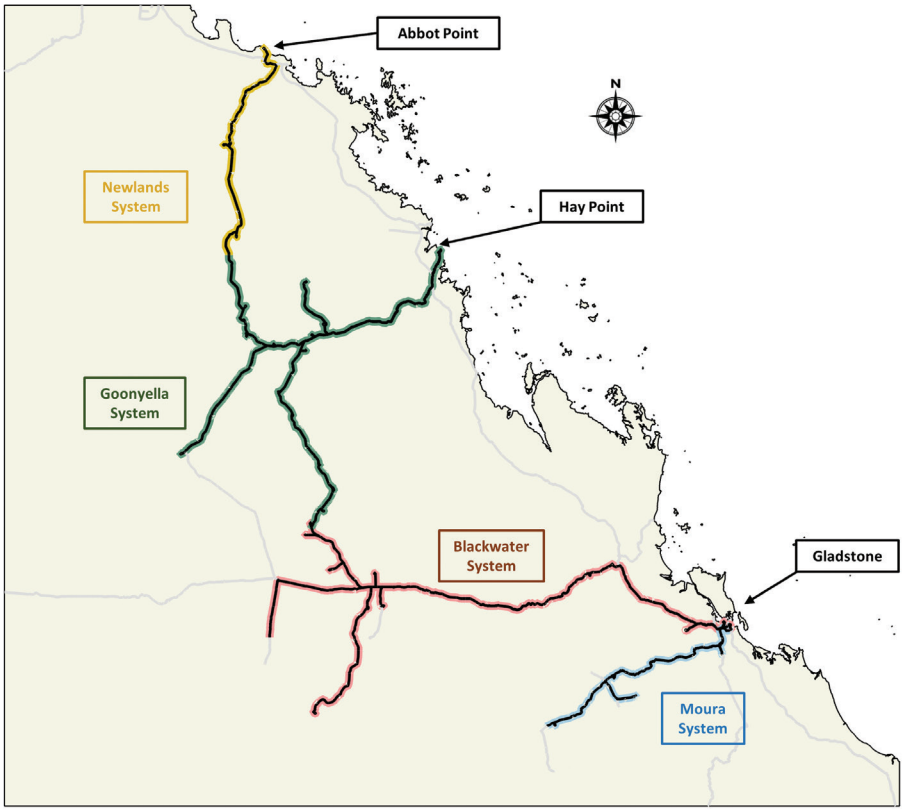
Hunter Valley tonnages are also available through the web site of the Hunter Valley Coal Chain Coordinator (https://www.hvccc.com.au/DailyPlanning/Pages/SummaryPerformanceReports.aspx).

Sources: Aurizon (2019a, p.60); ARTC n.d. (multiple issues).

Figure 11 ARTC Hunter Valley Coal Network

Map courtesy of ARTC.

Figure 12 Central Queensland Coal Network



In addition to the main coal systems, other places of significant coal haulage by rail includes:

- 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.

Aurizon and Pacific National dominate coal haulage, with involvement also by Genesee and Wyoming Australia, Southern Shorthaul Railroad[17] and Tasrail. Aurizon is the main coal train operator in Queensland, while Pacific National dominates in the Hunter Valley.

17 Southern Shorthaul Railroad operate coal trains in New South Wales on behalf of Centennial Coal.

Table 10 Aurizon above rail coal haulage, Queensland and New South Wales

	2016–17	2017–18	2018–19
Tonnes (million)	198.2	212.4	214.3
Net tonne kilometres (billion)	47.6	50.4	50.5

Source: Aurizon (2019a, p.45)

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 11 shows coal export volumes by port for 2017–18 and Figure 13 shows port specific coal exports over the five years 2013–14 to 2017–18.

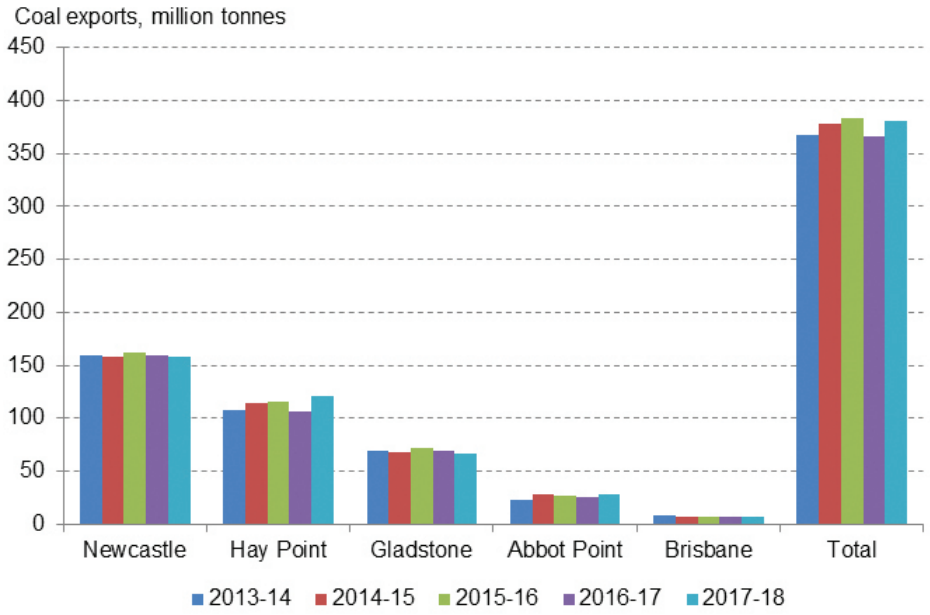
Table 11 Coal exports, by principal ports, (million tonnes), 2017–18

Newcastle[a]	Hay Point	Gladstone	Abbot Point	Port Kembla	Brisbane
158.6	49.6	67.1	28.0	n/a	7.2

[a] The Port of Newcastle figure is for the 2017 calendar year.

Sources: Port of Newcastle (2019), p.2; North Queensland Bulk Ports Corporation (2019), pp.16,18; Port of Brisbane (2019), Gladstone Ports Corporation (2019).

Figure 13 Coal exports by port



Sources: Port of Newcastle (2017); North Queensland Bulk Ports Corporation (2018); Port of Brisbane (2018); Gladstone Ports Corporation (2018); previous editions of *Trainline*

Grain traffic

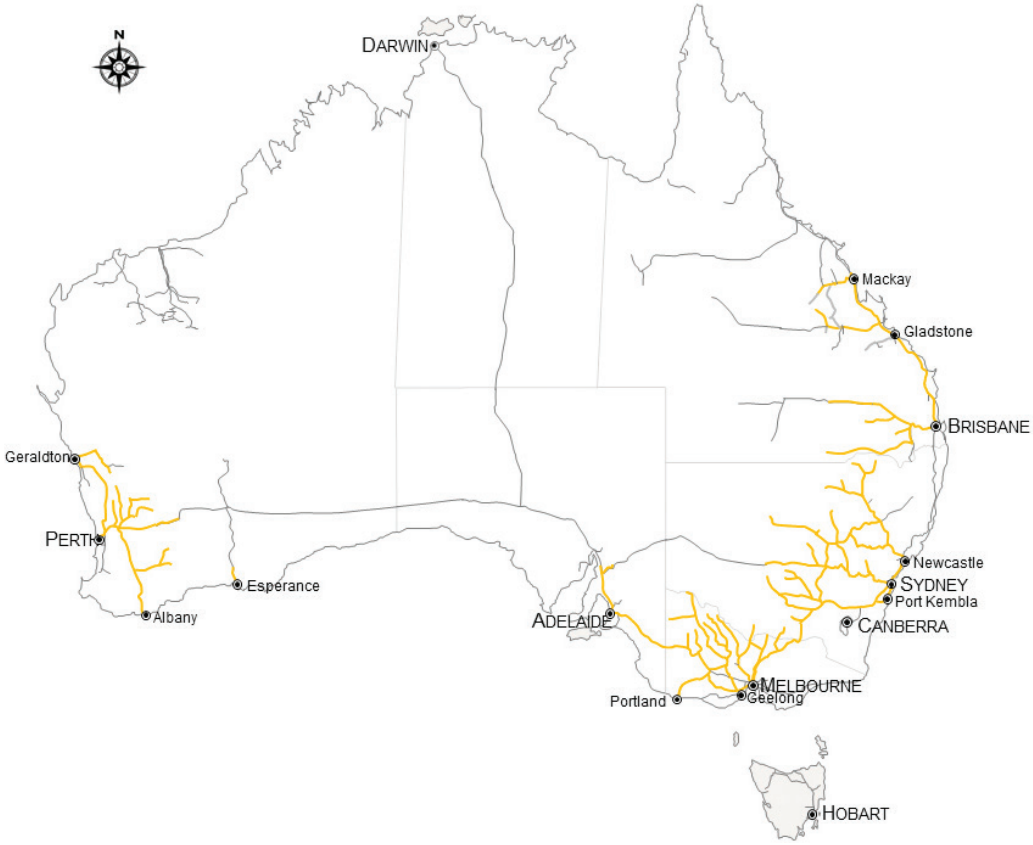
Figure 14 Southern Shorthaul Railroad grain train

Notes: The image above shows a loaded Southern Shorthaul Railroad train departing Milvale, NSW, in April 2018. Photo courtesy of Rodney Avery.

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 predominated by cereal grains (for example wheat, barley and oats), but also pulses and oilseeds. Rail has traditionally dominated grain transport over long distances, while road transport becomes more competitive over shorter distances.

Figure 15 shows grain flows by rail. This traffic largely uses dedicated grain haulage branch lines, which connect with main lines. In September 2018, there was an estimated 4 700 route-kilometres of operational railway track that was largely or exclusively used for grain haulage. This is a reduction of approximately 400 kilometres, reflecting the cessation of all grain haulage by rail in the Eyre Peninsula.

Figure 15 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 oilseeds are also included.

The map shows grain flows along the railway lines that are designated as operating in July 2019. Some railways — notably in south-west Western Australia and in central New South Wales — are not shown as they are classified non-operational.

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[18] 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

In May 2019, all grain haulage by rail in the Eyre Peninsula in South Australia ceased. This was due to grain handling group Viterra not renewing its contract with Genesee and Wyoming Australia (Australian Broadcasting Corporation, 2019). According to Viterra, it was rail infrastructure conditions, unspecified operations restrictions and other unspecified costs that led them to decide haulage by rail was no longer viable and to switch to road transport (Grain Central, 27 February 2019).

18 The farm gate price is the global price the grain grower receives, minus expenses.

US based company Watco currently hauls grain in Western Australia for CBH Group. In July 2018, the company announced it had signed a contract with GrainCorp to provide the company's rail transport of its Queensland crop. This will include hauling grain to Mackay, Gladstone, and Fisherman Islands. As part of the agreement, Watco is purchasing eight locomotives from the United States and an unspecified number of new wagons from China. Watco expects to commence services in the last quarter of 2019 (*The Dispatch*, July 2018, p.2). According to Watco, two of the locomotives had been constructed in August 2019, ahead of being shipped to Australia (*The Dispatch*, September 2019, p.8). The first of the wagons had arrived in Australia earlier (*The Dispatch*, July 2019, p.8).

According to the Australian Export Grains Innovation Centre (AEGIC), approximately half of the grain transported to port from upcountry storage travels by rail, with the remaining half travelling by road (AEGIC, 2018, p.50). AEGIC further claims that the shift from rail to road transport due to the closure of some lines in South Australia and Western Australia has been offset by new operational efficiencies in other parts of the rail network (AEGIC, 2018, p.50).

While rail transport has a traditional advantage for grain transportation over 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[19]. 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[20];
- 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, including closure of smaller 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.

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.

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

19 *Trainline 3* discusses in detail these changes and challenges to grain transport by rail. (See BITRE, 2015)
20 For more information on track infrastructure constraints, from a grain grower's perspective, see (Grain Central 2017)

times (Graincorp 2017). Project Regeneration is anticipated to return one million tonnes of grain presently by truck back to rail with half of that expected to occur in Victoria. The project is expected to be completed in 2020.

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. While the company works with and advises Transport for NSW, the latter 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. According to advice from John Holland Rail, all continuously-welded sections of the CRN are now steel sleepered, following completion of the steel sleeper insertion program on the Werris Creek-Armidale line. Timber sleepers are now only on jointed sections of rail. 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. 83 per cent of the CRN has a capability of 81 tonne gross or higher (which is the maximum capacity of more than 80 per cent of the current bulk grain wagon fleet). This translates to reduced transport costs and improved competitiveness of rail transport in turn[21].

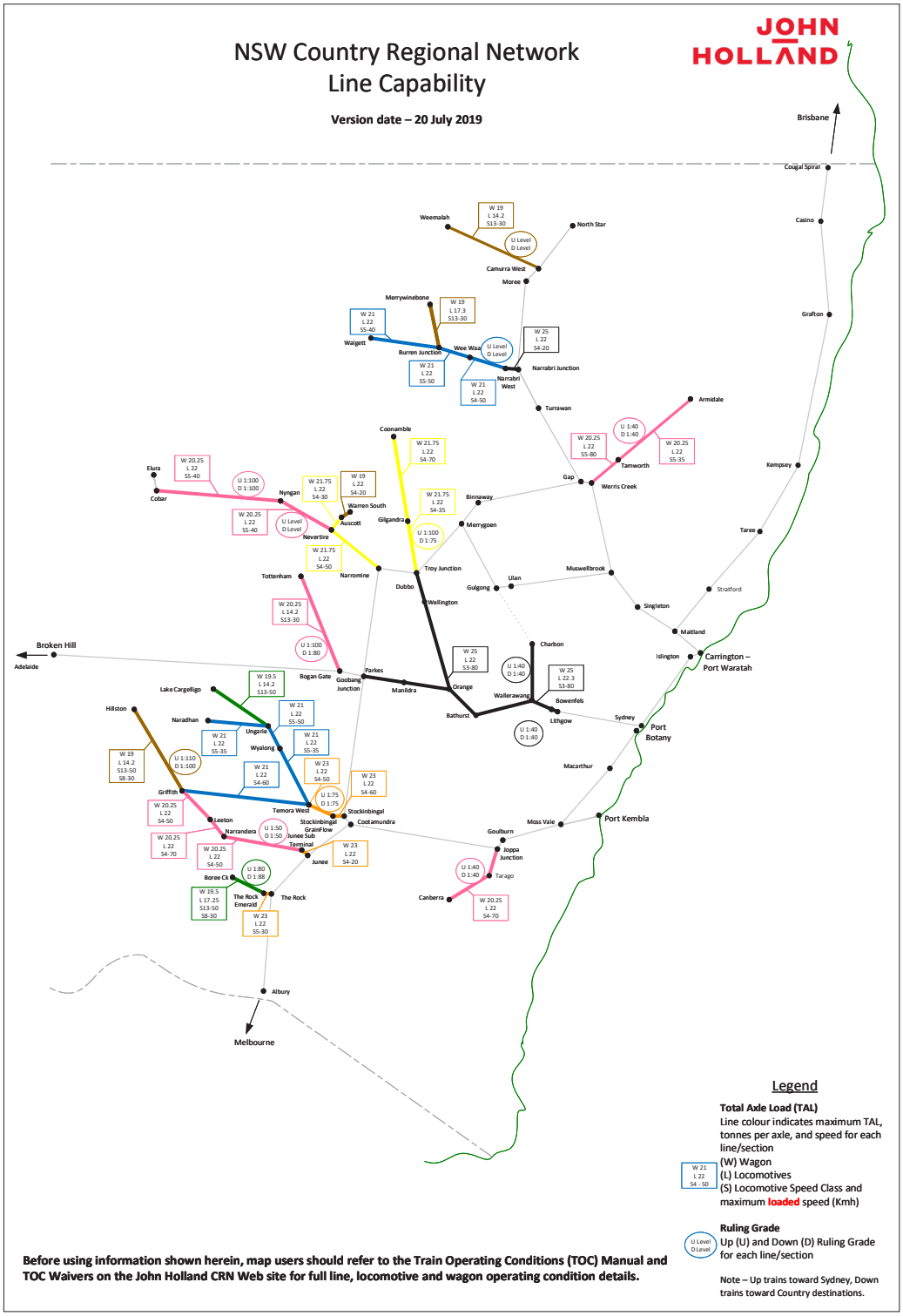
John Holland Rail has also received funding under the NSW Government's Fixing Country Rail programme for:

- $60 million rail replacement Junee—Griffith and increase in capability from 81 tonne to 100 tonne gross (project underway).
- Construction of 1 300 metre siding at Hermidale. This will allow the three operators servicing the mining sector to cease operating pull-push Nyngan—Hermidale—Nyngan, and thus reduce crew demand and improve operational efficiency (project underway).
- Construction of 1 300 metre siding at Temora West. This will relocate a major main line loading operation to the new siding. It will remove a significant bottleneck on the section between Temora and Griffith that affects trains loading at Barellan and Ardlethan (project in early stages).
- Construction of a 1 200 metre siding at Coonamble South. This will decongest a bottleneck associated with a main line intermodal loading location (project in early stages).
- $28 million rail replacement Temora—Wyalong, and increase line capability from 84 tonnes to 100 tonnes between Stockinbingal and Calleen (project yet to commence).
- 600-metre extension of the Tarago siding to accommodate Crisps Creek waste service train crossing. This will allow Veolia to run two full length (~50 wagon) services, rather than one long and two short consists, with the second half of the second train standing in Goulburn yard (project underway).
- Completion of two 1500 metre crossing loops on the main western line; Rydal and Georges Plains (completed).

Figure 16 shows the 2019 infrastructure standards for the New South Wales Country Rail Network for 2019.

21 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 16 New South Wales Country Rail Network Infrastructure Standards 2019



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

Box 2 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.

Victoria

- Victorian rail freight network review. Switchpoint: the template for rail freight to revive and thrive! (2007)
- *Grain Logistics Taskforce Report*, Department of Transport (2011)

For grain crop reports and forecasts see:

- http://www.graincorp.com.au/
- https://www.cbh.com.au/
- https://www.ldc.com/au/en/
- https://www.awb.com.au/

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. 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 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)[22].

22 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.

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 grain, hay, sugar, cotton, grains, livestock, wine and logs.
- 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. SCT Logistics' daily container shuttle train from its Penfield intermodal terminal to the Port of Adelaide for Treasury Wines Estate is an example.
- Export maritime activities are generally based around single commodities and/or a single company's logistics-based hub, such as agricultural produce from the Fletcher
- International terminal at Dubbo.

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.

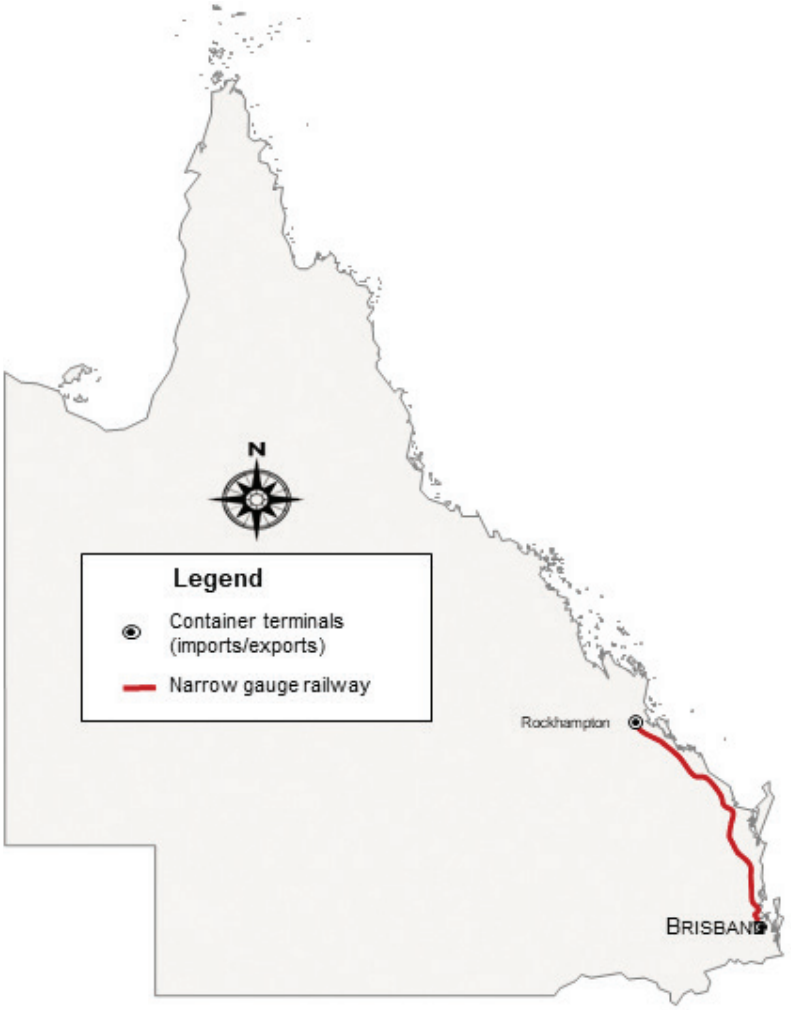
Rail (and road) volumes of containers through the primary capital city ports are reported in BITRE's regular Waterline series. (BITRE 2017 gives the latest figures.)

Landbridge and regional movements

Port of Brisbane — Fisherman Islands

Figure 17 shows the rail container flows between Queensland intermodal terminals and the Port of Brisbane (Fisherman Islands).

Figure 17 Rail container operations serving the Port of Brisbane (Fisherman Islands)

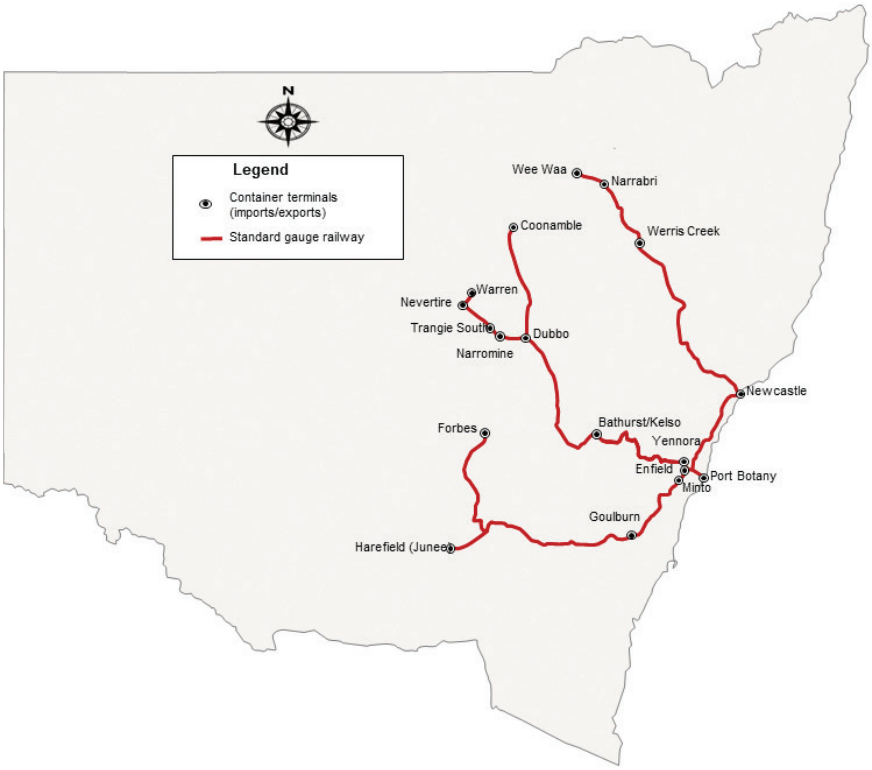


The only current containerised freight travelling to the Port of Brisbane by rail is refrigerated meat from Rockhampton.

The Port of Brisbane used to manage export traffic, including seasonal cotton, from Dalby and Goondiwindi, but these ceased in late 2009 and September 2014 respectively. This was due to tunnel height restrictions in the Toowoomba Range, which prevented the transportation of shipping containers higher than 8'6". This made rail transport from these centres unviable and the traffic has switched to road transport. The Queensland government is currently lowering the tunnels to facilitate the transportation of 9'6" containers. (*Railway Digest,* June 2018, p.15.)

Sydney Ports — Port Botany

Figure 18 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;
- Meat and other agricultural produce from Dubbo;
- Containerised grain and cardboard (from Visy's plant at Tumut) from Harefield (near Junee)[23];
- 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;
- Grain, oilseeds, pulses, and refrigerated meat from Dubbo;
- Containerised plantation logs, grain, meat and other agricultural products from Werris Creek; and
- Aluminium ingots and various agricultural produce from Newcastle.

23 QUBE Logistics, which operates this service, has been alternating between using the Port of Melbourne and Port Botany for this service.

In June 2019, Crawfords Freightlines commenced hauling plantation logs from its newly built terminal at Werris Creek to Port Botany. Crawfords says it built the terminal as an open access facility, which may attract other rail traffic from other operators. (Namoi Independent, June 2019)

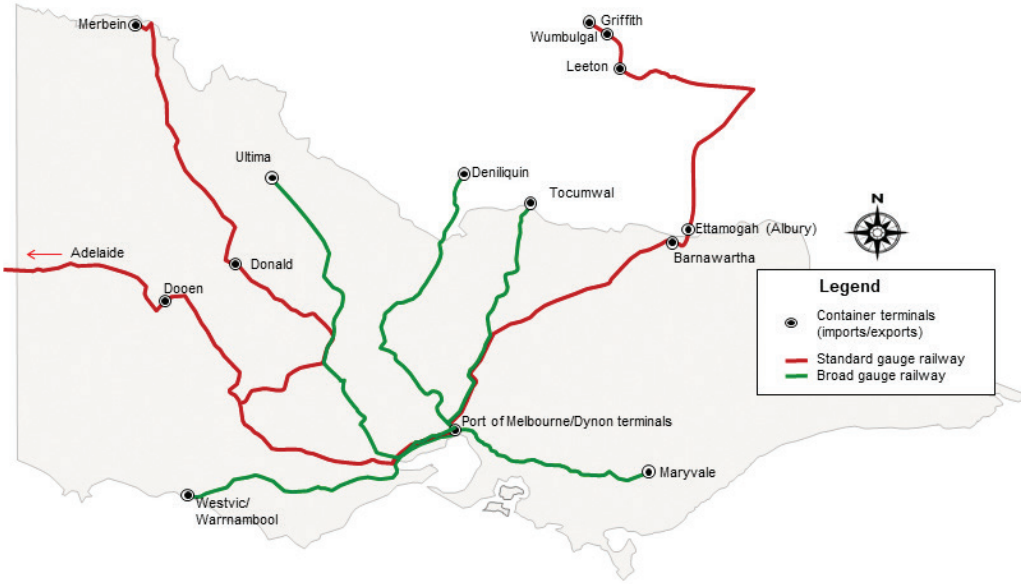
Figure 19 Fletcher International train

Note: The image above shows a fully loaded Fletcher International train at Millthorpe, NSW, en route from Dubbo to Port Botany, November 2019. Photo courtesy of Rodney Avery.

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 2017, p.4)

Figure 20 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.

Figure 20 Rail container 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.

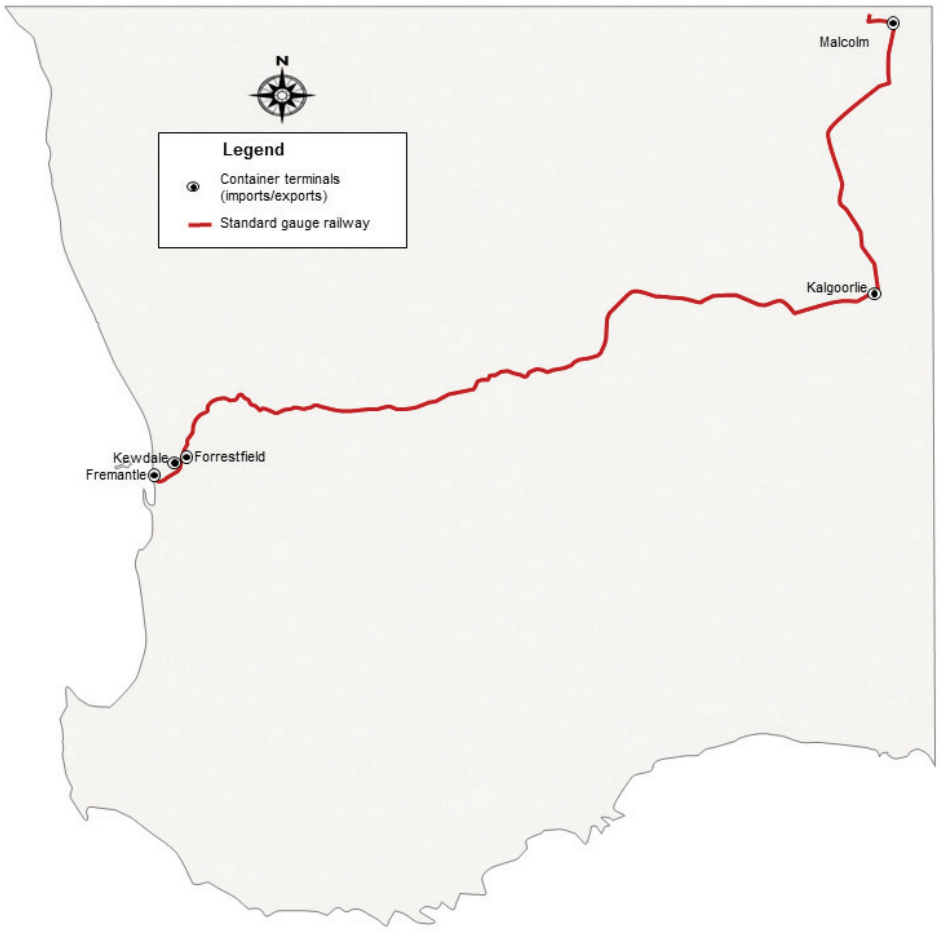
- Merbein (Mildura) – grain, wine, grapes, fruit;
- Donald - peas, grain;
- Westvic Container Export Services, at Warrnambool - meat and dairy products;
- Wimmera Container Line, at Dooen (near Horsham) - grain, hay, and pulses;
- Maryvale in the Latrobe Valley – containerised paper;
- North Geelong – Dandenong South containerised cement;
- Ultima – hay; 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, cottonseed, dairy;
- 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.

Port of Fremantle — Inner Harbour

Figure 21 Rail container operations serving Kwinana

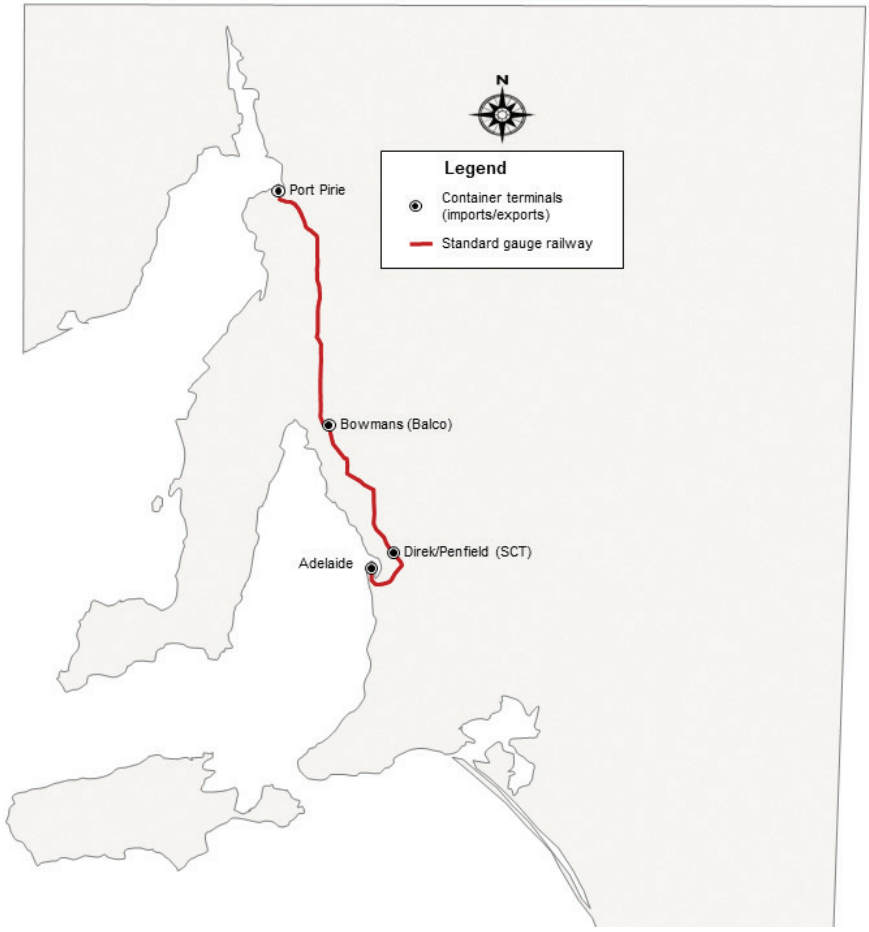


The primary regional container export flows are nickel from Malcolm (near Leonora) and nickel products from a nickel smelter south of Kalgoorlie.

Port Adelaide

There are regional maritime container traffic flows to Port Adelaide. 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 22 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 hay, pulses, lead, mineral sands and project materials. 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 from the smelter for export through Outer Harbor.

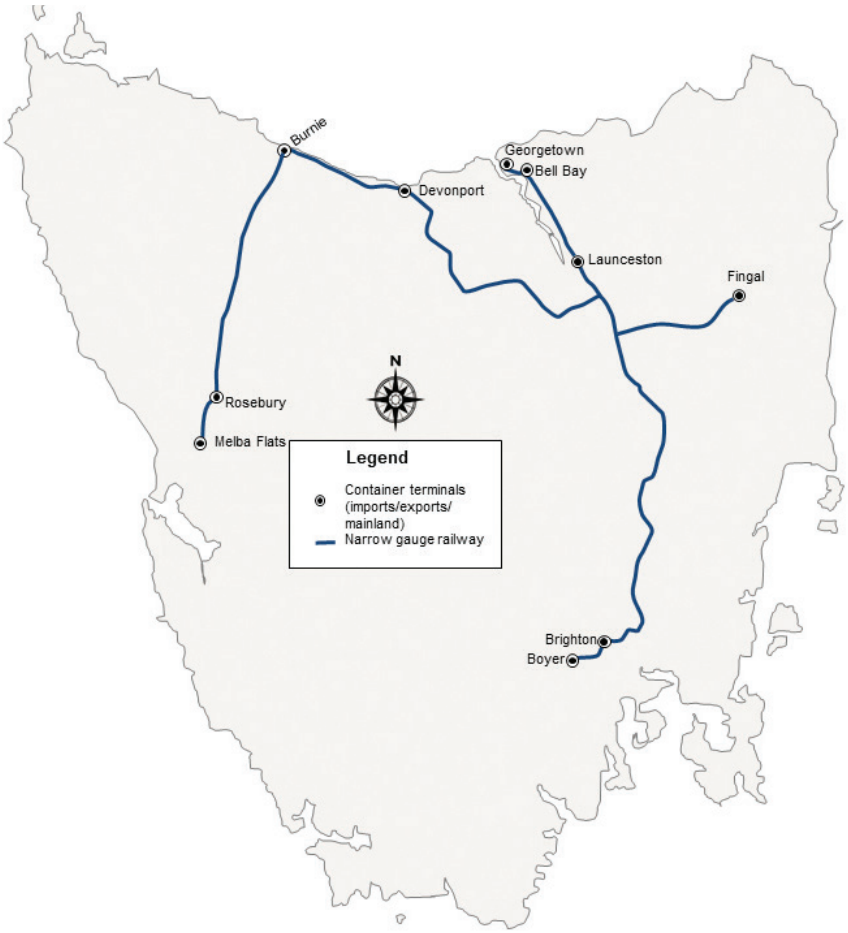
Genesee and Wyoming Australia also transports Oz Minerals copper concentrates for export from Prominent Hill in northern South Australia to the Inner Harbor Port Adelaide berth #29 bulk precinct.

According to advice from Flinders Ports, in October 2018 Flinders Ports upgraded the intermodal rail infrastructure by decommissioning the northern rail spur and building a new spur 25 metres north of the decommissioned track. This allows for 50 metres of operational working distance between tracks to pre stage and store rail containers.

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 provides 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. TasRail also has direct rail access to a woodchip mill within George Town. According to advice received from TasRail, forestry freight grew by 25 per cent in 2018-19, partly due to "TasRail's efficient and direct integration into the woodchip mill at George Town."
- 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; and
- Brighton: A multi-modal freight terminal with container hardstand and storage area that handles containerised general freight, bulk log freight, and metal ingots.

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

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);
- Kewdale/Forrestfield – Fremantle (Inner Harbour) (approximately 24 kilometres); and
- Fremantle (North Quay) – Kwinana (approximately 28 kilometres).

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 (loaded) containers between intermodal facilities at Forrestfield and Kwinana and North Quay at Fremantle. Empty containers and non-metropolitan movements are not subsidised. Intermodal Link Services (a part of the Intermodal Group) operate the train service between Fremantle and Forrestfield with 2–3 trains operated per day, 6–7 days per week. Aurizon operate two scheduled return trains per day between Kwinana and North Quay, carrying products off the Malcolm train and its Kalgoorlie-Perth freight trains. In a 31 July 2019 press release, the Western Australian Minister for Transport and Planning announced:

- In 2018–19, more than 20 per cent of container freight taken to Fremantle Port travelled by rail, with a record high of 23.7 in April 2019; and

- Just prior to the government's introduction of subsidies the share was 15.5 per cent. (Minister for Transport and Planning, 2019).

The federal and Victorian state governments have announced a jointly funded $58 million plan to build rail connections to suburban intermodal terminals. The existing terminals at Altona and Lyndhurst will need connecting to the rail network, while the Austrak terminal at Somerton is already rail connected. This will provide for rail shuttles between the Port of Melbourne and these terminals. The Victorian Government is currently assessing funding grant applications. (Transport for Victoria, 2018)

Box 3 Further resources on non-bulk freight activity

Most of Australia's major ports report throughput statistics by freight type, freight origin, and freight destination on their websites, through a search facility.

Most Australian ports publish throughput data either on their webpage or in their annual reports.

BITRE's Waterline series reports quarterly data on rail traffic volumes through the mainland state capital city ports (where traffic is measured in, twenty-foot container equivalent unit (TEU) containers).

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.

Table 12 Urban rail patronage (millions of journeys), 2017–18[a]

	Brisbane[b]	Sydney	Melbourne[c]	Adelaide	Perth	Gold Coast
Patronage – heavy rail	53.6	359.2	240.9	14.5	58.2	
Patronage – light rail		10.2	206.3	9.4		9.5

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

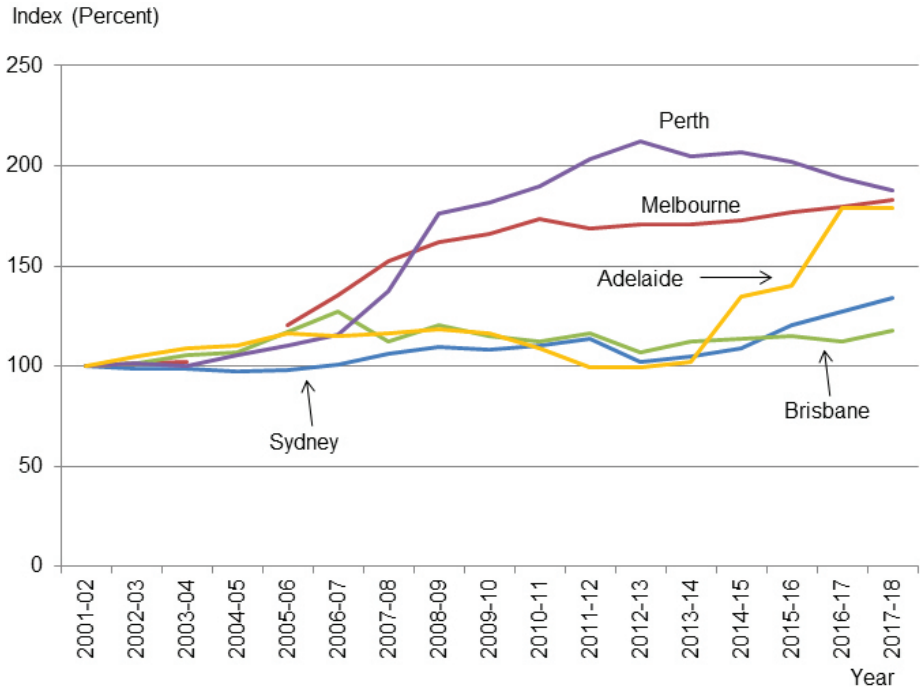
While annual patronage figures are not yet available for Canberra, Canberra Metro has advised BITRE that average daily patronage is currently 15,000–18,000 passenger journeys per day.

Sources: Public Transport Authority of Western Australia (2018); Public Transport Victoria (2018), p.12; Department of Planning, Transport and Infrastructure (2018), p.24; Queensland Rail (2018), p.19; Translink (2019), p.5; Transport for NSW (2018), p.17; Sydney Trains (2018), p.4.

Total urban heavy rail patronage for 2017–18 was 726.4 million passenger journeys, up from 702.9 million passenger journeys the previous financial year. Heavy rail patronage grew in all cities, except for Perth, which had a 0.3 per cent decline. Sydney continues to have the greatest patronage – approximately 30 per cent higher than Melbourne. In 2017–18, Sydney's patronage grew by approximately 1.4 per cent, Melbourne 1.7 per cent, Brisbane 5.00 per cent, and Adelaide 0.14 per cent.

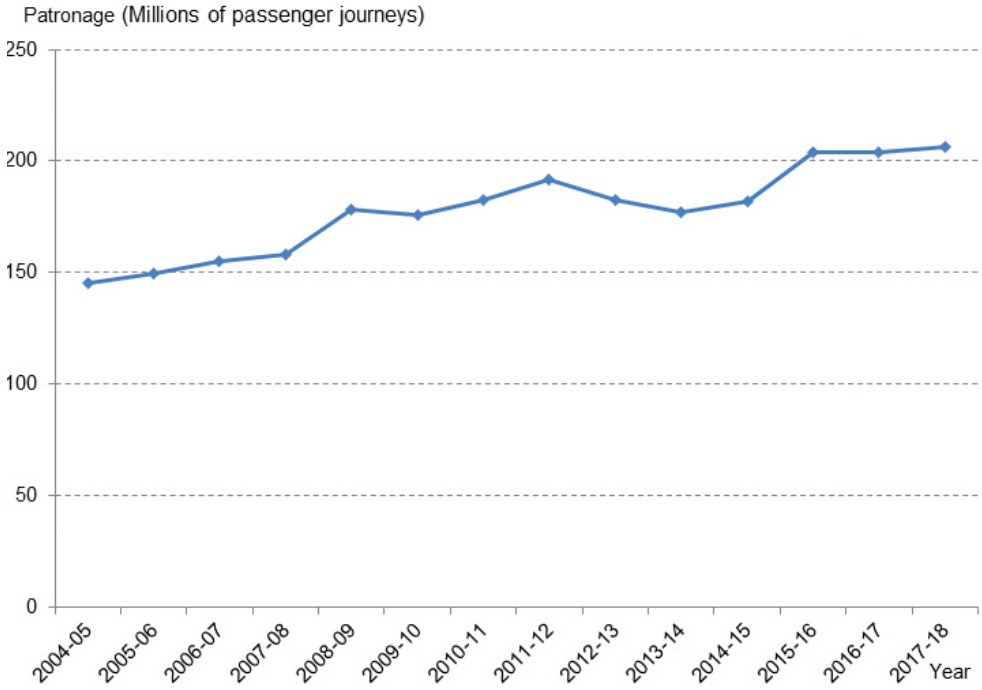
Total light rail patronage for 2017–18 was 235.4 million passenger journeys. Light rail patronage grew modestly on all networks except the Gold Coast (Melbourne 1.1 per cent, Adelaide 1.6 per cent, and Sydney 2.1 per cent. Patronage on the Gold Coast grew by 19 per cent. This is likely due to the 2018 Commonwealth Games.

Figure 24 Index of urban heavy rail patronage in Australian cities



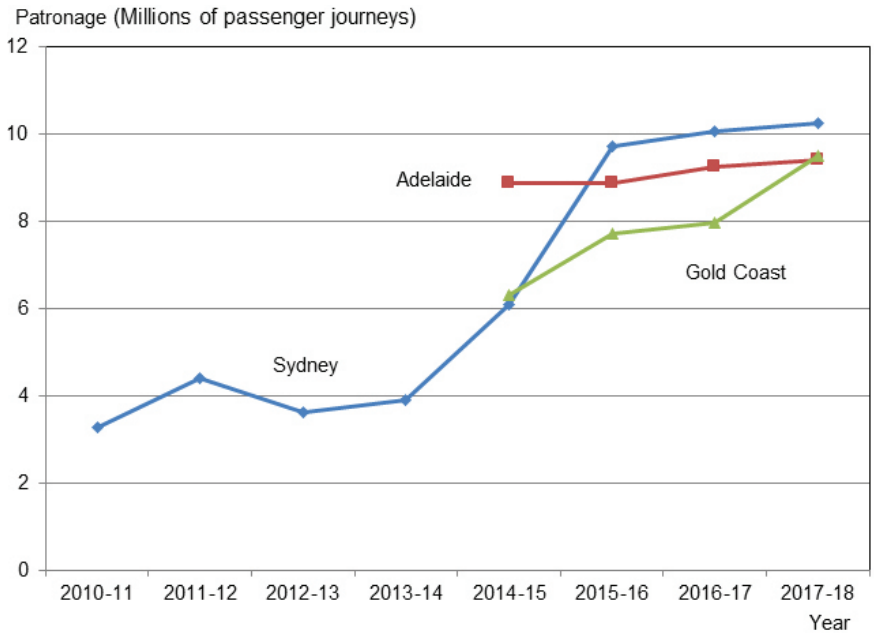
Sources: Index based on patronage data from: BITRE (2012) and previous *Trainline* editions; Public Transport Authority of Western Australia (2018); Public Transport Victoria (2018), p.12; Department of Planning, Transport and Infrastructure (2018), p.24; Queensland Rail (2018), p.19; Translink (2019); Sydney Trains (2018), p.4; historical annual reports.

Figure 25 Melbourne light rail patronage



Source: Public Transport Victoria (2018), p.12; historical annual reports.

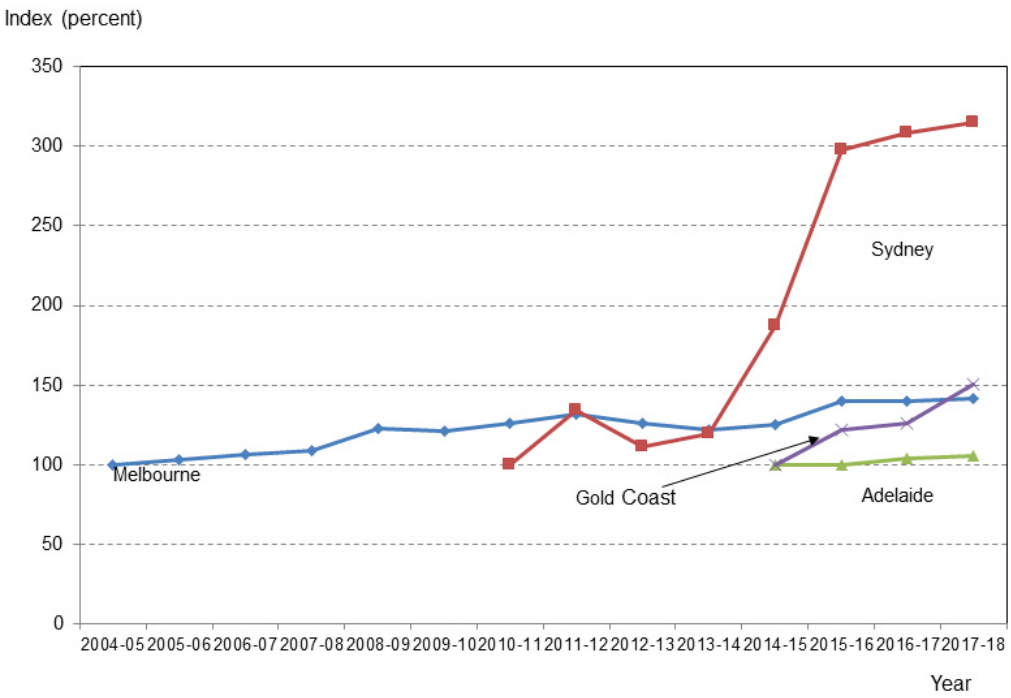
Figure 26 Sydney, Adelaide and Gold Coast light rail patronage



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

Sources: Department of Planning, Transport and Infrastructure (2018), p.24; Translink (2019), p.5; Transport for NSW (2018), p.17;); historical annual reports

Figure 27 Index of light rail patronage Melbourne, Sydney, Adelaide and Gold Coast



Sources: Department of Planning, Transport and Infrastructure (2018), p.24; Translink (2019), p.5; Transport for NSW (2018), p.17;); Public Transport Victoria (2018), p.12; historical annual reports

National (external) and local (network-specific) factors explain urban heavy rail 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.

Details of patronage changes in 2017–18, where available, 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). In a media release on 8 August 2018, the Queensland Minister for Transport and Main Roads attributed the patronage growth to the introduction of the Fairer Fares package. (Minister for Transport and Main Roads, 2018)
- **Sydney.** In November 2017, Sydney Trains introduced a new timetable. The new timetable provides an additional 1500 services per week, or an eight per cent service level increase (Sydney Trains, 2018, p.28). Opening of Sydney Metro Northwest in May 2019 is providing rail transport for the north western suburbs of Sydney from Chatswood to beyond Rouse Hill, an area which currently has no rail transport. This may boost patronage.
- **Perth.** According to the Public Transport Authority of Western Australia, the increased patronage in 2017–18 occurred in all ticket and fare types. All lines had decreased patronage, except the Armadale line, where patronage grew by 4.7 per cent. The Midland line had the greatest decrease, at 5.9 per cent. (Public Transport Authority of Western Australia 2018).

Table 13 and Table 14, below, shows Sydney Trains' busiest morning peak and afternoon peak hour services, as Transport of NSW Transport Performance and Analytics surveyed on 10–14 September 2018 (Transport for NSW Transport Performance and Analytics (2019). For the purpose of the survey, Transport for NSW defined AM peak as services that arrived at Sydney Central Station between 0800-0900 hours and the PM peak as those services that departed Sydney Central between 1700-1800 hours. The load factor shows how each service was at as it either arrived at or departed from the designated stations during its journey, not at its point of origin or departure. Transport for NSW defines its load factors as the number of passengers, divided by the number of seats. A load factor of 100 per cent means there is a seat for every passenger.

It is not possible to compare these results with those of September 2017, as reported in *Trainline 6,* the Transport for NSW sampled different stations and lines.

Table 13 Sydney AM peak top services, 10–14 September 2018

	Station	Scheduled peak period trains per day	Average daily peak period patronage	Average peak period load factor per day	Maximum Load Factor
T1 North Shore	Milsons Point	11	11 292	116%	149%
Central Coast via Shore	Milsons Point	4	4 000	116%	158%
T1 Northern via Strathfield[a]	Redfern[a]	6	6 832	142%	180%
T1 Northern via Macquarie Park	Milsons Point	4	3 937	110%	124%
T1 Western[a]	Redfern[a]	16	19 137	143%	180%
T2 Inner West[a]	Redfern[a]	6	5 440	100%	163%
T2 Leppington[a]	Redfern[a]	8	9 692	134%	160%
T3 Bankstown[a]	Redfern[a]	10	10 693	118%	156%
T4 Eastern Suburbs	Kings Cross	18	9 804	65%	92%
T4 Illawarra[a]	Redfern[a]	15	17 652	140%	169%
T5 Cumberland[b]	Harris Park[b]	2	1 392	154%	180%
T8 Airport	Green Square	10	11 921	132%	160%
T8 South[a]	Redfern[a]	4	5 149	141%	167%
Total Suburban		**114**	**116 941**	**120%**	

Notes: [a] All loads are for trains on departure, except Redfern, where loads are based on train arrivals.

[b] Trains heading towards Blacktown from Leppington.

The maximum load factor services are captured for Wednesday 12 September 2018 at arriving/departing stations between approximately 0800 and 0900.

Source: Transport for NSW Transport Performance and Analytics (2019).

Table 14 Sydney PM peak top services, 10–14 September 2018

	Station	Scheduled peak period trains per day	Average daily peak period patronage	Average peak period load factor per day	Maximum Load Factor
T1 North Shore	North Sydney	8	6 904	98%	121%
Central Coast via Shore	North Sydney	4	3 836	111%	134%
T1 Northern via Strathfield[a]	Redfern[a]	4	4 816	139%	161%
T1 Northern via Macquarie Park	North Sydney	4	3 612	101%	113%
T1 Western[a]	Redfern[a]	16	16 038	116%	157%
T2 Inner West[a]	Redfern[a]	4	3 086	86%	101%
T2 Leppington[a]	Redfern[a]	8	8 960	124%	155%
T3 Bankstown[a]	Redfern[a]	8	7 249	100%	123%
T4 Eastern Suburbs	Martin Place	16	7 108	53%	87%
T4 Illawarra[a]	Redfern[a]	15	12 781	103%	168%
T5 Cumberland[b]	Parramatta[b]	2	931	103%	116%
T8 Airport[b]	Green Square[b]	10	8 639	96%	147%
T8 South[a]	Redfern[a]	4	3 973	110%	131%
Total Suburban		**103**	**87 933**	**99%**	

Note: [a] All loads are for trains on departure, except Redfern, where loads are based on train arrivals.

[b] Trains from Blacktown heading towards Leppington.

The maximum load factor services are captured for Wednesday, 12 September 2018 arriving/ departing stations between approximately 1700–1800 hours.

Source: Transport for NSW Transport Performance and Analytics (2019).

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. In 2016, urban heavy rail's mode share increased in all cities except Brisbane and Perth compared to 2011. Sydney had the highest heavy rail mode share, at 19.1 per cent (See Table 15). Melbourne's combined heavy rail and light rail share was 17.6 per cent, while Brisbane and Perth's rail mode share was 7.3 and 7.5 per cent respectively.

Table 15 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.

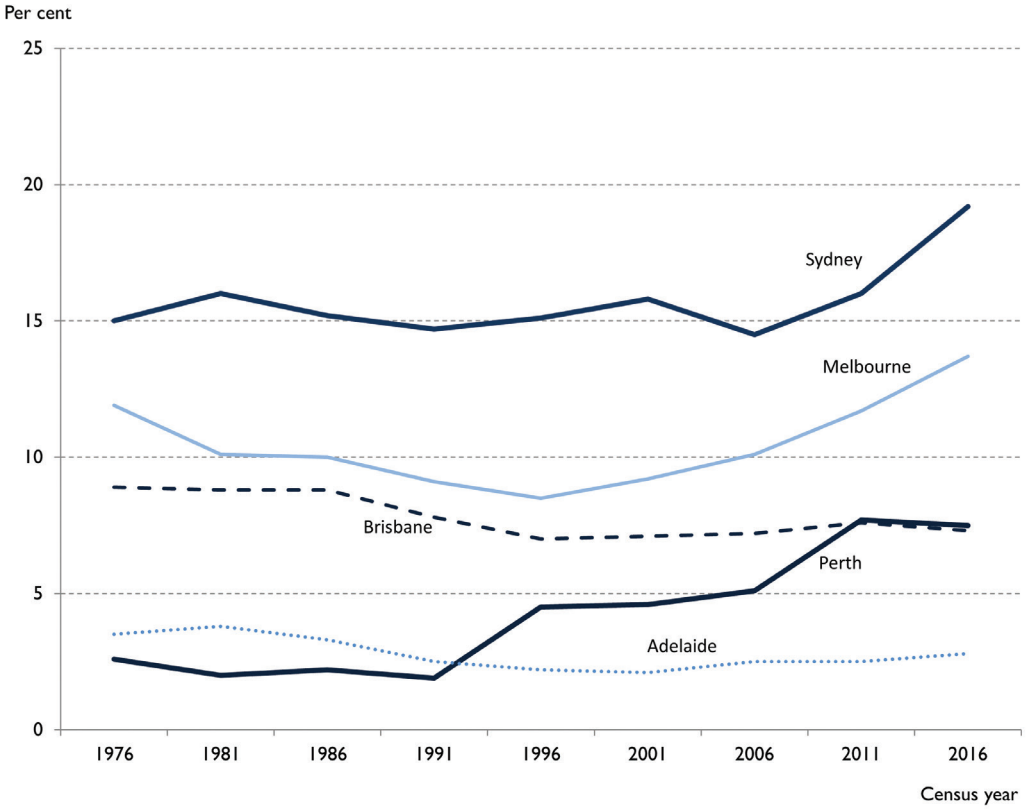
Mode shares defined as persons who caught a train/tram for all or part of their journey to work. Calculations exclude census respondents who did not specify travel mode, worked at home or did not go to work.

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 2016.

Following long-term declines in urban rail patronage for all cities from the mid-1970s, ridership began recovering in the 1990s[24]. Figure 28 shows the journey-to-work mode share data for heavy rail, derived from the census, since 1976. The journey to work data from 2001 closely resembles total patronage trends over the last decade.

Figure 28 Journey-to-work mode share, urban heavy rail, 2016



Note: Cities refer to greater metropolitan areas.

Sources: ABS (2016); Mees and Groenhart (2012).

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

Figure 29 Sydney Metro trains

Note: The image above shows a passenger view of a Sydney Metro train at Kellyville, as seen from the front of a crossing train. Because these trains have no driver's compartment by virtue of the trains being driverless, passengers at the front of the trains can see ahead as well as to the side. Photo courtesy of Andrew Tailby.

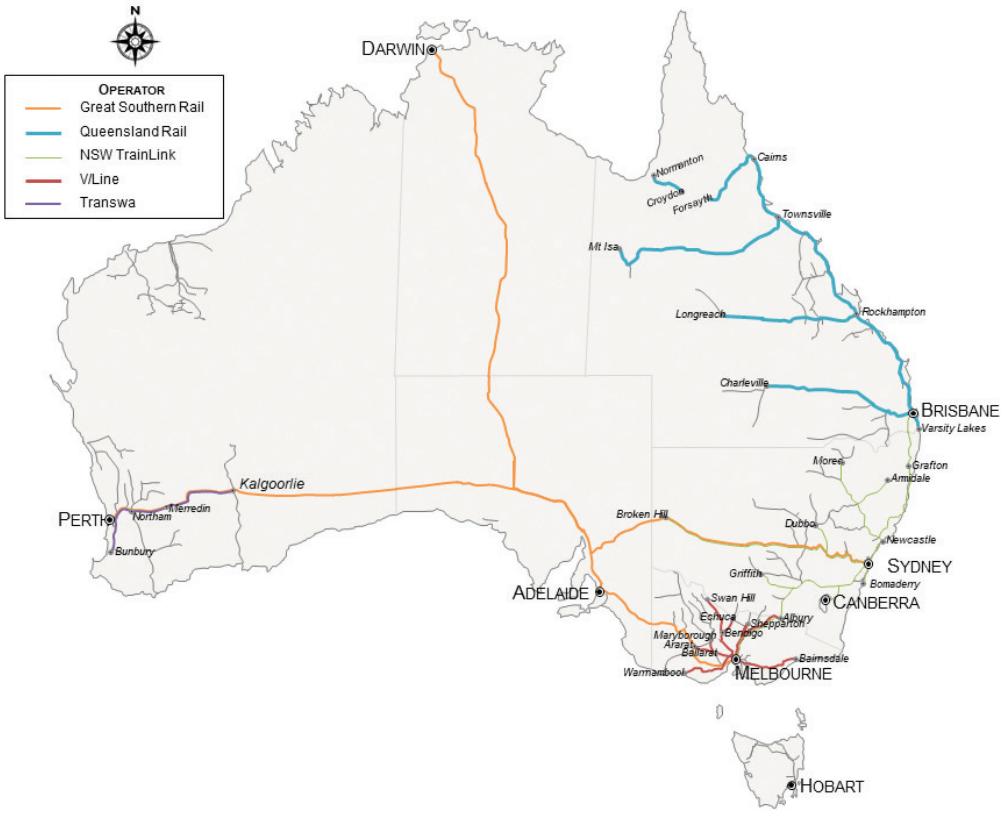
Box 4 Further reading

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

Figure 30 Non-urban passenger services, by operator



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

- "Inter-city" or "regional" travel, such as Sydney—Hamilton, Brisbane—Nambour, 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—Warrnambool and Perth—Kalgoorlie;
- Heritage railway travel, for nostalgia and leisure purposes; and
- Tourist-focused services such as the Kuranda Scenic Railway (Queensland Rail), and Sydney—Perth (The Ghan) (Great Southern Rail).

The scale of an operator's passenger task is largely determined by the function of their railway. Table 16, below, shows the latest available financial year patronage statistics by operator. Railways with a large commuter task have higher patronage than those which cater largely to long-distance travel. Only a small amount of rail travel for NSW TrainLink, for example, is regional travel.

Table 16 Non-urban rail patronage, by operator, 2017–18

	Queensland Rail	NSW TrainLink		V/Line	Transwa
		Regional	Intercity		
Patronage (million trips)	.75	1.28	44.7	19.5	.18

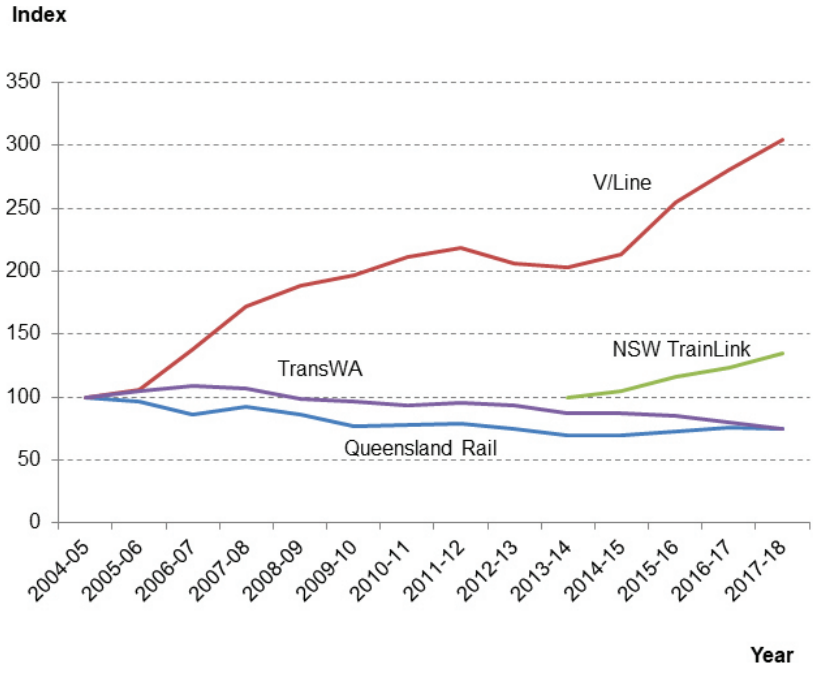
Notes: Data excludes patronage on services delivered under the Queensland "TransLink" brand.

Sources: NSW Trains (2018 p.8); Advice from Transport of NSW; Public Transport Authority of Western Australia (2018,); Queensland Rail (2018 p.42); V/Line 2018, (p. 10).

Similar to urban patronage, non-urban patronage is influenced by broad, macroeconomic factors and local, network specific factors.

Figure 31 shows patronage trends by operator. The index for NSW TrainLink is truncated to 2013–14 due to the patronage data revision.

Figure 31 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 shown for the period 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 (2018 p.8); Advice from Transport of NSW; Public Transport Authority of Western Australia (2018,); Queensland Rail (2018 p.42); V/Line 2018a, (p. 10).

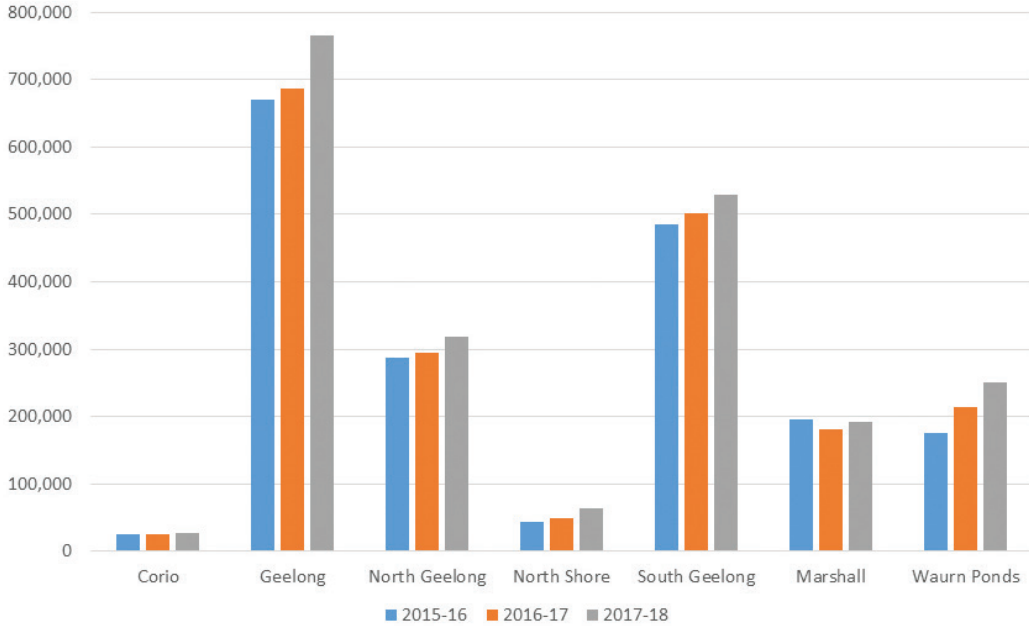
Some noteworthy trends are:

- **Queensland Rail** patronage, which is heavily tourism dependent, declined by less than two per cent.
- **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 2017-2018, patronage grew by almost 10 per cent, building upon previous growth. Intercity patronage grew by 9.8 per cent, while regional travel increased by 4.9 per cent.
- **Transwa** patronage continued its decline in 2017–18, at approximately four per cent cent. The *Australind*, which accounts for almost half of Transwa's total rail patronage, continued its decline, at more than four per cent.
- **V/Line** patronage continued to grow upon previous strong growth, at 8.8 per cent in 2017–18 from the previous financial year, but the rate of growth eased. All corridors had experienced growth, except Gippsland. The Geelong corridor had the largest growth, at 13.8 per cent. Patronage on the Gippsland corridor declined by 4.2 per cent. The Geelong corridor accounts for much of V/Line's recent patronage growth. Table 17 and
- Figure 32, below, show annual 'up' (Melbourne bound) boardings at Greater Geelong's seven stations. It is reasonable to presume the number of 'down' journeys would be roughly the same as 'up'. Some passenger trips captured in the figures may include people travelling wholly within Geelong and those who do not travel to suburban Melbourne, but these would be negligible, given the size of the Geelong-Melbourne task. These figures differ from Geelong line patronage figures as the line patronage figures include passengers boarding and alighting at stations outside Geelong, such as Tarneit and Little River.

Table 17 Annual 'up' boardings at Geelong stations

Station	2015–16	2016–17	2017–18	2015–16 to 2017–18 change (per cent)
Waurn Ponds	175 505	214 643	251 605	43.36
Marshall	195 640	181 872	191 640	-2.04
South Geelong	484 599	501 581	528 485	9.06
Geelong	669 706	687 315	765 580	14.32
North Geelong	287 171	295 318	317 759	10.65
North Shore	44 249	48 651	63 943	44.51
Corio	26247	25726	26 502	0.97
Total	1 883 117	1 955 106	2 145 514	13.93

Figure 32 Annual 'up' boardings at Geelong stations



Source: Data provided by Public Transport Victoria.

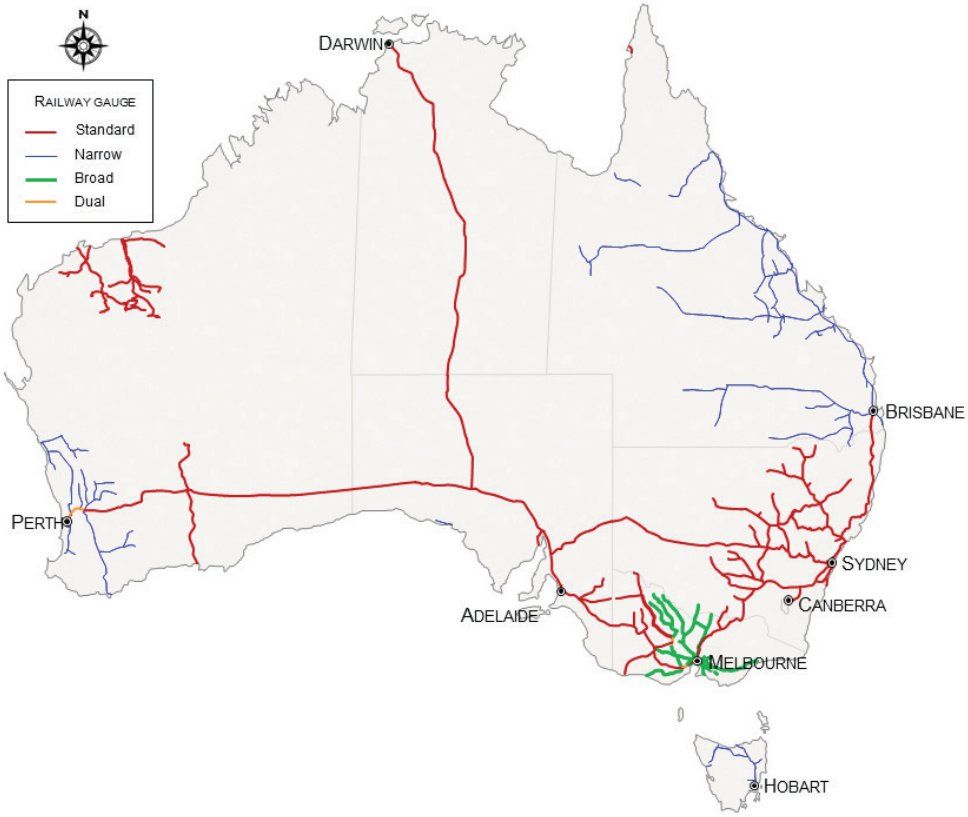
CHAPTER 3

Infrastructure and rolling stock provision

Railway network

Australia's colonies (then states in the post-federation era) commenced construction of 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, interstate trains now operate across a continuous 1435 mm 'standard' gauge.

Figure 33 Railway network, by track gauge, September 2019



Notes: The lines shown here are the railways that are open for traffic at June 2019.
Broad ("Irish") gauge is 1600 mm; standard ("Stephenson") gauge is 1435; and narrow ("Cape") gauge is 1067 mm.

BITRE estimates there were 32 894 route-kilometres of operational heavy railways in Australia in September 2019. This is approximately 350 kilometres less than 2018 due to the closure of most (narrow gauge) lines in the Eyre Peninsula of South Australia. This is offset slightly by the 19.5 kilometres of new track that is part of Sydney Metro Northwest[25] and the North West Connection near Parkes. Table 18 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 double track and some Fortescue Metals Group double track).

Table 18 Estimate of route kilometres of open (operational) heavy railways in September 2019, by jurisdiction, gauge and electrification

State or Territory	ACT	NT	NSW	Qld	SA	Tas	VIC	WA	Total
Route kilometres by gauge									
Broad			73		253		2 357		2 683
Narrow		3		8 146	184	611	16	2 970	11 930
Standard	6	1 690	7 128	117	2 561		1 912	4 558	17 972
Other			1	4		7			12
Dual				36	22		32	207	297
Total	**6**	**1 693**	**7 202**	**8 303**	**3 020**	**618**	**4 317**	**7 735**	**32 894**
1 500V DC			660				382		1 042
25 kV AC				2 173	44			181	2 398
33 kV AC			8						8
Total			**668**	**2 173**	**44**		**382**	**181**	**3 448**

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.

Excludes light rail and sugar tramways.

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

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

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).

Queensland has the largest electrified network, principally due to the electrified line between Rockhampton and Brisbane and a number of coal lines in the Central Queensland coal network. Elsewhere, overhead power systems have been installed on lines with relatively intensive urban and some intercity passenger services.

25 This figure is that of new track, not the existing track from Epping to Chatswood that was converted for Metro use.

New railways

Approximately 920 route-kilometres of freight track and 110 route-kilometres of passenger (heavy and light-rail) track have been opened since 2010. Table 19 provides a list of all new rail track additions since 2010, grouped by traffic type/purpose.

Table 19 Railways opened since 2010

Traffic	Location	Year	State	Length (km)	Project	Infrastructure builder
Iron ore	Mesa K – Waramboo (Mesa A)	2010	WA	49	Mesa A	Rio Tinto
Iron ore	Cloudbreak – Christmas Creek	2011	WA	50	Christmas Creek extension	Fortescue Metals Group
Iron ore	Tilley Siding (Morawa) – Karara	2012	WA	85	Karara Rail Spur	Karara Mining Ltd
Iron ore	Solomon Junction – Solomon	2012	WA	130	Solomon extension	Fortescue Metals Group
Iron ore	Hope Downs 4 railway	2013	WA	53	Hope Downs extension	Hope Downs Joint Venture (Hancock – Rio Tinto)
Iron ore	Roy Hill-Port Hedland	2015	WA	344	Roy Hill	Roy Hill Holdings
Coal	Cameby Downs Loop	2010	Queensland	7	Cameby Downs Loop	Queensland Rail
Coal	Goonyella–Newlands	2011	Queensland	68	Northern missing link	Aurizon
Coal	Middlemount Rail Spur	2011	Queensland	16	Middlemount Rail Spur	Macarthur Coal
Coal	Moranbah-Caval Ridge	2014	Queensland	12	Caval Ridge Spur	Billiton Mitsubishi Alliance
Coal	Maules Creek-Werris Creek line	2015	NSW	20	Maules Creek	Whitehaven
Coal	Aldoga-Wiggins Island	2015	Queensland	13	Wiggins Island Coal Export Terminal	Aurizon
Coal	Boggabri	2016	NSW	17	Boggabri Rail Spur	Idemitsu
Coal	Byerwen	2017	Queensland	5	New branch line in GAPE system	Private and Aurizon
Coal	Baralaba	2018	Queensland	6	New branch in Moura system	Private and Aurizon
Intermodal	Sefton–Macarthur	2012–13	NSW	36	Southern Sydney Freight Line	ARTC
Grain	Moree-Broadbent Grain facility	2017	NSW	3.5	Broadbent Grain facility- Moree connection	ARTC
Inter-Urban passenger	Deer Park-West Werribee	2015	Victoria	27	Regional Rail Link	V/Line
Urban passenger	Darra-Richlands	2010	Queensland	4.5	Springfield Branch	Queensland Rail
Urban passenger	Glenfield-Leppington	2015	NSW	12	Leppington line	RailCorp
Urban passenger	Epping – South Morang	2012	Victoria	4	South Morang Extension (re-opening)	Metro Trains Melbourne

(Continued)

Traffic	Location	Year	State	Length (km)	Project	Infrastructure builder
Urban passenger	Richlands-Springfield	2013	Queensland	9.5	Springfield Branch	Queensland Rail
Urban passenger	Noarlunga–Seaford	2014	SA	6	Noarlunga Line extension	Department of Planning, Transport and Infrastructure
Urban passenger	Clarkson–Butler	2014	WA	8	Joondalup Line extension	Transperth (Public Transport Authority)
Urban passenger	Petrie – Kippa-Ring	2016	Queensland	13	Moreton Bay Railway	Queensland Rail
Urban passenger	South Morang – Mernda	2018	Victoria	8	Mernda Rail Extension	Metro Trains Melbourne
Urban passenger	Sydney	2019	NSW	36	Sydney Metro Northwest	Transport for NSW
Urban passenger light rail	Gold Coast University Hospital – Broadbeach	2014	Queensland	13	Gold Coast Light Rail	Queensland and Australian governments; Gold Coast City Council, GoldLinQ
Urban passenger light rail	Lilyfield – Dulwich Hill	2014	NSW	6	Inner West Light Rail extension	Transport for NSW
Urban passenger light rail	North Terrace – Entertainment Centre	2010	SA	3	Port Road Light Rail Extension	Department of Planning, Transport and Infrastructure
Urban passenger light rail	Gold Coast University Hospital – Helensvale	2017	Queensland	7.3	Gold Coast Light Rail	Queensland and Australian governments; Gold Coast City Council, GoldLinQ
Canberra Light Rail	Gungahlin – Canberra City	2019	ACT	12	Canberra Metro	ACT government and Canberra Metro consortium
Newcastle Light Rail	Newcastle Interchange – Pacific Park	2019	NSW	2.7	Newcastle Light Rail	Transport for NSW

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.

Expansion of the mining industry in the Pilbara region of Western Australia underpins much of the recent rail infrastructure growth 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'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 2639 route kilometres of railway in the Pilbara region.

Since 2010, 177 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 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, 2017a). 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).

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.

As Table 20, below, shows, 569 route-kilometres of heavy and light railways were under construction in September 2019. Of this, 557 kilometres were heavy rail and 12 were light rail.

Table 20 Heavy and light railways under construction, September 2019

Traffic	Location	State	Length (route km)	Project	Infrastructure builder
Light rail	CBD and South East Light Rail	NSW	12	CBD and South Est Light Rail	Transport for NSW
Heavy Rail	Perth	WA	8	Forrestfield-Airport Link	PTA WA
Heavy Rail	Chatswood-Bankstown	NSW	30	Sydney Metro City and Southwest	Transport for NSW
Heavy Rail	Melbourne	Vic	9	Metro Tunnel	Melbourne Metro Rail Authority
Heavy Rail	Brisbane	Qld	10.2	Cross River Rail	Cross River Rail Delivery Authority
Heavy Rail	Melbourne-Brisbane	Vic, NSW, Qld	500[26]	Inland Rail	ARTC

26 The Inland Rail project consists of 1700 kilometres of upgraded infrastructure and newly built rail infrastructure. Of the 1700 kilometres, 600 will be new construction. Not all sections of the 600 kilometres of new construction is being completed at concurrently.

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[27] 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[28]. 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 15).

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

Victoria

Victoria has six track standard classifications. The highest standard is Class 1, and the lowest is Class 5 (VicSig 2019). 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.

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).

Commodity non-specific networks

Tasmania

According to advice from TasRail, it completed Tranche One of the Tasmanian Freight Rail Revitilsation Program on 30 June 2019. TasRail says the four-year $119.6 million project (funded by the Australian and Tasmanian Governments) "… has seen a significant reduction in percentage of network under Temporary Speed Restriction and improvement in the Track Quality Index." Tranche Two (also $119.6 million over four years) started on 1 July 2019. TasRail further states "The ongoing network investment is seeing TasRail experience record demand for its freight services and likewise derailments are at record

Box 5 Inland Rail

Construction of the Melbourne to Brisbane inland railway is underway. It is expected to be fully operational by the mid-2020s. Upon completion, Inland Rail will provide above rail operators with:

- A 1700 kilometre inland railway traversing inland Australia from Tottenham in Victoria to Acacia Ridge in Queensland;
- Travel speeds of up to 115 kilometres per hour;
- Container double-stacking;
- Maximum train lengths of 1 800 metres (the equivalent of 110 B-Double trucks);
- 21 tonne axle loads at a maximum speed of 115 kilometres per hour;
- Scheduled transit times not longer than 24 hours, which will be up to 10 hours faster than via the existing coastal route through Sydney;
- Reduced supply chain costs of an average of $76 per tonne for specific agricultural products (based on the results of a CSIRO pilot study to map supply chains and model transport cost savings available to businesses using Inland Rail.)

Inland Rail will serve both Melbourne—Brisbane traffic and regional trains that connect to Inland Rail en route.

70 per cent of Inland Rail will involve upgrading existing infrastructure ('brownfield' construction). The remaining 30 per cent consists of 'greenfield' construction, chiefly the Narromine—Narrabri section and most sections in Queensland.

Inland Rail is being built through 13 discrete projects. While final construction is due for completion in 2025, as each project is completed it will become operational and available regional rail service use. This means completion of Inland Rail construction and its use for rail services will be incremental.

The first project to be completed will be Parkes—Narromine (Project P2N). It is due to become fully operational in 2020. P2N construction consists of:

- Sleeper and track replacement;
- Track realignment to minimise tight curves;
- Raising the rail formation level;
- Replacing and upgrading culverts;
- Crossing loop construction; and
- Level crossing, signalling and communications, signage, fencing and service and utility works. (Inland Rail 2019a).[29]

The North West Connection, which was completed in August 2019 involved construction of around five kilometres of new track from the Broken Hill Line near Coopers Road to Henry Parkes Way in Parkes. It is anticipated the North West Connection will link into the Parkes to Narromine (P2N) line in the second quarter of 2020.

29 For more information on Inland Rail please see the Australian Government Inland Rail website: https://www.inlandrail.gov.au

Figure 34 New Pacific National inland rail terminal

Note: The image above shows a Pacific National double stacked intermodal train on the opening of its new Parkes facility in October 2019. Photo courtesy of Naomi Avery.

Urban heavy-rail passenger networks

Australia's urban heavy rail networks are extensive, even if the network coverage is not dense (see Table 21). 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[30].

Table 21 Network characteristics of urban passenger heavy railways, 2019

		Sydney	Melbourne	Brisbane	Adelaide	Perth
Operator	Sydney Trains	Sydney Metro	Metro Trains Melbourne	Queensland Rail	Adelaide Metro	Transperth
Ownership	Public	Public	Private (government franchise)	Public	Public	Public
Dedicated urban passenger lines (km)	n/a	36	183	128	126	180
Shared metropolitan freight/passenger lines (km)	n/a	-	230	268	-	1
Total route length (km)	364	36	413	396	126	181
Electrified route length (km)	364	36	382	396	44	181
Metropolitan stations (number)	175	13	221	152	87	71
Average distance between stations (km)	2.1	2.7	1.8	2.6	1.4	2.5
Metropolitan passenger route length under construction (km)	-	30	9	10.2	-	8
Passenger network gauge	Standard	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.

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.

The following characteristics and trends make each system distinctive:

- **Sydney Metro.** Sydney Metro Northwest opened on 26 May 2019 and provides driverless services from Rouse Hill to Chatswood. The Metro trains operate on a 'turn up and go' basis rather than by timetable. Construction of further stages of the system to the Sydney CBD and Bankstown is underway.
- **Network expansion.** Perth's system has grown significantly over the last 20 years with new lines from Perth to Joondalup/Currambine/Butler (41 km), and Mandurah (70 km), and the Thornlie branch line (three km). Construction of the 8.5-kilometre Forrestfield-Airport link will provide rail access for Perth's eastern suburbs to the city, via Perth Airport. Construction is due for completion in 2021.

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

- **In Melbourne,** completion of the metro tunnel, due in 2025, will ease congestion in the city loop by providing two new nine-kilometre tunnels under the CBD, with five new stations and High Capacity Signalling.
- **In Brisbane,** construction of the 10-kilometre Cross River Rail will similarly ease congestion by providing a second Brisbane River crossing and two six-kilometre tunnels, from Dalton Park to Bowen Hills. The project is due for completion in 2024.
- **Network form.** Perth's system is also distinctive relative to the other Australian networks due to the nature of its new railways. Table 21 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 49). 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 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. The Epping to Thornleigh third track also gives additional train capacity through Sydney's northern suburbs.
- **Electrification.** Electrified services began in Sydney and Melbourne[31] 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. Construction of the Gawler line is now also underway.

Urban light rail passenger networks

Australia has 313 route kilometres of operational light rail. The technological and operational differences between tramways, light rail and heavy rail are increasingly blurred[32]. 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 distance, Melbourne has the world's largest light rail network. There are single route operations in the other cities that have light rail. (see Table 22).

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

32 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 22 Network characteristics of light railways, 2019

	Gold Coast	Sydney	Melbourne	Adelaide	Canberra	Newcastle
Total route length (km)	20.3	12.8	250	16.5	12	2.7
Segregated right of way	segregated	largely segregated	24% segregated	largely segregated	segregated	segregated
Routes (no.)	1	1	24	1	1	1
Number of stops (no.)	19	23	1 717	29	13	6

Sources: Currie and Burke (2013); Yarra Trams (2017); Advice from Yarra Trams; G:link (2019); Capital. Metro (2019); Advice from Department of Planning, Transport and Infrastructure; Transdev Sydney (2019); Transport for NSW (2019); BITRE estimates.

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 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, with two short extensions from North Terrace in the CBD – to Festival Plaza and the Botanic Gardens. 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 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). In December 2017, the 7.3 kilometres Stage 2 expansion to Helensvale railway station opened.

New light railways in Canberra and Newcastle opened in 2019. The Canberra light railway runs from Canberra city to Gungahlin. Relatively long distances between stops enables Canberra's light rail to have the highest point to point average speed – 30 kilometres per hour. Newcastle's light rail has no overhead wires. Instead, the light rail vehicles recharge at every stop, by raising the pantograph to an overhead power supply located at the stop.

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 reduced this in Victoria.

Table 23 Network coverage of non-urban passenger rail services, 2019

	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 there were 2 005 operational locomotives in Australia in September 2019 (See Table 24). 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[33].

Figure 36 shows approximately 50 per cent of the fleet was aged approximately 12 years or less in mid-2019, compared to approximately 11 years or less the previous year. Figure 35 shows the age distribution by gauge. The newest locomotives at the time of analysis were six AC EVO, ES44ACi locomotives that belong to Rio Tinto Iron Ore.

Approximately 64 per cent of the fleet was built or rebuilt in Australia, with the remainder being built in the United States of America, China and Germany. Most imported locomotives are new and operate primarily in the Pilbara and central Queensland coal network.

Approximately 66 per cent of the fleet operate on the standard gauge network.

The analysis is for locomotives that almost exclusively perform freight duties. V/Line is expanding its diesel multiple unit (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. Conversion of some lines in Victoria's north west to standard gauge reduced the size of the broad gauge network further and, thus, the scope of its operations. To illustrate, there are no broad gauge locomotives aged less than 11 years. 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.

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

The status of the locomotive fleet is fluid, with locomotives frequently switching between active operations and being in 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 now arguably new locomotives.

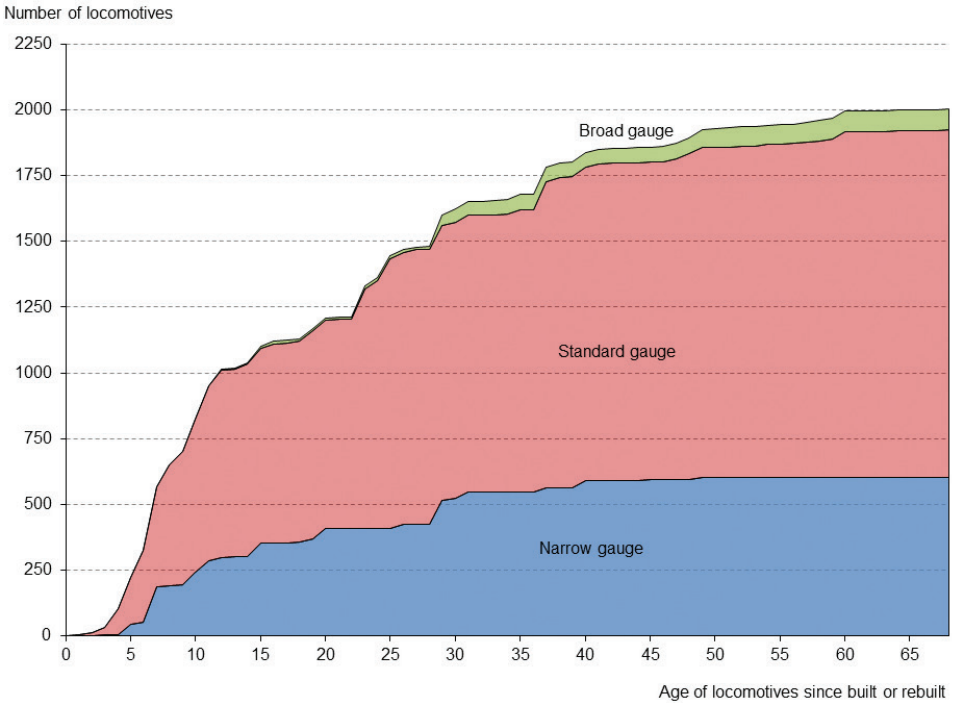
Care is also needed when comparing locomotive ages by gauge, particularly between the broad and standard gauges, where there is considerable re-gauging of the previous Victorian government owned fleet, such as the G, T, and N classes, many of which now operate outside Victoria.

Table 24 Locomotive ages

Age range (years)	Narrow Gauge	Standard Gauge	Broad Gauge	Total
0-5	45	176	0	221
6-10	195	397	0	592
11-15	111	158	11	280
16-20	56	51	0	107
21-25	2	234	0	236
26-30	107	22	0	129
31-35	29	29	42	100
36-40	47	112	3	162
41-45	1	19	0	20
46-50	8	50	1	59
51+	2	75	22	99
Total	603	1 323	79	2 005

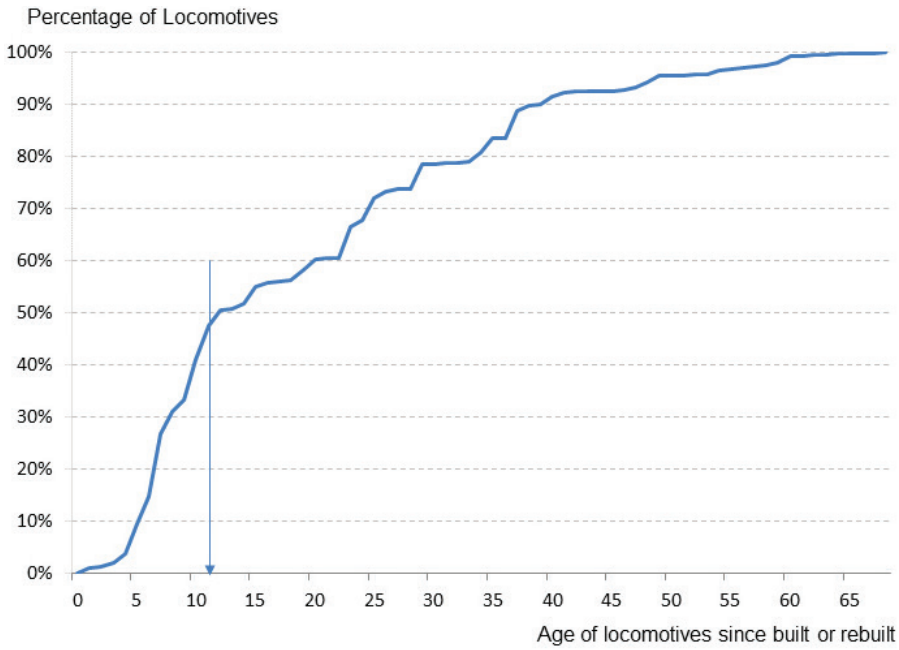
Sources: BITRE analysis of data from Pacific National, Aurizon, BHP, Fortesque Metals Group, Genesee and Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Roy Hill, Fletcher International, Southern Shorthaul Rail, Public Transport Victoria, and QUBE Logistics; Clark (2015); Railpage (2018)

Figure 35 Cumulative locomotive age profile, by number of locomotives



Sources: BITRE analysis of data from Pacific National, Aurizon, BHP, Fortesque Metals Group, Genesee and Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Roy Hill, Fletcher International, Southern Shorthaul Rail, Public Transport Victoria, and QUBE Logistics; Clark (2015); Railpage (2018).

Figure 36 Cumulative locomotive age profile, per cent



Source: BITRE analysis of data from Pacific National, Aurizon, BHP, Fortesque Metals Group, Genesee and Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Roy Hill, Fletcher International, Southern Shorthaul Rail, Public Transport Victoria, and QUBE Logistics; Clark (2015); Railpage (2018).

Box 6 Further resources

The monthly magazines *Railway Digest* compiles a list of current and recently completed rolling stock contracts and deliveries of locomotives, wagons, permanent-way vehicles and passenger stock. This list is published regularly in the magazine. 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 needed are governed by:

- 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

"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 units, 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 and three-car operations in Perth.

Table 25 Urban Heavy rail rolling stock, October 2019

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Vehicles (no.)	648[a]	1 886[b]	1 356	130[c]	330
Carriage format	Single-deck	Double-deck and single-deck	Single-deck	Single-deck	Single-deck
Multiple-unit format	495 three car 153 six car	200 four car 22 six car 119 eight car	three car		48 two car 78 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] The Brisbane and Sydney totals exclude interurban rollingstock.

[b] The Sydney total includes the Alstom Metropolis metro cars.

[c] The Adelaide vehicles includes the 4000 class, six cars of which are currently under repairs.

Sources: Data provided by Transport for NSW, Public Transport Victoria, Queensland Rail, Adelaide Metro, and Public Transport Authority WA.

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 converging at the carriage doors and fewer doors per carriage than single deck trains.

Light rail

Melbourne's light rail fleet is much larger and more varied than the other cities; see Table 26. 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. Since 2017, Yarra Trams has received an additional six E Class trams, and retired its two remaining B1 Class trams and one Z3 class vehicle. Overall, the fleet has thus increased. In 2019, Canberra and Newcastle's light rail networks opened, using Urbos 3 and 100 class trams.

Table 26 Light rail rolling stock, July 2019

City	Vehicle type	Length (metres)	No. vehicles
Gold Coast	Flexity 2	43	18
Sydney	Urbos 3	33	12
Melbourne	A1 class	15	27
	A2 class	15	42
	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	76
	Z3 class	16.6	114
	W class	14.2	13
Melbourne total			502
Adelaide	100 Flexity Classic	30	15
	200 Citadis	32	9
Adelaide total			24
Canberra	Urbos 3	32.9	14
Newcastle	Urbos 100	32.9	6

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.

Sources: Advice from G:Link; Advice from Adelaide Metro; Advice from Transdev NSW; Advice from Transport for Victoria.

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 27 shows the number of individual vehicles/cars, by type and operator.

Table 27 Non-urban passenger rolling stock in service, by vehicle type and operator, 2019

	Queensland Rail	NSW TrainLink	V/Line	Transwa
Electric multiple unit cars (no.)	138	424	-	-
Diesel multiple unit cars (no.)	27	65	258	14
Locomotives (no.)	27	19	33	-
Carriages (no.)	62	60	133	-
Total cars/vehicles	254	568	424	14

Notes: The Queensland Rail total excludes the New Generation Rollingstock. Most of that fleet is used in suburban operations, although they are also used on the Gold Coast Line.

The V/Line carriages total includes power vans but excludes the three flat wagons in its fleet.

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.

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

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

Sources: Data provided by Transport for NSW, Queensland Rail, Public Transport Victoria, and Transwa.

Locomotive hauled trains are primarily used for long-distance routes although V/Line still uses them on some commuter route services, such as Melbourne—Seymour. Some Queensland Rail long-distance services are 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 sets on its long distance services. While the XPTs are capable of travelling at 160km/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, 2016).

Medium-distance regional/commuter services are generally DMU operated. VLocity DMUs, that operate at speeds of up to 160 kilometres per hour, are used on Victoria's Regional Fast Rail services. Transwa uses DMUs for all its rail services. The Perth-Kalgoorlie *Prospector* DMU also travels at up to 160km/h.

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—Newcastle, Sydney—Lithgow and Sydney—Kiama (via Wollongong) services. Queensland Rail's intercity 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. It 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.)

CHAPTER 4

Railway performance

Network indicators

Safety

ONRSR, which, in 2017–18, had regulatory safety oversight for all of Australia[34], stated in its *Rail Safety Report 2017–2018*, there were 104 notified fatalities on railways regulated under Rail Safety National Law (2012). These fatalities were:

- 87 acts of suspected suicide;
- seven incidents of trespassers struck by rolling stock;
- one trespasser electrocuted in the rail corridor;
- four fatalities to members of the public involved in level crossing collisions between a train and a road vehicle;
- two instances of passengers falling from a platform and being struck by a train;
- a passenger falling down an escalator;
- one passenger who fell inside a train; and
- one member of the public who was struck by a train. (ONRSR, 2018, p.10)

ONRSR *Rail Safety Report 2017–2018* (p.13) provides details of these fatalities, excluding the cases of trespass and suspected suicide.

There were 90 reported railway-related serious injuries for the same period. Almost 50 per cent of these were slips, trips and falls. Just over 20 percent were cases of attempted suicide. ONRSR *Rail Safety Report 2017–2018* (p.15 provides details of some of these incidents.)

Employment

Approximately 45 600 people work in the Australian rail industry. Figure 37 and Table 28, below, show trends in rail industry employment since 2014, as reported by the Australian Bureau of Statistic (ABS). The ABS publishes the data quarterly, back to 1984, but this report only shows the figures for May each year, to make the data presentable[35].

The following results stand out:

34 ONRSR's oversight in Victoria excludes tramways and some tourist and heritage railways. Victorian law regulates these operations.

35 For the full data set see https://www.abs.gov.au/Ausstats/abs@.nsf/exnote/6291.0.55.003

- Employment in the industry grew by almost 25% from May 2016 to May 2017. Most of this growth occurred in the passenger transport component.
- In May 2017, New South Wales accounted for more than half of total employment in the Unspecified and Freight sectors, while Victoria accounted for more than half of total employment in the Passenger component.
- In May 2014, employment in the Unspecified component in Western Australia was approximately double what it was in May 2019. This is likely due to the construction phase boom in the mining industry, such as construction of the greenfield Roy Hill operation.

Figure 37 Rail transport employment by type, 2014–2019

Source: Australian Bureau of Statistics, 2019.

Table 28 Rail transport employment by type and jurisdiction, 2014–2019

Employed total ('000)	May 2019	May 2018	May 2017	May 2016	May 2015	May 2014
Rail Transport Unspecified						
New South Wales	11.7	7.5	13.0	8.4	12.0	10.7
Victoria	2.7	2.3	2.6	5.2	3.8	4.5
Queensland	6.1	9.8	9.0	8.8	7.7	5.8
South Australia	0.7	0.9	1.4	1.8	1.5	0.8
Western Australia	1.5	1.2	2.2	1.5	1.8	3.0
Tasmania	0.2	0.0	0.0	0.0	0.1	0.1
Northern Territory	0.0	0.3	0.2	0.0	0.0	0.1
Australian Capital Territory	0.0	0.0	0.0	0.0	0.0	0.0
Total	**22.9**	**22.0**	**28.4**	**25.7**	**26.9**	**25.1**
Rail Freight Transport						
New South Wales	4.7	2.5	2.8	3.3	1.4	1.5
Victoria	0.6	0.5	0.5	0.7	0.0	0.7
Queensland	2.5	3.1	2.5	2.5	1.2	2.2
South Australia	0.7	0.9	0.8	0.5	0.9	0.5
Western Australia	0.0	0.0	1.0	0.5	1.3	0.4
Tasmania	0.1	0.0	0.0	0.0	0.1	0.0
Northern Territory	0.0	0.0	0.0	0.0	0.0	0.0
Australian Capital Territory	0.0	0.0	0.0	0.0	0.0	0.0
Total	**8.5**	**6.9**	**7.5**	**7.5**	**5.1**	**5.2**
Rail Passenger Transport						
New South Wales	3.4	5.1	4.4	2.7	0.5	3.5
Victoria	7.3	4.4	5.0	1.9	2.7	2.5
Queensland	2.7	0.9	2.1	0.4	0.0	0.4
South Australia	0.3	1.0	0.5	0.2	0.9	0.3
Western Australia	0.3	1.0	0.7	1.0	0.3	0.4
Tasmania	0.0	0.3	0.0	0.0	0.0	0.0
Northern Territory	0.0	0.0	0.0	0.0	0.0	0.0
Australian Capital Territory	0.2	0.0	0.0	0.0	0.0	0.0
Total	**14.2**	**12.7**	**12.6**	**6.2**	**4.4**	**7.0**
Grand Total	**45.6**	**41.6**	**48.6**	**39.4**	**36.4**	**37.2**

Source: Australian Bureau of Statistics, 2019

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 29 shows BITRE's revised most recent carbon dioxide equivalent emissions estimate of the rail industry since 2006. According to the current estimate, emissions have increased by approximately 32 per cent since 2006.

The increased rail transport of bulk materials, particularly iron ore, 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 2016).

Table 29 Rail industry's full fuel cycle carbon dioxide equivalent emissions (billion grams)

Year											
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CO_2 emissions											
4 592	4 869	5 023	5 097	5 163	5 231	5 366	5 420	5 607	5 886	6 014	6 083

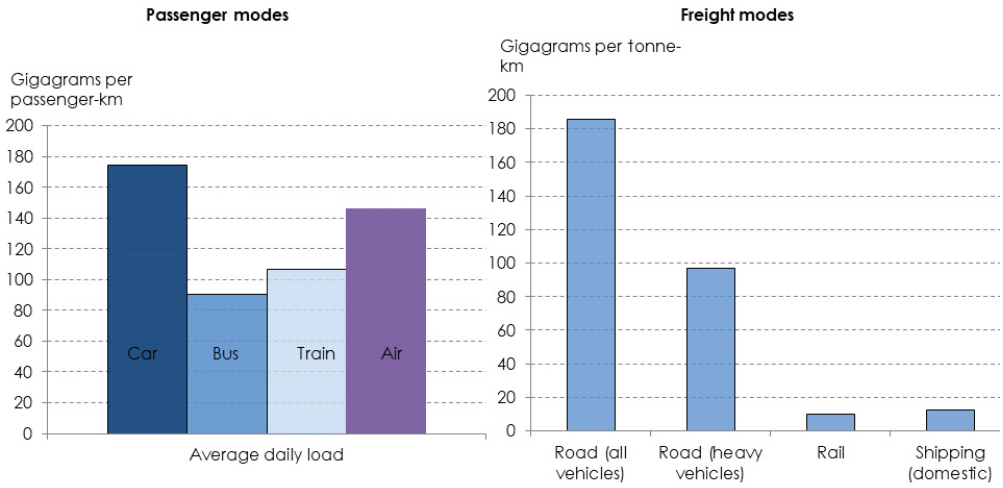
Note: Preliminary/provisional estimate.

Source: Revised BITRE estimates.

The emissions intensity of freight rail is low relative to road freight vehicles[35]. (Figure 38).

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 38 Estimated emissions intensity of passenger and freight modes, 2017, carbon dioxide equivalent



Source: BITRE estimates.

35 These figures have not been updated.

Interstate network indicators

Access revenue yield indicator (ARTC)

The access revenue yield data that ARTC provides 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 track that can accommodate the longer trains. Consequently, interstate network infrastructure managers have upgraded their networks to accommodate longer trains.

Table 30, 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 essentially identifies if there have been any real changes in access charges. 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).

Table 30 Index of real maximum access revenue yield, interstate network (2009–10 = 100)

	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18
North–South corridor										
Acacia Ridge – Border Loop	100	100	100	100	100	100	100	100	100	100
Border Loop – Newcastle	100	100	100	100	100	100	100	100	100	100
Macarthur–Albury	100	100	100	100	100	100	100	100	100	100
Albury–Tottenham	100	100	100	100	100	100	100	100	100	100
East–West corridor										
Melbourne–Adelaide	100	100	100	100	100	100	100	100	100	100
Adelaide–Kalgoorlie	100	100	100	100	100	100	100	100	100	100
Cootamundra–Parkes	100	100	100	100	100	100	100	100	100	100
Parkes – Broken Hill	100	100	100	100	100	100	100	100	100	100
Broken Hill – Crystal Brook	100	100	100	100	100	100	100	100	100	100

Note: Numbers are subject to rounding.

Source: Data provided by ARTC.

Interstate network utilisation

Train frequency on the interstate network

Table 31 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—Adelaide trains dwell in Sydney where goods are loaded and unloaded. Caution is also needed when comparing train numbers. Lower train numbers can be more than offset by longer train lengths.

The number of scheduled Brisbane—Melbourne has decreased due to Pacific National's cessation of its MB2 and BM2 services. Contrarily the number of Sydney—Melbourne services has increased. Pacific National has increased its number of services, while QUBE Logistics has commenced services. Even if the QUBE Logistics services are excluded there still has been an increase. There is one less Brisbane to Sydney service and one more Sydney to Brisbane service.

On the East–West corridor, the number of scheduled intermodal trains operating Melbourne—Perth has decreased slightly. The number of Adelaide—Melbourne services is unchanged. The number of Sydney—Perth trains (for which there were no previous Aurizon services) is also unchanged. There has also been no change in the number of Adelaide—Darwin services

Table 31 Number of scheduled weekly intermodal designated train services, by city pair

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
North–South corridor											
Brisbane to Sydney	1	1	1	2	2	2	2	5	5	6	5
Sydney to Brisbane	0	0	0	0	0	0	2	5	5	4	5
Sydney to Melbourne	0	2	2	3	2	2	1	1	2	2	9
Melbourne to Sydney	0	2	2	3	2	2	0	0	0	3	7
Brisbane to Melbourne	17	15	15	15	15	15	16	12	16	16	10
Melbourne to Brisbane	17	15	15	15	16	16	16	12	16	16	10
Brisbane to Adelaide	3	3	3	2	2	2	2	2	2	1	2
Adelaide to Brisbane	3	3	3	2	2	2	2	2	2	1	2
East–West corridor											
Melbourne to Adelaide	17	11	12	9	9	8	6	6	5	5	5
Adelaide to Melbourne	17	11	12	9	9	9	6	6	6	5	5
Melbourne to Perth	15	18	19	20	20	20	20	18	18	15	13
Perth to Melbourne	15	17	19	20	20	20	20	19	19	15	14
Sydney to Perth	7	7	7	8	9	10	8	7	7	7	7
Perth to Sydney	7	7	7	8	9	10	9	7	7	7	7
Adelaide to Perth	2	0	0	0	0	0	0	0	0	0	0
Perth to Adelaide	2	0	0	0	0	0	0	0	0	0	0
Central corridor											
Adelaide to Darwin	7	7	6	7	6	6	6	6	6	6	6
Darwin to Adelaide	6	6	6	7	6	6	6	6	6	6	6

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2019.

Figure 39 QUBE Logistics Maldon to Melbourne cement train

Note: The image above shows QUBE Logistics Maldon to Melbourne cement service 6SM7, three kilometres west of Cunningar in southern New South Wales in March 2019. Photo courtesy of Rodney Avery.

Weekly trains by interstate line segment

Table 32 shows the number of scheduled weekly interstate intermodal and steel trains on each line segment. This indicates how intensely the interstate network is used, by schedule. Table 32 differs from Table 31 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 32 also includes interstate trains that do not travel from capital city to capital city, such as the Melbourne—Griffith trains.

Crystal Brook—Port Augusta is still the busiest segment. The segment is a convergence point for interstate intermodal and steel 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 Sydney—Cootamundra and Cootamundra—Melbourne segments remain the busiest on the North—South corridor. In addition to intermodal and steel trains, passenger and bulk commodity (mostly grain) trains used these segments extensively. The significant decrease in 2019 is due largely to the cessation of some Melbourne—Brisbane services. QUBE Logistics has also switched its Harefield export product trains to Port Botany instead of Melbourne.

Table 32 Total scheduled weekly interstate intermodal and steel trains, by line segment

Line segment	2015	2016	2017	2018	2019
North–South corridor					
1. Brisbane–Sydney	42	48	58	56	46
2. Sydney–Melbourne					
Sydney–Cootamundra	58	60	70	71	72
Cootamundra–Melbourne	49	49	58	71	61
East–West corridor					
3. Sydney–Crystal Brook via Broken Hill					
Sydney–Parkes via Lithgow	11	6	6	6	6
Cootamundra–Parkes	20	22	22	20	22
Parkes–Crystal Brook	33	30	30	32	33
4. Melbourne – Crystal Brook					
Melbourne–Adelaide	59	55	53	46	43
Adelaide – Crystal Brook	64	60	60	55	52
5. Crystal Brook – Perth					
Crystal Brook – Port Augusta	90	84	84	80	76
Port Augusta – Tarcoola	77	69	69	63	60
Tarcoola–Perth	65	57	57	51	48

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure, and Genesee & Wyoming Australia) as at April 2019.

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 33, 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 other trains types' operations may influence intermodal train flow patterns in the infrastructure managers' path planning. Assessing what influences other trains' operations may have on intermodal train flow patterns is outside the scope of this publication. Train flow patterns are based on scheduled times. Actual times for individual trains may differ due to operational reasons.

Table 33 Scheduled inter-capital intermodal train flow patterns

Line segment/ direction	Number of weekly services		Average speed (kph)		Average stops		Average transit time (mins)		Average dwell time (mins)		Percentage dwell time (per cent)		Dwell time per stop (mins)	
Year	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
North-South corridor														
Brisbane to Sydney	23	17	54	54	8	8	1083	1081	181	165	17%	15%	22	21
Sydney to Brisbane	21	16	55	52	7	6	1054	1091	148	194	14%	17%	22	30
Sydney to Melbourne	18	19	64	66	4	3	905	874	86	93	10%	11%	24	29
Melbourne to Sydney	19	17	69	67	4	2	836	855	67	85	8%	10%	18	34
Brisbane to Melbourne	16	10	60	58	11	13	1959	1996	269	266	14%	13%	22	21
Melbourne to Brisbane	16	10	62	62	12	10	1865	1894	239	186	13%	10%	21	19
East-West corridor														
Melbourne to Adelaide	20	18	68	68	3	3	738	738	51	46	7%	6%	17	17
Adelaide to Melbourne	20	19	58	58	5	5	868	862	153	152	17%	18%	29	29
Adelaide to Perth	15	13	67	67	12	11	2366	2361	326	301	14%	13%	27	26
Perth to Adelaide	15	14	59	55	18	17	2689	2742	646	703	24%	24%	35	42
Cootamundra to Crystal Brook	4	3	67	67	4	5	1136	1132	266	262	23%	25%	61	56
Crystal Brook to Cootamundra	8	7	57	66	4	4	1326	1155	350	291	26%	25%	79	81
Brisbane to Adelaide	1	2	54	53	17	16	3145	3205	840	975	27%	28%	49	56
Adelaide to Brisbane	1	2	53	51	15	13	3180	3298	860	975	27%	30%	57	72
Central corridor														
Tarcoola to Darwin	6	6	64	71	4	4	2098	1905	266	266	13%	14%	67	69
Darwin to Tarcoola	6	6	68	68	4	4	1976	1976	285	286	14%	14%	68	69

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.

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at May 2019.

North–South corridor

All indicators, other than service frequency, have not changed significantly, to the extent at least in which distinct trends are apparent.

East–West corridor

The following significant changes have occurred since 2018:

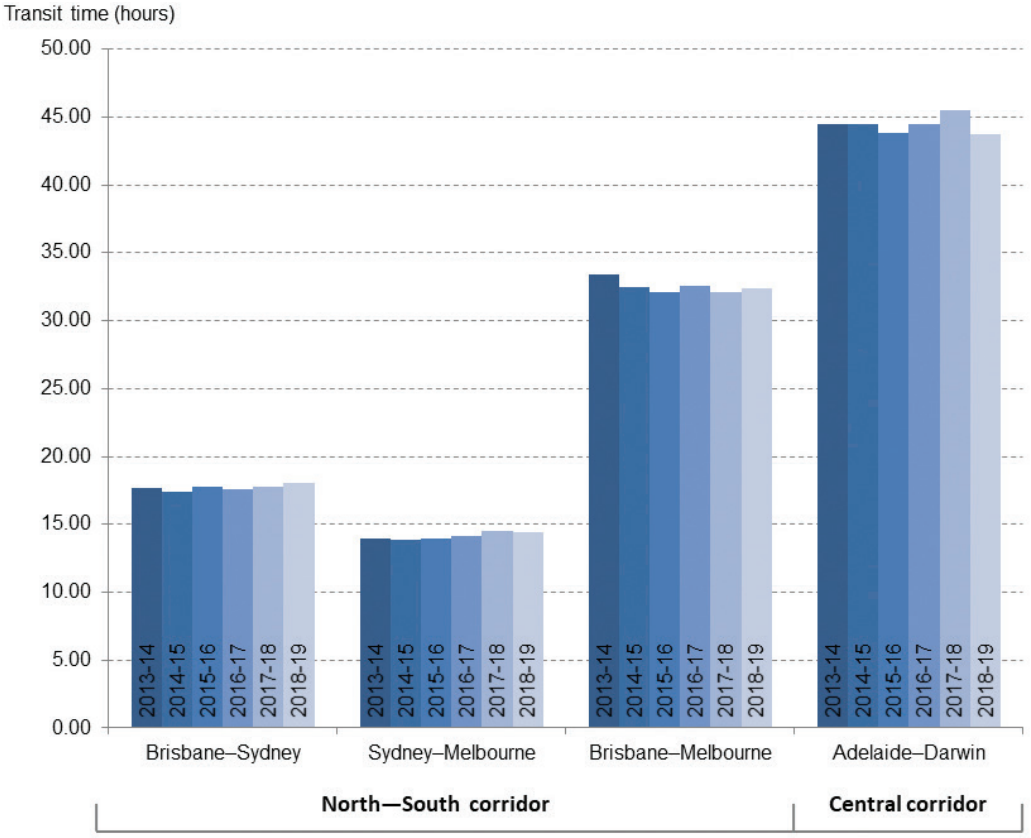
- Perth to Adelaide average transit times have increased. There are, on average, fewer stops en route, but dwell times per stop have increased;
- For Crystal Brook to Cootamundra West trains, while the average number of stops and dwell per stop is largely unchanged, trains complete their journeys almost three hours less than in 2018.

- Transit times for Brisbane—Adelaide trains have increased significantly, but as there was only one scheduled service each way in 2018 and two in 2019 it is not possible to draw reliable inferences as the base number of services is too low.

Central corridor

The only significant change from 2018 is Adelaide to Darwin trains are completing the Tarcoola to Darwin section more than three hours faster.

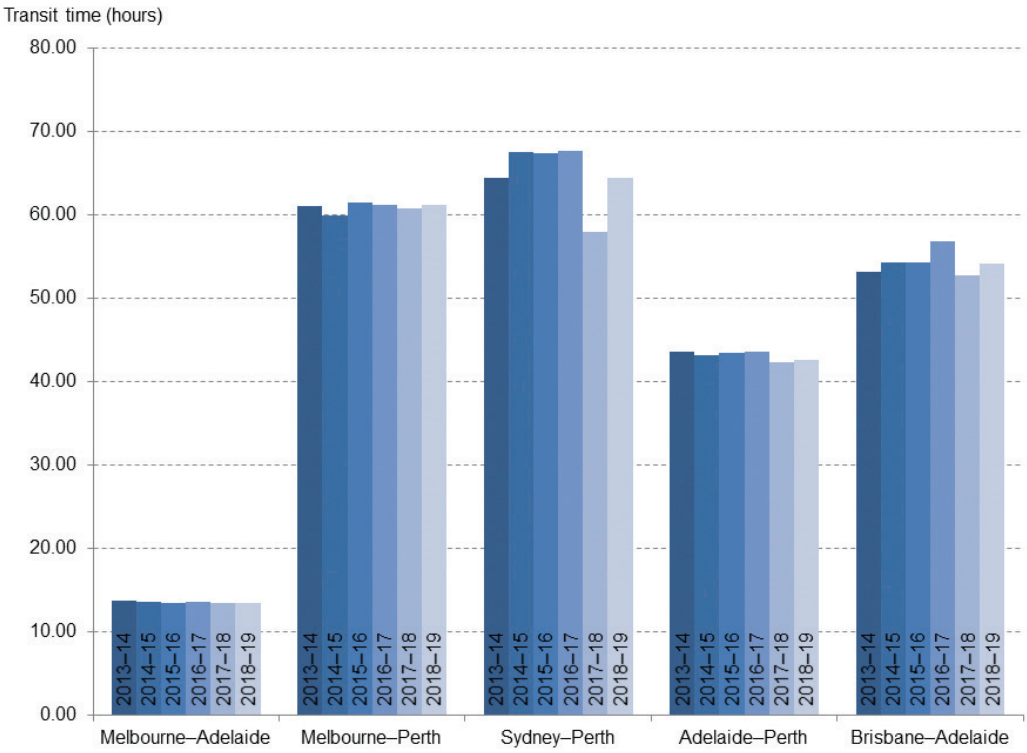
Figure 40 Average scheduled transit times, North–South and Central corridors, 2013–14 to 2018–19



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 2019.

Figure 41 Average scheduled transit times, East–West corridors, 2013–14 to 2018–19



Notes: Calculations include all trains on a given line segment, as at April 2019. 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.

Sources: Infrastructure managers' working timetables (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2019.

Train reliability on the interstate network

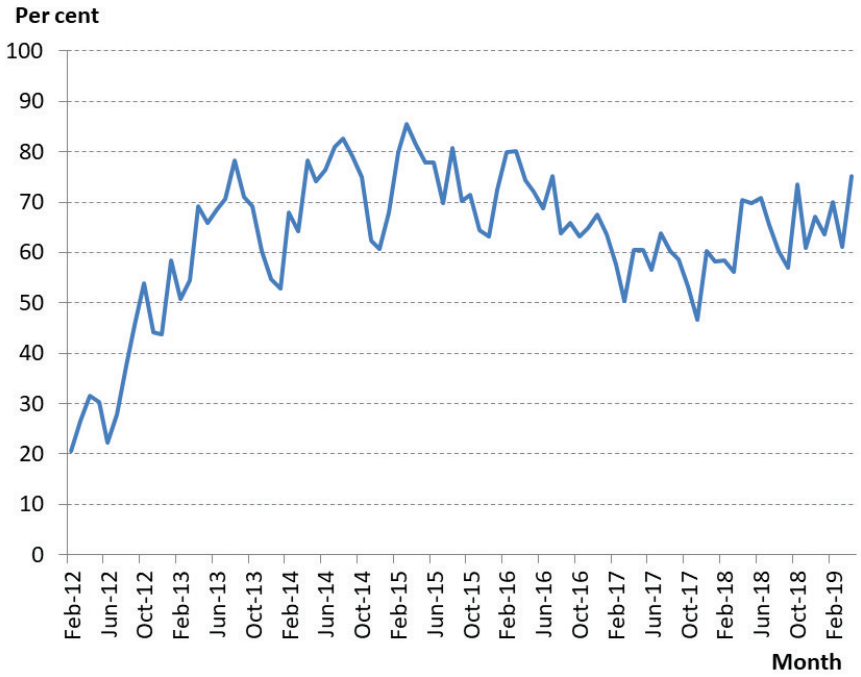
ARTC publishes performance indicators relating to service quality areas including reliability. Detailed information regarding reliability by city pair is available on ARTC's website.

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 42 and Figure 43 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.

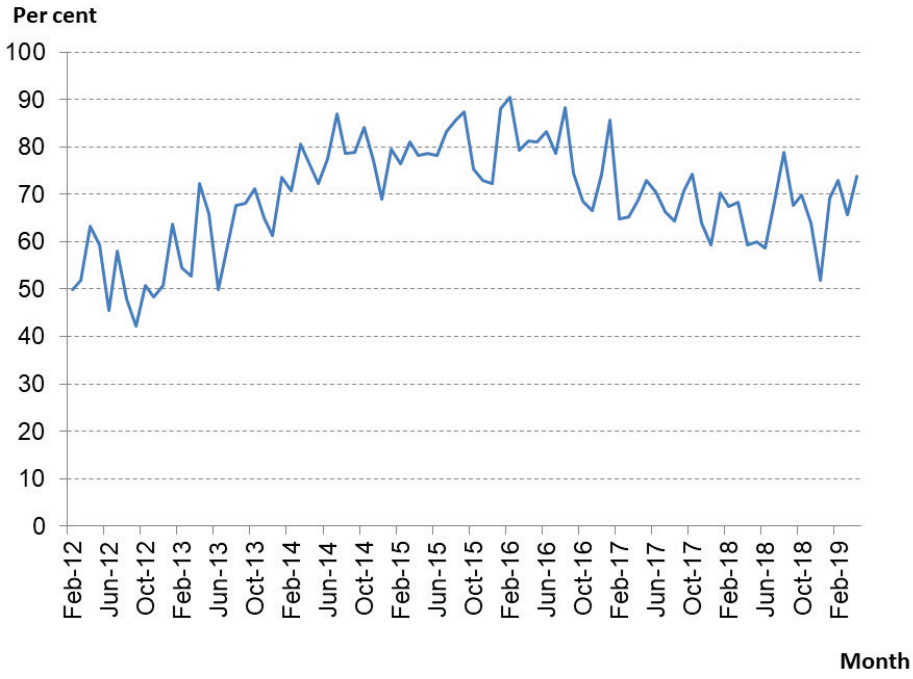
Figure 42 North–South corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Data provided by ARTC.

As Figure 43 (below) shows, train timeliness has trended upwards since October 2017. Timeliness also increased from February 2012 as ARTC rectified degraded track conditions, particularly between Melbourne and Sydney.

Figure 43 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 trended slightly downwards since the February 2016 peak.

Permitted train lengths on the interstate network

Permitted train lengths influence track capacity. On Australia's predominantly single track, crossing loops and passing lanes contribute to capacity. 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 also determine permitted train lengths.

Permitted train lengths on the interstate network are as follows:

- 1500 metres Brisbane–Sydney;
- 1800 metres Melbourne—Adelaide; and
- 1800 metres Sydney—Melbourne, Cootamundra—Crystal Brook, Adelaide—Perth, Tarcoola—Darwin.

Since 2007–08, additional crossing loops have been built on the Cootamundra—Parkes section and additional passing lanes[36] added on the single track sections between Junee and Melbourne to allow the unrestricted use of 1800 metre trains. Since completion of upgrades to Torrens Junction in Adelaide in 2018, 1800 metre trains may now operate on the Melbourne—Adelaide sector unrestricted.

36 A passing lane differs from a passing loop by virtue of the fact they are approximately eight kilometres in length, as opposed to approximately 1500 metres and 1800 metres, which is the typical crossing loop length on the interstate network, depending on the corridor. This enables trains to cross each other without stopping, subject to timings.

Double stacking capability on the interstate network

Double stacking containers on wagons also influences 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 Goobang (Parkes) and west of Adelaide. Figure 44, below, illustrates.

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 'piggybacked' on rail flat wagons.

Figure 44 Double stacking capability on the interstate network

Track quality of the interstate network

The maintenance and standards of railway infrastructure are important to train operating performance. The infrastructure quality, maintenance regime and underlying economic life of the infrastructure influence the permitted track speed and smoothness of wagon ride.

Figure 45 to Figure 48 illustrate physical measures of average track condition by line segment. These indicators use a 'track quality index' (TQI). Lower index numbers equates to higher track quality.

The figures 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.

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 7 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. *Trainline 6*, has a case study on ARTC's 'AK Car' track measuring operations (See BITRE, 2018a).

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:

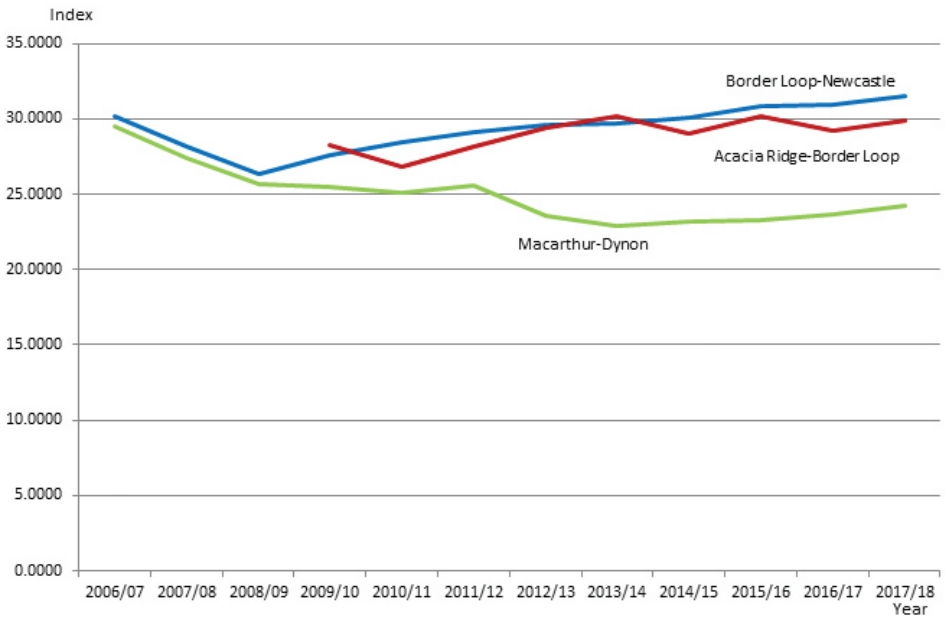
- Gauge;
- Twist (short), measured over two metres;
- Vertical irregularities ('top'), deviation over a 20 metre inertial reading (average of left and right rail); and
- Horizontal line irregularities ('versine'), 5/10 metre chord emulation (average of left and right rail).

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

As Figure 45, below, shows, the track quality decreased on all sections of the North-South network, while it has mostly improved on East-West network (see Figure 41).

Genesee & Wyoming Australia's TQI has continued to fluctuate significantly on all sectors (See Figure 47 and Figure 48). 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.

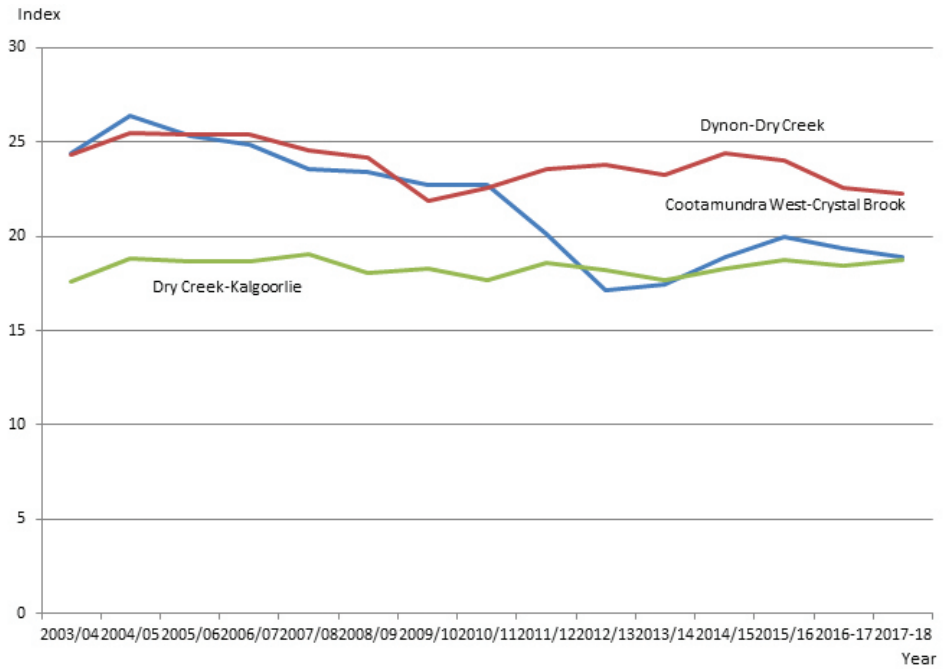
Figure 45 ARTC track quality index, North–South corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

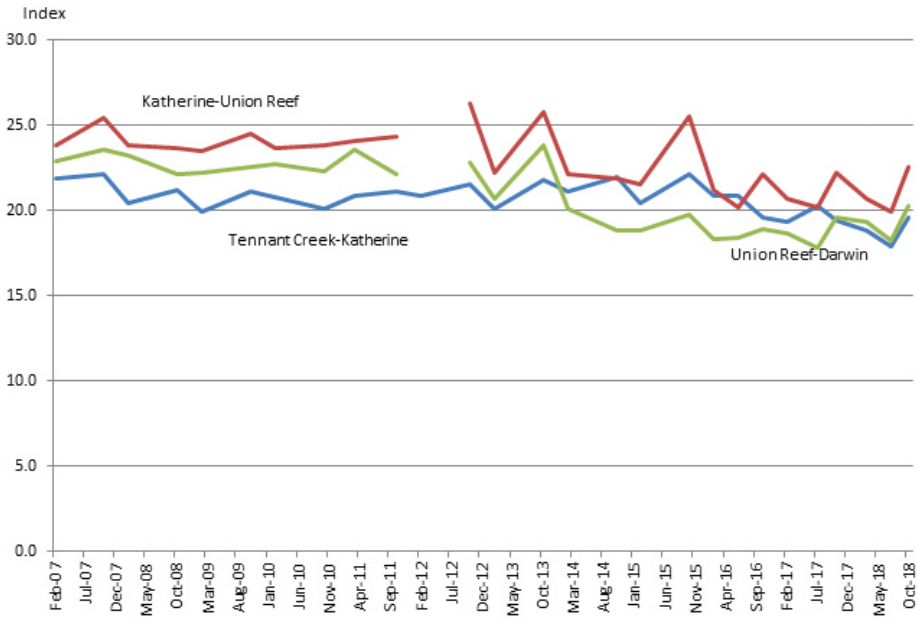
Figure 46 ARTC track quality index, East-West corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

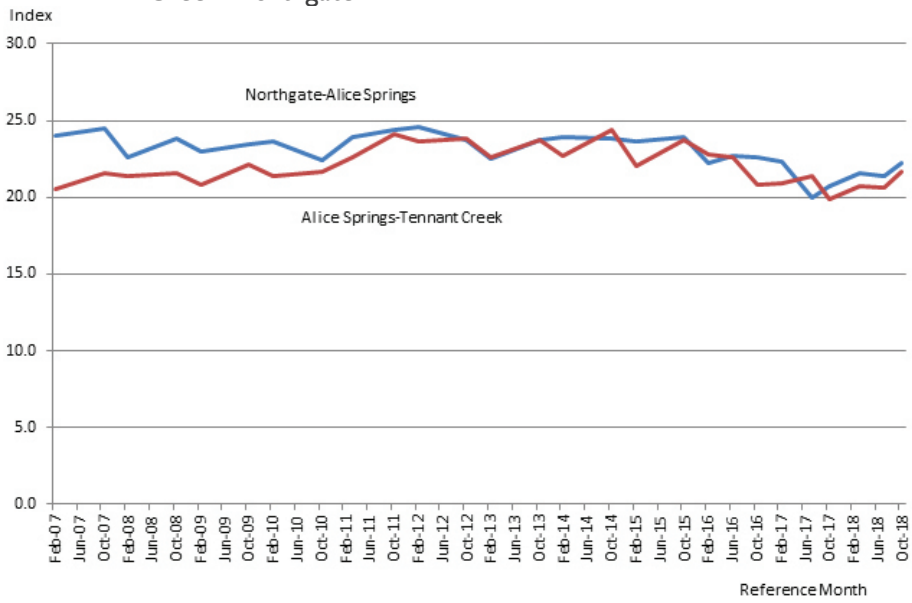
Figure 47 Genesee & Wyoming Australia track quality index, Darwin-Tennant Creek



Note: Lower indices indicate higher track quality.

Source: Data Provided by Genesee & Wyoming Australia.

Figure 48 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.

Intermodal train actual running times

This section compares actual running times of all timetabled Melbourne to Perth and Perth to Melbourne intermodal designated services against scheduled times, as shown in the ARTC Master Train Plan (timetable) and Arc Infrastructure timetable. The comparison is for the period 1 June – 31 August 2019.

The start/end point from which travel times were recorded is SCT – Laverton Loop ('Melbourne') and Forrestfield ('Perth'). SCT – Laverton Loop is where SCT Logistics trains enter/leave the corridor, while Forrestfield is where SCT Logistics trains enter/leave the corridor. Pacific National trains also pass SCT – Laverton Loop and Forrestfield but travel an additional 23.5 kilometres to/from South Dynon in Melbourne and four kilometres to/from Kewdale in Perth. They thus travel the same entire corridor as the SCT Logistics trains, plus the additional 23.5 and six kilometres. Arrival and departure times in Perth were converted to eastern standard time.

The online tracking tool which BITRE used to record actual running times sometimes had no record for a given service or only a partial record. This is why the results, shown in Table 34 and Table 35, below, list more scheduled services than actual recorded services. The fact there is no record for a service does not in itself mean there was no service. It just means there is no record of the service. Where there was a partial record of a service, BITRE recorded the information that was available, even though it was unable to record the entire trip details. It is for this reason some of the numbers in the tables below do not balance. The 'number of recorded services' figures are for those services for which there is a complete trip record only.

The analysis recorded and assessed the following:

- the point in time trains commenced their journey, as measured at the common departure point;
- the point in time trains completed their journey, as measured at the common arrival point; and
- total journey times.

BITRE acknowledges there are numerous factors that affect how close to schedule trains run. The analysis is not, and should not, be seen as a performance review of either the infrastructure managers or the train operators. BITRE is also unable to assess the reasons for differences between scheduled and actual running times.

Table 34 and Table 35, below, show the results, noting the number of scheduled services is the sum of that recorded in the infrastructure managers' timetables that was current at the time of the analysis. The number of recorded services are those whose times BITRE was able to record from its online tracking source for the entirety a train's journey.

The analysis also excludes services that may have run but did not appear in the timetables. This is because there were no published scheduled times that would have been needed for comparative purposes.

Table 34 June-August 2019 Eastbound

Number of scheduled services	186	Average scheduled transit time	2 days, 17:46:05
Number of recorded services	140	Average actual transit time	2 days, 18:12:26
Transit number of services faster than schedule	77		
Transit number of services of services 30 minutes or less slower than schedule	8		
Transit number of services more than 30 minutes slower than schedule	55		
Average early departure at Forrestfield	00:51:13	Number of services departing earlier than schedule	57
Average late departure at Forrestfield	01:27:08	Number of services departing 30 minutes or less later schedule	35
		Number of services departing more than 30 minutes later than schedule	48
Average early arrival at SCT – Laverton Loop	01:40:06	Number of services arriving earlier than schedule	93
Average late arrival at SCT – Laverton Loop	04:46:30	Number of services arriving 30 minutes or less later than schedule	13
		Number of services arriving more than 30 minutes later than schedule	64

Table 35 June-August 2019 Westbound

Number of scheduled services	171	Average scheduled transit time	2 days, 06:25:01
Number of recorded services	152	Average actual transit time	2 days, 07:46:41
Transit number of services faster than schedule	41		
Transit number of services 30 minutes or less slower than schedule	24		
Transit number of services of services more than 30 minutes slower than schedule	86		
Average early departure SCT – Laverton Loop	00:22:21	Number of services departing earlier than schedule	45
Average late departure SCT – Laverton Loop	01:19:45	Number of services departing 30 minutes or less later schedule	45
		Number of services departing more than 30 minutes later than schedule	69
Average early arrival at Forrestfield	00:38:45	Number of services arriving earlier than schedule	32
Average late arrival at Forrestfield	02:46:54	Number of services arriving 30 minutes or less later than schedule	23
		Number of services arriving more than 30 minutes later than schedule	103

Table 34 and Table 35, above, show the three month results for all recorded eastbound and westbound services. The tables show the following key findings.

Eastbound services:

- Average actual transit times was slightly greater than schedule, but most trains completed their journeys in times faster than schedule, while a further eight were 30 minutes or less slower than schedule;
- Most services (approximately 65%) departed Perth either ahead of schedule or 30 minutes or less later than schedule;
- Most services (approximately 62 per cent) arrived at Melbourne ahead of or 30 minutes or less later than schedule.

Westbound services:

- Average actual transit times was slightly greater than schedule, and approximately 60 per cent of services completed their journeys in times of more 30 minutes longer than schedule;
- Most services (approximately 57%) departed Melbourne either ahead of schedule or 30 minutes or less later than schedule;
- Approximately 65 per cent of services arrived at Perth more than 30 minutes behind schedule.

At a finer level, and which the tables cannot show, there were the following results and trends.

The fastest recorded service was a westbound train that departed Melbourne on a Wednesday. This was an express service that completed its journey in one day, 22 hours, and six minutes. The slowest recorded service was an eastbound train that departed Perth on a Wednesday. It completed the journey in three days, 10 hours, and 22 minutes.

On a by day of the week analysis over the three months, there were the following results:

- Eastbound Sunday[37]: No standout trends;
- Westbound Sunday: No scheduled services;
- Eastbound Monday: most trains departed Forrestfield later than schedule. Most subsequently completed their journey faster than schedule, with some arriving at Melbourne ahead of schedule.
- Westbound Monday: Most trains departed Melbourne later than schedule, while almost half of these arrived at Perth earlier than schedule.
- Eastbound Tuesday: No standout trends;
- Westbound Tuesday: Most services were late out of Melbourne and late into Perth. Most trains took longer than schedule.
- Eastbound Wednesday: Most trains departed Perth later than schedule but most arrived at Melbourne early;
- Westbound Wednesday: Most trains departed Melbourne later than schedule and similarly arrived at Perth later than schedule.

37 Day is the day of the week trains departed Perth or Melbourne, in eastern standard time. As a hypothetical, a train that departs Perth at 2300 hours local time on a Monday is recorded as a Tuesday departure due to the time zone adjustment..

- Eastbound Thursday: While all services took longer than schedule, all left Perth ahead of schedule and most arrived at Melbourne ahead of schedule.
- Westbound Friday: Most trains departed Melbourne more than 30 minutes later than schedule and most similarly arrived at Perth later than schedule. Almost half of the services made up time along the way and completed the journey faster than scheduled.
- Eastbound Saturday: No standout trends; and
- Westbound Saturday: While there were no clear trends in departure times, almost all services arrived at Perth more than 30 minutes later than schedule and all completed their trip in times longer than schedule.

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

Customers rely on timetables for infrequent services in particular. Punctuality is therefore part of a journey's perceived time. Punctuality is less significant for frequent "turn up and go" services.[38] 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 36, below, shows operators heavy rail punctuality targets and results in 2017–18. All cities for which BITRE was able to obtain annual results were within one per cent of either exceeding or failing to achieve their punctuality targets.

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

Table 36 Urban heavy and light rail punctuality, on time performance, 2017–18

	Sydney[a b]	Melbourne	Brisbane[c]	Adelaide[d]	Perth
Heavy rail punctuality (%)	91.6	91.9	95.8	n/a	95.6
Heavy rail target (%)	92	92.5	95	94	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 3 minutes 59 seconds of schedule for suburban trains and within 5 minutes 59 seconds of schedule for inter-urban trains, adjusted for force majeure events	No more than 4 minutes 59 seconds after the timetabled arrival time at the destination	Arriving within 4 minutes of schedule
Light rail punctuality (%)	91.2	81.7	99.9	n/a	-
Light rail target (%)	-	82.9	"at the station for you when it's scheduled to be there"	98	-
Light rail measure	-	Departing no more than 59 seconds early or 4 minutes 59 seconds after scheduled time in the timetable.	-	No more than 4 minutes 59 seconds after the timetabled arrival time at the destination	-

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.

[c] Brisbane light rail refers to the Gold Coast

[d] Adelaide's heavy and light rail annual results are not available. Adelaide Metro, however, publishes weekly results on its website. See https://adelaidemetro.com.au/About-us/On-Time-Running

Sources: Public Transport Victoria (2018, pp. 24); Public Transport Authority of Western Australia (2018), p. 83; Queensland Rail (2018), p.18; Transport for NSW (2018), p.16.

Non-urban rail punctuality

Punctuality targets for non-urban rail services 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 peak intercity services and V/Line's commuter services have targets of at least 92 per cent. In contrast, QR Travel, which operates numerous long-distance services, have a punctuality target of only 75 per cent.

Punctuality for Transwa's *Prospector* increased from the previous year's 36 per cent but was still well below target. According to the Public Transport Authority of Western Australia's annual report, this result was due to infrastructure works along the line and lost time crossing other trains on the line. The *Australind's* below target performance was due to mechanical faults, crossings and infrastructure maintenance (Public Transport Authority of Western Australia 2018, p. 47).

Table 37 Non-urban rail punctuality, on time performance, 2017–18

	Service type	Punctuality 2017–18 (%)	Punctuality target (%)	Measurement
Queensland Rail	QR Traveltrain	85	75	Arriving within 15 minutes, excluding the Kuranda Scenic Railway and *Gulflander* services
NSW TrainLink	Intercity (peak services)	90	>92	Arriving within 6 minutes
	Regional and interstate	78.3	>78	Arriving within 10 minutes
V/Line	Commuter	83.9	92	Arriving within 5 minutes and 59 seconds
	Long distance			Arriving within 10 minutes and 59 seconds
Transwa	*Australind*	83	90	Arriving within 10 minutes
	Prospector	50	80	Arriving within 15 minutes
	MerridinLink	79	90	Arriving within 10 minutes
	AvonLink	98	90	Arriving within 10 minutes

Sources: Public Transport Victoria 2018, p.24; Transport for NSW 2018, p.16; Transport for NSW (2019); Queensland Rail (2018), p.42; Public Transport Authority of Western Australia 2018, pp. 46-47; ; Advice from Queensland Rail

(b) Service attributes

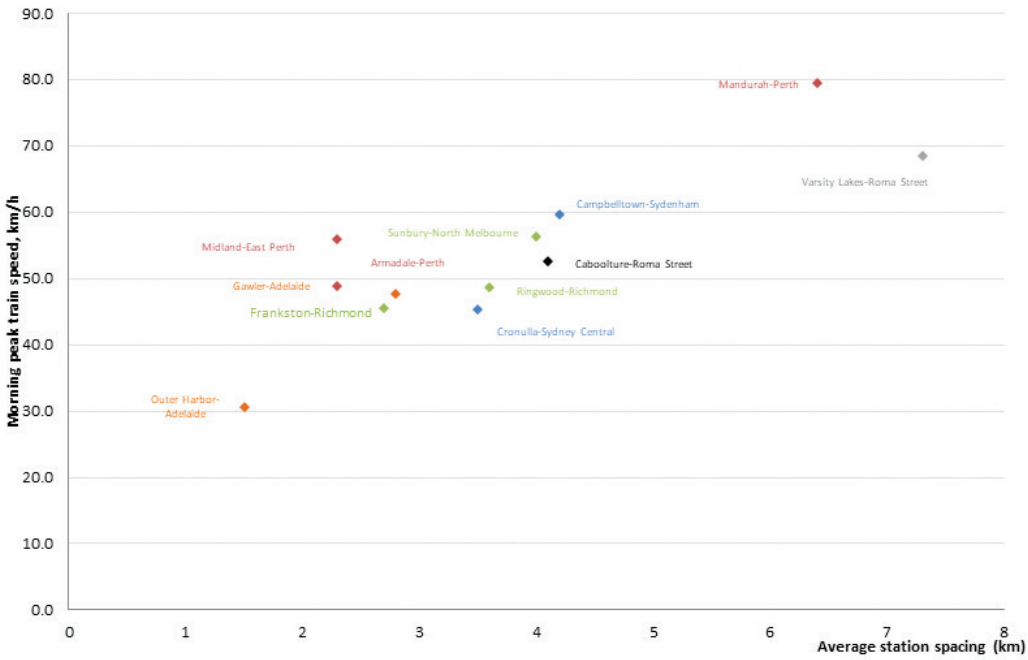
Train speeds and station spacing – urban heavy rail

Figure 49 shows relationship between station spacing and corresponding average train speeds for selected Australian urban passenger rail lines. Australia's older passenger lines have relatively short station spacing (for all stops services). Mees and Dodson (2011) observed that Australian lines were often built as a way of supporting urban expansion with consequent short distances between stations.[39] 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. Express services help overcome short station spacing. All station spacing shown in Figure 44, below, is based upon peak hour limited stops services, except Belair—Adelaide and Mandurah—Perth, which have no limited stops services. The number of stops between origin and destination for limited stops services varies by time of day and service. For example, the Varsity Lakes line has closer actual station spacing than the Mandurah line, but its limited stops services have greater average station spacing because the services do not stop at every station.

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

Figure 49 Station spacing and illustrative train speeds 2019



Source: BITRE analysis.

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.

Speeds and station spacing – light rail

Average scheduled light rail speeds also generally correlate to stop spacing. 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 38 Light rail station spacing and scheduled speeds 2019

	Gold Coast	Sydney	Melbourne	Adelaide	Canberra	Newcastle
Average station spacing (metres)	812	556	254	535	923	450
Average point to point scheduled speed (km/h)	23	21.3	16	17.3	30	13.5

Note: Sydney, Adelaide, Gold Coast, Canberra, and Newcastle average speeds derived from scheduled transit time and route kilometres.

Sources: Currie and Burke 2013; BITRE analysis.

Light rail average 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 mostly 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.

Canberra's light rail network, which opened in April 2019, is entirely segregated, except for street crossings, where variable frequency traffic signals prioritise light rail traffic at most intersections. Station spacing is the widest in Australia. This, combined with its traffic segregation and priority traffic signalling, enables Canberra's light rail vehicles to achieve the highest average scheduled speeds in Australia. Newcastle's light rail, which opened in February 2019 and which runs on battery power with charging at each stop, has approximately half the average distance between stops and less than half the average speed. Like Canberra, Newcastle's light rail network is segregated except at street crossings.

Frequency

Figure 50 to Figure 55, below, show, urban heavy rail service frequency by the time between arrival at the relevant city central station, for services originating at different points across the networks. 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).

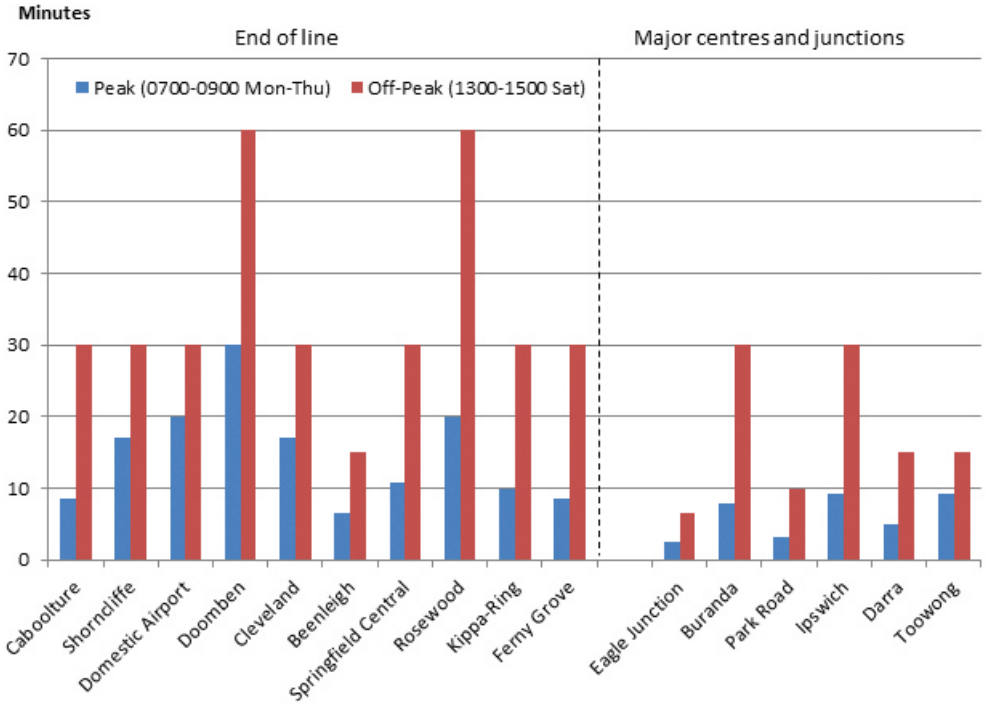
Frequency is also important in integrating rail services both with other rail lines and other transport modes. Services may have coordinated arrival and departure times for passenger interchanges between services. However, the scale of large urban networks can make coordination infeasible. In these cases, frequency is crucial in reducing passengers' interchange waiting times. Major centres and junction stations generally have high frequencies due to service densification. As Figure 50 to Figure 55, below, show, all Australian capital cities with urban heavy rail services have greater service frequency during peak periods.

Service frequencies in 2018 were 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 09:01 hours on a weekday, for example, would be excluded as it is outside the peak period scope.

Brisbane heavy rail

Figure 50 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 50 Average time between trains for services arriving at Brisbane Central, 2019



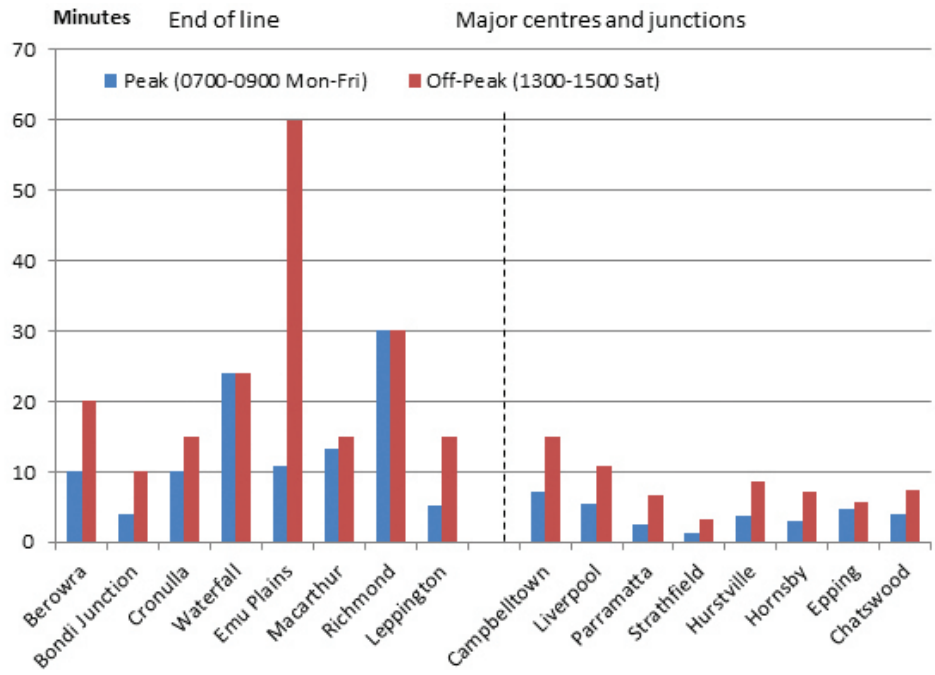
Source: Translink (2018).

Sydney heavy rail

Sydney Trains frequency depends on the time of day, service demand and network capacity. The Bondi Junction line has the most end of line AM peak services, with an average arrival at Sydney Central every four minutes, while the Richmond line has an average arrival every 30 minutes. There is less discrepancy for trains arriving from major centres and junctions in the AM peak, with arrivals at Sydney Central of between 1–7 minutes.

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

Figure 51 Average time between trains for services arriving at Sydney Central, 2019



Source: Transport for NSW (2019b)

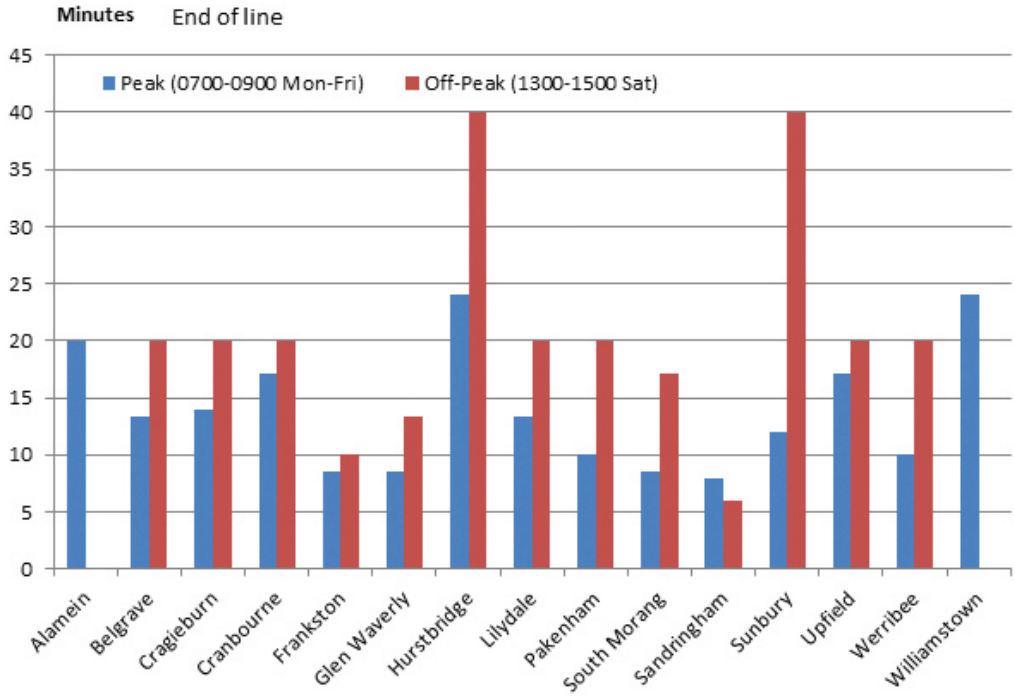
Figure 51 includes a number of stations listed in The New South Wales Government's Long Term Transport Master Plan as being "Regional Cities" (Parramatta and Liverpool) and "Major Centres" (Hornsby, Chatswood, Bondi Junction, Hurstville, Campbelltown, Macarthur)[40] . These locations are significant 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 peak hour frequencies similarly vary considerably across services (see Figure 52 and Figure 53), 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 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.

40 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).

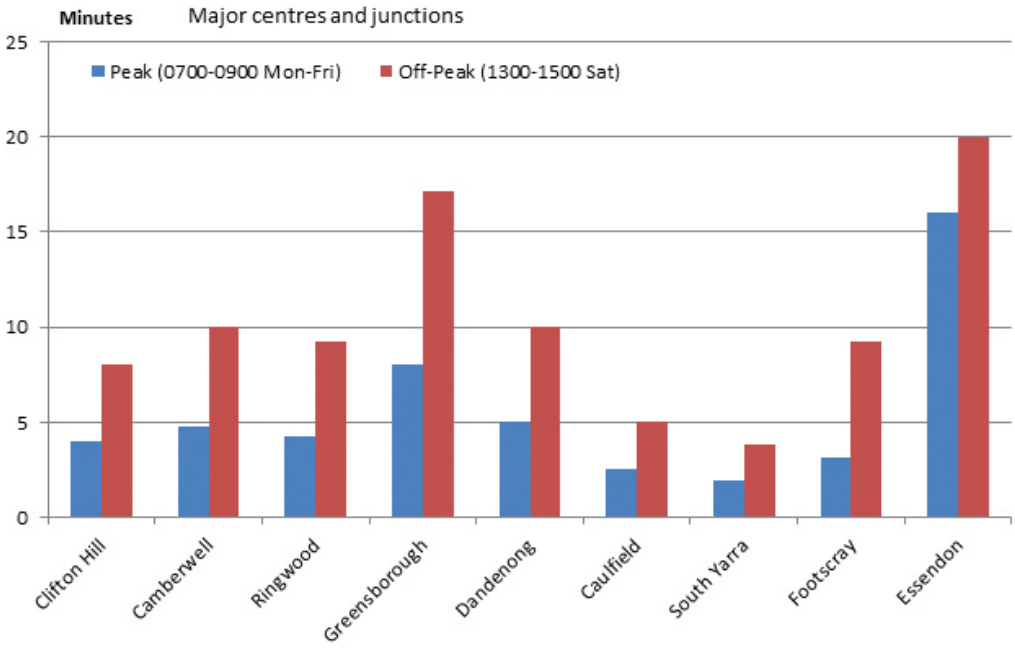
Figure 52 Average time between trains for services arriving at Flinders Street from end of line, 2019



Source: Public Transport Victoria (2019).

South Yarra is the busiest junction station, with an average departure every two minutes peak hours and four minutes off-peak hours. 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 53 Average time between trains arriving at Flinders Street Station from major centres and junctions, 2019

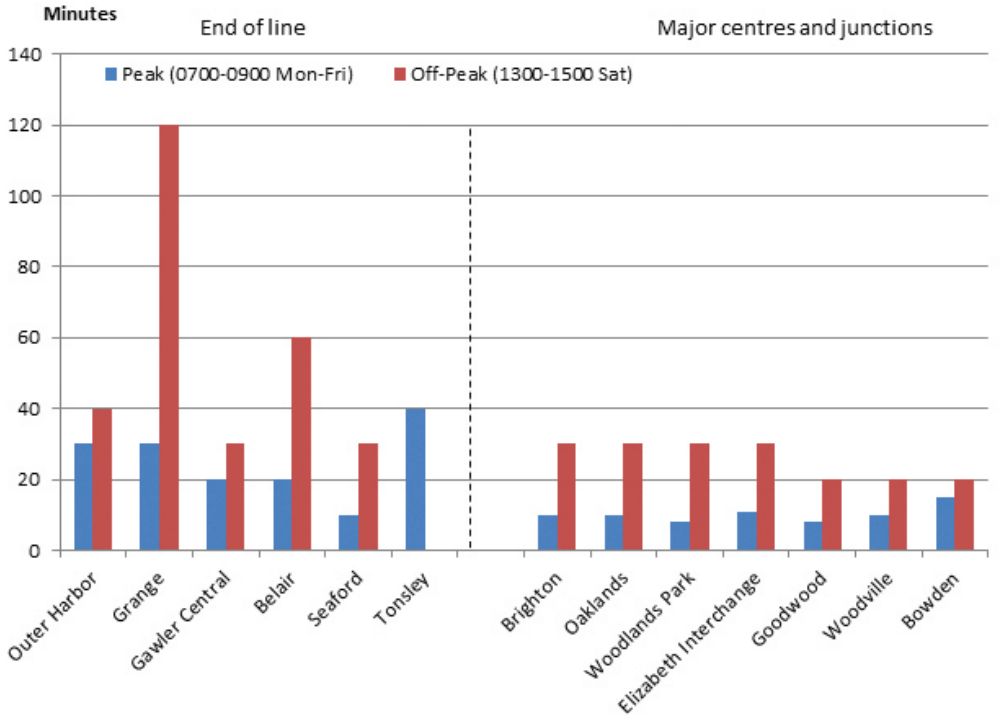


Source: Public Transport Victoria (2019).

Adelaide heavy rail

Adelaide heavy rail service patterns are strongly geared to peak-period commuting to Adelaide Railway Station (See Figure 54). Adelaide's lower service levels reflect its modest patronage compared to the other networks.

Figure 54 Average time between trains for services arriving at Adelaide Railway Station, 2019



Note: There are not weekend Tonsley line services.

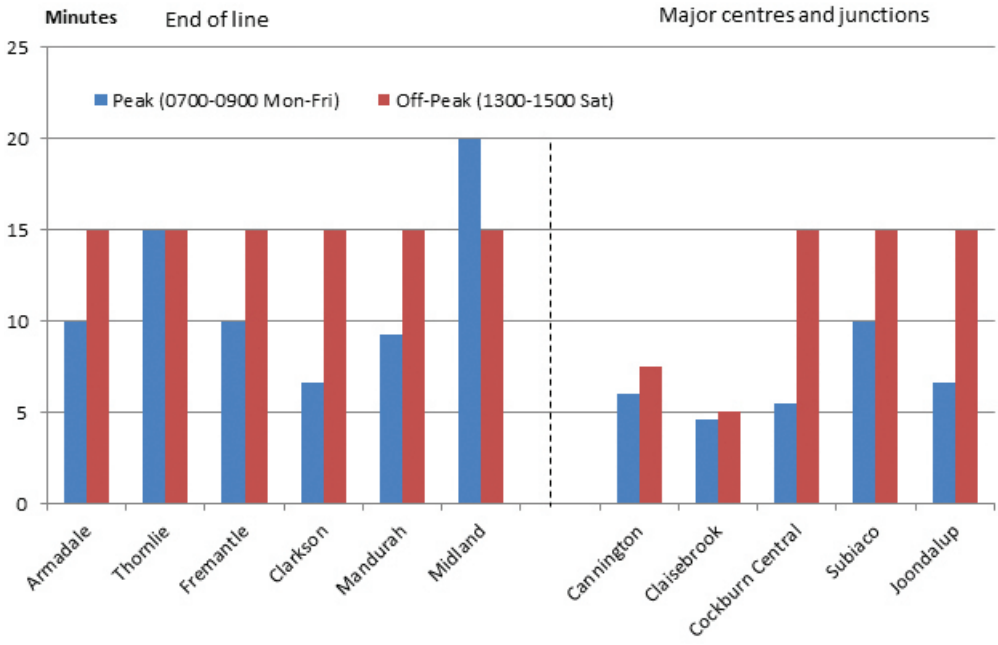
Source: Adelaide Metro (2019).

Perth heavy rail

There have been no changes to Transperth's service frequencies since publication of *Trainline 6*. 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.

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 55 Average time between trains for services arriving at Perth Central, 2019



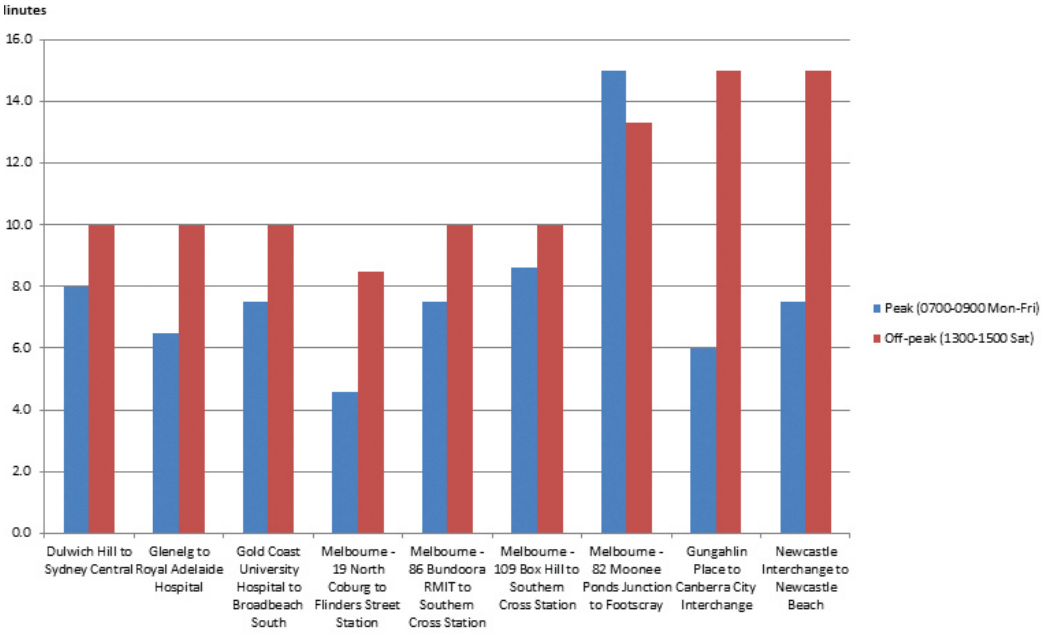
Source: Transperth (2019).

Light rail

Light rail frequencies in Australia vary (see Figure 56). Off-peak times between services are 15 minutes or less. 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 indicate service frequency 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 56 Average time between trams, by route and direction, 2019



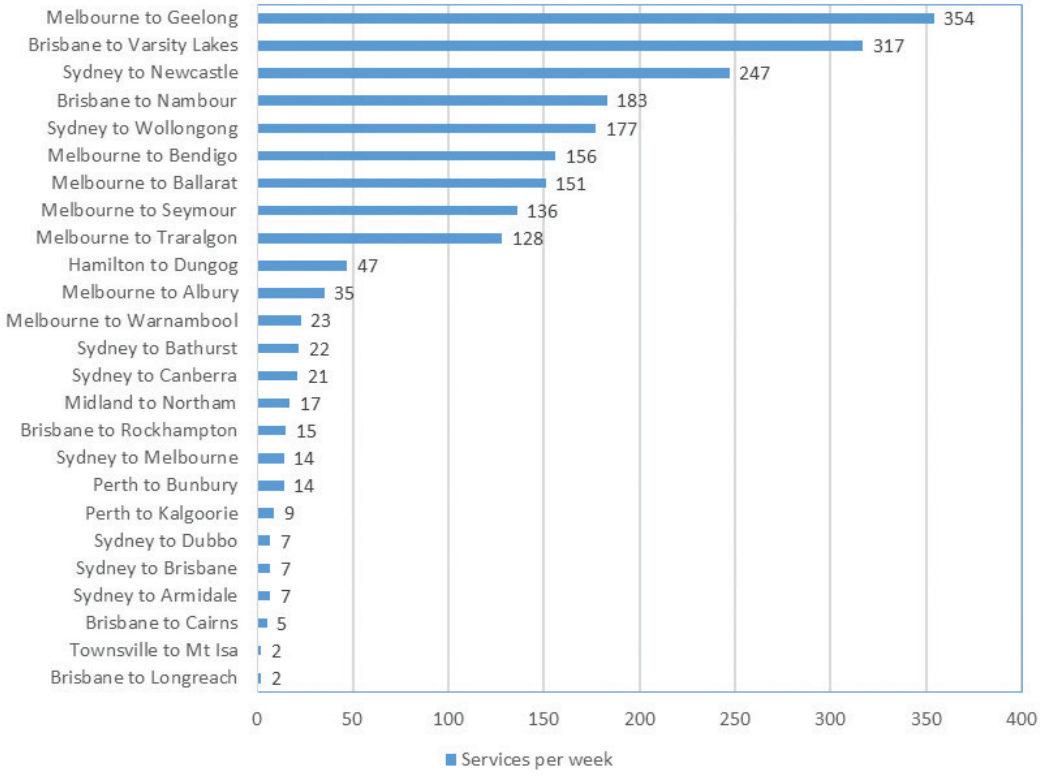
Notes: Gold Coast operations do not run to timetables. Melbourne tram services have a separate timetable for Fridays. As such, calculated peak hour frequency as shown above is based on the published Monday-Thursday timetables. Peak hour calculations are based on peak hour directions of travel.

Sources: Transport for NSW (2019b); G:link (2019a); Public Transport Victoria (2019); Adelaide Metro (2019a).

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 is therefore closely aligned with perceptions of total travel time and its generalised cost. Compared to 2018, the average time between off peak services from Glenelg to Adelaide Railway Station has doubled. This is due to a reworking of the timetable following the introduction of services to Festival Plaza and the Botanic Gardens.

Figure 57 Non-urban passenger rail services per week, 2019



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-Newcastle figures include long distance services that stop at nearby Broadmeadow.

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

Sources: Queensland Rail Travel (2019); Transport for NSW (2019b); Translink (2019a) Transwa (2019); V/Line (2019).

Figure 57, above, shows the number of weekly services on selected intercity/commuter and regional/interstate passenger rail services. Intercity/commuter services have the highest frequency.

Transit times — non-urban

Transit times are important for commuter travel as one factor 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 community service to those who do not have access to other transport modes.

Table 39 Key characteristics of selected non-urban passenger services, 2019

	Operator	Gauge	Distance (km)	Electrified	Scheduled transit time	Average speed (km/h)	Stopping stations (no.)
Regional/intercity3 hour 59 minutes or less							
Brisbane to Nambour	QR (TransLink)	Narrow	105	Yes	1h 52m	56	20
Brisbane to Varsity Lakes		Narrow	89	Yes	1h 20m	67	11
Hamilton to Dungog	NSW TrainLink	Standard	81	No	1h 21m	60	15
Sydney to Hamilton		Standard	165	Yes	2h 38m	63	15
Sydney to Wollongong		Standard	82	Yes	1h 27m	56	8
Sydney to Bathurst	NSW Trainlink	Standard	238	No	3h 46m	63	9
Melbourne to Ballarat	V/Line	Broad	118	No	1h 7m	106	4
Melbourne to Bendigo		Broad	162	No	1h 33m	104	4
Melbourne to Warrnambool		Broad	276	No	3h 45m	74	15
Melbourne to Geelong		Broad	81.5	No	50m	97	3
Melbourne to Seymour		Broad	99	No	1h 40m	59	9
Melbourne to Albury		Standard	305	No	4h 03m	75	11
Melbourne to Traralgon		Broad	158	No	2h 16m	70	12
Midland to Northam	Transwa	Standard	102	No	1h 20m	80	1
Perth to Bunbury		Narrow	183	No	2h 29m	73	11
Long-distance 4 hours or more							
Townsville to Mount Isa	QR Travel	Narrow	977	No	20h 55m	47	8
Brisbane to Charleville		Narrow	777	No	16h 30m	47	17
Brisbane to Cairns		Narrow	1681	No	24h 20m	69	26
Brisbane to Rockhampton (electric Tilt Train)		Narrow	639	Yes	7h 45m	82	11
Sydney to Canberra	NSW TrainLink	Standard	330	No	4h 8m	79	9
Sydney to Dubbo		Standard	462	No	6h 27m	72	14
Sydney to Armidale		Standard	579	No	8h 2m	72	19
Sydney to Brisbane		Standard	987	No	14h 12m	70	21
Sydney to Melbourne		Standard	951	No	10h 48m	88	17
Perth to Kalgoorlie	Transwa	Standard	653	No	6h 50m	96	17
Adelaide to Darwin	GSR	Standard	2 971	No	53h 15m	56	3

Note: The speed shown is the average over the length of the service, including stops.

Sources: Queensland Rail Travel (2019); Transport for NSW (2019b); Translink (2019a); Transwa (2019); V/Line (2019) Great Southern Rail (2019).

Average train speeds are a function of:

- Track quality, including condition, curves, level crossings and capacity;
- Rolling stock standards and quality, 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 scheduled stopping patterns; and
- For tourist-focused trains such as The Ghan, scheduled extended stops en route for passengers to do off train tours.

Comparative times to 2018 show little variance in scheduled transit times. There have been no increases or decreases in scheduled times greater than 10 minutes.

The Brisbane—Nambour, Sydney—Hamilton, and Sydney—Wollongong intercity commuter services continue to have similar, relatively low average train speeds. 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—Newcastle and Sydney—Wollongong rail corridors are slow and circuitous due to the 'steam era' alignments through the mountainous terrain in which they operate.

There is a wide dispersion of transit times across V/Line services, due to different stopping patterns that cater for different markets. V/Line's Melbourne—Geelong, Melbourne—Ballarat, and Melbourne—Bendigo commuter services are relatively fast (peak hour direction of travel) due to the VLocity DMU sets used and Regional Rail Link and Regional Fast Rail upgrades. Some peak-hour express services have additionally high average speeds and low travel times because of fewer stops en route. The Melbourne—Ballarat service cited above, for instance, is based on an express peak hour service with only three stops.

While infrastructure upgrades have enhanced services between Melbourne and Geelong, Ballarat, and Bendigo, Melbourne—Traralgon services lack a dedicated corridor through the more expansive south-eastern suburbs of Melbourne, which affects travel times. The Seymour corridor was not included in the Regional Rail Link and Regional Fast Rail upgrades, thus it does not have the high speed running of the other medium-distance services.

Elsewhere in Australia, the following services listed above have average point-to-point speeds of 80 kilometres per hour or greater:

- Midland to Northam, 80 kilometres per hour;
- Brisbane to Rockhampton (electric tilt-train), 82 kilometres per hour;
- Sydney to Melbourne, 88 kilometres per hour; and
- Perth to Kalgoorlie, 96 kilometres per hour.

Long-distance passenger trains in Australia have uncompetitive transit times compared to air and some road coach travel[41].

41 Long-distance trains provide services for centres along their route, thus acting as medium-distance services also.

CHAPTER 5

Case Study

On 20 April 2019, light rail services began in Canberra. The operator of Stage One Light Rail, is Canberra Metro Operations (CMET).

Stage 1 is the first section of an expanding light rail network, which runs from Canberra City (Alinga Street) to Gungahlin Place. The line is 12 kilometres in length, has 13 stops, and a scheduled point-to-point travel time of 24 minutes. This gives it the highest (scheduled) average point-to-point light rail speed in Australia of 30 kilometres per hour. This is due to wide station spacing, traffic segregation, and priority signalling. Dickson Interchange on Northbourne Avenue is a designated feeder stop, where local bus services connect with light rail.

Commencing from the Alinga Street terminus in Canberra City, the line travels north along Northbourne Avenue, turns left at Flemington Road in North Canberra, then follows Flemington Road to Gungahlin Place. Traction is by 750-volt direct current overhead wires. The gauge is standard (1 435 millimetres). The track is duplicated throughout and segregated from road traffic, except at level crossings. The light rail vehicles get priority signalling at level crossings except for the Barry Drive and Antill Street intersections where a Hybrid Priority is installed. This is because the side roads at the abovementioned two intersections are key arterial routes where road traffic would be excessively disrupted under full priority signalling.

CMET is part of a private-public partnership (PPP). CMET comprises of private shareholders (John Holland and UGL Ltd.) and provide the full light rail services, including staffing, training, and maintenance, to Transport Canberra for a set contracted monthly availability payment. Transport Canberra pays the availability payment regardless of patronage and subject to CMET meeting its key performance indicators (KPI) and operational performance standards. Transport Canberra applies an abatement to CMET for any KPIs or performance standard not met, such as the KPI for fare evasion which, if exceeded, results in abatement of the monthly availability payment. Transport Canberra collects all passenger revenue as part of an integrated light rail/bus network. Passengers use the network under the MyWay Card ticketing system or alternatively with a single ride paper ticket. According to CMET, current approximate daily patronage for light rail in Canberra is 15,000–17,000 passenger boardings during weekdays, a figure which it expects to grow.

The fleet consists of 14 Spanish built Urbos 3 light rail vehicles. Spanish Company, CAF, is the fleet supplier. According to CMET, this model was chosen because it is a well proven design standard platform and use of that vehicle formed part of the initial construction package.

The vehicles:

- Are just under 33 metres long and 2.65 metres wide;
- Have a maximum design speed of 70 kilometres per hour;
- Can carry at least 207 passengers (66 seated and 141 standing);
- Have 12 priority seats and two wheelchair spaces;
- Are equipped with on-board Wi-Fi (also available at light rail stops along the corridor);
- Are fully air conditioned;
- Are accessible via two double doors and two single doors per side;
- Are 100 per cent low floor; and
- Have storage for four bicycles (Transport Canberra, 2019).

The vehicles have three braking systems:

- Electro-Dynamic brake, with recaptured energy fed back into the overhead transmission wires;
- Mechanic Friction brake; and
- Electromagnetic Track brake (for emergency brake application and only applied at less than 30 kph).

On application of service brake, the vehicles use blended electro-dynamic and mechanical friction braking, with the degree of blending computer controlled. The vehicles cannot operate wireless in their current state, but can be converted to do so, which will be necessary if the network expands south and through the parliamentary triangle, where overhead wires are not permitted.

Light rail in Canberra operates on a 'turn up and go' basis, with the following service frequencies:

A departure in at least one direction. every six minutes from 0700-0900 and 1600–1800 hours;

Every 10 minutes off peak times on weekdays; and

Every 15 minutes on weekends, public holidays, and 0600–0700 and 1800–2300 weekdays.

Ten vehicles are needed to service the peak hour six minute headway (schedule), with an 11th vehicle sometimes used when demand is particularly high; six vehicles service the 10 minute headway; and four service the 15 minute headway. A provision in the contract sets out the process for timetable adjustments including additional services if requested by Transport Canberra.

All services are all stopping. On board, recorded voices announce each upcoming stop. Instead of using computerised voices, CMET uses the recorded voices of local residents, including high school students from local schools. The decision to do this was to foster a sense of community belonging with light rail.

CMET assess the greatest risk Canberra light rail currently faces is people's unfamiliarity with how light rail vehicles work due to very little, if any, exposure to previous light rail operations. This is further pronounced by Canberra's history as a city with no previous urban rail services. For example, many people do not yet appreciate that a light rail vehicle moves almost silently and often relatively quickly. CMET is mitigating this risk with interim speed reductions in heavily pedestrianised areas and an extensive rail safety public education campaign.

Figure 58 Canberra Metro, July 2019

Note: The image above shows an Urbos 3 light rail vehicle at the Alinga Street terminus in July 2019. Photo courtesy of Rodney Avery.

Figure 59 Canberra Metro, October 2019

Note: The image above shows weekday morning activity at the Alinga Street terminus in October 2019. The light rail vehicle in the background has just departed. Photo courtesy of Rodney Avery.

Figure 60 Canberra Metro Stage 1 network map

Note: Image Courtesy of Transport Canberra

APPENDIX A

Significant railway events since 2000

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	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

(Continued)

Date	Event	Description
September 2006	Victorian regional fast trains commence	The start of the first Regional Fast Train service begins. Faster services are introduced from Geelong, Ararat/Ballarat, Bendigo and the Latrobe Valley
October 2006	End of Sydney–Perth coastal shipping service	Boomerang coastal shipping service, operating between Sydney and Perth since June, ended after financial failure
20 October 2006	SCT commence Parkes service	SCT Logistics commenced freight service between Parkes and Perth
November 2006	Sandgate Flyover	Opening of main line flyover of coal lines, to enable unimpeded movement of coal trains, between Hunter Valley and Kooragang Island
18 December 2006	Pacific National wins 7-year steel contract	PN wins a contract extension, with Bluescope and 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.

(Continued)

Date	Event	Description
15 May 2008	Opening of Fortescue railway	Opening of Fortescue Metals Group's 260 km Cloudbreak railway in the Pilbara
13 June 2008	Cessation of Tasmanian train operations	Pacific National announced cessation of its Tasmanian train operations, later indicating it would sell the business
25 July 2008	Extension of double-stacking network	Commencement of standard double-stacking operations between Parkes and Perth following ARTC investment
5 August 2008	Pacific National wins Queensland coal haulage contracts	Asciano announces it has signed 10-year contracts with Rio Tinto and Xstrata for coal haulage in Queensland from early 2010
May–September 2008	Grain contracts awarded	GrainCorp, AWB, ABB sign contracts with train operators for grain haulage
15 September 2008	New Portland freight traffic	Commencement of movement of mineral sands between Portland and Melbourne
24 September 2008	Investment in Tasmanian tracks	Announcement by Tasmanian government of upgrading of its railway tracks
2 October 2008	Additional east–west train service	Pacific National adds a third "Express" freight train to its Melbourne–Perth service
27 October 2008	Pilbara railway access decision	The Treasurer, Mr Swan, announces that Fortescue Metals Group has the right to use Pilbara railways built by BHP 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

(Continued)

Date	Event	Description
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
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

(Continued)

Date	Event	Description
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	Line broken near Katherine after floodwaters 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 Logistics announced it was purchasing Independent Railways of Australia, including the Macarthur Intermodal Shipping Terminal at Minto, Sydney
5 August 2012	ARTC lease in Sydney	Enfield West – Port Botany section (19 km) of Metropolitan Freight Network leased by NSW to ARTC until 2064
14 September 2012	Trans Australian Railway	Centenary of the commencement of construction of the Trans Australian Railway
14 November 2012	MidWest Rail Upgrade	Formal completion of $550 million upgrade of the Morawa–Mullewa–Geraldton Port railway, including installing dual-gauge sleepers
1 December 2012	Aurizon	QR National changed its name to Aurizon
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

(Continued)

Date	Event	Description
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
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
29 January 2018	Ararat-Maryborough Line Re-opening	Ararat-Maryborough line re-opens following reconstruction of the previously mothballed line.
27 February 2018	Mildura Line Re-opening	Dunolly-Mildura line re-opens following track upgrades and conversion to standard gauge
10 July 2018	Driverless Trains	First Rio Tinto driverless train revenue service. The train carries iron ore from Tom Price to Cape Lambert.
17 February 2019	Newcastle Light Rail	Newcastle light rail commences operation
20 April 2019	Canberra Light Rail	Canberra light rail commences operation
26 May 2019	Sydney Metro Northwest	Sydney Metro Northwest commences operation

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
1982	Container Terminal – Outer Harbor	SA	Broad	1.3	Port
	Dry Creek North Junction – Dry Creek East Junction	SA	Broad	0.5	Port
	Lota–Thornside	Qld	Narrow	1.9	Re-opening/Urban passenger
	Elura Mine – Elura (CSA) Junction	NSW	Standard	33.6	Ore
	Glanville – Grand Junction Road Container Terminal – Glanville Container Terminal – Outer Harbor Dry Creek North – Dry Creek East Junction Cavan – Dry Creek East Junction Dry Creek – Gillman Junction Gillman Junction – Port Adelaide Junction Port Adelaide Flat – Gillman Junction	SA	Standard	2.7 10.9 1.3 0.5 1.1 4.7 2.4 3.1	Interstate standardisation
	Saxonvale Junction – Saxonvale Balloon Loop (Bulga Mine)	NSW	Standard	8.0	Coal
	Ulan Junction – Ulan Balloon Loop Sandy Hollow – Ulan	NSW	Standard	2.0 105.2	Coal
	German Creek – Gregory Mine Junction	Qld	Narrow	36.1	Coal
	Snowtown–Kadina Kadina–Wallaroo	SA	Standard	74.4 9.9	Gauge conversion (dual gauge)
	Crystal Brook East Fork	SA	Standard	1.2	Interstate standardisation
	Crystal Brook – Salisbury–Islington	SA	Standard	189.1	Interstate standardisation

(Continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
1983	Hamilton–Worsley Worsley North – Worsley East	WA	Narrow	11.0 1.0	Alumina/rural freight
	Norwich Park – German Creek Fork at German Creek	Qld	Narrow	21.7 1.3	Coal
	Oaky Creek Mine Balloon Loop Fork at Oaky Creek Mine balloon Loop	Qld	Narrow	6.1 0.5	Coal
	Riverside Mine Balloon Loop Riverside – Goonyella	Qld	Narrow	7.4 5.2	Coal
	Teralba Colliery Junction – Teralba Colliery Balloon Loop	NSW	Standard	3	Coal
	Watonga – Blair Athol Mine Blair Athol Balloon loop	Qld	Narrow	108.2 6.9	Coal
	Drayton Junction – Drayton Balloon Loop	NSW	Standard	8.0	Coal
	Curragh–Sagittarius	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
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

(Continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
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	Urban passenger
	Mount Owen Balloon Loop – Glennies Creek Junction	NSW	Standard	6.5	Coal
	Liddell Junction–Ravensworth Washery Balloon Loop	NSW	Standard	3.0	Coal

(Continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
	Helensvale–Nerang	Qld	Narrow	7.7	Urban passenger
1998	Arriga Junction – Arriga Junction Fork – Arriga	Qld	Narrow	4.1	Rural freight
	Nerang–Robina	Qld	Narrow	9.5	Urban passenger
	Moranbah North Balloon Loop	Qld	Narrow	7.3	Coal
	Pinnaroo – Tailem Bend	SA	Standard	144.5	Gauge conversion
	Olympic Park Flemington – Goods Junction	NSW	Standard	3.9	Urban passenger
1999	Macarthur Junction – Macarthur Balloon Loop	Qld	Narrow	5.1	Coal
	Yandi–Marandoo	WA	Standard	147.0	Iron ore
	Parkes Y-Link	NSW	Standard	0.4	Rural freight
	Mount Thorley Junction – Wambo Balloon Loop	NSW	Standard	16.0	Coal
2000	Sydney Central – Turrella (Airport line)	NSW	Standard	7.3	Urban passenger
2001	Brisbane Airport – Eagle Junction	Qld	Narrow	8.5	Urban passenger
2002	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
	Moranbah-Caval Ridge	Qld	Narrow	12	Coal
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
	Aldoga-Wiggins Island	Qld	Narrow	13	Coal
	Maules Creek-Werris Creek	NSW	Standard	20	Coal
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
2018	Baralaba (Moura System)	Qld	Narrow	6	Coal
	Mernda Line Extension	Vic	Broad	8	Urban Passenger
2019	Sydney Metro Northwest Inland Rail North West Connection	NSW NSW	Standard Standard	36 5	Urban Passenger Interstate and Intrastate freight

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
	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	-	-	-	-	-

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
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: 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 to 2018–19

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**
	Coal	Bulk[42]	Freight	Total
Sep-17	13.1	3.5	n/a	16.6
Dec-17	12.7	3.5	n/a	16.2
1HY-17	**25.8**	**7.0**	**n/a**	**32.8**
Mar-18	11.8	3.0	n/a	14.8
Jun-18	12.8	3.4	n/a	16.2
2HY-18	**24.6**	**6.4**	**n/a**	**31**
Full year 2017–18	**50.4**	**13.4**	**n/a**	**63.8**
	Coal	Bulk[43]	Freight	Total
Sep-18	12.4	2.5	n/a	14.9
Dec-18	12.7	2.5	n/a	15.2
1HY-18	**25.1**	**5**	**n/a**	**30.1**
Mar-19	12.2	1.7	n/a	13.9
Jun-19	13.2	2	n/a	15.2
2HY-19	**25.4**	**3.7**	**n/a**	**29.1**
Full year 2018–19	**50.5**	**8.7**	**n/a**	**59.2**

Source: Aurizon 2019a, p.45.

42 Aurizon reports bulk as including iron ore, agricultural products, and mining and industrial inputs. It no longer reports 'freight' tonnages due probably to its (planned) withdrawal from intermodal operations.

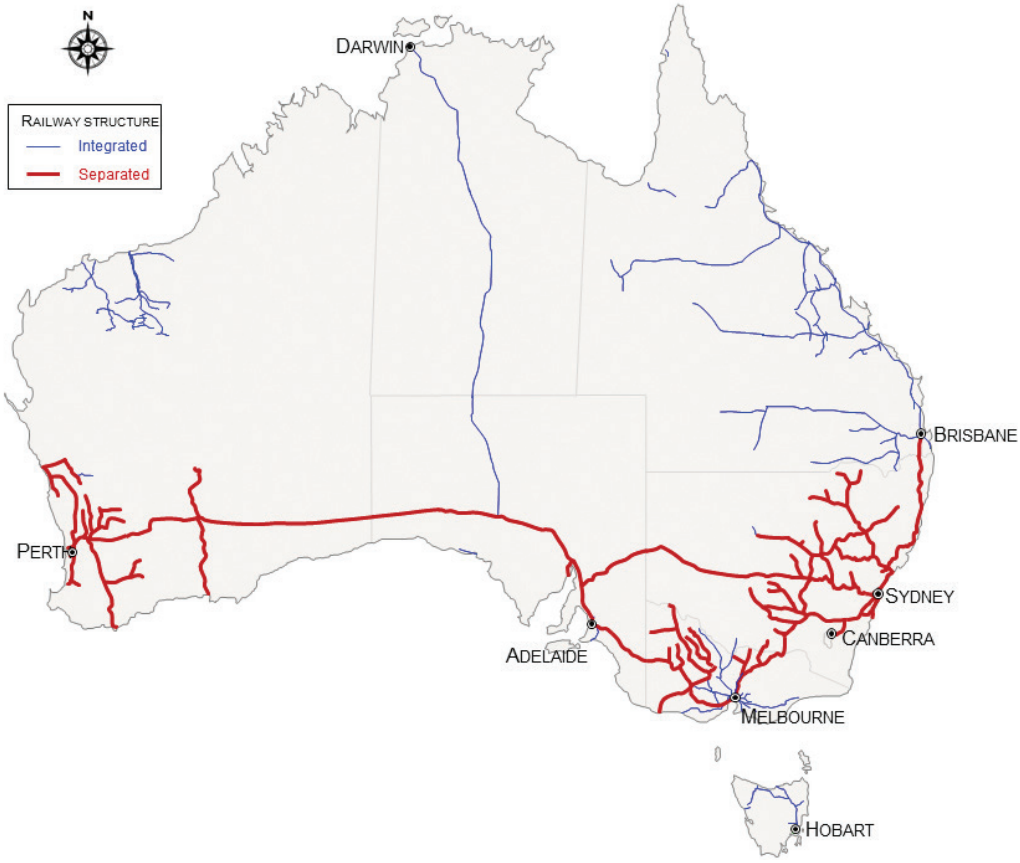
43 Aurizon reports bulk as including iron ore, agricultural products, and mining and industrial inputs. It no longer reports 'freight' tonnages due probably to its (planned) withdrawal from intermodal operations.

APPENDIX E

Industry structure

The Australian rail industry consists of vertically-separated and vertically-integrated railways. In vertically separated railways, the railway infrastructure manager does not operate revenue earning services. 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.

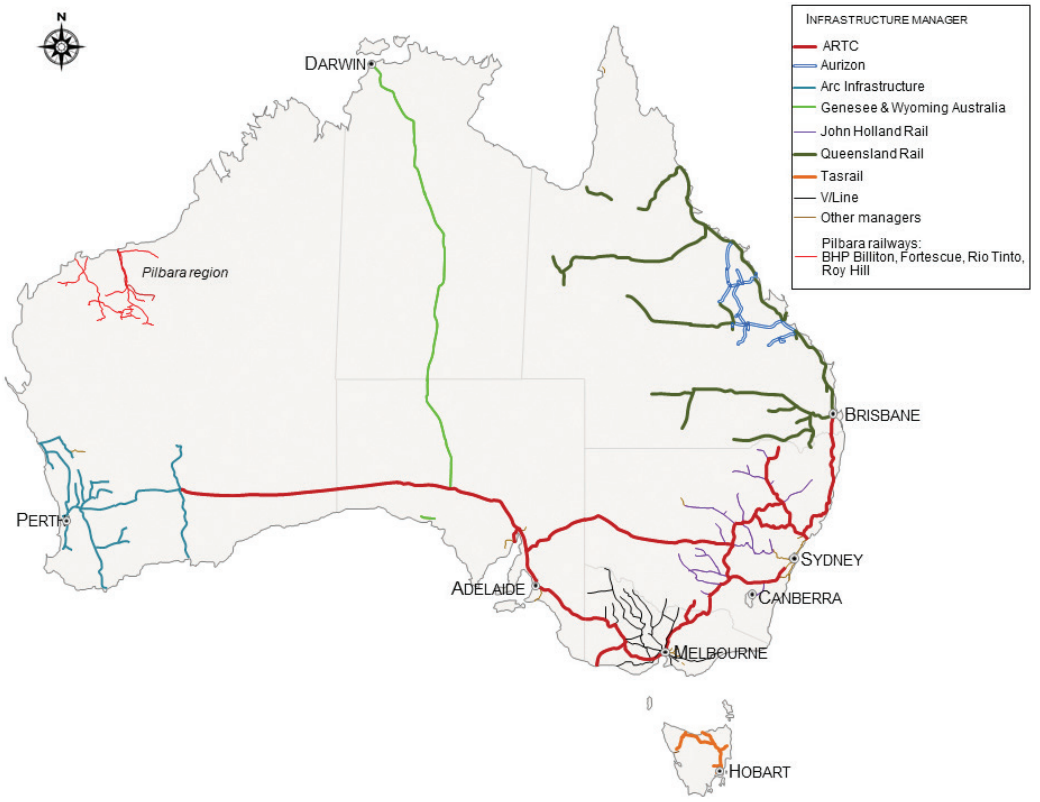
Figure 61 Australian rail industry structure



Infrastructure management

Australia's infrastructure managers are diverse in structure and operation. Figure 62 shows Australia's railway system by network manager.

Figure 62 Australian railways, by network manager, 2019



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 that 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, 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. Aurizon provides third-party access to its central Queensland lines. Coal railways in New South Wales are vertically separated. ARTC manages the Hunter Valley coal network with John Holland Rail managing some other New South Wales coal lines.

- **Mixed.** Tasmania's railways are vertically integrated. TasRail manages the system and operates the trains.
- **Grain.** Grain railways are vertically separated in Queensland, New South Wales (ARTC, John Holland Rail), Victoria (V/Line)[44] and Western Australia (Arc Infrastructure). Genesee and Wyoming Australia operates as a vertically-integrated operator in South Australia.
- **Passenger.** Urban systems are vertically integrated, except for Sydney where Sydney Trains both operates as vertically-integrated operator and provides track access to Trainlink that provides additional limited stops urban services. Non-urban passenger operations are a mix of vertical integration and separation.

Table 40 Principal infrastructure managers of Australian railways, 2019

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 Rail	Separated	Intermodal, grain, ores, cotton, passenger
ARTC (New South Wales regional and Hunter Valley)	Separated	Intermodal, coal, grain, other agricultural produce, passenger
V/Line	Integrated (passenger); Separated (freight)	Passenger, grains, other agricultural produce, 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	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
Sydney Trains	Separated	Passenger, freight
Urban		
Queensland Rail (Brisbane, Gold Coast)	Integrated	Passenger
Airtrain CityLink Limited	Integrated	Passenger
Sydney Trains	Integrated and Separated	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.

44 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 organisation. 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.
- National rail freight operators. The two largest national rail freight train operators are Pacific National and Aurizon. Both company's 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.
- **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, QUBE Logistics, and Linfox — 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 Logistics also has a diverse intermodal and bulk portfolio, with a primary focus on local and regional port-based operations. Fletcher International 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, Fortescue Metals Group and Roy Hill operate trains on their own railways.

Table 41 Principal train operators in Australia, 2019[45]

Train operator	Infrastructure network used	Primary tasks
Aurizon	Aurizon, Queensland Rail, ARTC, Arc Infrastructure	Coal, iron ore, 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	Genesee & Wyoming Australia, ARTC, Sydney Trains, John Holland Rail	Intermodal, ores, agricultural produce, coal
SCT Logistics/Specialised Bulk Rail	ARTC, Arc Infrastructure, Sydney Trains	Intermodal, grain, iron ore
QUBE Logistics	ARTC, V/Line, Sydney Trains, John Holland Rail, Metro Trains Melbourne	Intermodal, grain, mixed bulk
Watco	Arc Infrastructure	Grain, urban freight
Southern Shorthaul Railroad	ARTC, Sydney Trains, John Holland Rail, V/Line, Metro Trains Melbourne	Coal, grain, intermodal, infrastructure works
TasRail	TasRail	Intermodal, coal, ores, timber
Fletcher International	ARTC, John Holland Rail, Sydney Trains	Agricultural produce
Linfox	Queensland Rail	Queensland intrastate intermodal
Rio Tinto	Rio Tinto	Iron ore
BHP	BHP	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 (urban, intercity, and long distance)
NSW TrainLink	Sydney Trains, ARTC, John Holland Rail, V/Line, Queensland Rail	Heavy Rail Passenger (long distance, interstate, intrastate, urban, intercity)
V/Line	V/Line, ARTC, Metro Trains Melbourne	Heavy Rail Passenger (intercity and non-urban)
Transwa	Transperth, Arc Infrastructure	Heavy Rail Passenger (non-urban)
Great Southern Railway	Sydney Trains, John Holland Rail, ARTC, Arc Infrastructure, Genesee and Wyoming Australia	Heavy Rail Passenger (interstate premium tourist oriented)
Sydney Trains	Sydney Trains	Heavy Rail Passenger (urban)
Metro Trains Melbourne	Metro Trains Melbourne	Heavy Rail Passenger (urban)
Adelaide Metro	Adelaide Metro	Heavy Rail Passenger (urban)
Transperth	Transperth	Heavy Rail Passenger (urban)
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
Canberra Metro	Canberra Metro	Light Rail Passenger
Newcastle Transport	Newcastle Transport	Light Rail Passenger

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

APPENDIX F

Urban heavy rail network maps – September 2019

Figure 63 Adelaide

Figure 64 Brisbane

Figure 65 Melbourne

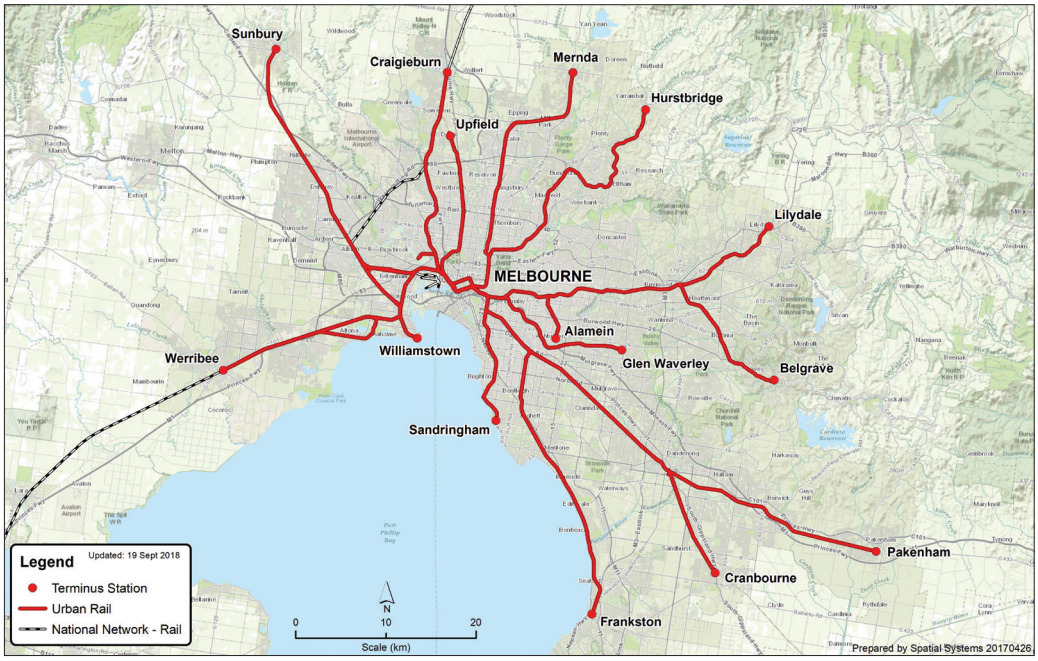


Figure 66 Perth

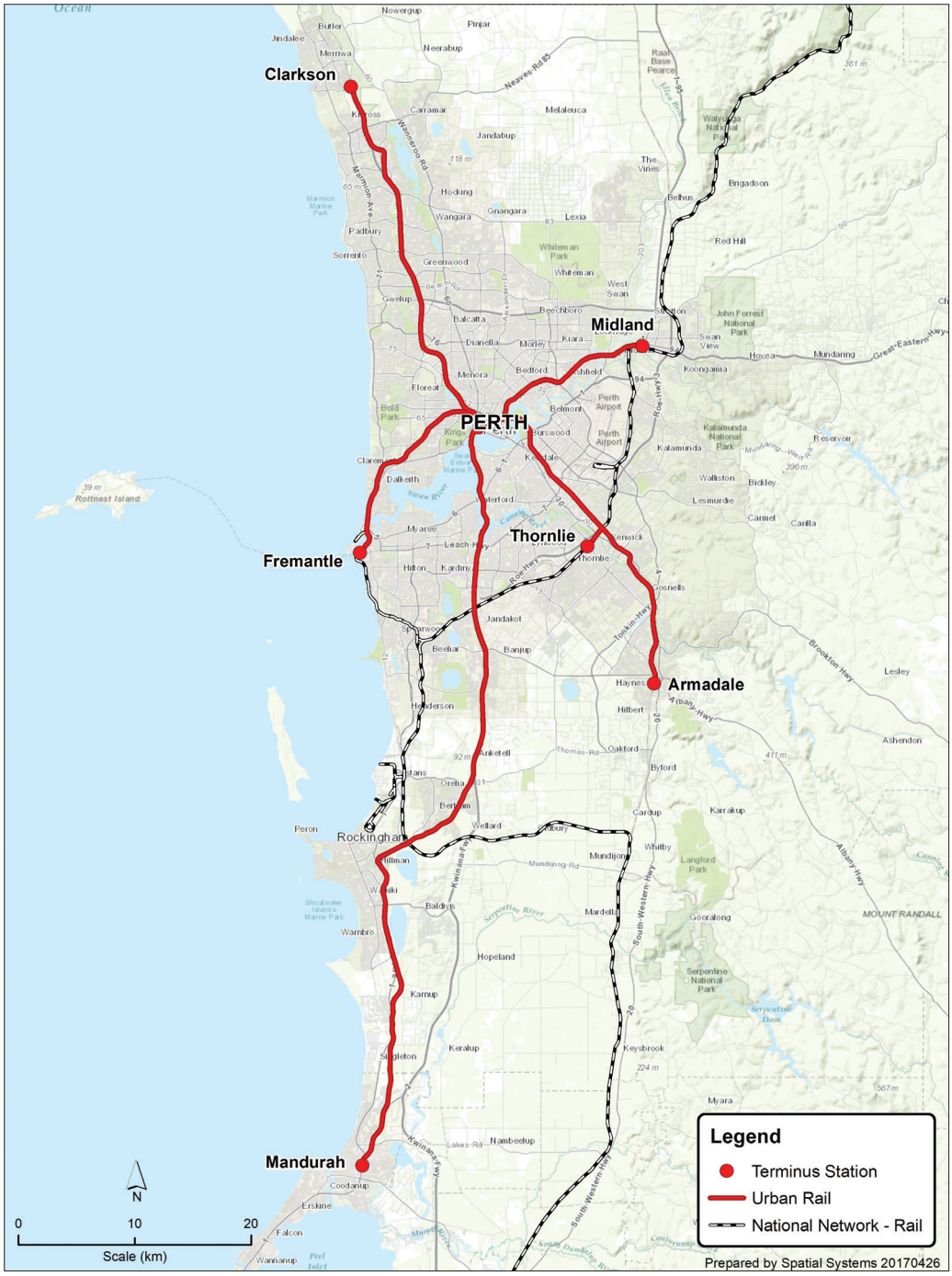


Figure 67 Sydney

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