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Rail

Trainline 10

May 2023

Bureau of Infrastructure and Transport Research Economics

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Department of Infrastructure, Transport, Regional Development, Communications and the Arts

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Cover photograph: Loaded single rake Roy Hill train approaching the company's Port Rail Loop at Port Hedland. (Photo courtesy of Rodney Avery.

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Foreword

Trainline 10 gives an overview of freight, urban and non-urban passenger rail transport in Australia. The report analyses traffic levels, the provision of infrastructure and rolling stock, and railway performance. It is the tenth in the publication series.

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.

This report was prepared by Rodney Avery.

Shona Rosengren
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May 2023

At a glance

Outcomes

- In 2020–21, intermodal freight tonnages reported by infrastructure managers ('below-rail') increased on all sectors of the North—South corridor, in both directions of travel. On the East—West corridor, tonnages either increased slightly or remained unchanged for westbound traffic while eastbound tonnages were roughly unchanged.
- For non-intermodal freight traffic in 2020–21, on the interstate corridors there were major increases in tonnages on some sectors, due partly to bumper crop harvests.
- Scheduled intermodal freight train transit times on the ARTC and Arc Infrastructure interstate corridors in 2022 were largely unchanged from 2021.
- The number of scheduled intermodal train services on both the North—South and East—West corridors either remained unchanged or increased slightly, compared to 2021. The scheduled running times of those services was largely unchanged.
- Total urban heavy rail patronage for 2020–21 was 396 million passenger journeys, a reduction of approximately 38 per cent from the previous financial year; while for light rail there were 93 million passenger journeys, a reduction of 47 per cent from the previous financial year. Melbourne had the greatest patronage declines, at 56 per cent for heavy rail, and 57 per cent for light rail. These reductions occurred in the context of COVID lockdowns.
- Total non-urban rail patronage for 2020–21 was approximately 29.7 million passenger journeys, a reduction of approximately 40 per cent compared to the previous financial year, which, in turn, had a 23 per cent reduction from its previous financial year. All operators experienced declines. Victoria had the greatest decline, at approximately 50 per cent. These reductions also occurred in the context of COVID lockdowns.
- All cities' urban heavy rail services exceeded punctuality targets in 2020–21. All light rail service providers exceeded punctuality targets except Adelaide, whose result was only slightly short of its target. For non-urban services, Victoria exceeded targets, while NSW, Queensland and Western Australia mostly fell short of targets.
- In June 2022, Adelaide's Gawler line re-opened, following conversion to electrified operations.
- In October 2022, Perth's Forrestfield-Airport Link urban passenger line opened to revenue services.
- An estimated 36 newly built Victorian VLocity diesel multiple unit (DMU) cars (in three car sets), including 18 cars on the standard gauge, entered service. These are progressively replacing older diesel locomotive hauled trains.
- In December 2022, there were approximately 174 route-kilometres of heavy and light rail railways under construction in Australia. Urban heavy railways were under construction in Sydney, Melbourne, Brisbane and Perth. This included preliminary construction of Melbourne's airport line and the Suburban Rail Loop. There was light rail construction in Sydney and the Gold Coast and preliminary construction to expand Canberra's network.
- In 2021–22, there were 74 notified fatalities on Australian railways that the Office of the National Rail Safety Regulator regulates. This is ten less than the previous financial year.
- Ongoing construction of parts of the Melbourne—Brisbane inland railway is underway, with some sectors now operational.

Infrastructure and assets

In 2022, Australia had:

- An estimated 33 000 route-kilometres of operational heavy railways. Of these, approximately 11 per cent of were electrified. Approximately 55 per cent of the network was standard gauge, with the remainder being narrow gauge (approximately 36 per cent), broad gauge (approximately eight per cent), and dual gauge (less than one per cent). All states and territories had operational railways, to varying degrees and for various needs.
- 16 mainline heavy rail infrastructure managers.
- Approximately 4 500 urban heavy rail cars (both electric and diesel, formed into multiple unit sets). New sets came online in Melbourne and Adelaide, as they replaced older stock.
- An estimated 326 route-kilometres of operational light rail/tramways, all standard gauge, in Melbourne, Sydney, Adelaide, Gold Coast, Canberra, and Newcastle.
- Approximately 600 light rail vehicles, with no changes to fleet numbers since 2021.
- Approximately 1100 non-urban cars and carriages (mostly formed into electric and diesel multiple unit sets, with the remainder being locomotive hauled), and 86 locomotives for non-urban passenger train haulage duties.

The total number of operational locomotives for freight duties was unknown due to an ongoing lack of data provision from parts of the rail industry.

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Chapter 1
Introduction

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

- **Patronage.** The introduction of frequent urban and interurban rail services with high average speeds, good bus, cycling, and parking links to high amenity stations, along with the opening of new or extended lines has generated strong patronage growth in parts of Australia, although COVID lockdowns in recent years has seen major declines in patronage, particularly in Victoria.
- **Resurgence of light rail.** In addition to Melbourne's extensive tram/light rail network, there are also light rail networks in Sydney, Adelaide, Canberra, the Gold Coast and Newcastle. Construction is underway to extend the Gold Coast and Canberra lines, while construction of the discrete Parramatta light rail in Sydney is also underway. Melbourne is replacing its remaining ageing light rail vehicles with new, locally built, high capacity stock.
- **Regional and inter-urban passenger service.** Regional passenger services, specifically in Victoria, have been upgraded both in rollingstock and infrastructure within the last decade. NSW is due to replace its ageing XPT and Xplorer trains with new stock.
- **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.

1 As a statistical report, the industry analysis does not consider operational, technical or regulatory aspects.

Chapter 2
Freight transport results

No single data source covers the entire Australian network. Data sources are train operator data, and track/infrastructure manager data and much of this is not public information. TasRail provides information on tonnages of some commodities that it transports, such as logs and minerals (TasRail 2021). ARTC reports aggregated Hunter Valley network quarterly coal tonnage throughput (ARTC n.d.). Aurizon has information packs for each of its coal networks (Aurizon 2022). Traffic data and projections can also be provided to the infrastructure managers' economic regulators, which may then publish that material[2]. BITRE's *Freightline* series also presents freight flows by commodity (BITRE 2014 and BITRE 2014a, BITRE 2016, BITRE 2018, BITRE2018a). While explicit rail traffic data is 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).

Freight transport by rail's role in the Australian economy has increased sharply this century; see Figure 1. Rail now accounts for more than one-half of Australian freight transport activity (approximately 58 per cent in 2021–22, 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.

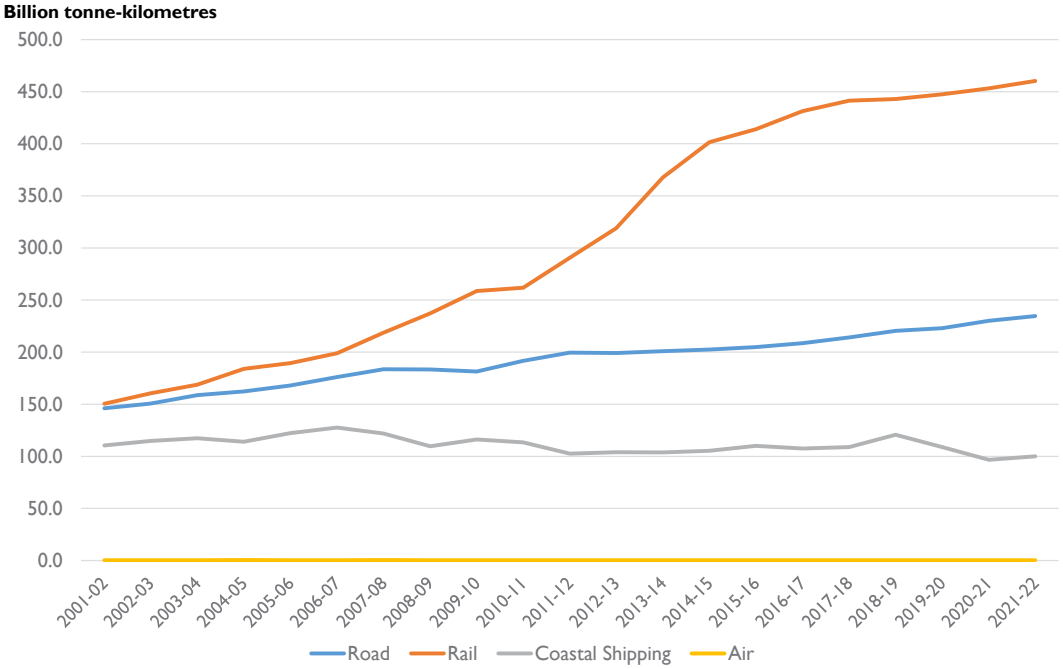
Rail and road transport compete strongly for short-haul and long-distance non-bulk freight, but as distances increase rail transport's competitiveness increases. Rail's mode share of non-bulk freight is highest between the eastern states and Perth (the East—West Corridor)[3].

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.

2 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/by-industry/rail-shipping-and-ports/interstate-rail-network-access-undertaking/the-regulatory-framework-for-artcs-interstate-network); Arc Infrastructure is the Economic Regulation Authority [WA] (http://www.erawa.com.au/rail/rail-access).

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 2014, 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 (2022), (Table T4.1c).

National rail freight task, tonnages

Freight type defined

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, 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 carried in a louvre wagon. Steel may also be deemed intermodal, particularly on trains that carry both intermodal and steel products on intermodal designated trains.

Tonnages, by operator

Due to an ongoing data shortage from freight train ('above rail') operators, Trainline is unable to report national above rail tonnages[4]. There is some publicly-available data on rail freight activity. Aurizon reports its data to the Australian Stock Exchange (ASX) and on its website. That material forms the basis of the data shown in Table 1 and Table 2. For coal, Aurizon reports both tonnes hauled and NTKs, while for other bulk goods it reports tonnes hauled only. Table 3 shows below-rail tonnages hauled on the Aurizon managed Central Queensland Coal Network. It thus includes the tonnages of all above-rail operators using the network. (For older Aurizon data, see Appendix C.)

Table 1 Aurizon above-rail volumes hauled (million tonnes)

Financial Year	2018–19	2019–20	2020–21	2021–22
Coal				
CQCN	152.3	150.1	143.7	141.1
NSW &SEQ	62	63.8	58.4	52.9
Total	**214.3**	**213.9**	**202.1**	**194**
Bulk Volumes	44.6	48.1	51.2	50.8
Coal and Bulk Total	**258.9**	**262**	**253.3**	**244.8**

Sources: Aurizon (2022a),p.40; Aurizon (2020), pp.16–17

CQCN = Central Queensland Coal Network, SEQ = South east Queensland

Table 2 Aurizon above-rail coal NTKs hauled (billion tonnes)

Financial Year	2018–19	2019–20	2020–21	2021–22
Coal				
CQCN	38.3	37.8	35.3	35.8
NSW &SEQ	12.2	12.2	11.3	9.9
Total	**50.5**	**50**	**46.6**	**45.7**

Sources: Aurizon (2022a),p.40; Aurizon (2020), p.16

Note: Totals are subject to rounding

Table 3 Aurizon network (below-rail) tonnages hauled (million tonnes)

Financial Year	2018–19	2019–20	2020–21	2021–22
Total	**232.7**	**226.9**	**208.3**	**206.5**

Sources: Aurizon (2022a), p.15, Aurizon (2020), p.19.

4 BITRE has been unable to report above rail tonnages since 2015-16. For historical data from 2001–02 to 2015–16, see *Trainline* 9 at https://www.bitre.gov.au/sites/default/files/train_006.pdf.

TasRail reports its freight task in its annual report. Table 4, below, shows and compares TasRail's freight task for the 2019–20 and 2020–21 financial years.

Table 4 TasRail freight task (net tonne kilometres)

	2019–20	2020–21	Change (per cent)
Coal	37 776 703	36 038 989	-4.60
Cement	23 983 822	24 357 043	1.56
Mineral concentrates	22 695 639	21 519 335	-5.18
Logs	41 110 223	38 667 048	-5.94
Intermodal general	244 765 564	273 587 415	11.78
Paper	109 291 862	114 467 944	4.74
Total	**479 623 813**	**508 637 774**	**6.05**

Source: TasRail 2021, p.8.

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 and much of this is not public information.

TasRail provides information on tonnages of some commodities that it transports, such as logs and minerals. (TasRail 2020)

The ARTC reports aggregated Hunter Valley network quarterly coal tonnage throughput (ARTC n.d.)

Aurizon has information packs for each of its coal networks (Aurizon 2020).

Traffic data and projections can also be provided to the infrastructure managers' economic regulators, which may then publish that material[5].

While explicit rail traffic data is 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 2014 and BITRE 2014a, BITRE 2016, BITRE 2018, BITRE2018a).

5 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/by-industry/rail-shipping-and-ports/interstate-rail-network-access-undertaking/the-regulatory-framework-for-artcs-interstate-network); Arc Infrastructure is the Economic Regulation Authority [WA] (http://www.erawa.com.au/rail/rail-access).

Interstate network freight traffic

This section reports interstate freight tonnages 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 5 and Table 6 show intermodal and total gross tonnes by line segment, with line segments ordered from north to south and east to west. ARTC's intermodal data only includes capital city to capital city trains, inclusive of regional/export traffic that is attached/detached to/from these trains en route. Wimmera Container Line export agricultural produce from Dooen (near Horsham) in Victoria being added to and removed from SCT Logistics' Melbourne-Perth trains is an example. Tonnages for regional intermodal trains, such as QUBE's Harefield (Junee)-Port Botany trains are captured in 'other' tonnages. 'Other' tonnages can be calculated by subtracting the intermodal component from the total tonnages. There are two 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.
- All 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.

Table 5 Below-rail gross tonnes by line segment, North—South corridor

	Million gross tonnes					
	Intermodal			Total		
Line segment, by direction of freight	2018–19	2019–20	2020–21	2018–19	2019–20	2020–21
Acacia Ridge to Casino	2.68	2.22	2.28	2.70	2.30	2.31
Casino to Acacia Ridge	4.13	3.44	3.51	4.15	3.50	3.54
Acacia Ridge – Casino	6.81	5.66	5.80	6.86	5.80	5.85
Casino to Islington	2.70	2.23	2.31	2.99	2.52	2.48
Islington to Casino	4.14	3.45	3.53	4.45	3.77	3.72
Casino – Islington	6.83	5.68	5.84	7.44	6.28	6.21
Chullora to Sefton Park	5.93	5.19	5.49	16.80	15.37	16.79
Sefton Park to Chullora	6.92	6.56	7.02	20.70	19.84	20.83
Chullora – Sefton Park	12.85	11.75	12.51	37.50	35.21	37.62
Sefton Park to Macarthur	4.48	3.66	3.86	7.18	6.26	6.51
Macarthur to Sefton Park	4.48	4.23	4.29	11.30	10.93	11.63
Sefton Park – Macarthur	8.96	7.89	8.15	18.48	17.20	18.13
Macarthur to Tahmoor	4.49	3.70	3.87	9.53	8.86	8.66
Tahmoor to Macarthur	4.50	4.28	4.32	15.00	14.59	14.91
Macarthur – Tahmoor	8.99	7.98	8.20	24.53	23.46	23.57
Moss Vale to Tahmoor	4.49	3.70	3.87	10.52	9.73	9.75
Tahmoor to Moss Vale	4.50	4.28	4.32	17.78	17.08	17.60
Tahmoor – Moss Vale	8.99	7.98	8.20	28.30	26.82	27.36
Moss Vale to Marulan	4.67	3.84	4.04	11.20	10.03	10.88
Marulan to Moss vale	4.78	4.51	4.62	18.79	17.22	19.89
Moss Vale – Marulan	9.45	8.36	8.66	29.99	27.25	30.77
Marulan to Goulburn	4.67	3.84	4.04	8.69	7.66	8.47
Goulburn to Marulan	4.78	4.51	4.62	11.12	15.34	18.25
Marulan – Goulburn	9.45	8.36	8.66	19.81	22.99	26.72
Goulburn to Cootamundra	4.67	3.83	4.05	6.18	5.39	6.46
Cootamundra to Goulburn	4.78	4.50	4.62	8.04	7.60	10.57
Goulburn – Cootamundra	9.45	8.34	8.67	14.22	12.99	17.03
Cootamundra to Junee	3.37	2.82	3.23	5.59	4.63	6.43
Junee to Cootamundra	2.94	2.60	2.85	6.44	5.92	7.08
Cootamundra – Junee	6.31	5.41	6.08	12.03	10.55	13.51
Junee to Albury	3.37	2.82	3.22	6.45	5.55	6.50
Albury to Junee	2.94	2.60	2.85	7.33	7.02	6.99
Junee – Albury	6.31	5.42	6.08	13.78	12.57	13.49
Albury to Tottenham	3.39	2.86	3.44	5.54	5.37	6.31
Tottenham to Albury	2.88	2.58	3.02	4.46	5.02	5.06
Albury – Tottenham	6.26	5.44	6.47	9.99	10.40	11.38

Note: Totals are subject to rounding.

Source: Data provided by ARTC.

Table 6 Below-rail gross tonnes by line segment, East—West corridor

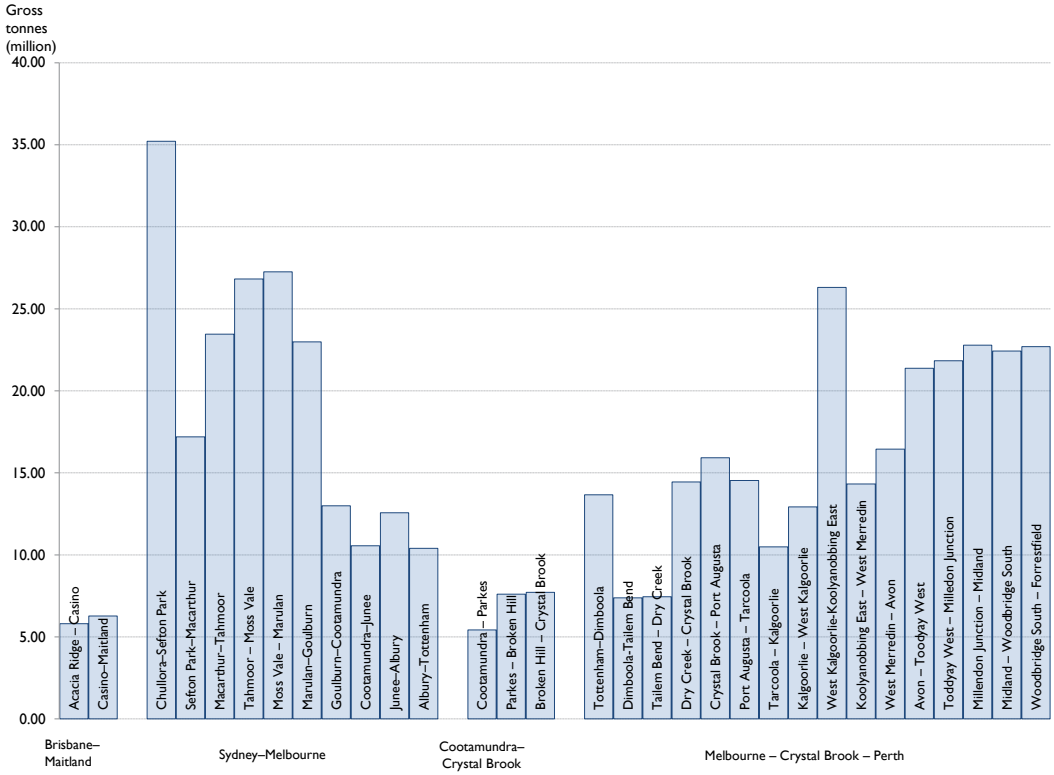
	Million gross tonnes					
	Intermodal			Total		
Line segment, by direction of freight	2018–19	2019–20	2020–21	2018–19	2019–20	2020–21
Cootamundra to Parkes	1.32	1.00	0.81	2.45	2.20	2.70
Parkes to Cootamundra	1.87	1.92	1.80	3.55	3.24	5.99
Cootamundra – Parkes	3.19	2.92	2.61	6.00	5.43	8.70
Parkes to Broken Hill	2.43	2.57	2.57	2.98	3.38	3.32
Broken Hill to Parkes	2.48	2.65	2.58	3.57	4.23	3.75
Parkes – Broken Hill	4.91	5.21	5.15	6.55	7.61	7.07
Broken Hill to Crystal Brook	2.32	2.40	2.52	3.67	3.78	3.81
Crystal Brook to Broken Hill	2.46	2.48	2.42	3.47	3.94	2.99
Broken Hill – Crystal Brook	4.79	4.89	4.94	7.14	7.72	6.80
Tottenham to Dimboola	3.91	3.97	4.17	5.76	5.97	6.43
Dimboola to Tottenham	3.60	3.70	3.65	6.45	7.69	7.55
Tottenham – Dimboola	7.51	7.67	7.82	12.22	13.66	13.98
Dimboola to Tailem Bend	3.41	3.54	3.75	3.71	3.99	4.80
Tailem Bend to Dimboola	2.99	3.12	3.12	3.17	3.39	3.58
Dimboola – Tailem Bend	6.40	6.65	6.87	6.88	7.38	8.38
Tailem Bend to Dry Creek	3.45	3.59	3.80	3.77	4.04	4.85
Dry Creek to Tailem Bend	3.03	3.17	3.17	3.21	3.41	3.58
Tailem Bend – Dry Creek	6.48	6.75	6.97	6.98	7.45	8.43
Dry Creek to Crystal Brook	4.71	4.93	5.29	6.23	6.77	6.89
Crystal Brook to Dry Creek	4.19	4.46	4.64	7.07	7.66	8.53
Dry Creek – Crystal Brook	8.90	9.40	9.92	13.30	14.44	15.42
Crystal Brook to Port Augusta	6.53	6.73	7.11	7.78	7.87	8.46
Port Augusta to Crystal Brook	6.12	6.35	6.39	7.65	8.05	8.48
Crystal Brook – Port Augusta	12.65	13.08	13.49	15.43	15.92	16.94
Port Augusta to Tarcoola	6.63	6.84	7.25	7.08	7.23	7.89
Tarcoola to Port Augusta	6.21	6.44	6.42	6.84	7.31	8.21
Port Augusta – Tarcoola	12.85	13.29	13.67	13.92	14.54	16.10
Tarcoola to Kalgoorlie	5.10	5.27	5.69	5.46	5.60	5.98
Kalgoorlie to Tarcoola	4.28	4.35	4.39	4.77	4.90	4.89
Tarcoola – Kalgoorlie	9.37	9.62	10.08	10.24	10.49	10.87
Kalgoorlie to West Kalgoorlie	5.16	5.28	5.69	6.72	6.78	7.32
West Kalgoorlie to Kalgoorlie	4.29	4.36	4.40	5.94	6.14	6.13
Kalgoorlie – West Kalgoorlie	9.45	9.65	10.10	12.66	12.93	13.45
West Kalgoorlie to Koolyanobbing East	5.06	5.21	5.60	8.06	9.37	11.11
Koolyanobbing East to West Kalgoorlie	4.21	4.30	4.33	11.03	16.94	20.69
West Kalgoorlie – Koolyanobbing East	9.27	9.51	9.93	19.09	26.31	31.80
Koolyanobbing East to West Merredin	5.06	5.21	5.57	7.31	7.28	8.13
West Merredin to Koolyanobbing East	4.21	4.30	4.33	6.80	7.04	7.10
Koolyanobbing East – West Merredin	9.27	9.51	9.91	14.10	14.32	15.23

	Million gross tonnes					
	Intermodal			Total		
Line segment, by direction of freight	**2018–19**	**2019–20**	**2020–21**	**2018–19**	**2019–20**	**2020–21**
West Merredin to Avon	5.07	5.22	5.54	9.71	8.94	9.89
Avon to West Merredin	4.21	4.29	4.33	7.45	7.51	7.51
West Merredin – Avon	9.28	9.51	9.87	17.16	16.45	17.40
Avon to Toodyay West	5.06	5.22	5.61	14.63	12.80	13.72
Toodyay West to Avon	4.21	4.29	4.33	8.81	8.57	8.61
Avon – Toodyay West	9.27	9.51	9.95	23.44	21.37	22.32
Toodyay West to Millendon Junction	5.06	5.22	5.60	15.02	13.14	13.97
Millendon Junction to Toodyay West	4.21	4.30	4.33	8.94	8.69	8.70
Toodyay West – Millendon Junction	9.27	9.52	9.93	23.96	21.83	22.67
Millendon Junction to Midland	5.06	5.22	5.63	15.78	13.86	14.54
Midland to Millendon Junction	4.21	4.30	4.33	9.17	8.92	8.87
Millendon Junction – Midland	9.27	9.52	9.96	24.96	22.78	23.42
Midland to Woodbridge South	5.07	5.23	5.64	15.59	13.69	14.43
Woodbridge South to Midland	4.22	4.30	4.33	8.97	8.74	8.73
Midland – Woodbridge South	9.29	9.53	9.97	24.56	22.43	23.16
Woodbridge South to Forrestfield	5.08	5.24	5.65	15.77	13.82	14.53
Forrestfield to Woodbridge South	4.23	4.31	4.33	9.14	8.86	8.83
Woodbridge South – Forrestfield	9.31	9.55	9.99	24.90	22.69	23.35

Notes: Totals are subject to rounding.

Sources: Data provided by ARTC and Arc Infrastructure.

Figure 2 **Total below rail gross tonnes on the interstate network, by line segment, 2020–21**



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 some diverging/converging traffic at Cootamundra from the East—West Corridor (via Broken Hill)[6].

6 Until 2020 about half of Sydney to Perth trains travelled via Cootamundra West with the other half travelling via Lithgow. All Perth to Sydney trains travelled via Cootamundra West. Now, almost all Sydney to Perth trains travel via Lithgow and all Perth to Sydney trains continue to travel via Cootamundra West.

- Some intermodal rail traffic originates/terminates at terminals in 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. Pacific National operates shuttle trains from/to Sydney and Parkes, where it is consolidated and double stacked on other Sydney—Perth trains. Westbound traffic tends to travel via Lithgow on the Transport for NSW network and details of its tonnages is thus not captured, while eastbound traffic tends to travel via Cootamundra, on the ARTC network, thus details of its tonnages is captured.
- Almost all Sydney to Perth intermodal trains now travel via Lithgow on Transport for NSW infrastructure, in place of the previous route via Cootamundra. This has shifted some tonnages away from Sydney to Cootamundra and Cootamundra to Parkes. Details of these tonnages are not captured.
- 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 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).

According to ARTC's and Arc Infrastructure's data, the following changes occurred to the intermodal task on their networks in 2020/21 compared to the previous financial year:

- Tonnages on all sectors of the North—South corridor, in both directions of travel, increased. This ranged from one per cent (Tahmoor to Macarthur and Moss Vale to Tahmoor, to 20 per cent (Albury to Tottenham).
- On the East—West corridor, tonnages increased slightly on all sectors for westbound traffic on the Tottenham-Dry Creek, and Dry Creek-Kalgoorlie sectors. Eastbound tonnages were roughly unchanged. On the Cootamundra to Parkes sector tonnages dropped by 19 per cent. This decline is partly attributable to Pacific National re-routing most of its Sydney to Perth trains and one weekly Brisbane to Adelaide train to the more direct route to Parkes via Lithgow. Tonnages from Parkes to Crystal Brook were largely stable. For eastbound traffic, tonnages dropped by three per cent (Crystal Brook to Broken Hill), two per cent (Broken Hill to Parkes), and six per cent (Parkes to Cootamundra).
- The increased westbound intermodal tonnages flowed through on Arc Infrastructure's Kalgoorlie-Perth sectors, while eastbound tonnages were largely unchanged.

"Other" traffic on the interstate network

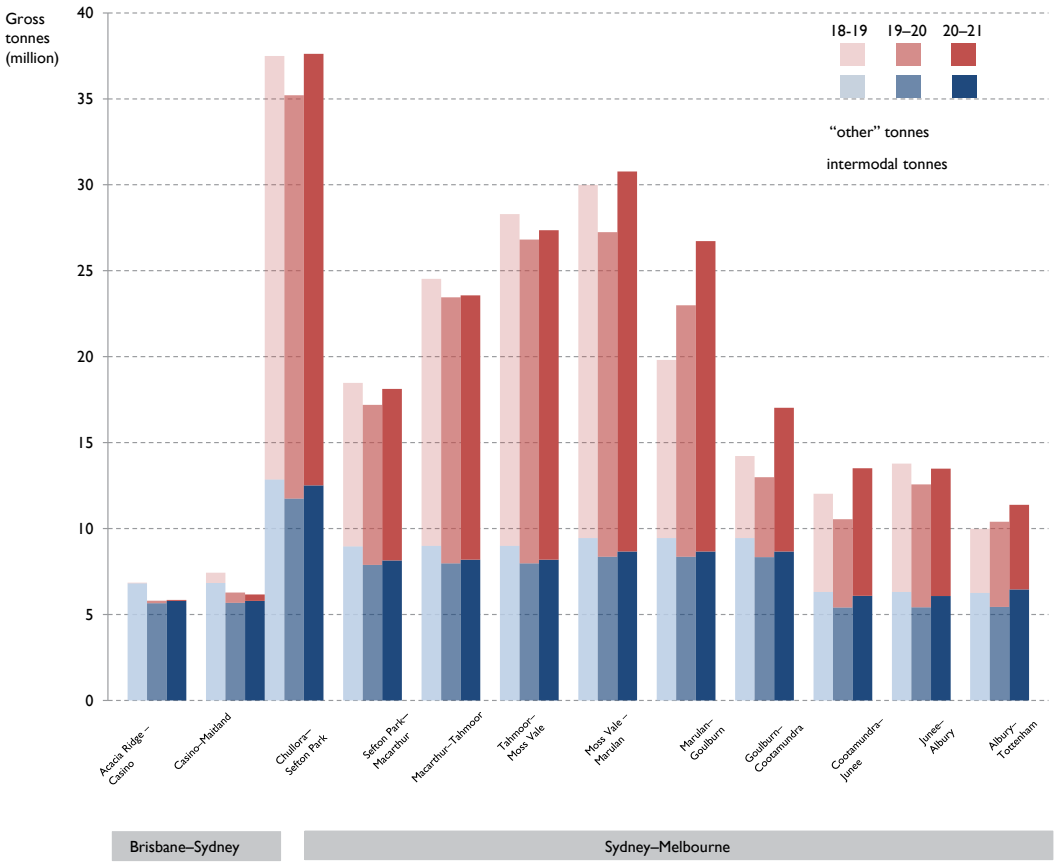
Other significant non-intermodal freight flows are as follows:

- 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. Harvest sizes contribute to variations in the size of the freight task.
- Aggregate, sand and limestone quarries in the southern New South Wales Southern Highlands boost tonnages between Macarthur and Goulburn.
- 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.

Compared to the previous financial year, the following notable changes occurred in 2020–21:

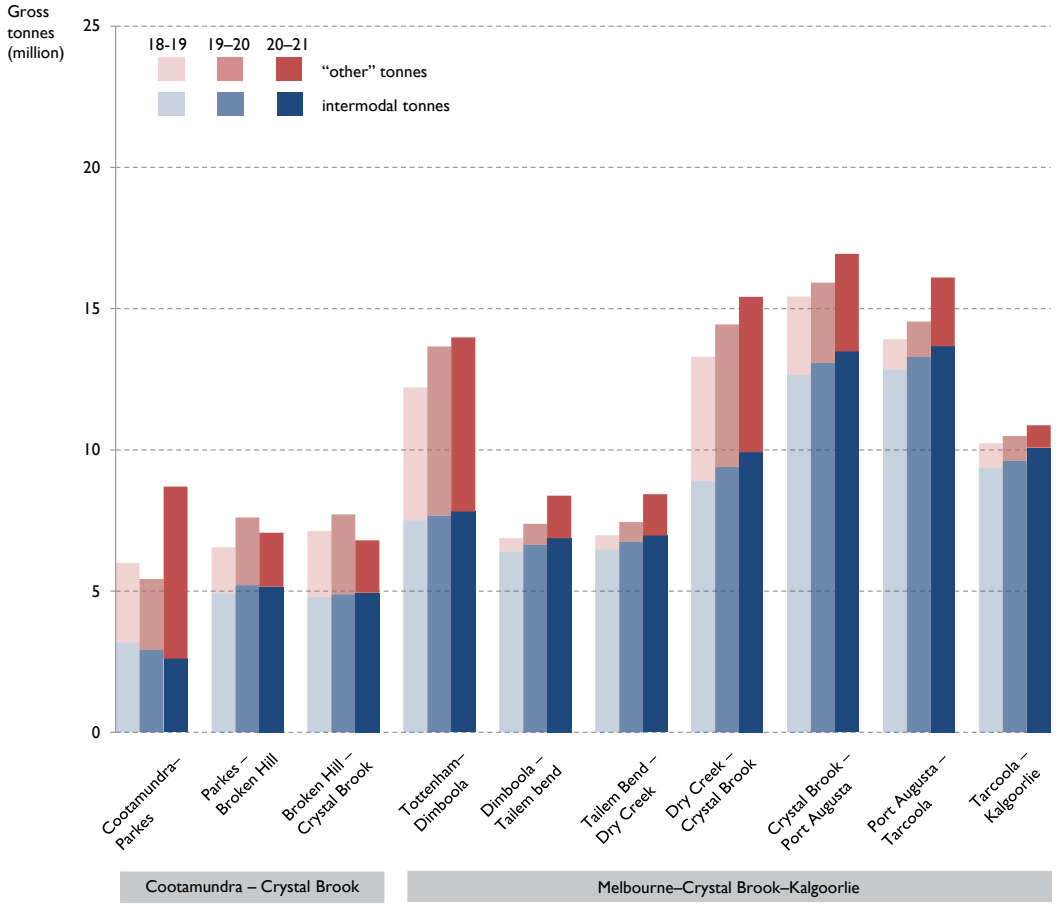
- There were major increases, as high as 92 per cent, on the Sydney—Melbourne sectors, particularly between Junee and Moss Vale. This was due to increased grain traffic following a bumper harvest. Numbers drop off past Moss Vale as this grain traffic leaves the Sydney—Melbourne corridor and travels to Port Kembla, via Macquarie Pass.
- There were also major increases (as high as 220 per cent) between Cootamundra and Parkes, due also to the bumper grain harvest.
- There were major decreases (as much as 67 per cent) on the Islington—Acacia Ridge sectors, but this occurred in the context of very small tonnages where minor changes can translate to major percentage changes.
- There were major increases between Melbourne and Adelaide, as high as 133 per cent in places. Between Adelaide and Kalgoorlie there was also mostly significant to major increases. On the Kalgoorlie—Perth sector, there were major increases between West Kalgoorlie to Koolyanobbing East, due partly to increased iron ore traffic. Tonnages on other sectors between Kalgoorlie and Perth were either roughly static or increased slightly.

Figure 3 **Gross tonnage on the North—South corridor, by line segment, 2018–19 to 2020–21**



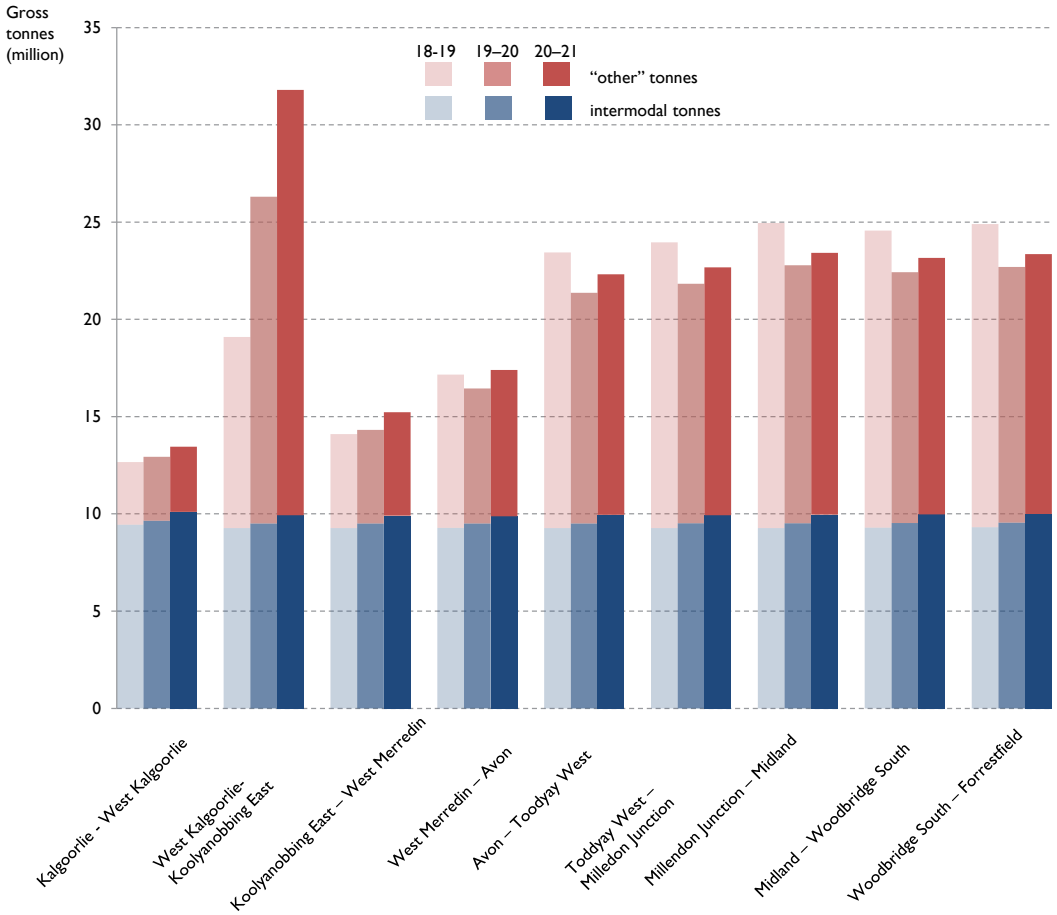
Source: Data provided by ARTC.

Figure 4 Gross tonnage on the East—West corridor, by line segment, 2018–19 to 2020–21



Source: Data provided by ARTC.

Figure 5 **Gross tonnage on the East—West corridor, by line segment, 2018–19 to 20–21**



Source: Data provided by Arc Infrastructure.

Figure 6 QUBE steel train

Note: The image above shows QUBE Wollongong to Melbourne steel train service 5WM7 at Chiltern in Victoria in March 2022. (Photo courtesy of Rodney Avery).

Intermodal freight train reliability on the interstate network

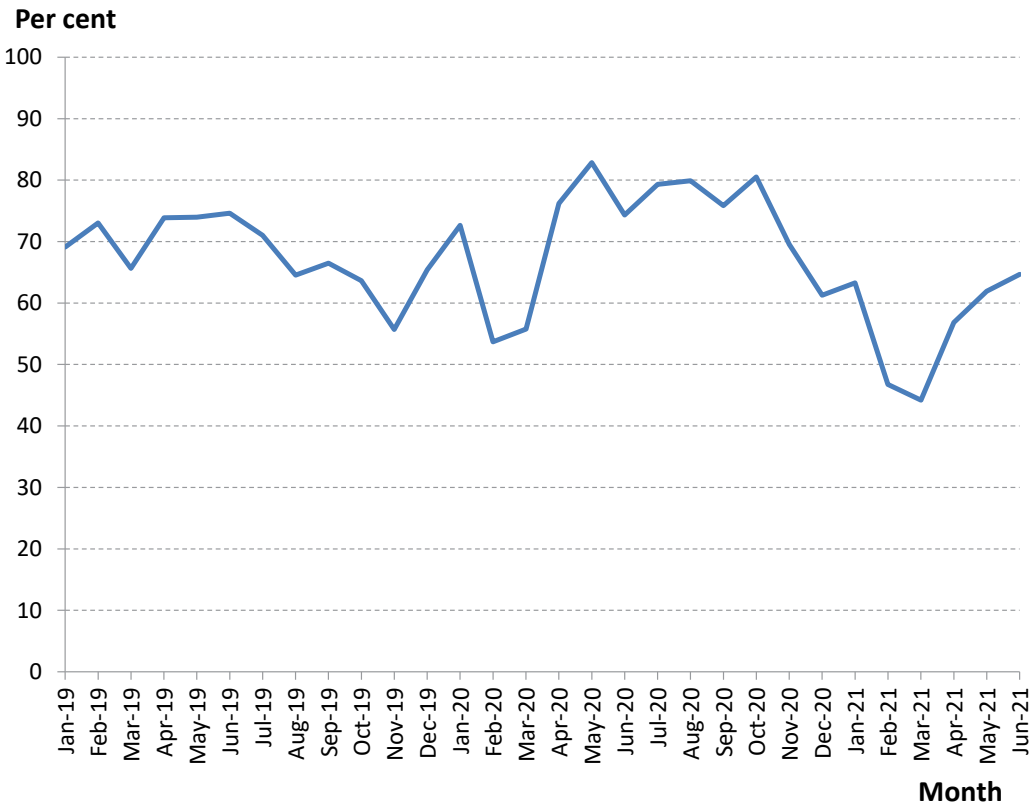
ARTC publishes performance indicators relating to service quality areas, including reliability. Detailed information regarding reliability by city pair is available on ARTC's website.

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 7 and Figure 8 show the percentage of intermodal trains that left the ARTC network within 30 minutes of schedule between January 2019 and June 2021.

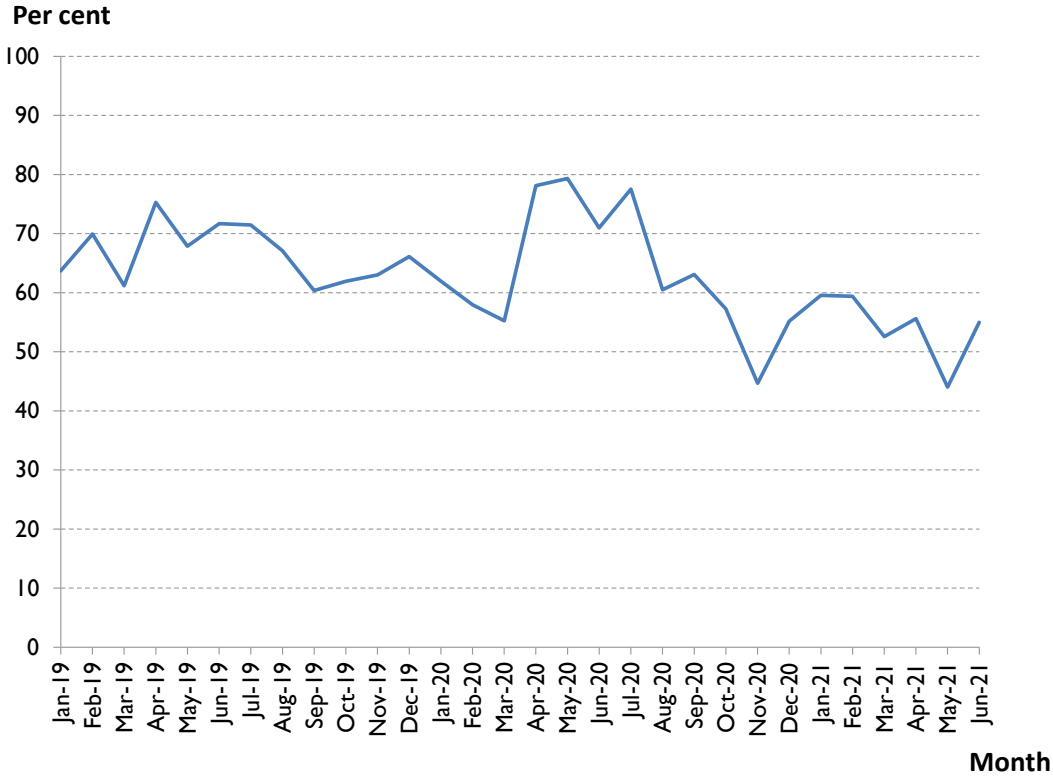
Figure 7 **North—South corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule**



Source: Data provided by ARTC.

As Figure 7 shows, intermodal train timeliness on the North—South corridor went into decline after October 2020, but began recovering from April 2021. It was at its highest in May 2020, at almost 83 per cent. It was at its lowest in March 2021 at almost 44 per cent.

Figure 8 **East—West corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule**



Source: Data provided by ARTC.

Reliability on the ARTC managed East—West corridor sectors (Cootamundra West/Parkes—Kalgoorlie and Melbourne—Kalgoorlie) reached a low in November 2020 at approximately 45 per cent, before increasing to almost 60 per cent in January 2021. Reliability shown in the chart was at its highest in July 2020, at approximately 80 per cent.

Intermodal train frequency on the interstate network

Table 7, below, 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, Melbourne—Perth trains dwell in Adelaide where freight is loaded and unloaded. Caution is also needed when comparing train numbers. Lower train numbers can be offset by longer train lengths.

Changes in the number of services per week from 2021 are:

- Brisbane to Sydney: up by one;
- Melbourne to Sydney: down by one;
- Melbourne to Brisbane: up by one;
- Melbourne to Adelaide and Adelaide to Melbourne: up by one each;
- Melbourne to Peth and Perth to Melbourne: up by one each; and
- Sydney to Perth and Perth to Sydney: up by two each.

Many of the increases listed above occurred on top of growth experienced the previous year. For example, in 2020, the number of Melbourne to Perth services was 13. In 2021, it was 15, which grew again in 2022 to 16. On the Sydney—Perth corridor, the number scheduled services went from six in 2020 to nine in 2022 in each direction. While the number of Melbourne to Sydney services declined by one, an additional Melbourne to Brisbane service offset this.

Pacific National also runs shuttle trains from Sydney to Parkes (and return). For westbound services, the freight from these trains is added to other Sydney to Perth trains waiting at Parkes, from where double stacked 1800-metre trains can operate and are formed. The reverse happens for eastbound services at Parkes.

Table 7 Number of scheduled weekly intermodal designated train services, by city pair

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
North—South corridor											
Brisbane to Sydney	2	2	2	2	5	5	6	5	3	3	4
Sydney to Brisbane	0	0	0	2	5	5	4	5	2	2	2
Sydney to Melbourne	3	2	2	1	1	2	2	5	6	5	5
Melbourne to Sydney	3	2	2	0	0	0	3	5	5	3	2
Brisbane to Melbourne	15	15	15	16	12	16	16	10	10	11	11
Melbourne to Brisbane	15	16	16	16	12	16	16	10	10	12	13
Brisbane to Adelaide	2	2	2	2	2	2	1	2	2	2	2
Adelaide to Brisbane	2	2	2	2	2	2	1	2	2	2	2
East—West corridor											
Melbourne to Adelaide	9	9	8	6	6	5	5	5	5	5	6
Adelaide to Melbourne	9	9	9	6	6	6	5	5	5	5	6
Melbourne to Perth	20	20	20	20	18	18	15	13	13	15	16
Perth to Melbourne	20	20	20	20	19	19	15	14	14	15	16
Sydney to Perth	8	9	10	8	7	7	7	7	6	7	9
Perth to Sydney	8	9	10	9	7	7	7	7	6	7	9
Adelaide to Perth	0	0	0	0	0	0	0	0	0	0	0
Perth to Adelaide	0	0	0	0	0	0	0	0	0	0	0
Central corridor											
Adelaide to Darwin	7	6	6	6	6	6	6	6	6	6	6
Darwin to Adelaide	7	6	6	6	6	6	6	6	6	6	6

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure, UGL Regional Linx, One Rail Australia) as at June 2022.

Table 8 shows the number of scheduled weekly interstate intermodal and steel trains on each line segment. This shows how intensely the interstate network is used, by schedule. Table 8 differs from Table 7 because it includes all interstate 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 of that route. Table 8 also includes interstate trains that do not travel from capital city to capital city, such as the Melbourne—Griffith trains.

Crystal Brook—Port Augusta remains the busiest segment. This is because it is a convergence point for interstate intermodal and steel trains travelling to and from Perth and Melbourne; intermodal trains to and from Sydney and Perth, and 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 use these segments extensively.

Increases seen across the network are reflective of the increased number of services shown in Table 8. The Adelaide—Crystal Brook sector remains unchanged despite the increased number of Melbourne—Perth intermodal services. This is because there is one less Melbourne—Perth steel service per week and the once weekly Adelaide to Goobang intermodal service has ceased. Scheduled services on the Brisbane—Wollongong sector corridor have increased significantly. This is due to QUBE Logistics taking over from Pacific National the Bluescope contract for steel services between Wollongong and Brisbane. According to advice from ARTC, Pacific National's previous Wollongong—Sydney steel designated train services carried mixed freight, such as sugar, in addition to steel. Despite losing the contract, Pacific National still carries some non-Bluescope steel and other mixed freight on these steel designated services, which are now operate to/from Sydney instead of Wollongong.

Table 8 Total scheduled weekly interstate intermodal and steel trains, by line segment

Line segment	2018	2019	2020	2021	2022
North—South corridor					
1. Brisbane-Sydney	56	46	40	42	50
2. Sydney-Melbourne					
Sydney-Cootamundra	71	72	63	64	64
Cootamundra-Melbourne	71	61	55	55	54
East—West corridor					
3. Sydney-Crystal Brook via Broken Hill					
Sydney-Parkes via Lithgow	6	6	9	9	11
Cootamundra-Parkes	20	22	18	19	21
Parkes-Crystal Brook	32	33	32	33	36
4. Melbourne – Crystal Brook					
Melbourne-Adelaide	46	43	43	45	48
Adelaide – Crystal Brook	55	52	52	54	54
5. Crystal Brook – Perth					
Crystal Brook – Port Augusta	80	76	76	78	83
Port Augusta – Tarcoola	63	60	58	63	70
Tarcoola-Perth	51	48	46	51	58

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure, UGL Regional Linx, One Rail Australia) as at June 2022.

Intermodal train flow patterns on the interstate network

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

Table 9, 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 train 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 movement patterns is outside the scope of this publication. Train movement patterns are based on scheduled times. Actual times for individual trains may differ due to operational reasons.

Table 9 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)		Average dwell per stop (mins)	
Year	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
North—South corridor														
Brisbane to Sydney	16	17	54	54	8	9	1081	1085	158	163	15%	15%	19	19
Sydney to Brisbane	16	17	55	55	6	6	1055	1056	146	144	14%	14%	24	22
Sydney to Melbourne	16	16	60	63	4	4	956	917	143	135	15%	15%	34	32
Melbourne to Sydney	15	15	66	68	3	3	854	843	63	66	7%	8%	24	24
Brisbane to Melbourne	11	11	58	58	13	13	2020	2000	300	287	15%	14%	22	21
Melbourne to Brisbane	12	13	61	61	10	10	1906	1915	231	241	12%	13%	24	24
East—West corridor														
Melbourne to Adelaide	20	22	67	68	3	3	742	736	48	55	6%	7%	16	19
Adelaide to Melbourne	20	22	57	59	6	5	875	850	169	150	19%	18%	28	28
Adelaide to Perth	15	16	67	64	13	14	2380	2505	330	362	14%	14%	26	26
Perth to Adelaide	15	16	58	59	17	16	2727	2695	686	655	25%	24%	40	40
Melbourne to Perth	15	16	62	62	16	17	3338	3359	599	618	18%	18%	37	36
Perth to Melbourne	15	16	51	52	24	23.5	4043	4008	1295	1256	32%	31%	53	53
Sydney to Perth (via Lithgow)	6	8	66	64	15	18	3597	3730	568	697	16%	19%	38	40
Sydney to Perth (via Cootamundra West)	1	1	65	65	26	26	3991	3991	803	798	20%	20%	31	31
Perth to Sydney (via Cootamundra West)	7	9	59	59	21	23	4200	4213	1082	1095	25%	26%	50	48
Brisbane to Adelaide (via Lithgow)	1	1	51	51	14	14	3115	3105	911	922	29%	30%	65	66
Brisbane to Adelaide (via Cootamundra	1	1	54	54	14	17	3115	3145	911	839	29%	27%	49	49
Adelaide to Brisbane (via Cootamundra, both trains)	2	2	52	52	14	13.5	3240	3241	914	915	28%	28%	65	68
Central corridor														
Adelaide to Darwin	6	6	69	69	6	6	2584	2564	318	360	12%	14%	52	57
Darwin to Adelaide	6	6	65	65	9	9	2720	2748	431	446	16%	16%	47	51

Notes: The number of services excludes trains that do not run the entire line segment. Cootamundra to Crystal Brook, for example, excludes Adelaide to Brisbane trains.

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure, UGL Regional Linx, One Rail Australia) as at June 2022.

North–South corridor

The only significant change since 2021 is the average point to point travel time for trains travelling from Sydney to Melbourne has reduced by approximately 40 minutes. This may be due to one service whose scheduled trave time is approximately 13.5 hours, compared to the average of 15.5 hours for the other 15 services. This service has only two scheduled stops compared to an average of approximately four for the other 15 services.

East–West corridor

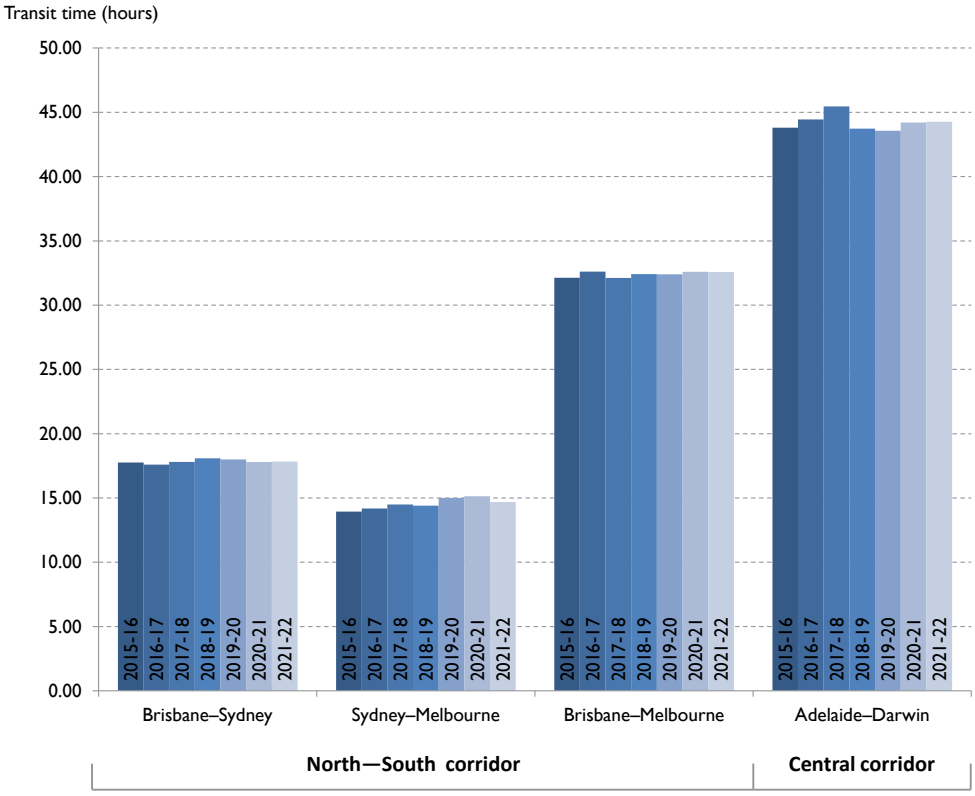
Compared to 2021 there have been no significant changes, except:

- Average transit times for Adelaide to Melbourne trains has decreased by 25 minutes; and
- Average transit times for Sydney to Perth trains taking the Lithgow route have increased by 133 minutes. This is largely due to one train whose dwell times have increased significantly.

Central corridor

There have been no significant changes in travel patterns since 2021.

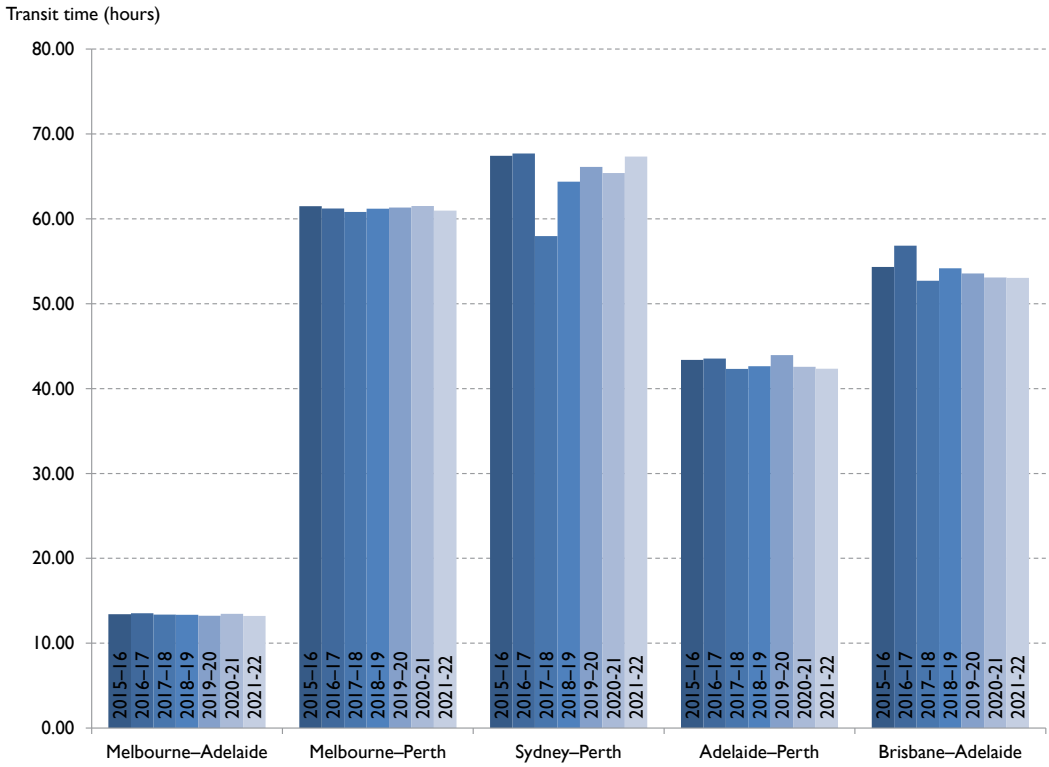
Figure 9 **Average scheduled transit times, North—South and Central corridors, 2015–16 to 2021–22**



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, and One Rail Australia) as at June 2022.

Figure 10 Average scheduled transit times, East—West corridors, 2015–16 to 2021–22



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

All but one scheduled Perth to Sydney service per week travelled via Lithgow. The other service travelled via Cootamundra West. All scheduled Sydney to Perth services travel via Cootamundra. The figure shown for 2021–22 is the average of all services, including the westbound service that travels via Cootamundra West.

Sources: Infrastructure managers' working timetables (ARTC, Sydney Trains, and Arc Infrastructure) as at June 2022.

Figure 11 Melbourne to Brisbane intermodal train

Note: The image above shows Melbourne to Brisbane SCT service 4MB9 at Coolalie in NSW, September 2022. Photo courtesy of Rodney Avery.

Intermodal train actual running times

This section compares actual running times of all timetabled Sydney to Perth and Perth to Sydney intermodal designated services against scheduled times, as shown in the ARTC Master Train Plan (timetable), and Arc Infrastructure and Sydney Trains timetables. The comparison is for the period 5 June – 28 August 2022. BITRE used the online 4Trak tool for extracting the trip details from which it did its analysis.

It can be difficult to determine with 4Trak when Sydney to Perth services taking the Lithgow route actually depart Chullora and begin their journeys. This is because of the nature of shunting at Chullora and how a given train's movements correspondingly appear on the extracted trip report. Likewise, it can be difficult to determine when a train arrives at or departs from the Kewdale terminal in Perth. As such and for the purposes of this analysis, the measured point of commenced journey for Sydney to Perth trains taking the Lithgow route is Flemington. For trains arriving at or departing Kewdale, the measured start/end point is Midland. Trains passing through these two points are clear of the terminals and clearly underway. For Sydney to Perth trains timetabled to take the Cootamundra West route, the departure point is Chullora. For all eastbound trains into Sydney, the arrival point is Chullora. 'Perth' therefore means Midland, approximately 14 kilometres from the Kewdale terminal. 'Sydney' means either Chullora or Flemington (approximately two kilometres from Chullora), depending on what route each train was timetabled to take.

4Trak sometimes had no record for a given service or only a partial record. This is why the results, shown in Table 10 and Table 11, below, list more scheduled services than fully recorded actual services and this is why the results do not always balance. The fact there is no record for a given service does not in itself mean there was no service[7]. It just means there is no record (available) of the service under the train's identifier.

7 It is not known why there are sometimes no records or only partial records for a given service. BITRE in no ways claims or suggests there is a problem with 4Trak when this happens.

Of the 94 Sydney to Perth scheduled services for the reporting period that were to take the Lithgow route, there are records showing 19 of them taking the Cootamundra West route instead[8]. These services have been excluded from the analysis because part of their actual route does not correlate with timetabled route, which makes any comparison unrealistic. One weekly service was timetabled to take the Cootamundra West route and its running times have been included because its actual route correlates to the timetabled route. All of these recorded services took the timetabled route.

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. The number of fully recorded services figures are for those services for which there is a complete trip record only.

The analysis recorded and assessed the following:

- the time trains[9] commenced their journey;
- the time trains completed their journey; 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 operator. BITRE is also unable to assess the reasons for differences between scheduled and actual running times.

Table 10 and Table 11, below, show the results, noting the number of scheduled services is the sum of those recorded on the corresponding ARTC Mater Train Plans for the 5 June – 28 August 2022 period. Services that commenced their journey before 5 June but completed it after 5 June are excluded. The same applies to services that commenced their journey before 28 August but completed it after 28 August[10].

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.

8 For the Sydney to Parkes sector of the route to Perth, there are two routes trains can take. The Lithgow route goes via the Blue Mountains. The Cootamundra West route follows the Main South line to Cootamundra West, before exiting the Main South and travelling largely due north to Parkes. The Lithgow route is shorter and quicker, but requires locomotives to use more fuel due to the steeper grades. The Cootamundra West route is longer and slower, but flatter and more economical fuel wise.

9 All times were standardised to Eastern Standard Time.

10 5 June was when a new ARTC timetable came into effect, which expired on 28 August.

Table 10 Westbound times

Number of scheduled services	105	Average scheduled transit time (days, hours, minutes)	2 days, 14:04
Number of fully recorded services	60	Average recorded transit time	2 days, 15:45
Number of services with travel time faster than schedule	21		
Number of services with travel time up to and including 30 minutes slower than schedule	4		
Number of services more than 30 minutes slower than schedule	35		
Average early departure from Sydney (hours, minutes)	00:13	Number of services departing on time or earlier than schedule	22
Average late departure from Sydney	01:22	Number of services departing 30 minutes or less later schedule	16
		Number of services departing more than 30 minutes later than schedule	23
Average early arrival at Perth	01:22	Number of services arriving on time or earlier than schedule	16
Average late arrival at Perth	04:30	Number of services arriving 30 minutes or less later than schedule	5
		Number of services arriving more than 30 minutes later than schedule	42

Table 11 Eastbound times

Number of scheduled services	105	Average scheduled transit time (days, hours, minutes)	2 days, 21:22
Number of fully recorded services	65	Average recorded transit time	3 days, 00:09
Number of services with travel time faster than schedule	18		
Number of services with travel time up to and including 30 minutes slower than schedule	1		
Number of services more than 30 minutes slower than schedule	46		
Average early departure from Perth (hours, minutes)	00:12	Number of services departing on time or earlier than schedule	20
Average late departure from Perth	01:32	Number of services departing 30 minutes or less later schedule	7
		Number of services departing more than 30 minutes later than schedule	34
Average early arrival at Sydney	00:26	Number of services arriving on time or earlier than schedule	5
Average late arrival at Sydney	04:06	Number of services arriving 30 minutes or less later than schedule	10
		Number of services arriving more than 30 minutes later than schedule	62

The tables show the following key findings.

Westbound services:

- Average recorded transit times were close to schedule;
- Approximately 42 per cent of services completed their journey faster than schedule or no more than 30 minutes behind schedule.
- Most recorded services departed Sydney either early or no more than 30 minutes behind schedule, but most arrived in Perth more than 30 minutes behind schedule. There was, thus, a trend for services lose time en route[11].
- Services arriving at Perth early were, on average, approximately one hour 30 minutes early, while late arrivals were, on average, approximately four hours 30 minutes late.

Eastbound services:

- Average actual transit times were three hours slower than schedule.
- Approximately 30 per cent of services completed their journey 30 minutes or more longer than schedule.
- Just under half of all recorded services departed Perth either early or no later than 30 minutes behind schedule, but approximately 80 per cent of recorded services arrived at Sydney more than 30 minutes later than scheduled.
- For the five recorded services that arrived at Sydney ahead of schedule, they arrived on average approximately half an hour early, while for the 72 services arriving later than schedule, the average delay was four hours.

BITRE is able to provide more detailed analysis of the results, such as by month or day of the week, upon request.

The four charts below show the running times in graphic format of two sample Sydney to Perth and two Perth to Sydney services included in the analysis. All four services ran close to scheduled time. The Sydney to Perth services travelled via Lithgow, while the Perth to Sydney services travelled via Cootamundra West. The blue and red bars show how long it took the train to complete its journey through each section of the line, as recorded in 4Trak. The blue bars denote when the train is in motion, while the red bars denote when the train is stationary. The shorter a given bar is means the faster the train passed through the given section. For three of the four examples shown below, Port Augusta (a crew change point) was the point of longest dwell. In the fourth example, the train dwelled the longest at Goobang, near Parkes. Goobang is where double-stacked eastbound trains are changed to single stack running (and the reverse for westbound trains) for the onward leg to Sydney.

11 It is beyond the scope of this analysis to determine where trains tended to lose time en route.

Figure 12 Sydney to Perth sample one

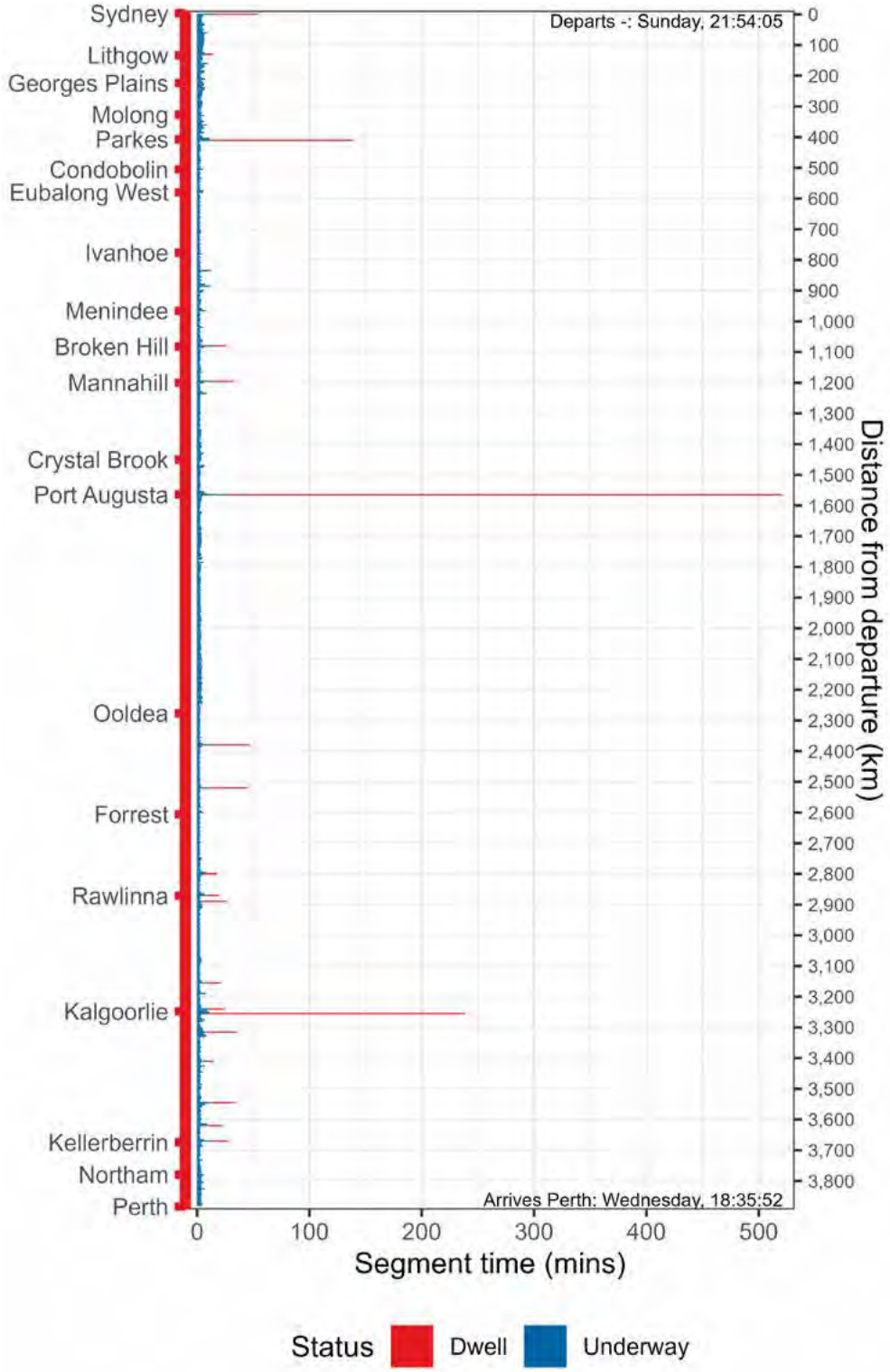


Figure 13 Sydney to Perth sample two

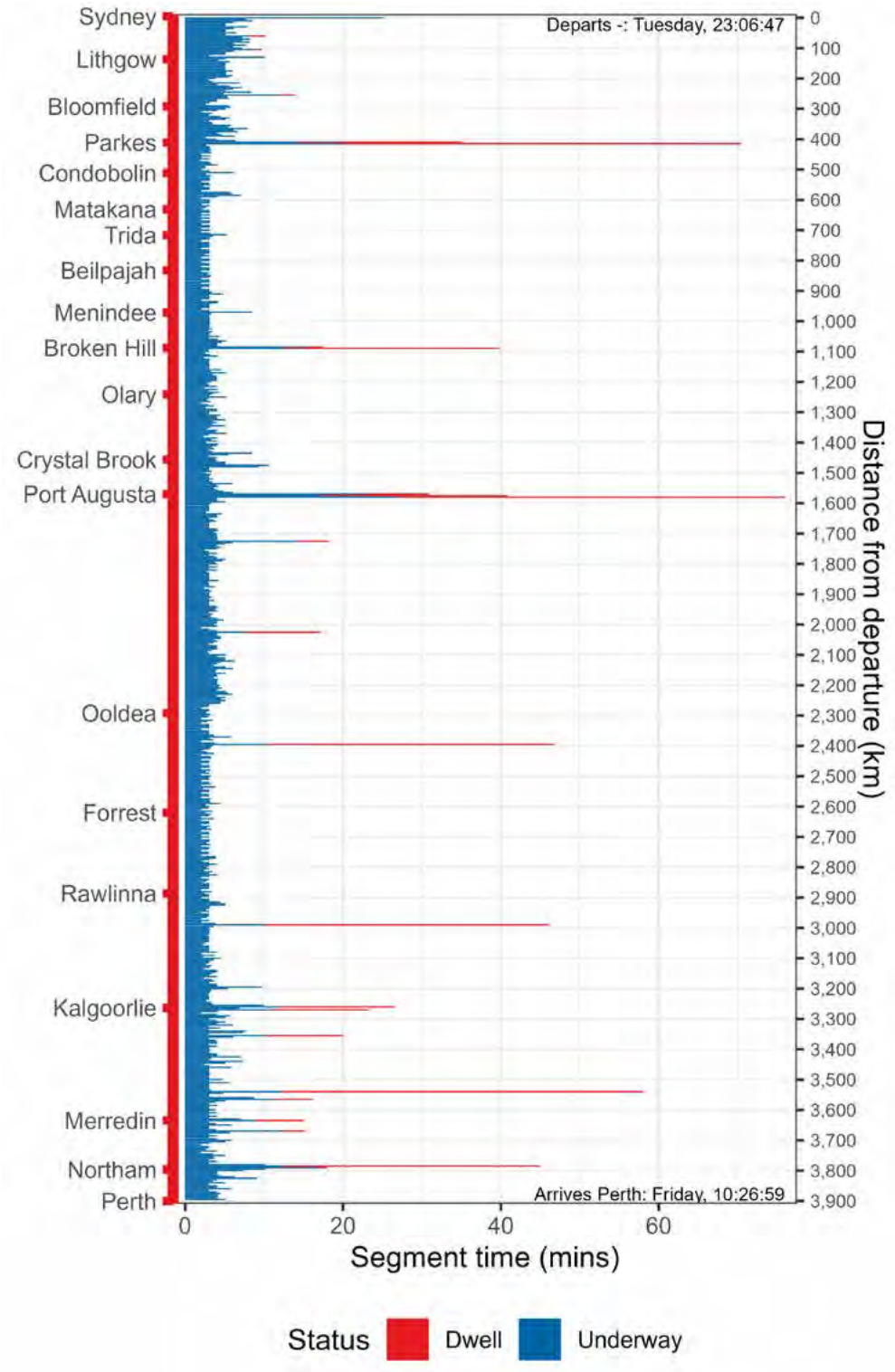


Figure 14 Perth to Sydney sample one

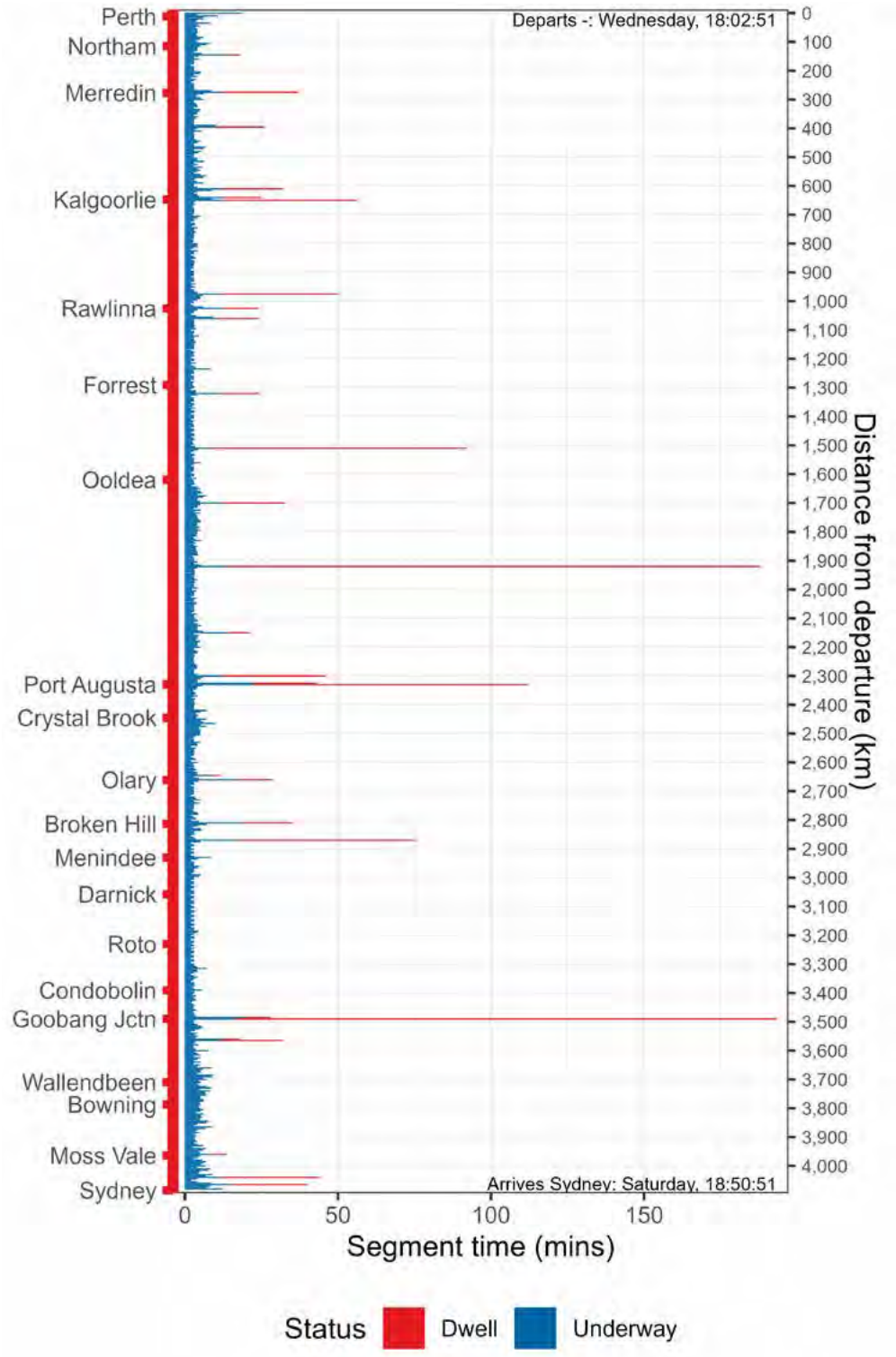
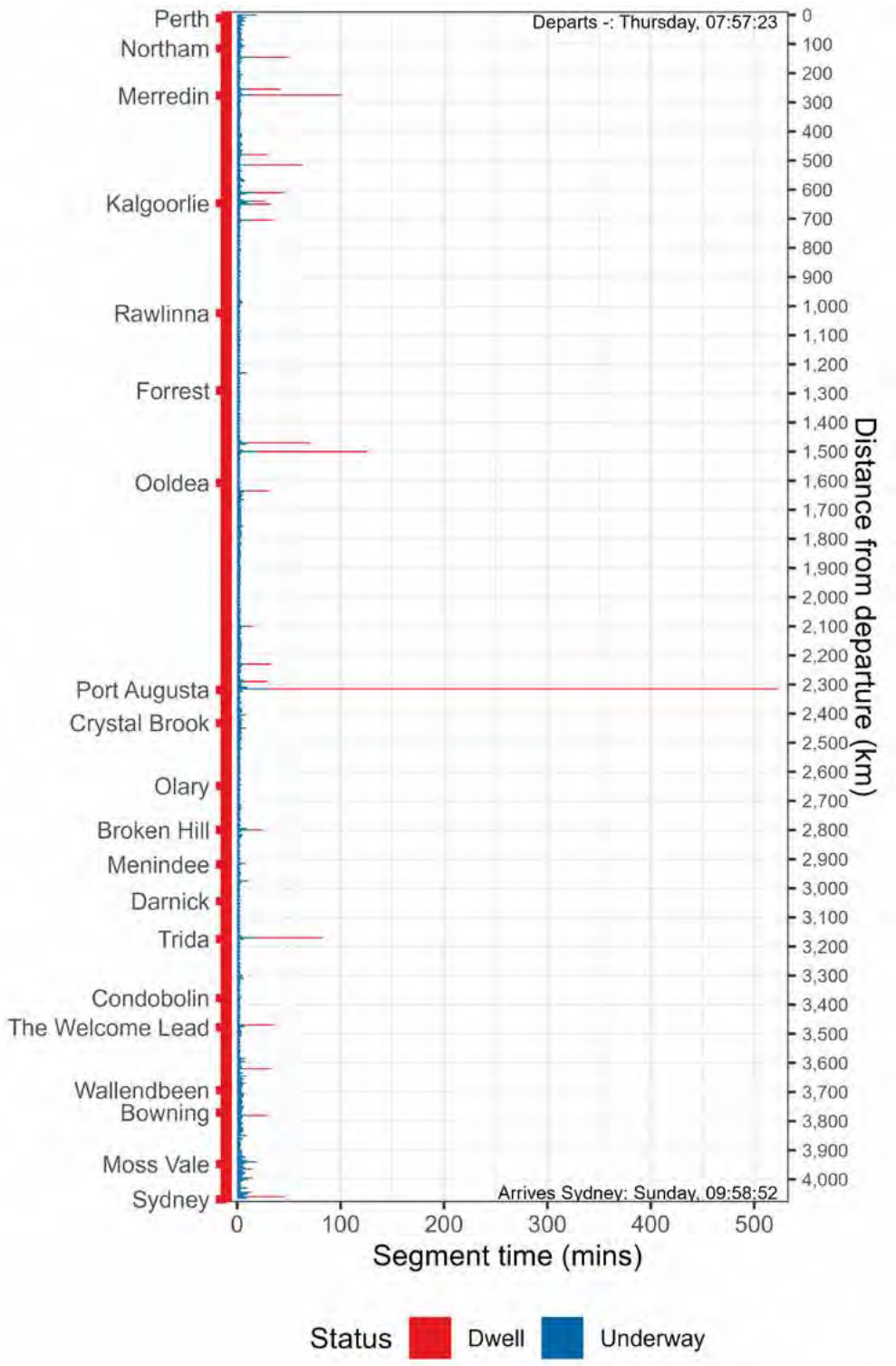


Figure 15 Perth to Sydney sample two



Bulk rail freight traffic, by commodity

Iron ore and coal are the rail industry's two largest bulk freight flows.

Iron ore traffic

Australia exports most of its iron ore,[12] almost all of which is moved to port by rail. The scale of the task means rail is best suited for transporting iron ore from mine to port. 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, 2014a). For discussion of the iron ore railway's infrastructure see Chapter 5.

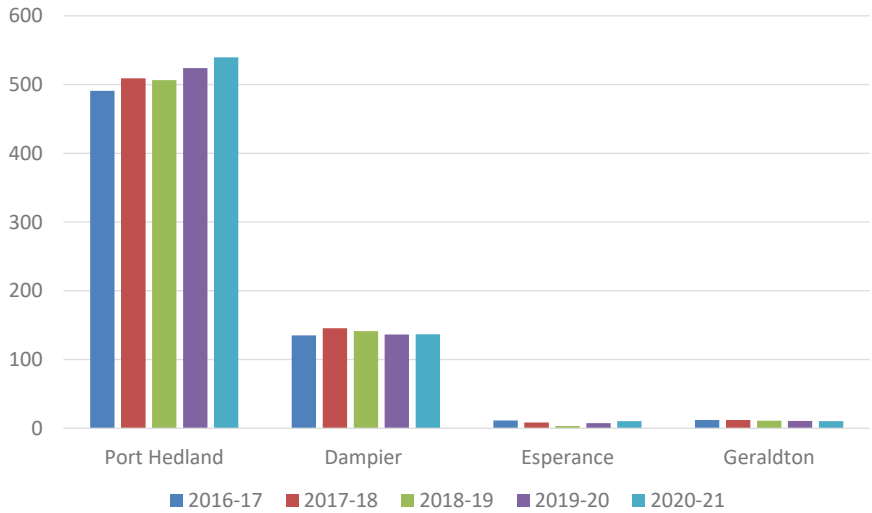
Table 12 Iron ore exports, million tonnes, 2020–21

Port Hedland[13]	Dampier	Esperance	Geraldton	Total
539.8	136.6	10.19	10.12	696.71

Sources: Pilbara Ports Authority (2022); Southern Ports (2021, p.7); Mid West Ports (2021), p.6.

Tonnages exported, by principal port, denote tonnages hauled by the iron ore railways; see Table 12. Exports through Esperance grew by more than 38 per cent compared to the previous financial year, when exports almost doubled that year alone. In its previous annual report, Southern Ports attributed this growth to Mineral Resources Limited re-starting iron ore exports through the port in December 2018 (Southern Ports 2020, p.40).

Figure 16 Iron ore exports (million tonnes) 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.

Sources: Pilbara Ports Authority (2022); Southern Ports (2021, p.7); Mid West Ports (2021), p.6; BITRE (2014a).

12 There are two domestic manufacturers of steel, Liberty and BlueScope Steel, with a blast furnace at Whyalla and Port Kembla, respectively. Liberty 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.

13 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.

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)[14]. For more discussion on the coal network infrastructure, see Chapter 5 – Infrastructure.

Aurizon and Pacific National dominate coal haulage, with involvement also by One Rail Australia, Southern Shorthaul Railroad,[15] and TasRail. Aurizon is the main operator in Queensland, while Pacific National dominates in the Hunter Valley. Coal extracted in Tasmania is used domestically.

Table 13 shows coal export volumes by port for 2020–21 and Figure 17 shows port specific coal exports over the seven years 2014–15 to 2020–21.

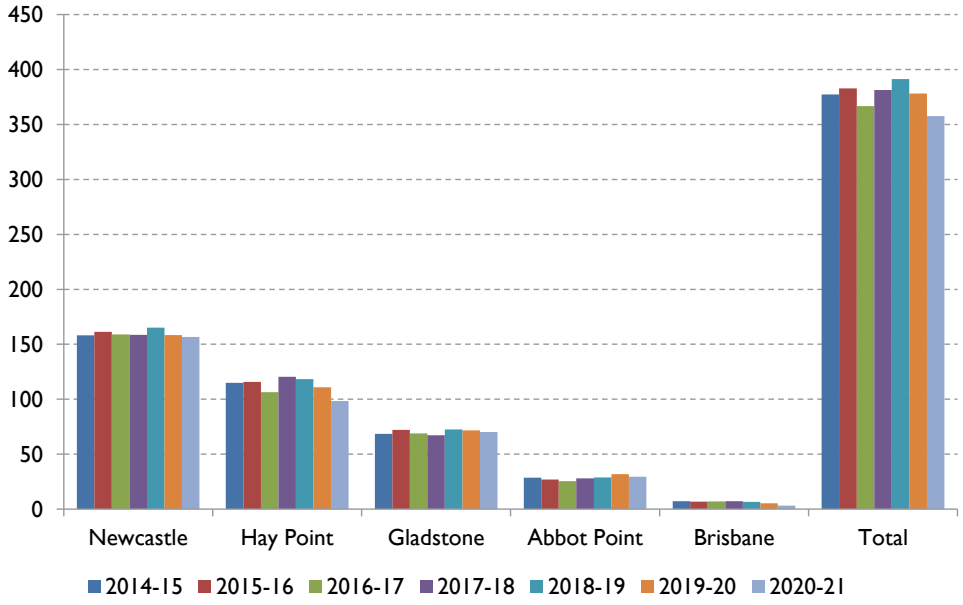
Table 13 Coal exports, by principal ports, (million tonnes), 2020–21

Newcastle[a]	Hay Point	Gladstone	Abbot Point	Port Kembla	Brisbane
156.6	98.3	70.1	29.5	n/a	3.1

Note: The Port of Newcastle figure is for the 2020 calendar year.

Sources: Port of Newcastle (2022), p.2; North Queensland Bulk Ports Corporation (2020), p.10; Gladstone Ports Corporation (2022); Port of Brisbane (2022).

Figure 17 Coal exports (million tonnes) by port



Sources: Port of Newcastle (2022), p.2; North Queensland Bulk Ports Corporation (2020), p.10; Gladstone Ports Corporation (2022); Port of Brisbane (2022); previous editions of Trainline.

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

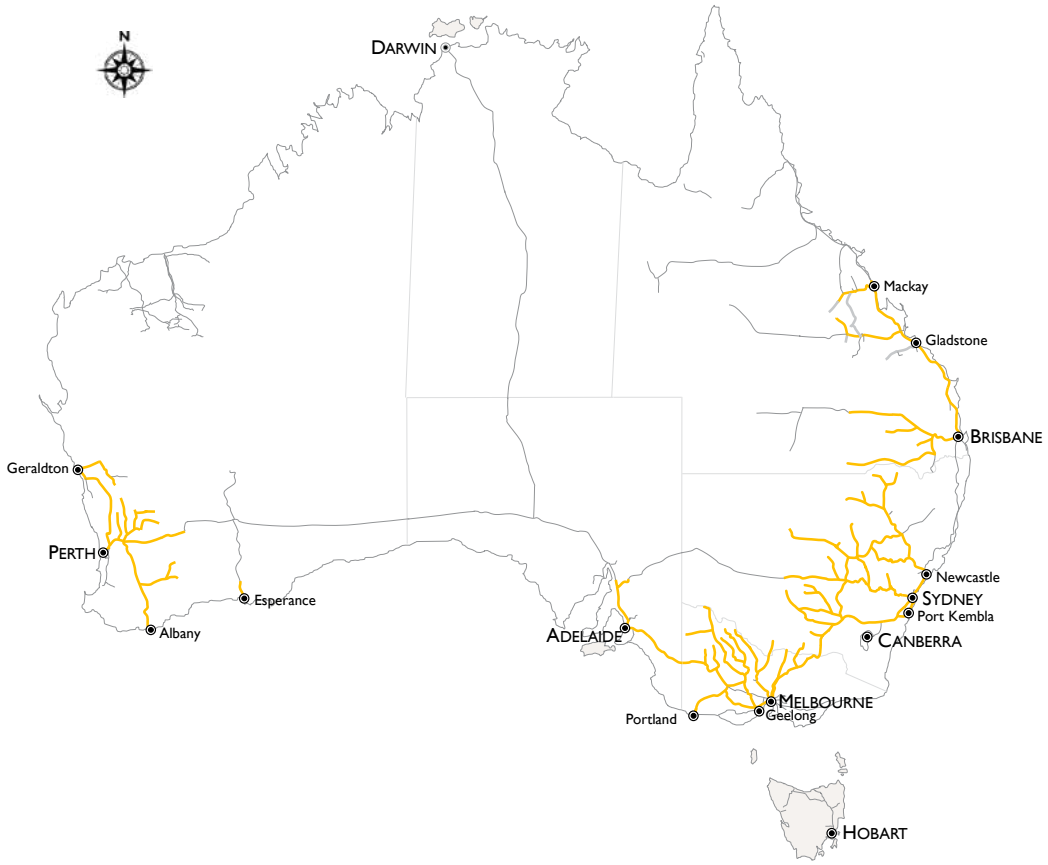
15 Southern Shorthaul Railroad operate coal trains in New South Wales on behalf of Centennial Coal.

Grain traffic

Another major role for Australia's railways is hauling agricultural produce from rural areas to ports for export and, to a lesser extent, domestic consumption. Following bumper harvests, such as 2016 and 2020, rail's grain haulage task increases significantly. Grain harvests are predominated by cereal grains (for example wheat and barley), but also pulses and oilseeds. Rail has traditionally dominated grain transport over long distances, while road transport becomes more competitive over shorter distances or when taking grain from farmgate to consolidation point.

Figure 18 shows grain flows by rail. This traffic largely uses dedicated grain haulage branch lines of varying quality, which connect with main lines. In September 2022, there was an estimated 4 700 route-kilometres of operational railway track that was largely or exclusively used for grain haulage.

Figure 18 Australian grain rail transport flows



Notes: The major grains hauled by rail in Australia for domestic and export consumption include; milling wheat, stockfeed wheat, durum, malt barley, feed barley, sorghum, canola, chickpeas.

The map shows grain flows along the railway lines that are designated as operating in September 2022. Some railways, notably in south-west Western Australia and in central New South Wales, are not shown as they are classified non-operational. The Toolamba—Echuca line in Victoria is currently also non-operational, thus it is not shown.

According to the AEGIC in 2018, 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 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 bulk 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[16]. These include:

- Variable infrastructure quality across the networks, slower speeds, the need in places to change locomotives from mainline types to branch line types, chokepoints and short crossing loops at strategic locations [17];
- Variable rolling stock age and capacity, which can at times be greater 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, including more widespread use of bigger and heavier trucks;
- Increased containerisation of grain, although this is still usually transported by rail;
- 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;
- Increased on-farm grain storage that is more suited to truck transport;
- Increased number of farming cooperatives based around truck transport;
- 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, where smaller harvests in droughts reduce the export grain task and are focused on the domestic grain task that is mostly trucked.

While poor quality 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 in the first place.

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 both containerised and non-containerised. Examples of such non-containerised traffic includes SCT Logistics' louvre wagon trains for their palletised traffic, the Kilmore East quarry train, the Berrima—Maldon clinker train, the Railton—Devonport cement train, the Kevin—Thevenard gypsum train, and the Mirambeena—Albany Port woodchip train. 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:

16 *Trainline 3* discusses in detail these changes and challenges to grain transport by rail. (See BITRE, 2015)

17 For more information on track infrastructure constraints, from a grain grower's perspective, see (Grain Central, 2017)

- 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 2016a, pp v-vi)[18].

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, 2022a, gives the latest figures.)

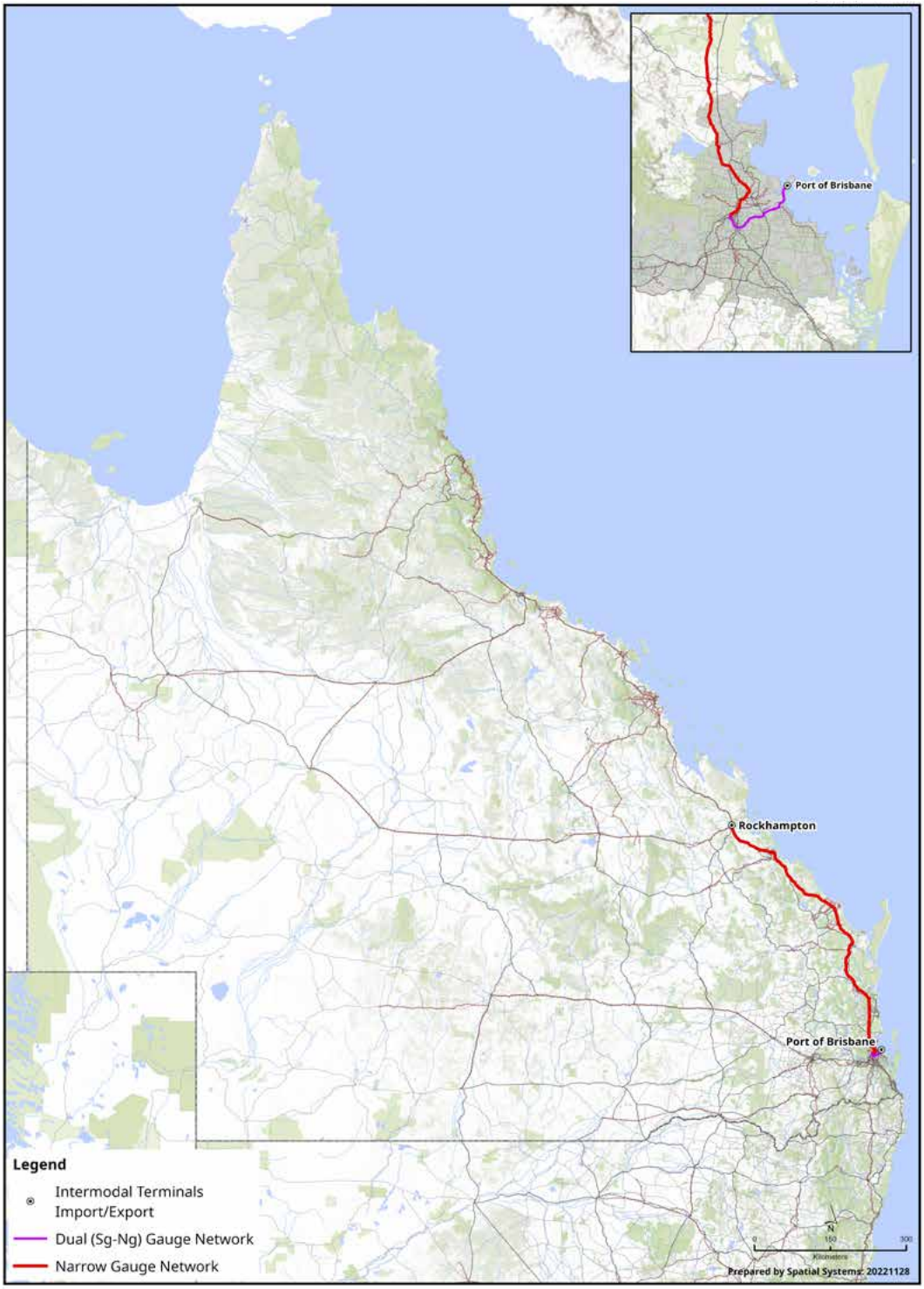
Landbridge and regional movements

Port of Brisbane

Figure 19 shows the rail container flows between Queensland intermodal terminals and the Port of Brisbane (Fisherman Islands).

18 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.

Figure 19 Rail container operations serving the Port of Brisbane

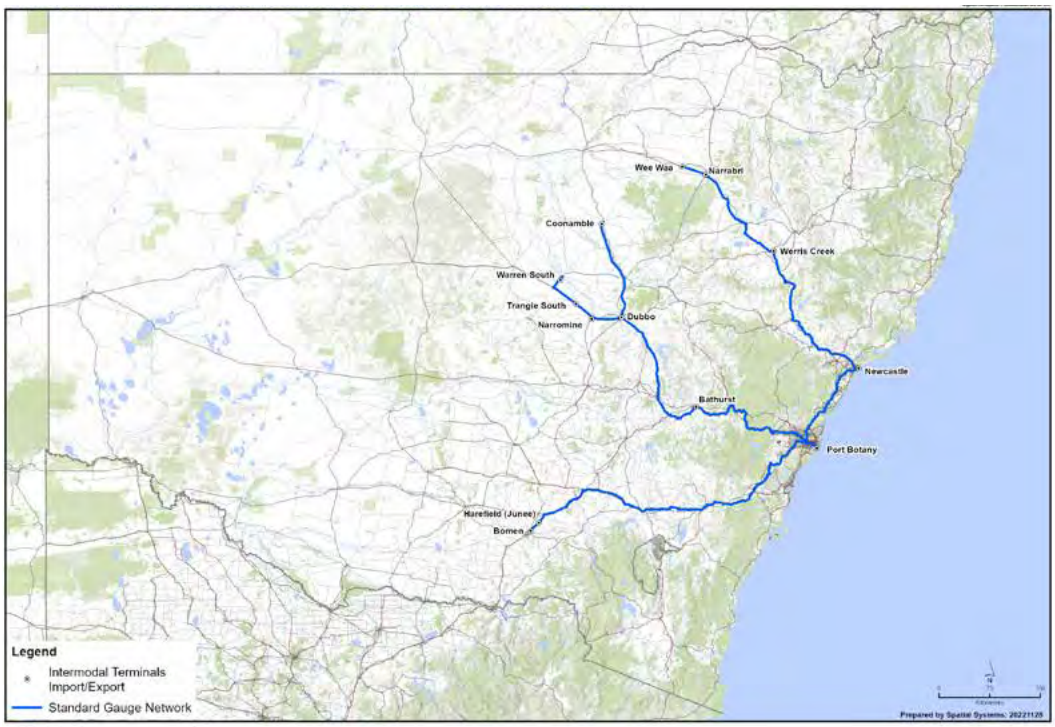


The only current containerised freight travelling to the Port of Brisbane by rail is refrigerated meat from Rockhampton.

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 has since lowered the 11 affected tunnels, thus increasing clearances.

Sydney Ports – Port Botany

Figure 20 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 Narrabri, Dubbo, Coonamble and Narromine;
- Containerised grain and cardboard (from Visy's plant at Tumut) from Harefield (near Junee);
- Viterra pack cereals (wheat and barley), oilseeds and pulses from Narrabri;
- Cotton from Warren, Wee Waa, Narrabri, and Trangie South;
- Grain, oilseeds, pulses, and refrigerated meat from Dubbo;
- Containerised grain from Kelso;

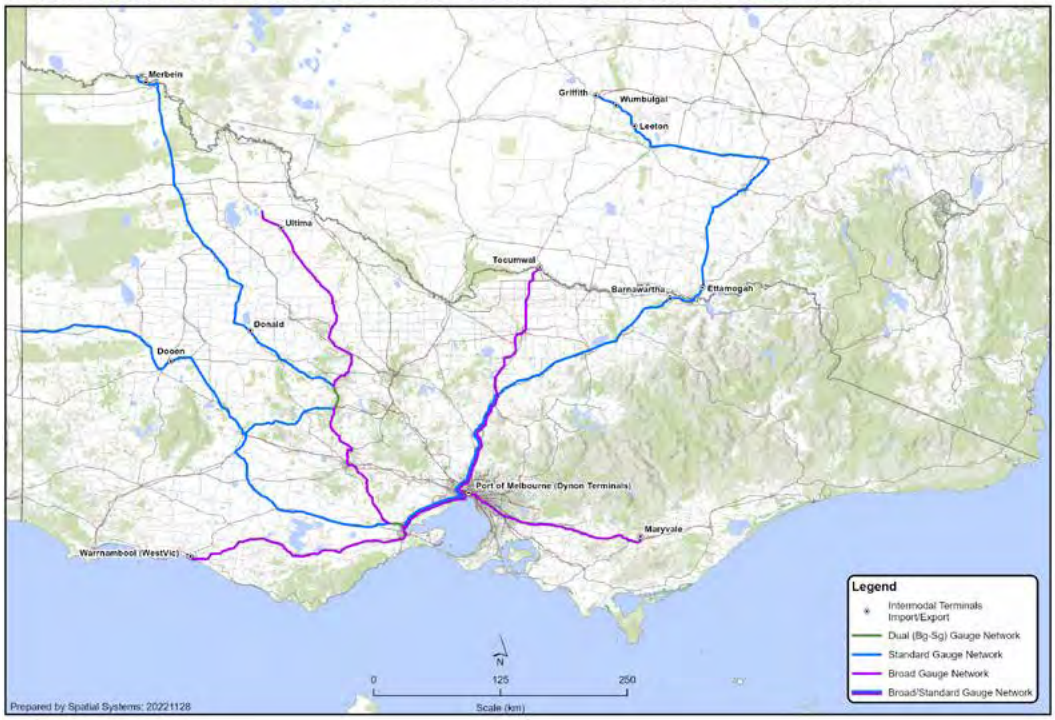
- Grain, meat and other agricultural products from Werris Creek;
- Paper and agricultural products from Bomen (Wagga Wagga); and
- Aluminium ingots and various agricultural produce from Newcastle.

Construction of the Riverina Intermodal Freight and Logistics Hub at Bomen (Wagga Wagga) has been completed and it became operational in December 2022.

Port of Melbourne

Figure 21 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 21 Rail container freight operations serving the Port of Melbourne



There are regional flows, both from within Victoria and from and southern New South Wale. 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, dairy products, machinery and ingots;
- Wimmera Container Line, at Dooen (near Horsham) – grain, hay, and pulses;
- Maryvale in the Latrobe Valley – containerised paper;

- Ultima – hay, grain, and wine; and
- SCT Logistics rail hub at Barnawartha – import/export trade for solar farms, grain, cotton, resin, meat, biodiesel, machinery and wine.

The Deniliquin rice train, previously reported here, no longer operates. The last service was in May 2022.

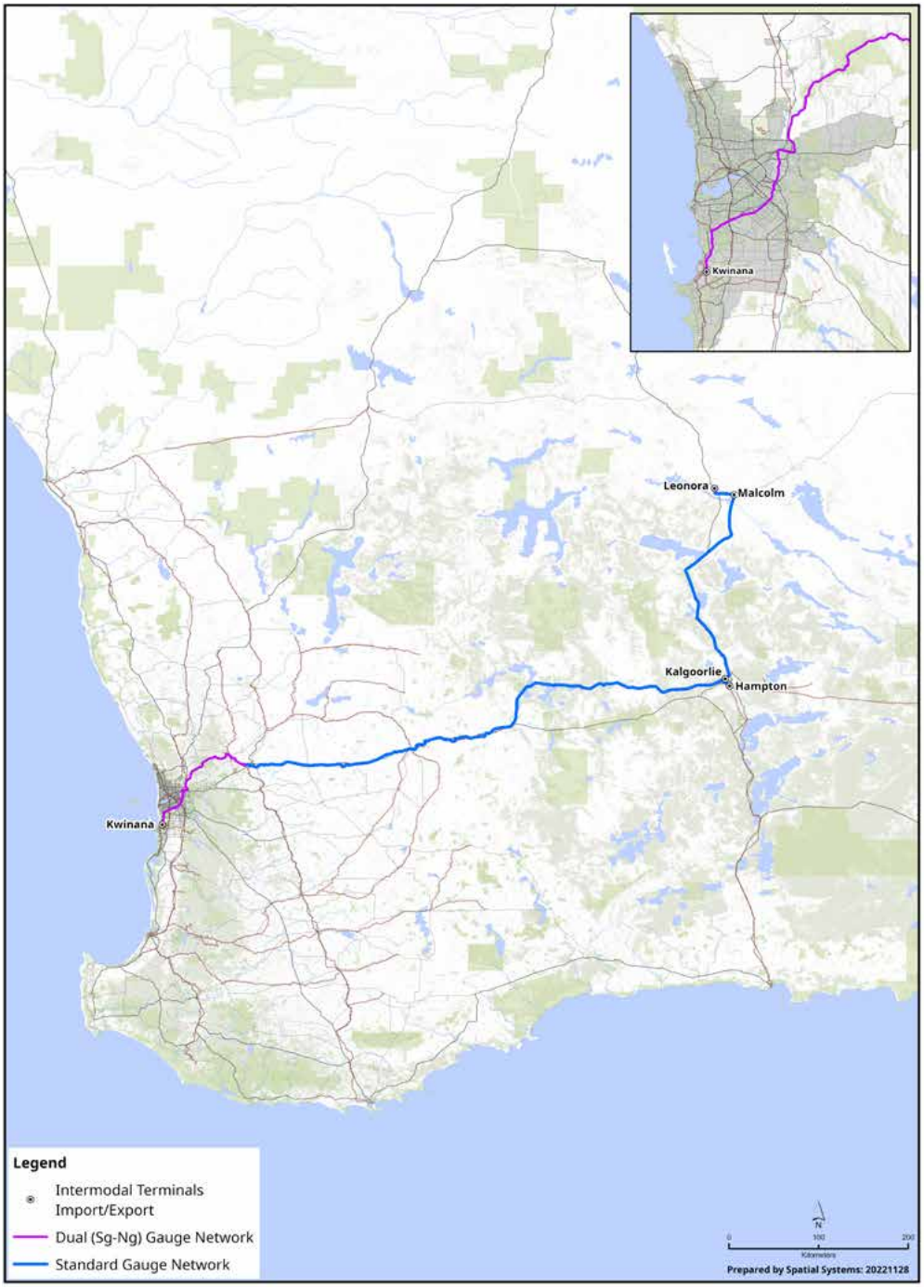
Southern New South Wales.

- Tocumwal – grain and hay[19];
- Griffith and the Wumbulgal terminal – containerised wine, rice, grain, cotton;
- Rice and pelleted feeds for animals, from Leeton; and
- Containerised paper and bottled water from the Ettamogah Rail Hub.

19 Previous rice, potatos, and dairy traffic on this line dropped off from late 2021 due to disruptions on the Shepparton line.

Kwinana

Figure 22 Rail container operations serving Kwinana



The primary regional container export flows are rare earth minerals and nickel from Leonora and Malcolm and nickel products from a nickel smelter south of Kalgoorlie.

Port Adelaide

Figure 23 Rail container operations serving Port Adelaide

There are regional maritime container traffic flows to Port Adelaide. Purpose-built containers are used for haulage of mineral sands, such as from Kanandah, near Broken Hill, to Port Flat. Minerals Sands are exported through Inner Harbor at Berth #29. The minerals sands travel to the port by rail in purpose built 20 foot bulk containers. Up to five trains can enter the port per week.

CU River exports iron ore from the Cairn Hill mine site, near Coober Pedy. Ore is trucked from the mine site to the rail siding of Rankin Dam, for onward travel by rail to Port Adelaide (Berth 29 + Flinders Adelaide Container Terminal) for export to China. The project currently has three scheduled rail services per week and commenced in August 2021.

According to advice from Bowmans Rail, regional trains operate between the Bowmans Rail's intermodal terminal (operated by Balco Australia) and the Flinders Adelaide Container Terminal (FACT) (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. 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.

SCT Rail operates a service out of Penfield SA, used predominantly for wine export (Treasury Wines), this service utilises the same corridor/time as Bowmans trains to the Outer Harbor.

Aurizon transports Oz Minerals copper concentrates for export from Prominent Hill in central South Australia to the Inner Harbour Port Adelaide Berth #29 bulk precinct. The product is transported from the mine to Wirrida by road, where it is transferred to rail transport.

Tasmania

TasRail operates the Tasmanian network, as a fully integrated railway. With modernised terminals located at Burnie, Brighton and George Town, 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 minerals, which is located within the Port of Burnie.

Figure 24 Rail container operations serving Tasmanian ports

Rail traffic terminals in Tasmania include:

- George Town: A multi modal-terminal with a container storage area capable of handling containerised general freight, metal ingots and bulk log freight. TasRail also has direct rail access to two woodchips mills within Bell Bay.
- 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 hauls zinc ingots, bulk minerals concentrates, bulk cement, coal, finished 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 nearby 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);
- Forrestfield/Kewdale – Fremantle (Inner Harbour) (approximately 24 kilometres);
- 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 Western Australian Government subsidises (loaded) containers delivered by rail from intermodal terminals at Forrestfield and Kwinana into North Quay at Fremantle. Empty containers and non-metropolitan movements (excluding hay containers) are not subsidised. Intermodal Link Services (a part of the Intermodal Group) and Watco operate train services between Fremantle and Forrestfield, with 2–3 trains operated per day, 6–7 days per week and each one-way service hauling up to 100 import/export containers. Aurizon operate 1–2 trains per day, five days per week between Kwinana and North Quay. In March 2022, the proportion of containers at the port being moved by rail increased to a record 24.3 per cent, higher than the Western Australian's target of 20 per cent. (Fremantle Ports, 2022)

In August 2021, the West Australian government announced the construction of new road and rail bridges at Fremantle. A new rail bridge will be built that will service passenger traffic only, while the existing bridge will remain in service for freight traffic only. This separation of passenger and freight traffic will remove the current peak hour curfews freight trains are subject to. (Fremantle Ports, 2021) Construction is due to begin in 2023.

Following an agreement between Salta Properties and Victorian government, construction of a new intermodal terminal in the outer south eastern Melbourne suburb of Dandenong South was to start in 2021. The agreement involved the federal and Victorian governments investing a $28 million to connect rail to Salta's boundary site, while Salta will invest $50 in the facility itself. The facility will connect with the Port of Melbourne via the existing suburban rail network. Upon completion, the terminal will have 110,000 square metres for storing full and empty containers (The Urban Developer, 2020). In October 2021, the media reported the actual cost would be $155 million with construction to commence by year's end with an estimated 24 months completion data (Australasian Transport News, 2021). In September 2022, Salta announced construction of the rail connection to the terminal had been completed. (Salta, 2022)

In September 2020, Patrick Terminals and the Port of Melbourne agreed to construct a new rail terminal, which is due to commence in early 2021 and expected to be finished by mid-2023. The facility will provide an additional connection between the port and suburban intermodal terminals and it will handle 200 000 TEUs annually. The terminal will have two dual gauge 23 tonne axle load sidings of 600 metres (Rail Express, September 2020). This is part of the Port of Melbourne's Port Rail Transformation Project.

The Port Rail Transformation Project is intended to provide a rail solution to meet the needs of a growing port, and aims to reduce truck movements across Victoria, particularly in Melbourne's inner western suburbs. According to advice from the Victorian Department of Transport, the key elements of the project are:

- Integrated provision of port, rail, land and assets at the port – Port of Melbourne will provide rail land and rail assets on a similar basis to it provides wharf and road land and assets;
- New on-dock rail terminal capacity – development of a new on-dock rail terminal at Swanson Dock East;
- New road and rail infrastructure – to improve operational efficiencies of rail inside the port gate; and
- Improved rail terminal operation arrangements and transparency – new working arrangements between Port of Melbourne and Rail Terminal Operators that are currently part of the PRTP. From commencement, this will included ACFS (Appleton Rail Terminal) and QUBE (Victoria Dock Rail Terminal), with Patrick to also participate in the near future (Swanson Dock East) once infrastructure has been constructed.

Box 2 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).

Chapter 3

Urban passenger transport results – heavy rail and light rail

Each of the mainland state capital cities operate urban heavy rail passenger rail services. Melbourne, Sydney, Adelaide, Canberra, the Gold Coast, and Newcastle operate light rail services. These services enable the mass movement of passengers. These services provide an alternative to private cars, which minimises road congestion.

Patronage

Table 14 **Urban rail patronage (millions of journeys), 2020–21**

	Brisbane[a]	Sydney[b]	Melbourne[c]	Adelaide	Perth	Gold Coast	Canberra	Newcastle
Heavy rail	33.3	230.3	81.7	9.1	41.7	-	-	-
Light rail		17	60.2	5.9		6.1	3	.73

Notes: a. 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.

b. Sydney's patronage includes Sydney Metro services.

c. Melbourne's light rail patronage includes the CBD free travel zone.

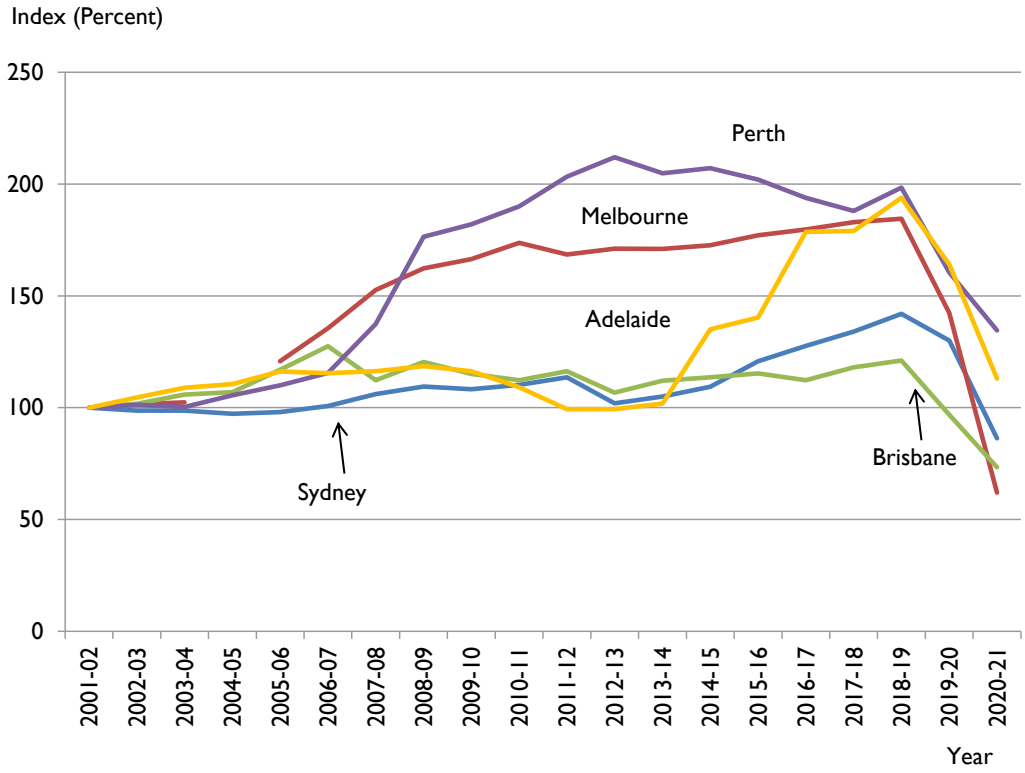
Sources: Public Transport Authority of Western Australia (2021), p.18; Department of Transport, Victoria, 2021, pp.158, 161; Department for Infrastructure and Transport (2021), p.38; Queensland Rail (2021), p.18; Canberra Metro Operations (undated); Department of Transport and Main Roads (2021), p.175; Sydney Trains (2021), pp.18-19; Transport for NSW (2021), p.21; Transport for NSW (undated).

Total urban heavy rail patronage for 2020–21 was approximately 396 million passenger journeys, down from 641 million passenger journeys the previous financial year. This was a reduction of almost 38 per cent. This occurred on top of a 15 per cent decline the previous financial year. Patronage fell in all cities. Melbourne had the greatest decline – approximately 56 percent, while Perth had the smallest – approximately 13 per cent. These declines are likely due to lengthy COVID lockdowns and travel restrictions that occurred throughout the financial year. Melbourne having the greatest decline is probably due to the city being in lockdown longer than the other cities.

Total light rail patronage for 2020–21 was approximately 93 million passenger journeys, a reduction of approximately 47 per cent from the previous financial year. Patronage declined significantly in all cities except Sydney. Melbourne had the greatest decline – approximately 57 per cent. Adelaide, the Gold Coast, Canberra, and Newcastle each had declines of approximately 20, 28, 18, and 24 per cent respectively. These declines were also most likely due to COVID lockdowns and travel restrictions. Patronage grew in Sydney by approximately 37 per cent. This is likely due to the operation of two new routes, from Circular Quay to Randwick and Circular Quay to Kingsford for the first time for the full financial year[20].

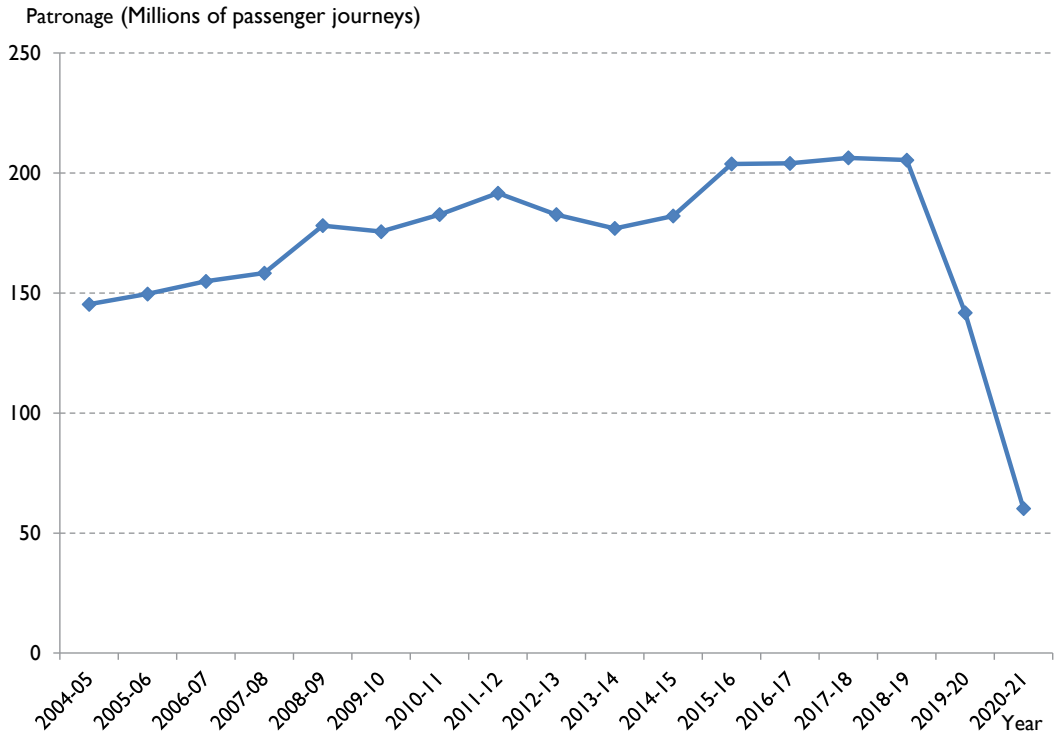
20 Sydney experienced smaller light rail patronage growth the previous financial year, during time which time the new routes became operational for the second half of the financial year.

Figure 25 Index of urban heavy rail patronage in Australian cities



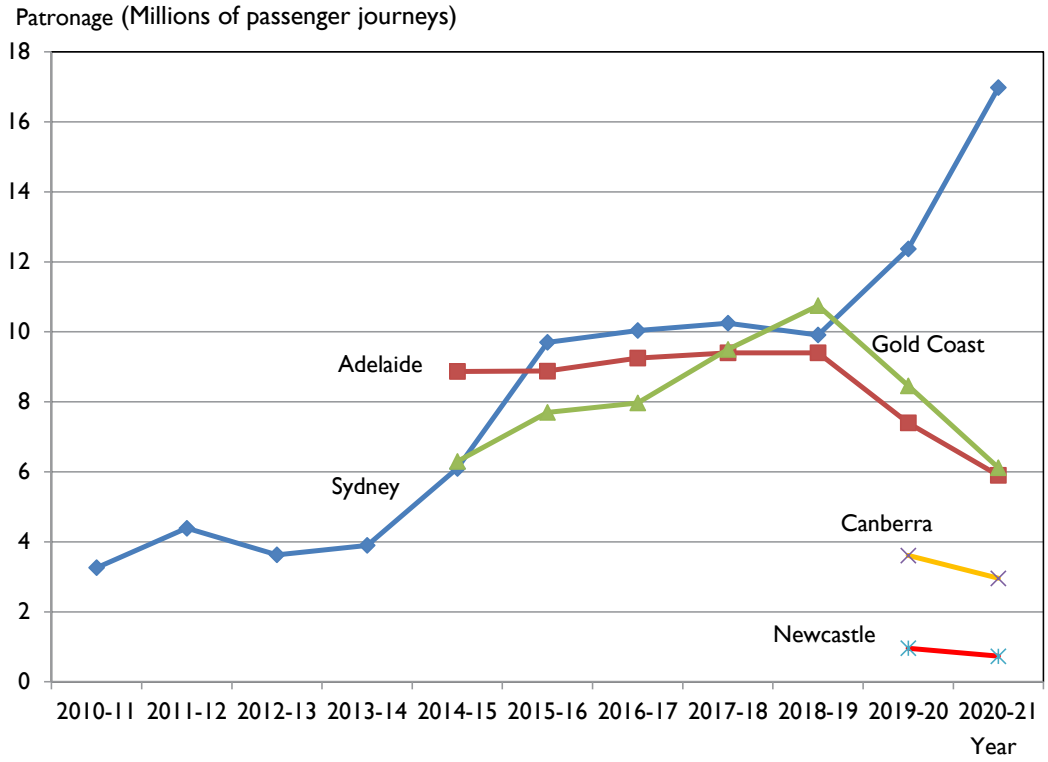
Sources: Index based on patronage data from previous Trainline editions; Public Transport Authority of Western Australia (2021), p.18; Department of Transport, Victoria, 2021, pp.158; Department for Infrastructure and Transport (2021), p.38; Queensland Rail (2021), p.18; Sydney Trains (2021), pp.18-19; Transport for NSW (2021), p.21.

Figure 26 Melbourne light rail patronage



Source: Department of Transport, Victoria, 2021, p.161; historical Public Transport Victoria annual reports.

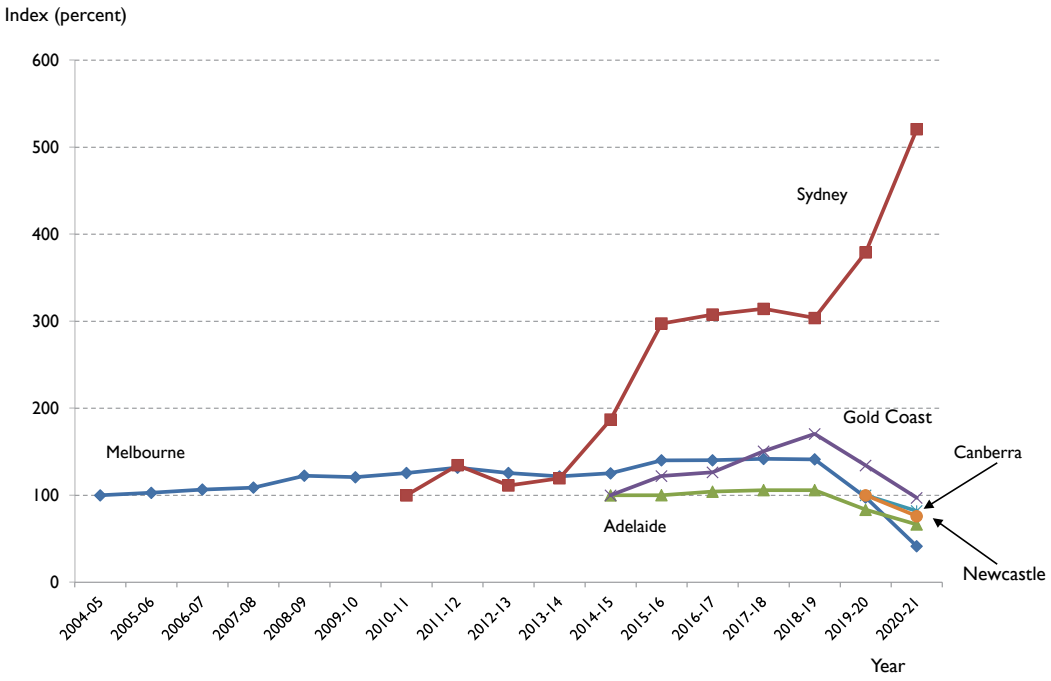
Figure 27 Sydney, Adelaide, Gold Coast, Canberra and Newcastle light rail patronage



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

Sources: Department for Infrastructure and Transport (2021), p.38; Canberra Metro Operations (undated); Department of Transport and Main Roads (2021), p.175; Transport for NSW (undated); historical annual reports.

Figure 28 Index of light rail patronage Melbourne, Sydney, Adelaide, Gold Coast, Canberra and Newcastle



Sources: Index based on patronage data from previous Trainline editions; Department of Transport, Victoria, 2021, p.161; Department for Infrastructure and Transport (2021), p.38; Canberra Metro Operations (undated); Department of Transport and Main Roads (2021), p.175; Transport for NSW (undated).

Commuting Mode Share

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.

Table 15 Urban rail journey-to-work mode shares, 2021

	Brisbane	Sydney	Melbourne	Adelaide	Perth	Canberra
Heavy rail (%)	4.8	8.9	6.3	1.7	6.5	-
Light rail (%)	-	0.2	2.0	0.6	-	1.7

Notes: All cities except Canberra refer to greater metropolitan areas. Canberra refers to Canberra and Queanbeyan.

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; or 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 2022.

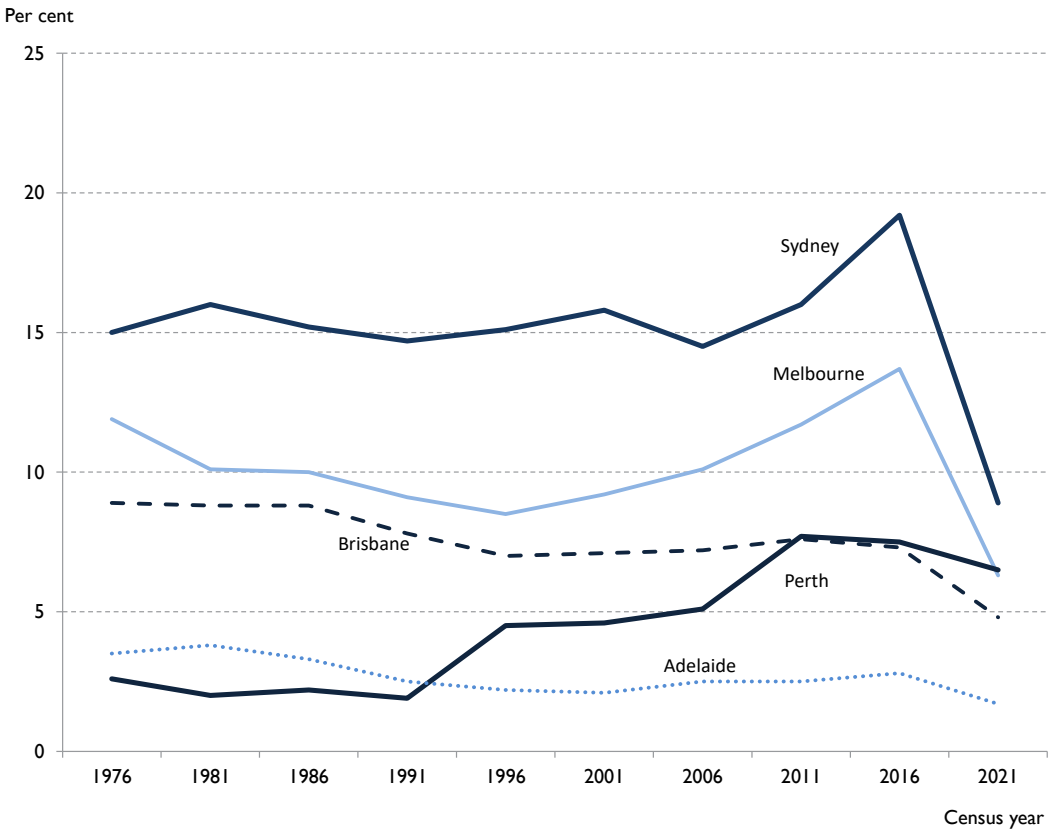
Following long-term declines in urban rail patronage for all cities from the mid-1970s, ridership began recovering in the 1990s. Figure 29, below, shows the journey-to-work mode share data for heavy rail, derived from the census results, since 1976.

In 2021, urban heavy rail's mode share decreased sharply in all cities compared to 2016, except Perth, which had a more modest decline. Details of these declines are as follows:

- Sydney: 54 per cent
- Melbourne: 54 per cent
- Brisbane: 34 per cent
- Adelaide: 39 per cent
- Perth: 13 per cent.

By way of comparison, mode share for travel by bus also halved in Sydney, Melbourne, and Brisbane, while it remained relatively unchanged in Adelaide and Perth. Travel by private motor vehicle as a proportion of total mode share, however, increased in each city.

Figure 29 Journey-to-work mode share, urban heavy rail, 1976–2021



Note: Cities refer to greater metropolitan areas.

Sources: ABS (2022); Mees and Groenhart (2012).

Box 3 Further reading

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

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

Punctuality

Punctuality is important to rail's competitiveness. 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.

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.[21] 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 16 Urban heavy rail punctuality, on time performance, 2020–21

	Sydney	Sydney Metro	Melbourne	Brisbane	Adelaide	Perth
Result (%)	94.4	98.7	95.2	96.3	97.2	95.25
Target (%)	92	98	92.5	95	94	95
Measure	At least 92% of peak services arrive within five minutes for Sydney Trains services and six minutes for NSW TrainLink (Intercity) services.	One minute headway	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 services	No more than 4 minutes 59 seconds after the timetabled arrival time at the destination	Arriving within 4 minutes of schedule

Note: Sydney results are for peak hour services only and include both Sydney Trains and Trainlink intercity services.

Sources: Transport for NSW (undated); Department of Transport, Victoria, 2021, p.140: Public Transport Authority of Western Australia (2021), pp.68-69; Queensland Rail (2021), p.12; Sydney Metro (2021), p.30; Adelaide Metro (undated).

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

Table 17 Light rail punctuality, on time performance, 2020–21

	Result (%)	Target (%)	Measure
Sydney (Central Station-Dulwich Hill)	91	90	Headway achieved within a two-minute tolerance; headway being the time between two light rail vehicles.
Sydney (Circular Quay-Randwick and Randwick-Kingsford)	90	90	Headway achieved within a two-minute tolerance; headway being the time between two light rail vehicles.
Melbourne	92.2	82.9	Arrives no later than four minutes and 59 seconds after and departs no earlier than 59 seconds before the timetable
Adelaide	97.6	98	No more than 4 minutes 59 seconds after the timetabled arrival time at the destination
Gold Coast	100	"at the station for you when it's scheduled to be there"	-
Canberra	99.4	98	Arriving at a measuring stop no more than 2 minutes after its scheduled arrival time
Newcastle	n/a	n/a	Neither early nor late. Early is departing before the scheduled departure time and late is departing more than 59 seconds after the scheduled departure time.

Sources: Transport for NSW (2021), p.36; advice from Department of Planning, Transport, and Infrastructure; Department of Transport, Victoria (2021), p.161; advice from Transport for NSW; Canberra Metro Operations (undated); Translink (undated).

Speed and stopping patterns

Heavy rail

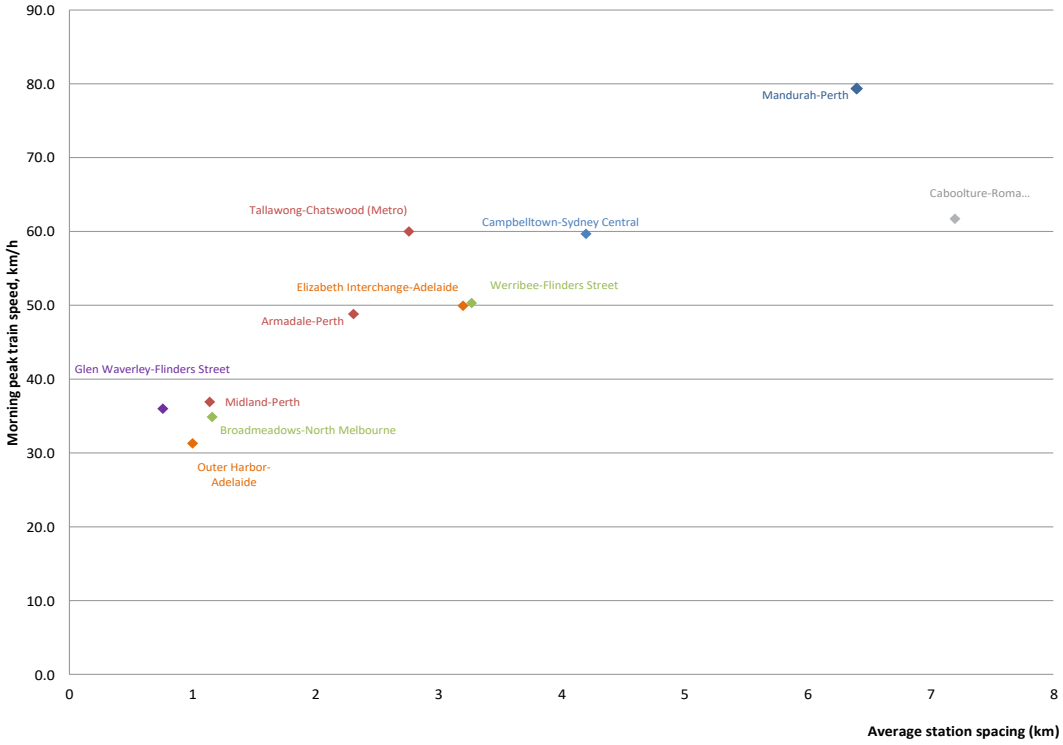
Figure 30 shows relationship between station spacing and corresponding average train speeds for selected Australian urban passenger rail lines. Australia's older passenger lines have relatively short station spacing (for all stops services). Mees and Dodson (2011) observed that Australian lines were often built as a way of supporting urban expansion with consequent short distances between stations.[22] A consequence of this, however, is the regular stops cause slower speeds.

In contrast, newer lines, such as Mandurah—Perth, 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. Wide station spacing, however, 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, whose arrival and departure times are aligned to that of train services, and park and ride facilities therefore become crucial. Express services help overcome short station spacing.

All station spacing shown in Figure 30, below, is based upon a mix of peak hour limited stops and all 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.

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

Figure 30 Station spacing and illustrative train speeds 2022



Source: BITRE analysis.

Light rail

Average scheduled light rail speeds also generally correlate to stop spacing, together with integration with/segregation from road traffic and pedestrian traffic.

Table 18 Light rail station spacing and scheduled speeds 2022

	Gold Coast	Sydney (Route L1)	Melbourne (Route 59)	Adelaide[a]	Canberra	Newcastle
Average station spacing (metres)	1050	600	290	530	923	450
Average point to point scheduled speed (km/h)	27	16.5	13.1	18	30	13.5

Notes: a. Calculations are based on travel from the East Brunswick terminus to Southern Cross Railway Station.

b. Calculations are based on travel from Glenelg to Adelaide Railway Station.

Source: 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 with wide station/stop spacing. Sometimes a single route will have a mixed infrastructure type.

Sydney's light rail operates mostly on segregated lines. Canberra's light rail network is entirely segregated, except for intersections, where variable frequency traffic signals prioritise light rail traffic at most intersections. The Gold Coast and Canberra have the widest station/stop spacing in Australia. This, combined with its traffic segregation and priority traffic signalling (in Canberra), enables the light rail vehicles to achieve the highest average scheduled speeds in Australia. Newcastle's light rail, which runs on battery power with charging at each stop, has approximately half the average distance between stations/stops and less than half the scheduled average speed. Like the Gold Coast and Canberra, Newcastle's light rail network is segregated except at street crossings. Most of the Melbourne light rail network is shared with road traffic. In the case of Route 96 (East Brunswick to Southern Cross Railway Station component) this, combined with narrow spacing between stops, causes it to have an average scheduled speed that is approximately half that of the Gold Coast and Canberra.

Frequency

Figure 31 to Figure 36, below, show, urban heavy rail service frequency by the time between arrivals at the relevant city central stations, for services originating at various designated 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 can affect 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 31 to Figure 36, below, show, all Australian capital cities with urban heavy rail services mostly have greater service frequency during peak periods.

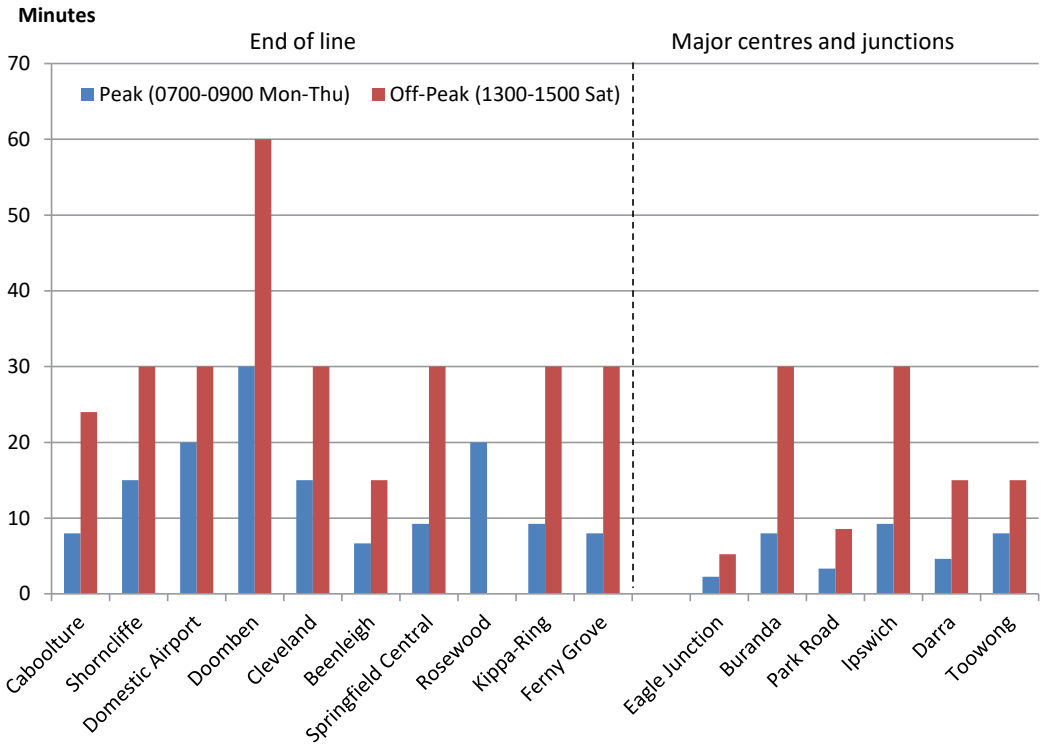
Service frequency across the cities in 2022 was largely the same as the previous year. There have been some minor increases and decreases across the times of day periods measured, although this should not be interpreted to mean there are fewer services overall. A train that arrives at its destination at 09:01 hours on a weekday, for example, would be excluded as it is outside the peak period scope.

Heavy rail

Brisbane

Service frequency in Brisbane is almost unchanged from 2021. The only noted change was Eagle Farm, which had one additional peak hour service in 2022.

Figure 31 Average time between trains for services arriving at Brisbane Roma Street Station, 2022



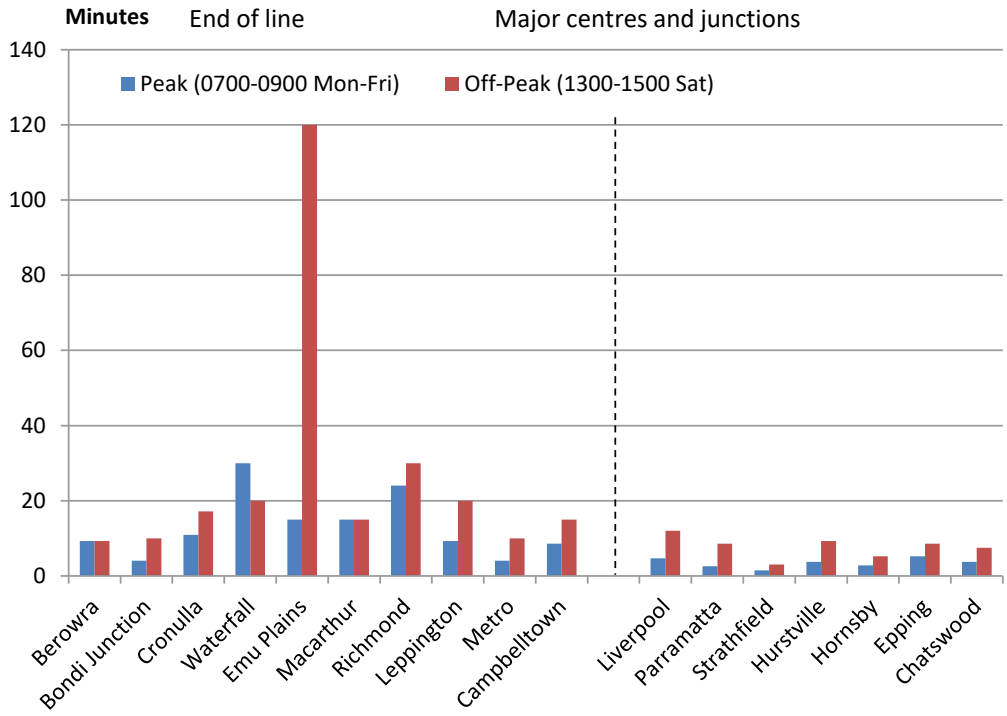
Source: Translink (2022).

Sydney

Sydney Trains frequency depends on the time of day, service demand and network capacity. There were no significant changes in service frequency since 2021. The Bondi Junction and Metro lines have the most end of line AM peak services, with an average arrival at Sydney Central and Chatswood respectively every four minutes, while the Richmond and Waterfall lines have an average arrival every 24 and 30 minutes respectively. Trains arriving from major centres and junctions in the AM peak have average arrivals of between one to five minutes.

Off-peak service frequencies similarly vary significantly across the network from both points of origin and major centres and junctions. There is, on average, a train arriving at Central Station from every three minutes from Strathfield to two hours from Emu Plains.

Figure 32 Average time between trains for services arriving at Sydney Central, 2022



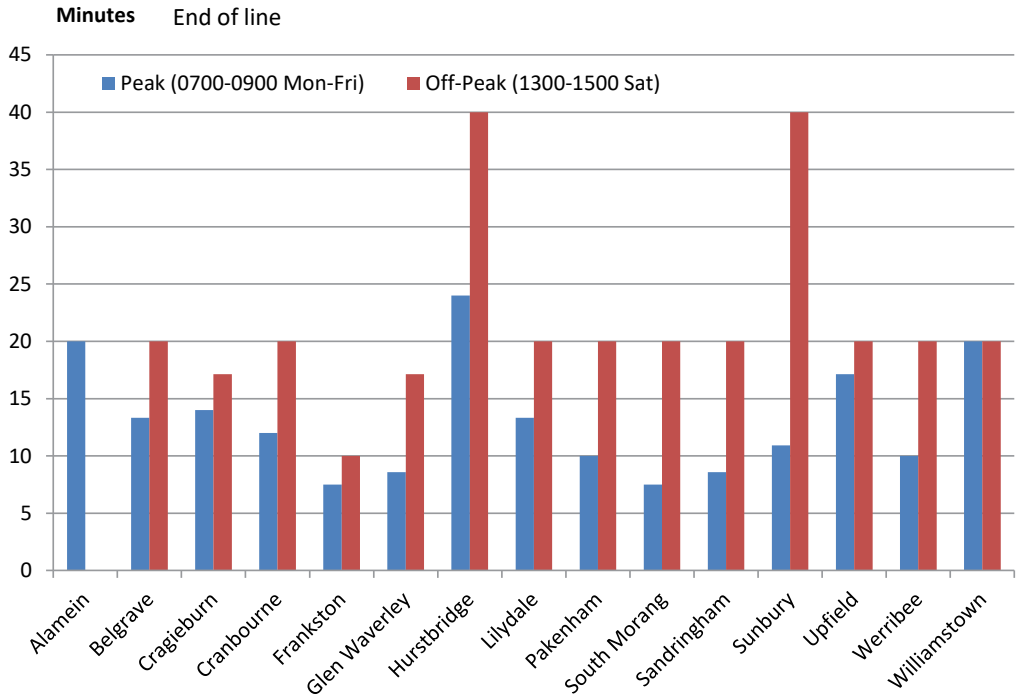
Note: Metro services are those arriving at Chatswood.

Source: Transport for NSW (2022).

Melbourne

Melbourne peak hour frequencies similarly vary considerably across services (see Figure 33 and Figure 34), with smaller branch lines running fewer trains. For end of line services, Frankston and South Morang have the most services, each with trains arriving at Flinders Street Station on average every eight minutes. Hurstbridge has the fewest end of line peak time services, with average intervals of 24 minutes. Average off peak services vary from 10 minutes on Frankston trains to 40 minutes for Sunbury line and Hurstbridge trains. Alamein continues to have no direct services to Flinders Street station in the off-peak period. Rather, shuttle trains run to Camberwell, where passengers change trains for ongoing travel.

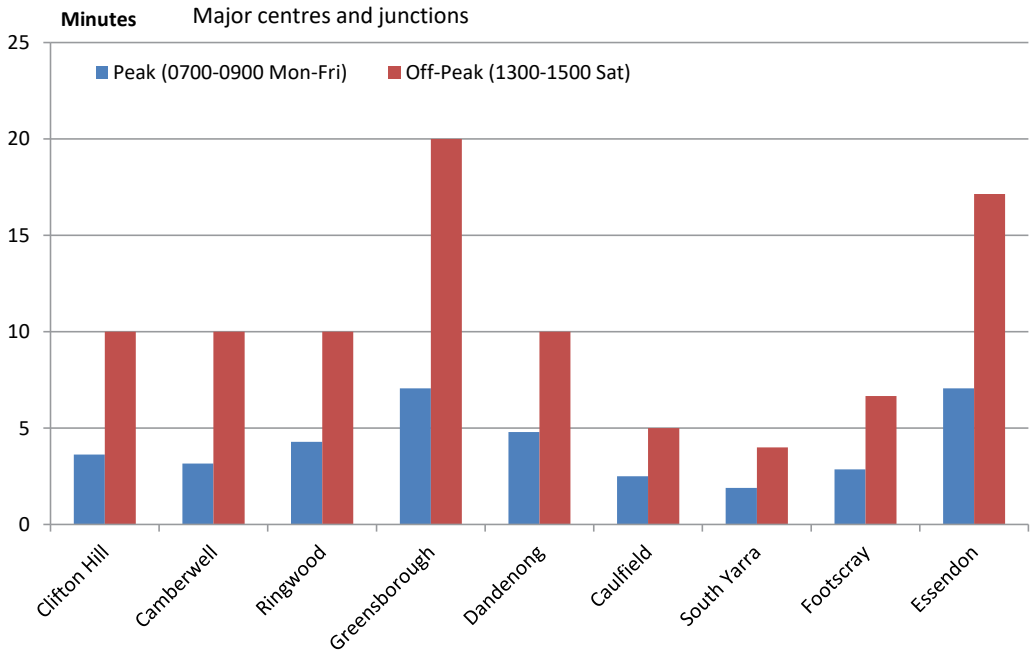
Figure 33 Average time between trains for services arriving at Flinders Street from end of line, 2022



Source: Data provided by Public Transport Victoria.

Peak hour service frequency from Melbourne's major centres and junctions is high, ranging from 2-7 minutes. South Yarra is the busiest junction station, with an average arrival at Flinders Street Station every two minutes, while trains arrive at Flinders Street Station on average every seven minutes from Essendon and Greensborough. During off peak periods, service frequency at most of the major centres and junctions is approximately half that of peak-hour services, except Essendon, where off peak frequency is approximately the same as peak hour services. In the off peak, frequency ranges from four minutes (South Yarra), to 20 minutes (Greensborough). South Yarra is the busiest because it channels converged traffic from the Pakenham, Cranbourne, Frankston, and Sandringham lines.

Figure 34 Average time between trains arriving at Flinders Street Station from major centres and junctions, 2022

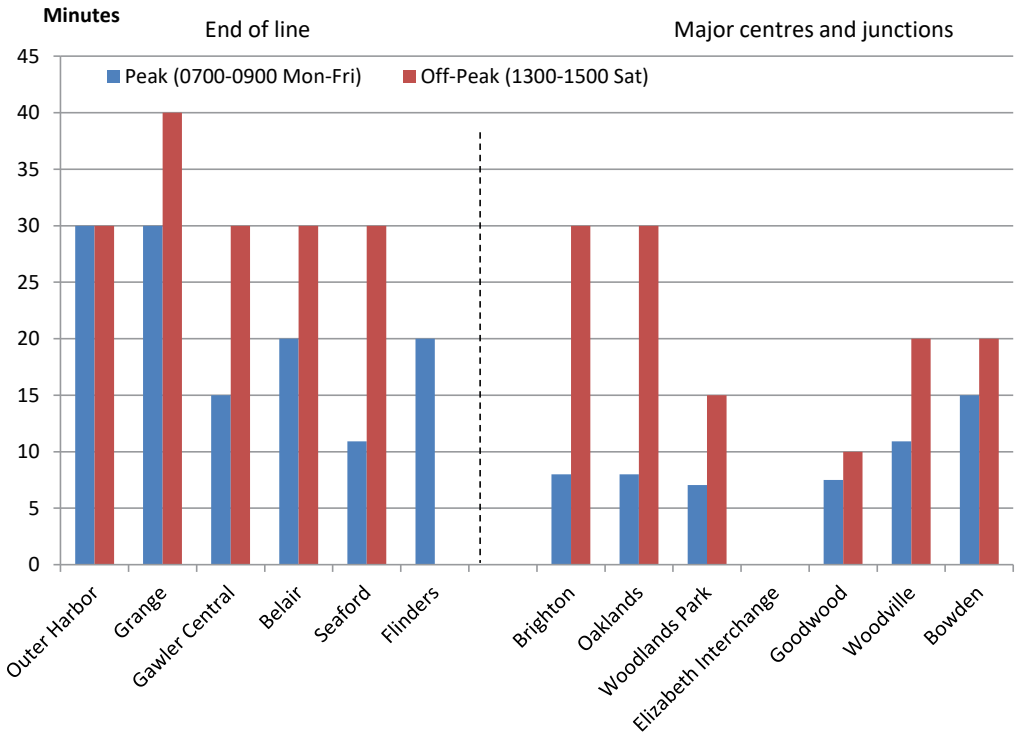


Source: Data provided by Public Transport Victoria.

Adelaide

Adelaide heavy rail service patterns are strongly geared to peak-period commuting to Adelaide Railway Station. Adelaide's lower service levels reflect its modest patronage compared to the other networks. The only significant change since 2021 is the resumption of services on the Gawler line, following electrification works[23].

Figure 35 Average time between trains for services arriving at Adelaide Railway Station, 2022



Source: Adelaide Metro (2022).

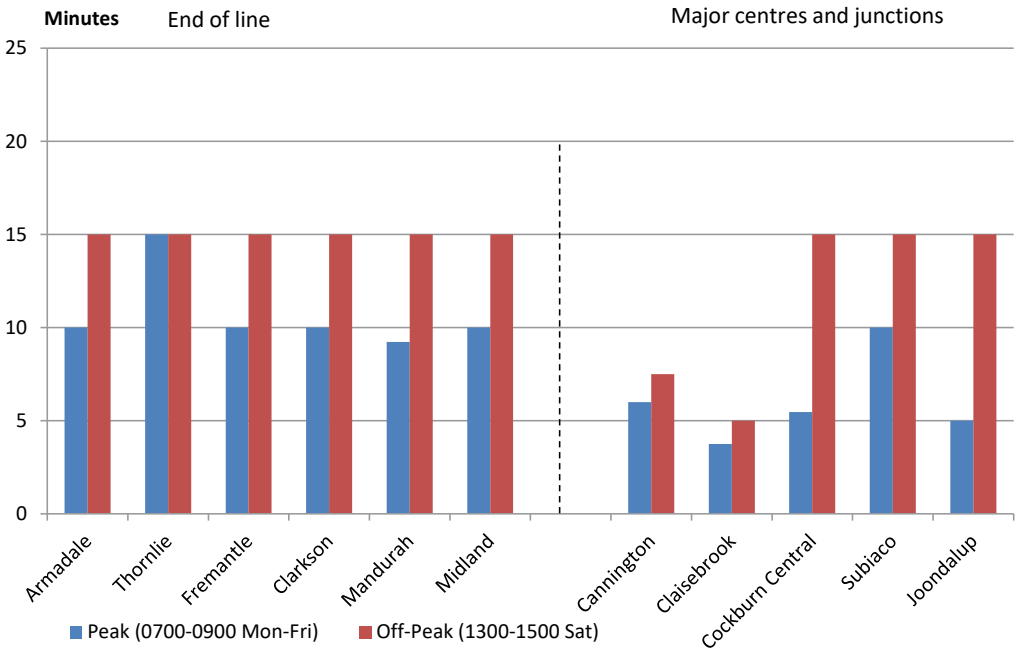
23 Services resumed on 12 June 2022.

Perth

There have been no changes to Transperth's service frequencies since 2021. Transperth's trains mostly stop at all stations. Its focus on maintaining low dwell times and long distances between stations on its Mandurah and Butler 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 36 Average time between trains for services arriving at Perth Central/Perth Underground stations, 2022

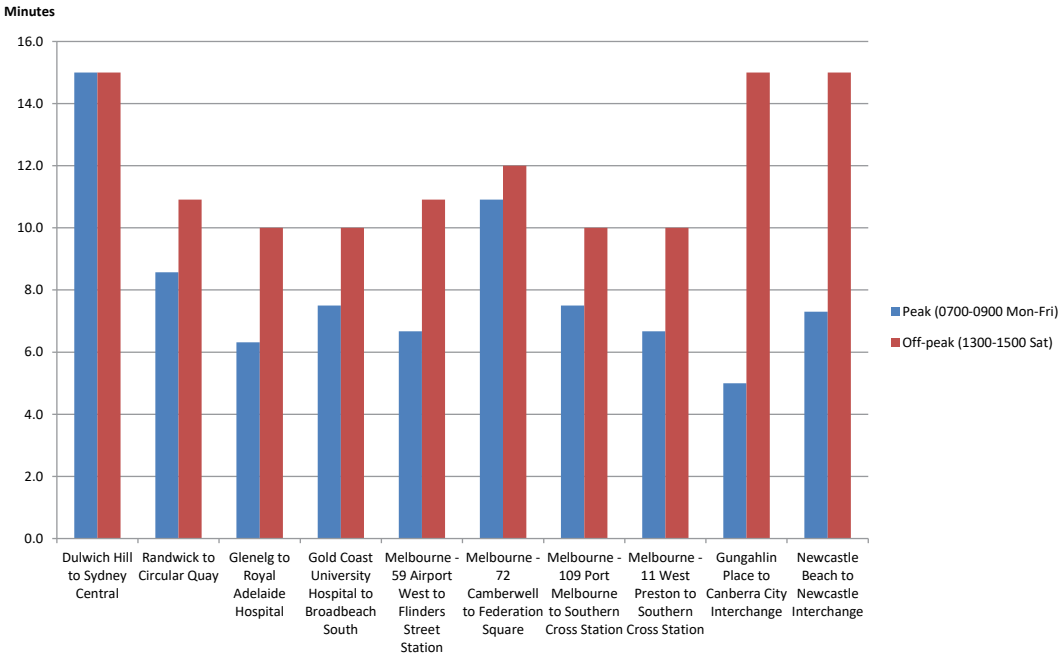


Source: Transperth (2022).

Light rail

Light rail frequencies in Australia vary (see Figure 37). Peak hour frequency in the sample shown in Figure 37 is mostly less than ten minutes. Off-peak times are between 10–20 minutes.

Figure 37 Average time between light rail services, by route and direction, 2022

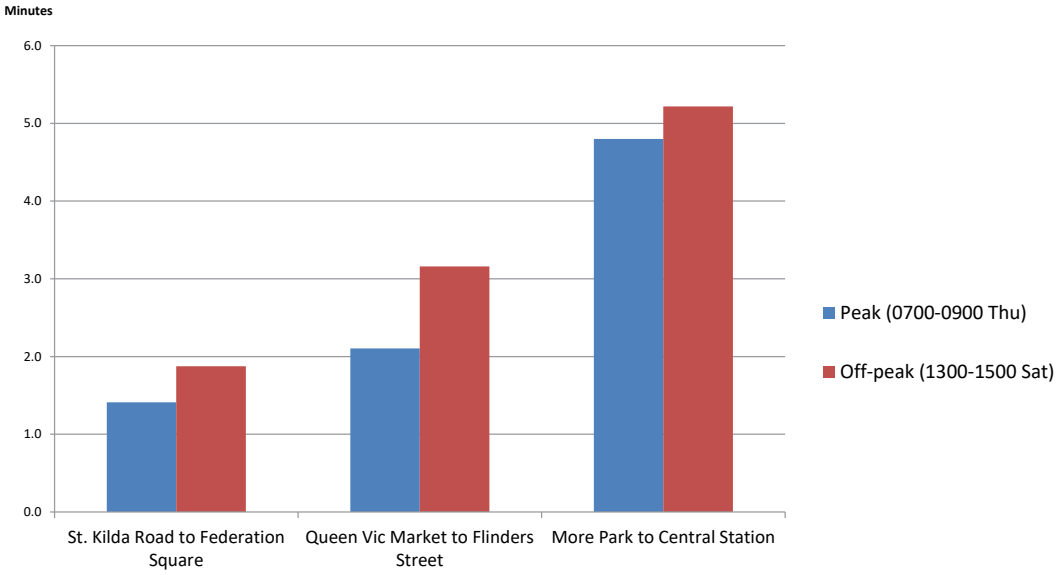


Notes: Gold Coast operations do not run to timetables. Melbourne tram services have a separate timetable for Fridays. As such, calculated peak hour frequency as shown above is based on the published Monday-Thursday timetables. Peak hour calculations are based on peak hour directions of travel.

Sources: Transport for NSW (2022); G:link (2022a); Public Transport Victoria (2022); Adelaide Metro (2022).

Care is needed when comparing Melbourne with routes in other Australian cities. Many Melbourne routes share tracks (converged routes), particularly in and near the CBD. This means a passenger may have more than one tram route option, thus increasing frequency on shared tracks.

Figure 38 Average times between light rail services – converged routes, 2022



Sources: Public Transport Victoria (2022); Transport for NSW (2022).

Figure 38, above, shows average times between light rail services on a sample of converged route corridors in Melbourne and Sydney[24]. For Melbourne, this is for converged services departing Stop 22 (St. Kilda Road/Toorak Road), with Federation Square as the arrival point, and services departing Queen Victoria Markets, with Flinders Street as the arrival point. For Sydney, this is for the L2 and L3 services departing Moore Park, with Central Station as the arrival point. Frequency along St. Kilda Road is high because seven routes share the corridor [25]. Frequency is slightly less on the Queen Victoria Markets to Flinders Street corridor as only three routes serve the corridor[26]. For services to Central Station, frequency is lower again as only two routes serve the corridor.

24 The graph shows Thursdays only for peak hour as neither Melbourne nor Sydney have Monday-Friday timetables. Thursdays are the selected point of comparison between the two cities.

25 These services are routes 3(a), 5, 6, 16, 64, 67, and 72.

26 These services are routes 57, 59, and 19.

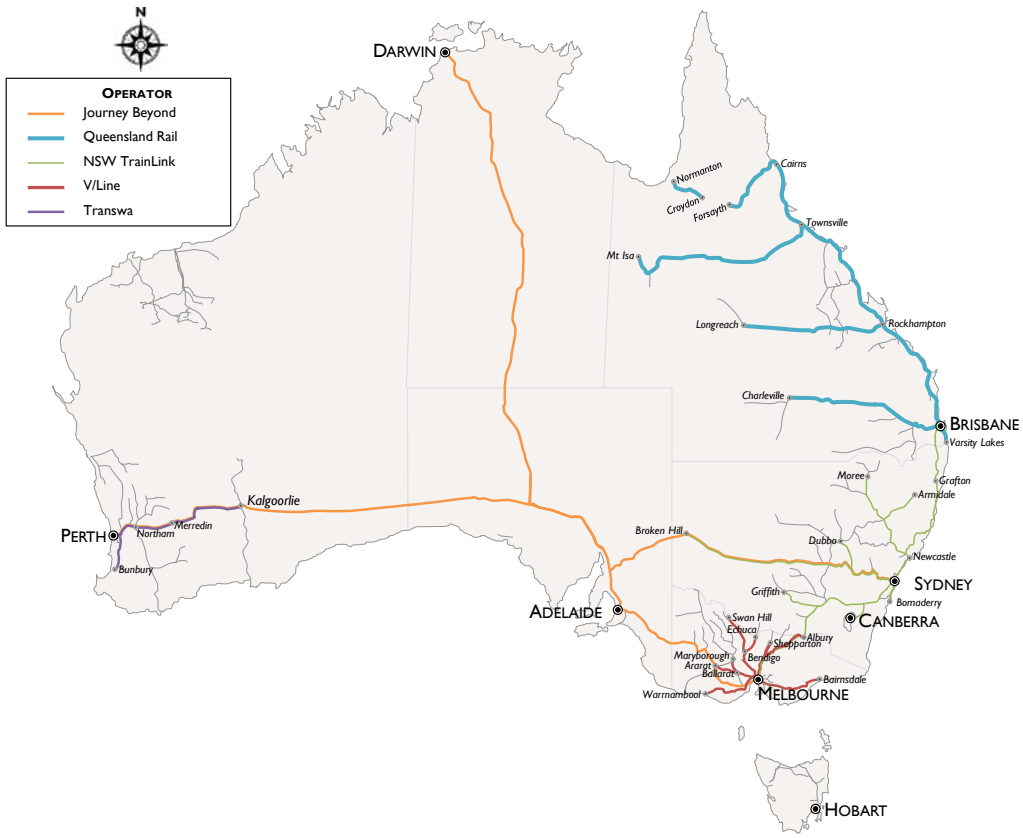
Chapter 4

Passenger transport results – Non urban rail

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—Bendigo 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 Adelaide—Darwin (*The Ghan*) (Journey Beyond).

Figure 39 Non-urban passenger services, by operator



Patronage

The scale of an operator's passenger task is largely determined by the function of their railway. Table 19, 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.

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

Table 19 Non-urban rail patronage, by operator, 2020–21

		NSW TrainLink			
	Queensland Rail	Regional	Intercity	V/Line	Transwa
Patronage (million trips)	.375	.64	20.2	8.38	.150

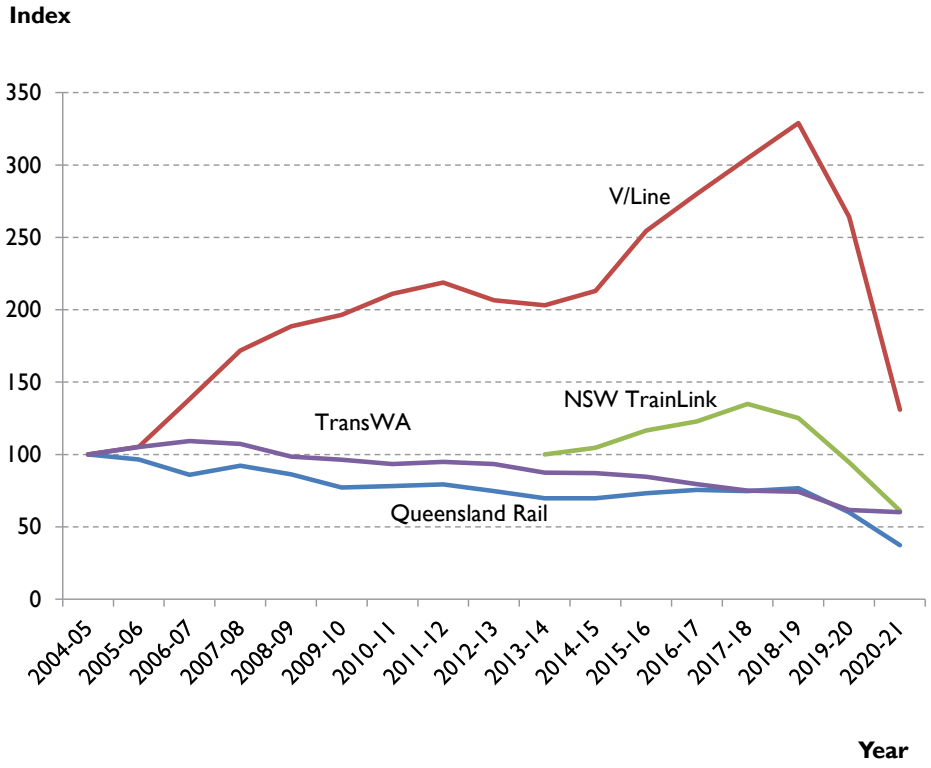
Notes: Data excludes patronage on services delivered under the Queensland "TransLink" brand. TransLink data is reported in urban patronage.

Sources: NSW Trains (2021), p.10; Advice from Transport of NSW; Public Transport Authority of Western Australia (2020), p.21; Queensland Rail (2021), p.22; V/Line (2021), p.14.

Total non-urban rail patronage for 2020–21 was approximately 29.7 million passenger journeys, a reduction of approximately 40 per cent compared to the previous financial year, which, in turn, had a 23 per cent reduction from its previous financial year. All operators had declines – Queensland Rail (38 percent), NSW TrainLink (35 per cent), V/Line (50 per cent), and Transwa (two per cent). Like declines in urban patronage, these declines are likely due to COVD-19 travel restrictions throughout the financial year. V/Line's greater decline than other operators may be due to Victoria having longer lockdown periods.

The bulk of V/Line's and Trainlink's patronage was inter-urban commuter services, such as Katoomba to Sydney and Geelong to Melbourne, while almost all of Queensland Rail's and Transwa's patronage is from longer distance non commuter travel. Figure 40, below, shows patronage trends by operator. The index for NSW TrainLink is truncated to 2013–14 due to a revision of patronage data calculation methodology.

Figure 40 Index of non-urban rail patronage, by operator



Notes: The NSW TrainLink index is the sum of regional (train) 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 (2021), p.10; Advice from Transport of NSW; Public Transport Authority of Western Australia (2020), p.21; Queensland Rail (2021), p.22; V/Line (2021), p.14.

Punctuality

Table 20 Non-urban rail punctuality, on time performance, 2020–21

	Service type	Result (%)	Target (%)	Measurement
Queensland Rail	QR Traveltrain	>85.1	75	Arriving within 15 minutes, excluding the Kuranda Scenic Railway and Gulflander services
NSW Trainlink	Intercity (peak services)	90.2	92	Arriving within six minutes
	Regional & interstate	76.5	78	Arriving within 10 minutes
V/Line	Commuter	93.5	92	Arriving on time to five minutes and 59 seconds
	Long distance	93.4	92	Arriving on time to 10 minutes and 59 seconds
Transwa	Australind	80	90	Arriving within 10 minutes
	Prospector	47	80	Arriving within 15 minutes
	MerridinLink	71	90	Arriving within 10 minutes
	AvonLink	96	90	Arriving within 10 minutes

Sources: V/Line (2021), p.15; NSW Trains (2021), p.23; Queensland Rail (2021), p.22; Public Transport Authority of Western Australia (2021), pp.69-70.

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 92 per cent and smaller margins for being considered on time. In contrast, QR Traveltrain, which operates long-distance services in Queensland, has a punctuality target of 75 per cent and a 15 minute margin.

NSW Trainlink attributes its failure to meet targets in 2020–21 due primarily to major weather events (particularly flooding), track works, speed restrictions and other unspecified infrastructure issues (NSW Trains 2021, p.23).

V/Line's punctuality for both commuter and long distance rail services recovered and exceeded targets. V/Line attributes this to concerted efforts to lift performance, the introduction of modernisation projects, timetable adjustments, station platform management, better coordination with urban services, improvement and upgrade works, and the safe removal of temporary speed restrictions. Lower patronage also reduced delays when stopped at stations (V/Line 2021, p.16).

Transwa attributes its below target results to freight train crossing issues, mechanical issues, and track works (Public Transport Authority of Western Australia 2021, pp.69–70).

Travel times

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 longer distance 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 21 Key characteristics of selected non-urban passenger services, 2022

	Operator	Gauge	Distance (km)	Electrified	Scheduled transit time	Average speed (km/h)	Stopping stations (no.)
Regional/intercity 3 hour 59 minutes or less							
Brisbane to Nambour	QR (TransLink)	Narrow	105	Yes	1h 52m	56	20
Brisbane to Varsity Lakes	QR (TransLink)	Narrow	89	Yes	1h 20m	67	11
Newcastle Interchange to Muswellbrook	NSW TrainLink	Standard	123	No	1h 36m	77	12
Sydney to Newcastle Interchange	NSW TrainLink	Standard	165	Yes	2h 39m	62	14
Sydney to Wollongong	NSW TrainLink	Standard	82	Yes	1h 31m	54	7
Sydney to Bathurst	NSW Trainlink	Standard	238	No	3h 46m	63	9
Melbourne to Ballarat	V/Line	Broad	118	No	1h 16m	93	6
Melbourne to Bendigo	V/Line	Broad	162	No	1h 42m	95	3
Melbourne to Warrnambool	V/Line	Broad	276	No	3h 36m	76	13
Melbourne to Geelong	V/Line	Broad	81.5	No	58m	83	5
Melbourne to Seymour	V/Line	Broad	99	No	1h 35m	62	10
Melbourne to Traralgon	V/Line	Broad	158	No	2h 20m	67	12
Midland to Northam	Transwa	Standard	102	No	1h 20m	80	1
Perth to Bunbury	Transwa	Narrow	183	No	2h 30m	72	11
Long-distance 4 hours or more							
Townsville to Mount Isa	QR Travel	Narrow	977	No	20h 55m	47	8
Brisbane to Charleville	QR Travel	Narrow	777	No	16h 30m	47	16
Brisbane to Cairns	QR Travel	Narrow	1681	No	24h 45m	68	26
Brisbane to Rockhampton (electric Tilt Train)	QR Travel	Narrow	639	Yes	7h 45m	82	11
Sydney to Canberra	NSW TrainLink	Standard	330	No	4h 8m	80	9
Melbourne to Swan Hill	V/Line	Broad	345	No	4h 45m	73	7
Sydney to Dubbo	NSW TrainLink	Standard	462	No	6h 26m	72	14
Sydney to Armidale	NSW TrainLink	Standard	579	No	8h 5m	72	19
Sydney to Casino	NSW TrainLink	Standard	805	No	11h 32m	70	21
Sydney to Albury	NSW TrainLink	Standard	646	No	7h 30m	86	12
Perth to Kalgoorlie	Transwa	Standard	653	No	6h 50m	96	17
Adelaide to Darwin	Journey Beyond	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 (2022); Transport for NSW (2022); Translink (2022); Transwa (2022); V/Line (2022); Journey Beyond Rail Expeditions (2022).

Average train speeds are a function of:

- Track quality, 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 2021 show little variance in scheduled transit times.

The Brisbane—Nambour, Sydney—Newcastle Interchange, and Sydney—Wollongong services continue to have similar, relatively low average point to point speeds. The services stop at many stations relative to distance travelled. This is because they function as limited-stop and all stops commuter trains in the peri-urban regions and urban areas of Brisbane and Sydney respectively. In addition, the Sydney—Newcastle Interchange 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 and differing track conditions. V/Line's Melbourne—Geelong, Melbourne—Ballarat, and Melbourne—Bendigo commuter services are relatively fast (peak hour direction of travel) due to the express running VLocity DMU sets used and Regional Rail Link and Regional Fast Rail infrastructure. The Melbourne—Bendigo service cited above, for instance, is based on an express peak hour service with only three stops.

Elsewhere in Australia, the following services listed above have average point-to-point speeds of 90 kilometres per hour or greater:

- Melbourne to Bendigo, 95 kilometres per hour;
- Melbourne to Ballarat, 93 kilometres per hour;
- Melbourne to Geelong, 83 kilometres per hour; and
- Perth to Kalgoorlie, 96 kilometres per hour.

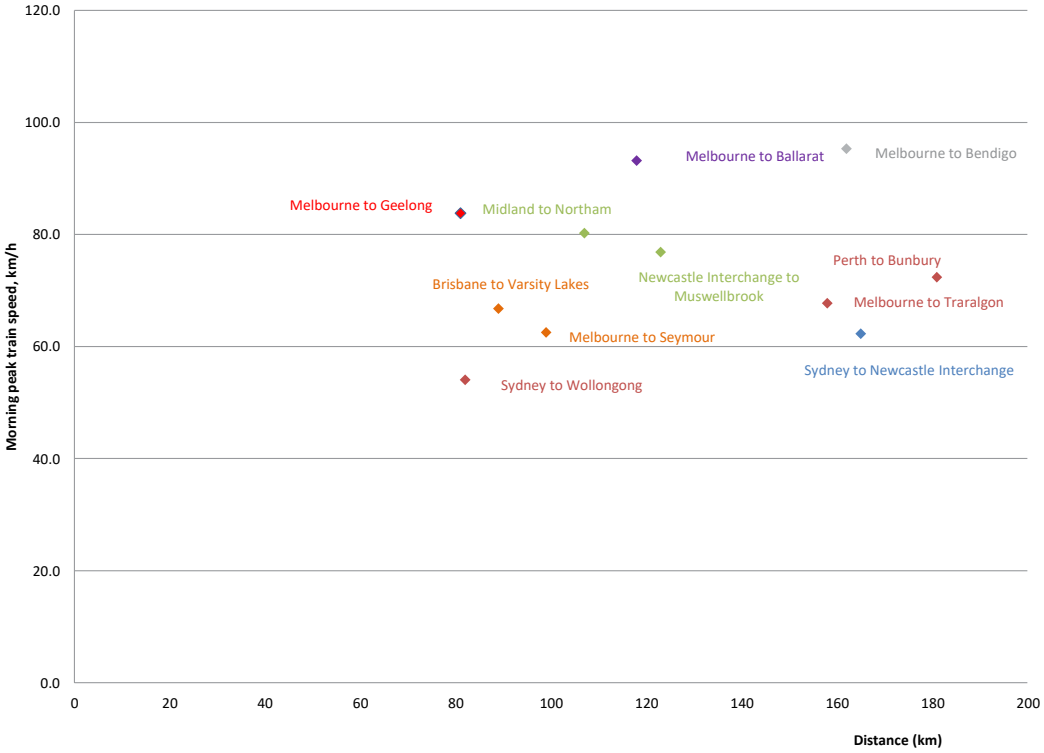
Long-distance passenger trains in Australia have uncompetitive transit times compared to air and some road coach travel[27].

Figure 41 Trainlink XPT service

Note: The image above shows Melbourne to Sydney day XPT service ST24 at Bethungra Spiral in October 2022. This train has just left the higher speed running that typifies much of the journey between Melbourne and Bethungra due to its flatter terrain and gentler curves. From here this service enters the 'steam era' alignment, characterised by frequent tight curves that, while easing grades, hampers the XPT's potential speed. Photo courtesy of Rodney Avery.

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

Figure 42 Distance and illustrative speeds for selected non-urban passenger rail services, 2022



Source: BITRE analysis.

Figure 42 above, shows average timetabled point to point train speeds and distances travelled for non-urban services that are of less than three hours in duration. The calculations are for selected services shown in Table 21. Of particular note is the Melbourne to Bendigo service, which maintains a high average point to point speed over a relatively long distance, and the Sydney to Wollongong service, which is of a relatively short distance, and has a low average speed. The Melbourne to Bendigo service achieves this through having a dedicated corridor through suburban Melbourne, good track infrastructure, and having only three stops en route, while the Sydney to Wollongong service has seven stops, shares part of the line with suburban services in Sydney, and is subject to tight curves for much of the journey. The Melbourne to Bendigo service illustrated in the chart travels approximately twice the distance of the corresponding Sydney to Wollongong service and it completes the journey at almost twice the average point to point speed.

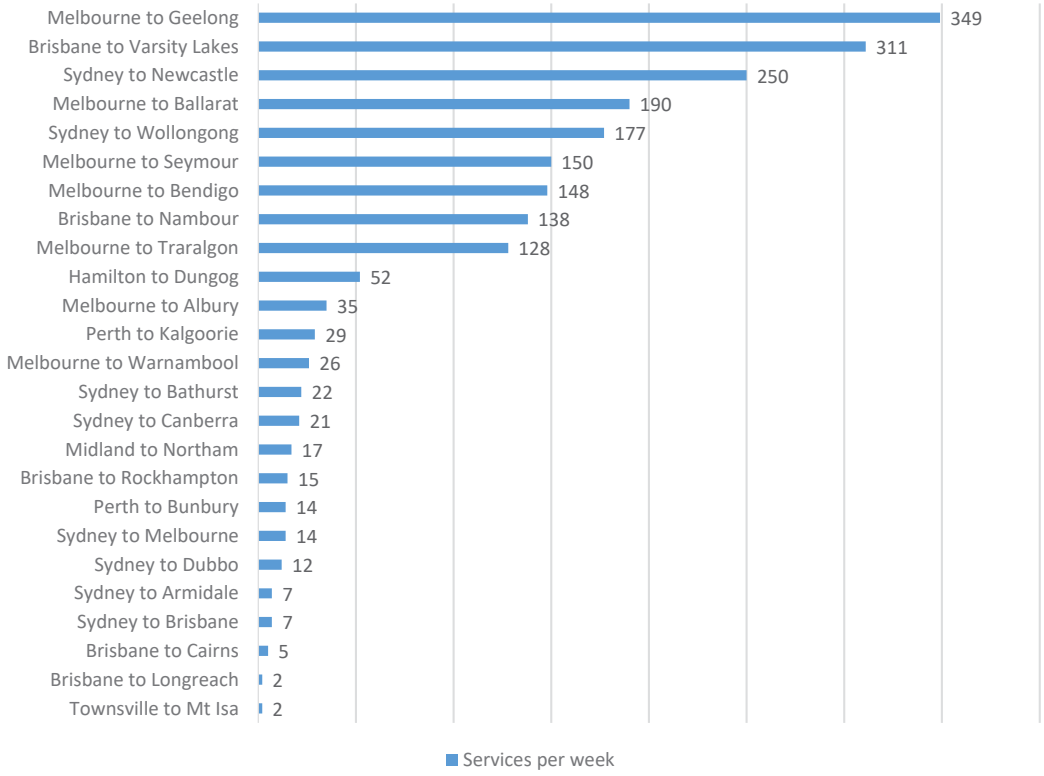
Figure 43 XPlorer train

Note: The image above shows Canberra to Sydney XPlorer service SP34 at Bungendore, October 2022. Photo courtesy of Rodney Avery.

Frequency

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.

Figure 44 Non-urban passenger rail services per week, 2022



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, Brisbane to Cairns services that stop at Rockhampton.

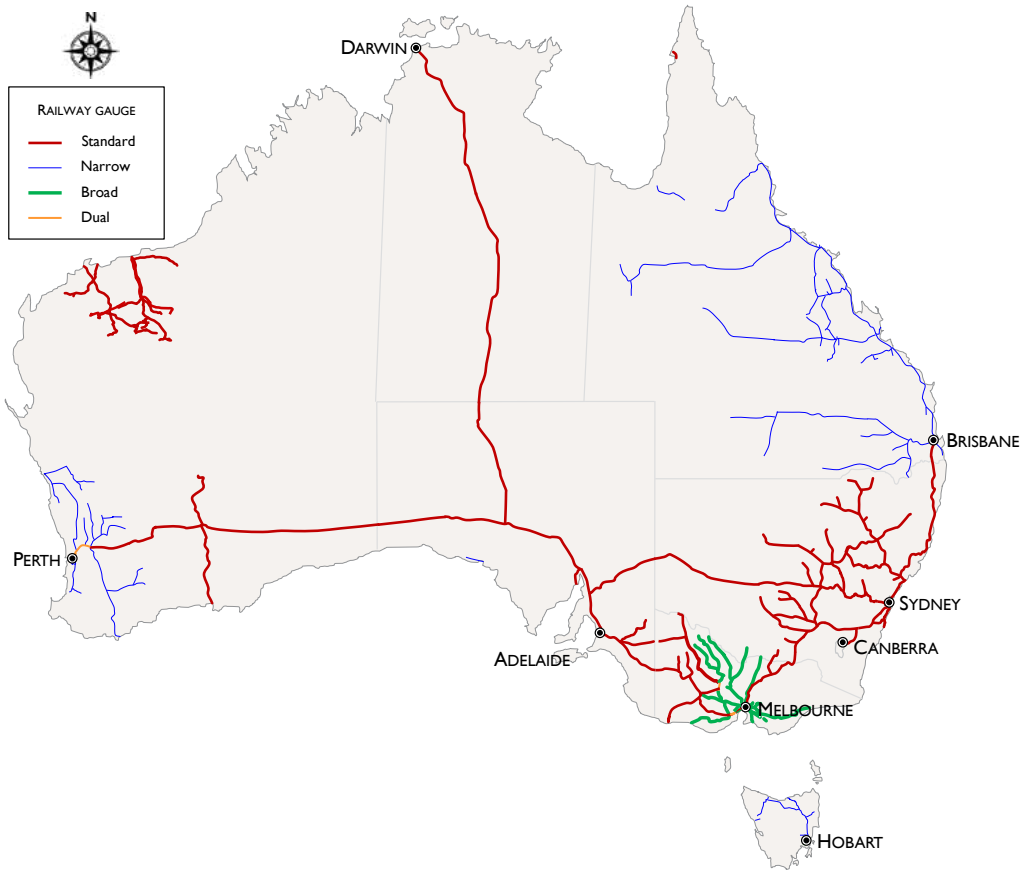
Sources: Queensland Rail Travel (2022); Transport for NSW (2022); Translink (2022); Transwa (2022); V/Line (2022).

Figure 44, above, shows the number of scheduled services per week on selected intercity/commuter and regional/interstate passenger rail services. Intercity/commuter services have the highest frequency.

Chapter 5
Infrastructure

Australia's colonies (then states in the post-federation era) built the continent's first railways as separate networks, often 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 45 Railway network, by track gauge, September 2022



Notes: The lines shown here are the railways that are open for traffic at October 2022.

Broad ("Irish") gauge is 1600 mm; standard ("Stephenson") gauge is 1435; and narrow ("Cape") gauge is 1067 mm.

Current Network

BITRE estimates there were 32 665 route-kilometres of operational heavy railways in Australia in December 2022. The only change since 2021 was the opening of the Forrestfield-Airport Link (Metronet) line (eight kilometres) in Perth, and revised estimates for NSW, Vic and SA.

Table 22, below, 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 88 per cent). Most urban networks, 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) is multiple track.

Table 22 Estimate of route kilometres of open (operational) heavy railways in December 2022, by jurisdiction, gauge and electrification

	State or Territory								
	ACT	**NT**	**NSW**	**Qld**	**SA**	**Tas**	**VIC**	**WA**	**Total**
Route kilometres by gauge									
Broad			73		133		2384		**2590**
Narrow				8146	184	611		2978	**11919**
Standard	6	1690	6967	117	2561		1794	4701	**17836**
Dual				36	22		55	207	**320**
Total	**6**	**1690**	**7040**	**8299**	**2900**	**611**	**4233**	**7886**	**32665**
1 500V DC			666				364		**1030**
25 kV AC				2173	84			189	**2446**
Total			**666**	**2173**	**84**		**364**	**189**	**3476**

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, sugar tramways and heritage only railways.
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, Aurizon, Rio Tinto Alcan, and TasRail; Advice from Freight Victoria.

Around 11 per cent of the Australian network route-kilometres are electrified. 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.

New railways

Approximately 162 route-kilometres of freight track and 88 route-kilometres of passenger (heavy and light rail) track have been opened since 2017. Table 23 provides a list of all new rail track additions since 2017, grouped by traffic type/purpose[28].

Table 23 Railways opened since 2017

Traffic	Location	Year	State	Length (km)	Project	Infrastructure builder
Iron Ore	Western Hub (Eliwana)	2020	WA	143	Western Hub (Eliwana)	Fortescue Metals Group
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	North West Connection	2019	NSW	5	Inland Rail	ARTC
Grain	Moree-Broadbent Grain facility	2017	NSW	3.5	Broadbent Grain facility- Moree connection	ARTC
Urban passenger heavy rail	South Morang – Mernda	2018	Victoria	8	Mernda Rail Extension	Metro Trains Melbourne
Urban passenger heavy rail	Sydney	2019	NSW	36	Sydney Metro Northwest	Transport for NSW
Urban passenger heavy rail	Adelaide	2020	SA	.65	Flinders Link	Department of Planning, Transport and Infrastructure
Urban passenger heavy rail	Perth	2022	WA	8	Forrestfield-Airport Link	Metronet
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
Urban passenger light rail	King William Street – East Terrace	2018	South Australia	1	City Tram Extension Project	Department of Planning, Transport and Infrastructure
Urban passenger light rail	King William Street – Festival Plaza Precinct	2018	South Australia	.350	City Tram Extension Project	Department of Planning, Transport and Infrastructure
Urban passenger light rail	Gungahlin – Canberra City	2019	ACT	12	Canberra Metro	ACT government and Canberra Metro consortium
Urban Passenger Light Rail	Newcastle Interchange – Pacific Park	2019	NSW	2.7	Newcastle Light Rail	Transport for NSW
Urban Passenger Light Rail	Circular – Quay Randwick and Juniors Kingsford	2019–20	NSW	12	CBD and South East Light Rail	Transport for NSW

Notes: A list of network additions since 2000 is at Appendix A.

Sources: BITRE estimates, data provided by Aurizon.

28 While the Parkes—Narromine section of the Inland Rail project was completed and open to revenue services in September 2020, the line was not a new construction, hence it is not considered a new railway.

Since 2017, 143 route kilometres of iron ore railways in the Pilbara region of Western Australia have been opened. There is currently an estimated 2782 route kilometres of railways in the Pilbara region. For coal haulage, 11 route kilometres of railway have been opened, all in the Central Queensland Coal Network.

Most urban heavy railway expansion since 2017 has been in Sydney, specifically Sydney Metro Northwest. While there has only been minimal network expansion in Adelaide since 2017, electrification of the Gawler line was completed in 2022. Other infrastructure activities in addition to new railway construction, includes Victoria's Level Crossing Removal and NSW's Fixing Country Rail projects.

As Table 24, below, shows, approximately 174 route-kilometres of heavy and light railways were under construction in December 2022. Of this, approximately 155 kilometres were heavy rail and 18.5 were light rail.

Table 24 Heavy and light railways under construction, December 2022

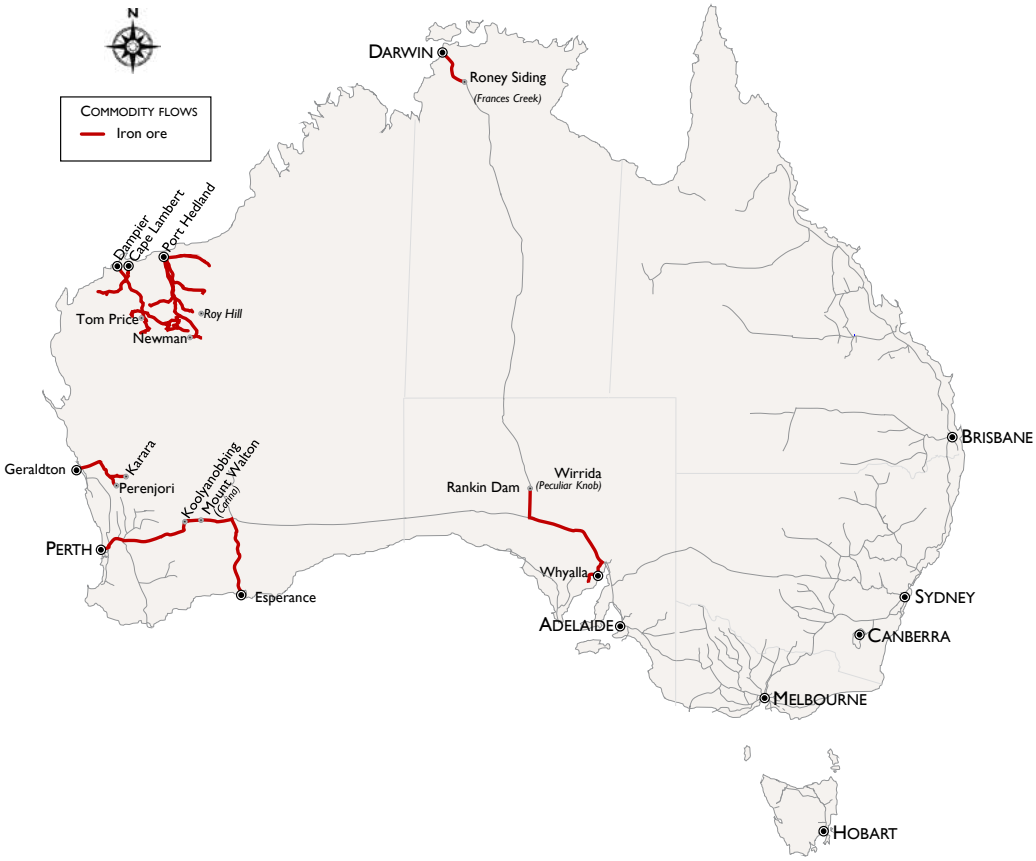
Traffic	Location	State	Length (route km)	Project
Light rail	Parramatta	NSW	12	Parramatta Light Rail
Light Rail	Gold Coast	Qld	6.7	Gold Coast Light Rail Stage 3
Light Rail	Canberra	ACT	1.7	Canberra Light Rail Stage 2A
Heavy Rail	Sydney	NSW	30	Sydney Metro City & Southwest
Heavy Rail	Melbourne	Vic	9	Metro Tunnel
Heavy Rail	Brisbane	Qld	10.2	Cross River Rail
Heavy Rail	Perth	WA	17.5	Thornlie-Cockburn Link
Heavy Rail	Perth	WA	21	Morley-Ellenbrook Line
Heavy Rail	Perth	WA	14.5	Yanchep Rail Extension
Heavy Rail	Melbourne	Vic	26	Suburban Rail Loop East
Heavy Rail	Melbourne	Vic	27	Melbourne Airport Rail Link
Heavy Rail	Sydney	NSW	24	Sydney Metro West

Dedicated commodity networks

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 networks

Figure 46 Iron ore transport by rail corridors

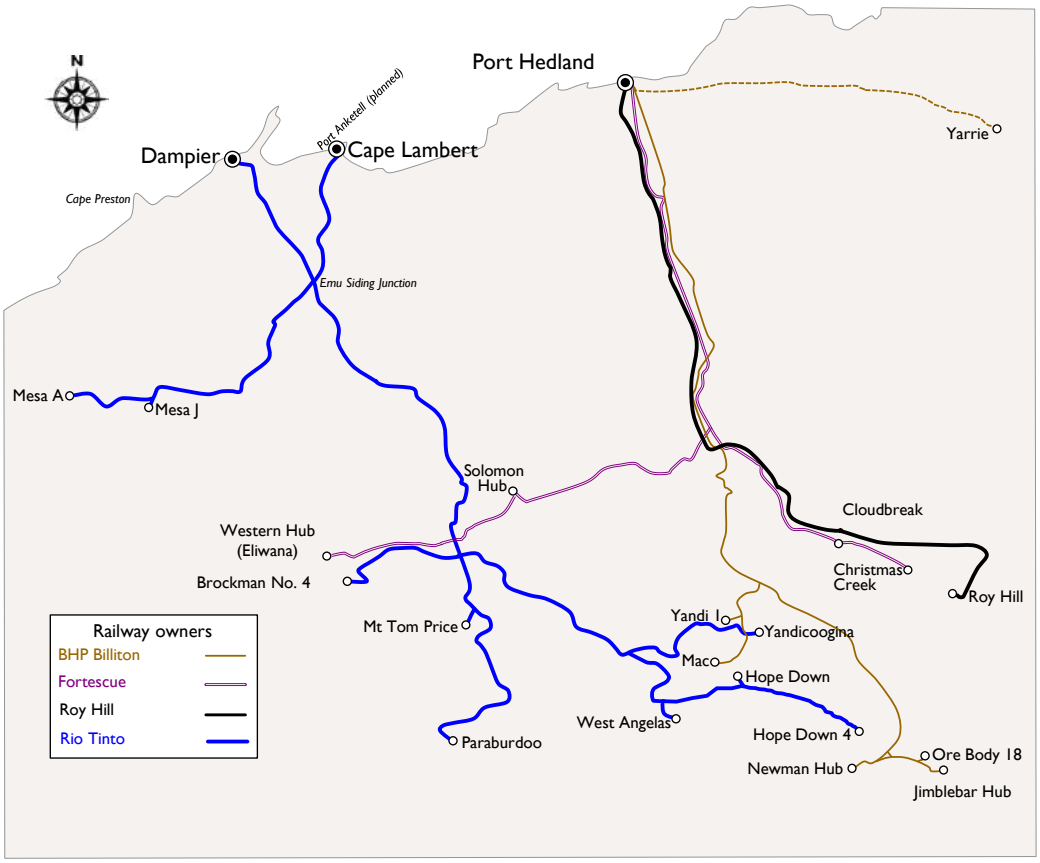


Most iron ore transport by rail in Australia occurs in the Pilbara region of Western Australia. Mining companies built the iron ore railway networks in the Pilbara region exclusively to serve the iron ore mines, as was the Karara (Western Australia) spur line and the Middleback railways (near Whyalla) 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.

The integrated railways of the Pilbara region, all fully privately owned and operated, by infrastructure owner, are:

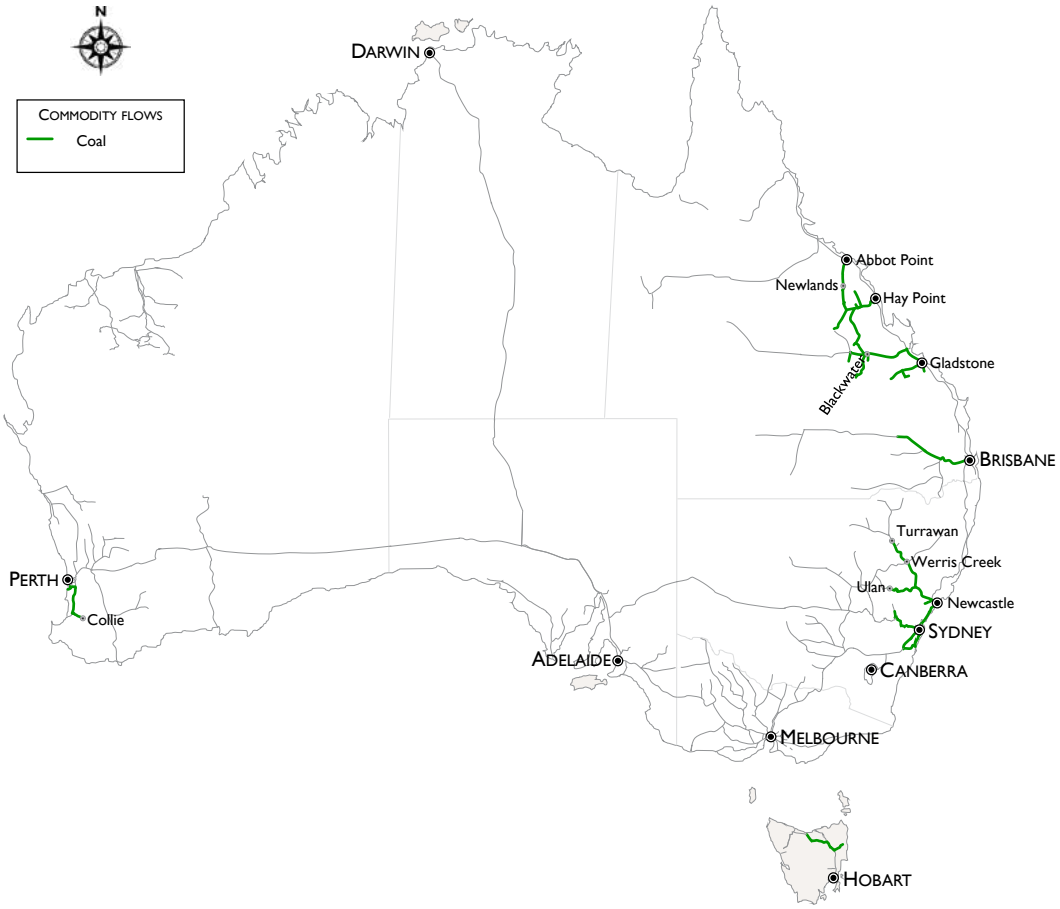
- **Rio Tinto:** The Robe River to Cape Lambert and the former Hamersley Iron's network to Port Dampier. Since 2012, trains on the Hamersley railway have been approximately 2.4 kilometres long and with a capacity of 26 000 tonnes (BITRE 2013, p. 31). Rio Tinto inaugurated its first driverless train revenue 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 232 cars at 42 tonne axle loads. In December 2020, Fortescue Metals Group opened its 143 kilometre Western Hub (Eliwana) line, as part of the development of the new Western Hub.
- **Roy Hill Holdings:** A 344 kilometre railway from Roy Hill to Port Hedland, as part of a which began operations in December 2015. These trains typically haul 232 ore cars, with a payload of more than 32 000 tonnes of ore.

Figure 47 Pilbara iron ore railways, by infrastructure owner



Coal networks

Figure 48 Coal transport by rail corridors



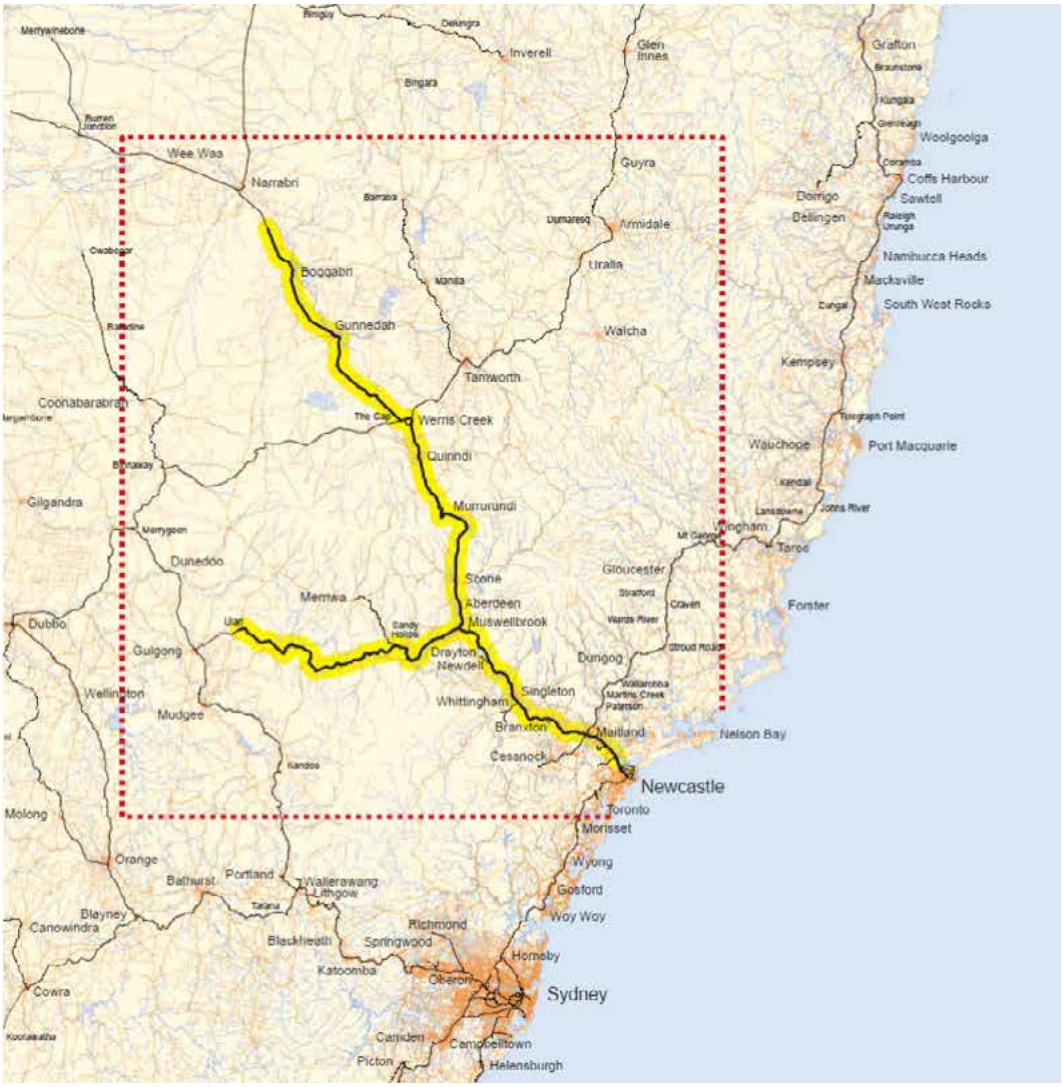
Coal lines were developed mostly in eastern Australia, generally being grafted onto the existing mixed-traffic networks. While the track standards are high, and include some electrified systems in Queensland, they are generally of a lower standard than the dedicated iron ore lines.

Aurizon manages the Central Queensland Coal Network (CQCN), under an open access regime. The network is narrow gauge with train axle loads of 26.5 tonnes. ARTC manages the New South Wales (standard gauge) Hunter Valley system in New South Wales. The systems are:

- **Newlands (CQCN).** This system is located at the northern end of the Bowen Basin. In 2012, the Newlands system was linked to Aurizon's Goonyella Coal Rail System, which has given additional flexibility to access the Port of Abbot Point. The project included construction of the 69 kilometre 'Northern Missing Link', which connects the two rail systems, along with substantial upgrades to existing Newlands rail infrastructure. (For more details see Aurizon 2022)
- **Goonyella (CQCN).** Goonyella is an electrified system that services the Bowen Basin coal region. It primarily serves the terminals at Hay Point/Dalrymple Bay near Mackay, and Abbot Point near Bowen. (For more details, see Aurizon 2022)

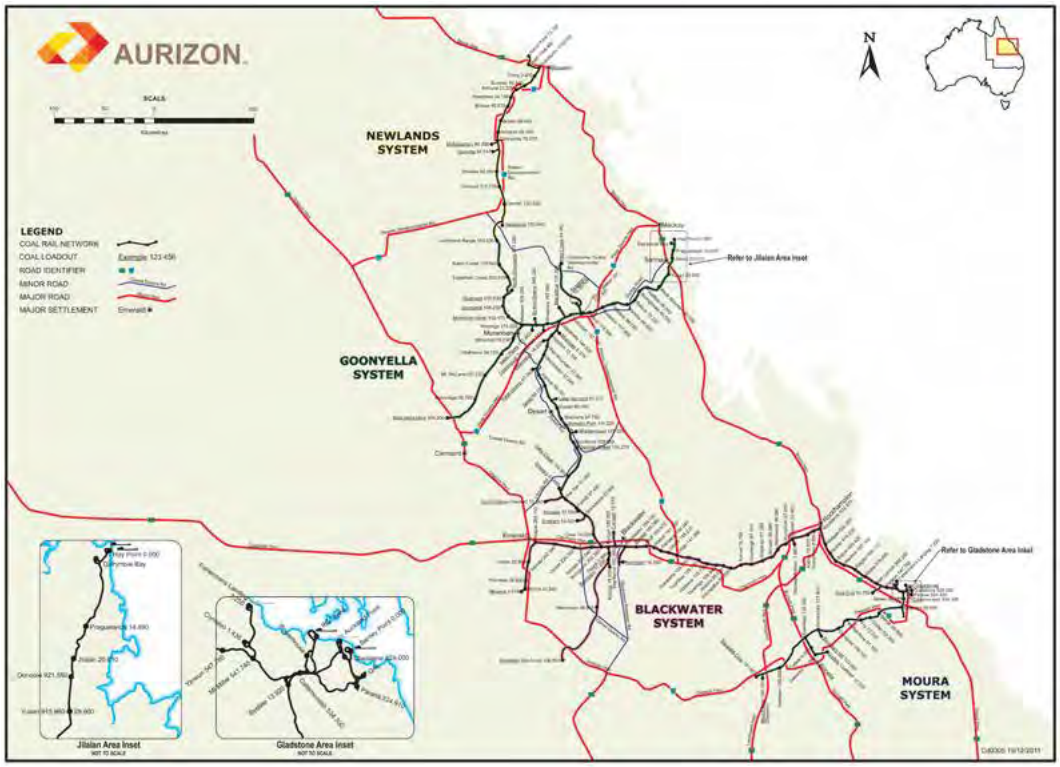
- **Blackwater (CQCN).** This system services the Bowen Basin coal region and it is the largest system in Central Queensland in terms of route kilometres. It delivers coal to the two export terminals at the Port of Gladstone of RG Tanna Coal Terminal and the Wiggins Island Coal Export Terminal (WICET). The system consists of mostly electrified duplicated lines that extend west from Rockhampton. (For more details see Aurizon 2022)
- **Moura (CQCN).** This system runs from Moura to Gladstone where it connects to the two export terminals – the RG Tanna Coal Terminal and the WICET. In late 2015, Aurizon finished the Wiggins Island Rail Project (WIRP), which involved the development of new rail lines and upgrades of existing lines to WICET. The project created a link between the coal terminal and mines in the Southern Bowen and Surat Basins. The project comprised interdependent infrastructure projects across the Blackwater Rail System, the Moura Rail System and the North Coast Line. (For more details see Aurizon 2022)
- **South-West Rail Corridor (Queensland).** Aurizon hauls coal from the West Moreton Coal System along the South-West Rail Corridor through to the Port of Brisbane. Axle loads vary across the corridor. (For more details see Aurizon 2022)
- **Hunter Valley (New South Wales).** Coal is transported to three coal-loading terminals in Newcastle and to domestic users. Train axle loads are 30 tonnes for most of the network. The North Coast line to Stratford and the lines south to Vales Point on the Central Coast are rated for 25 tonne axle loads. The existing 30 tonne axle load infrastructure can accommodate 32 tonne axle loads but the higher load provides limited benefit unless the outline gauge is increased. Trains consisting of '120 tonne' (30 tonne axle load) wagons are typically restricted to 60 kilometres per hour when loaded and 100 kilometres per hour when empty. Locomotives of up to 30 tonne axle load are authorised to run at 80 kilometres per hour. (ARTC, 2022, p.15) Contracted export coal volumes were 198.9 mega tonnes per annum in the first quarter of 2022, declining to 135 mega tonnes per annum in 2030. (ARTC, 2022, p.5)

Figure 49 ARTC Hunter Valley Coal Network



Map courtesy of ARTC.

Figure 50 Central Queensland Coal Network



Source: Aurizon (https://www.aurizon.com.au/what-we-deliver/network#central-queensland-coal-network-cqcn).

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.

Grain railways

Unlike dedicated iron ore and coal railways, grain railways usually feed into main or secondary mixed use lines. 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[29] are outlined below.

29 Most of South Australia's grain railways are non operational and the remaining four lines have not been classified.

Despite the enhanced competition from grain transport by road, bulk grain transport by rail in parts of New South Wales is becoming more efficient and competitive as a result of improvements to the NSW Government's Country Regional Network (CRN). Annual work plan improvements include replacement of life expired bridges, under-bridges and culverts; level crossing and signalling system upgrades; ballast re-surfacing and depth increase; track re-conditioning; re-railing with heavier rail (new and used); and replacement of timber sleepers with steel sleepers, except in sections where jointed track remains, including The Rock—Boree Creek, Griffith—Hillston, Ungarie—Naradhan, Ungarie—Lake Cargelligo, Bogan Gate—Tottenham, Burren Junction—Merrywinebone and Camurra—Weemelah. All other lines now feature full 'face' steel sleeper pattern and continuous welded rail.

The track maintenance strategy has improved line capabilities (speed and/or higher axle loads). Heavier and more powerful locomotives can operate on sections of the CRN where they previously could not (for example to Walgett) and wagons can carry heavier payloads.

While 21 per cent of the CRN has a line capability of 76–78 tonnes gross (low traffic western lines), 61 per cent of the network now permits gross wagon tonnage of 84 tonnes or higher. This exceeds the maximum capability of more than ~75 per cent of the current bulk grain wagon fleet. This translates to reduced transport costs and improved competitiveness of rail transport in turn.[30]

The current Fixing Country Rail project, which aligns with and complements Fixing Country Roads, is a $400 million NSW Government programme whose aim is:

- moving freight more efficiently around NSW;
- increasing the capacity, access and reliability of the rail network;
- reducing the cost of getting goods to market;
- supporting jobs, growth and the economic productivity; and
- supporting a freight modal shift from road to rail. (Transport for NSW, 2022a)

Projects funded under fixing Country Rail include:

- building new sidings that allow freight trains to load and unload freight, while enabling trains on the same line to pass;
- building and upgrading crossing loops that allow the use of high productivity trains and enable trains to overtake and pass each other more efficiently; and
- upgrading the network so that trains can carry larger loads. (Transport for NSW, 2022a)

In 2022, 174 kilometres of rail between Junee and Griffith has been replaced. An $11.7 million project is also underway to extend Coolamon Siding, so it can accommodate freight trains of up to 1500 metres without blocking the mainline, thus keeping the mainline clear for other trains. The project is due for completion in early 2023. (Transport for NSW, 2022b)

30 For complete details of the CRN network standards see https://www.uglregionallinx.com.au/api/getdocument?document=%7b17C0F916-797A-430A-8A98-7EFCA4921790%7d

Details of current projects and projects completed since 2021 are shown below.

Table 25 Fixing Country Rail projects

Project	Current Status (2022)
Junee to Griffith Line Upgrade project	Completed early 2022
Temora to Calleen Upgrade to 25 TAL project	Project is currently on hold due to price escalation, TfNSW are currently considering options
Kandos to Gulgong Feasibility Study	Feasibility Study has been completed
Maryvale to Gulgong Feasibility Study	Feasibility Study has been completed
Narromine to Ulan Upgrade projects	Completed late 2022
Red Bend Rail Siding	In delivery
Bellata Rail Siding	In delivery
Condobolin Rail Siding	In delivery
Berry to Bomaderry Rail Line and the OMEGA tunnel track upgrade	Completed mid 2022
Riverina Intermodal Freight and Logistics Hub project	Completed late 2021
Coolamon – Crossing Loop Extension	Procurement and early works commenced
Pinecliffe Crossing Loop (Molong)	Completed mid 2021
Maryvale Crossing Loop	Completed late 2021
Bumberry Crossing Loop	Completed late 2021
Polona Crossing Loop	Completed mid 2021

Source: Information provided by Transport for NSW.

Box 4 Further reading on railway grain handling

For grain crop reports and forecasts see:

- http://www.graincorp.com.au/
- https://www.cbh.com.au/
- https://www.awb.com.au/
- https://www.ldc.com/au/en/business-lines/grains-oilseeds/
- www.emeraldgrain.com

Commodity non-specific networks

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[31]. 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). For more information on Queensland Rail's regional network, see (Queensland Rail 2022).

New South Wales

While the New South Wales government's country 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 (in its previous capacity of manager of the CRN), for example, a Class 3 track can range in operational capability from 81 to 100 tonnes gross.

Victoria

Victoria has six track standard classifications. The highest standard is Class 1, and the lowest is Class 5 (VicSig 2020). Details are as follows:

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

The state's amended Murray Basin Rail Project is ongoing[32]. According to the Victorian Government, the current project includes:

- re-sleepering, adding ballast and adjusting track on the Ouyen to Murrayville Line (complete);
- track upgrades from Ararat to Maryborough (complete);
- new or upgraded sidings at Donald and Merbein (complete);
- new and extended crossing loops;
- upgraded signalling at Ararat and Maryborough junctions and the Ouyen yard;
- new turnouts at Dunolly junction;
- re-sleepering from Sea Lake to Dunolly (complete); and
- planning and assessment work for further upgrades. (Victoria's Big Build, 2023)

31 An illustration of this information can be seen with the "Information pack" for South Western Queensland (Queensland Rail, 2016).

32 For details of the project's original scope, see BITRE, 2017, p.63

The estimated cost of the project is $706.45 million, of which he Commonwealth Government is contributing $454.4 million and the Victorian Government $248.6 million. (Department of Infrastructure, Transport, Regional Development, Communications and the Arts, 2023)

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 considered 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. They are also typified by low (16-tonne) axle loads, with low-standard track structure. (Strategic Design and Development 2009, p. 8). All Tier 3 lines are currently non-operational.

In September 2020, the Western Australian Government released an independent engineering assessment outlining the estimated cost of restoring each section of the state's Tier 3 rail network, including the potential for some lines to be converted to standard gauge.

Subject to further stakeholder consultation, the first upgrade proposals for Tier 3 lines under consideration for business case preparation were:

- Quairading to York (estimated cost $110.91 million);
- Kulin (via Yilliminning) to Narrogin (estimated cost $164.41 million); and
- Kondinin (via Narembeen) to West Merredin (estimated cost $210.67 million narrow gauge or $238.08 million standard gauge) (Minister for Transport; Planning; Ports, 2020).

Furthermore, the Western Australian Government's Revitalising Agricultural Region Freight (RARF) Strategy identifies investment opportunities in the freight rail line network and provides a list of prioritised rail and intermodal projects on the currently operational Tier 1 and 2 networks (Department of Transport, 2020). In implementation of the Strategy, the West Australian Government announced in May 2022 a $200 million joint state/Commonwealth ($160 million) funding boost for the state's regional freight network. The funding package was for the following four projects:

- $22 million for four rail siding extensions for CBH grain bins at Moora, Brookton, Cranbrook, and Broomehill, complementing CBH investment in rail loading facilities. These works are now underway;
- $46 million for seven additional grain rail siding upgrades at Avon, Kellerberrin, Dowerin, Konnongorring, Ballidu, Mingenew, and Perenjori North, which will help CBH load longer trains faster;
- $60 million for the Midland Line Main Line upgrading from 16 to 19 tonne axle loading between Carnamah and Mingenew, allowing heavier trains and a 20 per cent increase in train loads; and
- $72 million for the Southern Wheatbelt region towards the progressive recommissioning of the Narrogin-Kulin rail line (closed since 2013) and associated works to service grain and other potential customers in the Narrogin-Wickepin area. The first stage of this project will be a study to assess the most useful way to implement the investment. (Minister for Transport; Planning; Ports, 2022)

Tasmania

In 2020–21, the Tasmanian Freight Rail Revitalisation Program delivered:

- Installation of 16,599 sleepers and 53,670 metres of new rail;
- Six track turnouts (or points) on the network repaired or replaced;
- Renewal of six level crossings; and (TasRail, 2021, p.13).

TasRail claims a direct dividend of this is the zero derailment incidents recorded in the financial year, a first for TasRail (TasRail, 2021, p.13).

Tranche Two is $119.6 million four-year program, equally funded by the Tasmanian and Australian governments. TasRail delivered the program in mid-2023. The $96 million Tranche Three program, which has run in parallel with Tranche Two, began in in 2020–21. This is due for completion by mid 2024 (TasRail, 2021, p.13).

Box 5 Inland Rail

Construction of the Melbourne to Brisbane inland railway is underway. When completed, Inland Rail will provide freight train operators with:

- A 1,700 kilometre inland railway traversing eastern inland Australia;
- Up to 21 tonne axle loads at a maximum speed of 115 kilometres per hour;
- Container double-stacking;
- Maximum train lengths of 1,800 metres (the equivalent of 110 B-Double trucks),
- Scheduled transit times of less than 24 hours, which will be up to 10 hours faster than via the existing coastal rail route through Sydney; and
- Reduced transport costs by an average of $80.77 per payload tonne when switching existing road-based supply chains to Inland Rail, based on the CSIRO Inland Rail Supply Chain Mapping research of March 2022 (Department of Infrastructure, Transport, Regional Development and Communications, 2022).

Inland Rail will serve the growing cities of Melbourne and Brisbane, ease congestion on roads and the existing rail corridor, and connect with other interstate lines, ports and other regional trains along the route. Inland Rail will reduce the distance by rail between Brisbane and Melbourne by 200kms and Brisbane to Perth or Brisbane to Adelaide by 500 kilometres, cutting interstate travels times and costs.

65 per cent of Inland Rail will involve upgrading existing infrastructure ('brownfield' construction). The remaining 35 per cent consists of 'greenfield' construction, chiefly the Narromine-Narrabri section and most sections in Queensland.

Construction of the first section of track between Parkes and Narromine New South Wales was completed in September 2020, with the first train running a week later. As each section of Inland Rail is finished, it becomes operational and available for regional rail service use.

In late November 2020, Narrabri to North Star Phase 1 was the second section to begin construction with 83 kilometres of upgraded track between Moree and Narrabri commissioned in November 2022, to support that year's cropping season.

Continued next page

As at December 2022, approximately 16 per cent of the total Inland Rail track had been constructed, including the 104 kilometre Parkes to Narromine line and 174.5 kilometres of the Narrabri to North Star section.

ARTC is delivering the technically complex 128 kilometre Gowrie to Kagaru section through a Public Private Partnership (PPP). This section is the most challenging to deliver from an engineering perspective, and includes approximately eight kilometres of tunnelling through the Toowoomba, Teviot and Little Liverpool ranges.

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

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 infrastructure that can accommodate the longer trains. Consequently, interstate network infrastructure managers have upgraded their networks to accommodate longer trains.

Table 26, 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 of 2010–11) 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 26 Index of real maximum access revenue yield, interstate network (2010–11 = 100)

	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21
North-South corridor											
Acacia Ridge – Border Loop	100	100	100	100	100	100	100	100	100	100	97.63
Border Loop – Newcastle	100	100	100	100	100	100	100	100	100	100	97.63
Macarthur – Albury	100	100	100	100	100	100	100	100	100	100	97.79
Albury – Tottenham	100	100	100	100	100	100	100	100	100	100	97.79
East-West corridor											
Melbourne – Adelaide	100	100	100	100	100	100	100	100	100	100	97.99
Adelaide – Kalgoorlie	100	100	100	100	100	100	100	100	100	100	97.87
Cootamundra – Parkes	100	100	100	100	100	100	100	100	100	100	97.84
Parkes – Broken Hill	100	100	100	100	100	100	100	100	100	100	98.00
Broken Hill – Crystal Brook	100	100	100	100	100	100	100	100	100	100	97.81

Note: Numbers are subject to rounding.

Source: Data provided by ARTC.

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 unrestricted train lengths on the interstate network are as follows:

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

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

Passing lanes[33] have been built on the single track sections between Junee and Melbourne, on the Sydney—Melbourne corridor. This, combined with double track between Sydney and Junee, and Albury and Seymour, have enabled the use of unrestricted 1800 metre trains between Sydney and Melbourne.

Double stacking capability on the interstate network

Double stacking containers on wagons increases 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 7.1 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 51, 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 51 Double stacking capability on the interstate network

33 A passing lane differs from a passing loop by viritue 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.

Track quality of the interstate network

The maintenance and standards of railway infrastructure influence 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.

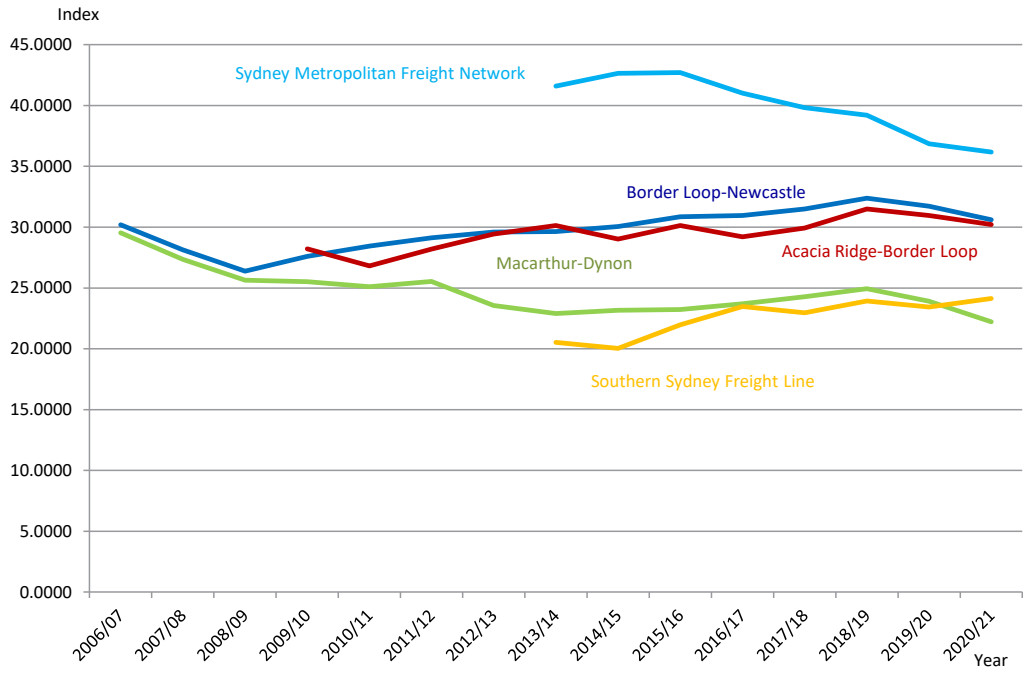
Figure 52 to Figure 55 show physical measures of average track condition by line segment. These indicators use a 'track quality index' (TQI). Lower index numbers equates to higher track quality.

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, weather 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.

As Figure 52 and Figure 53, below, shows, that, in 2020–21, track quality increased slightly on all sectors of the North—South corridor, except the Southern Sydney Freight Line. On the East—West corridor, track quality declined slightly on the Dynon-Dry Creek and Dry Creek-Kalgoorlie sectors, while it increased on the Cootamundra West-Crystal Brook sector. One Rail's TQI improved on all sectors.

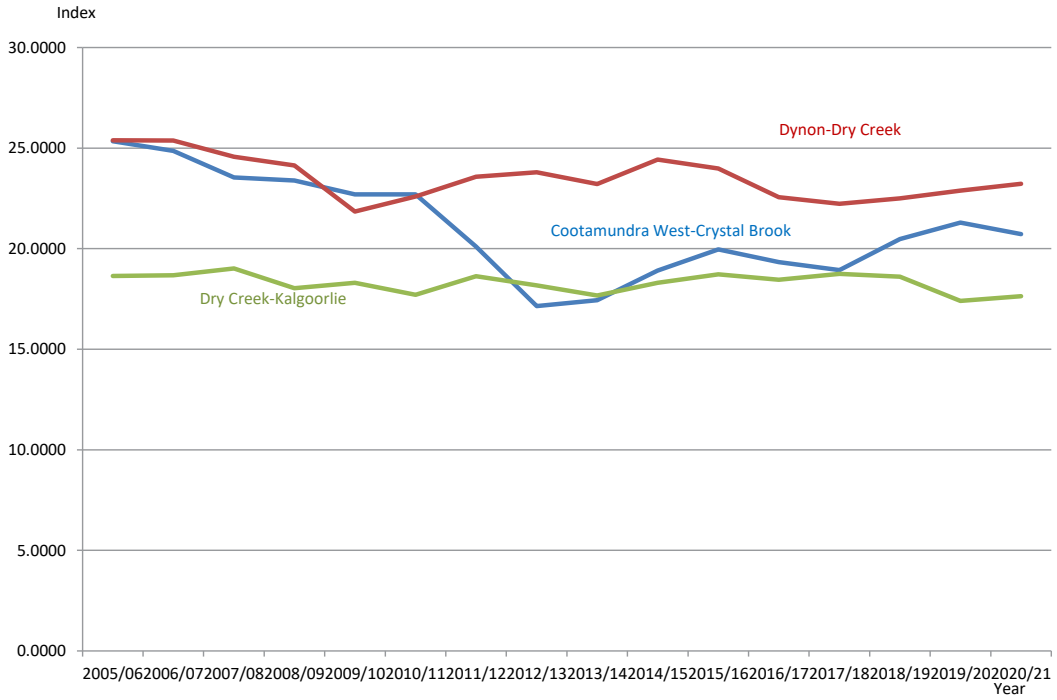
Figure 52 ARTC track quality index, North—South corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

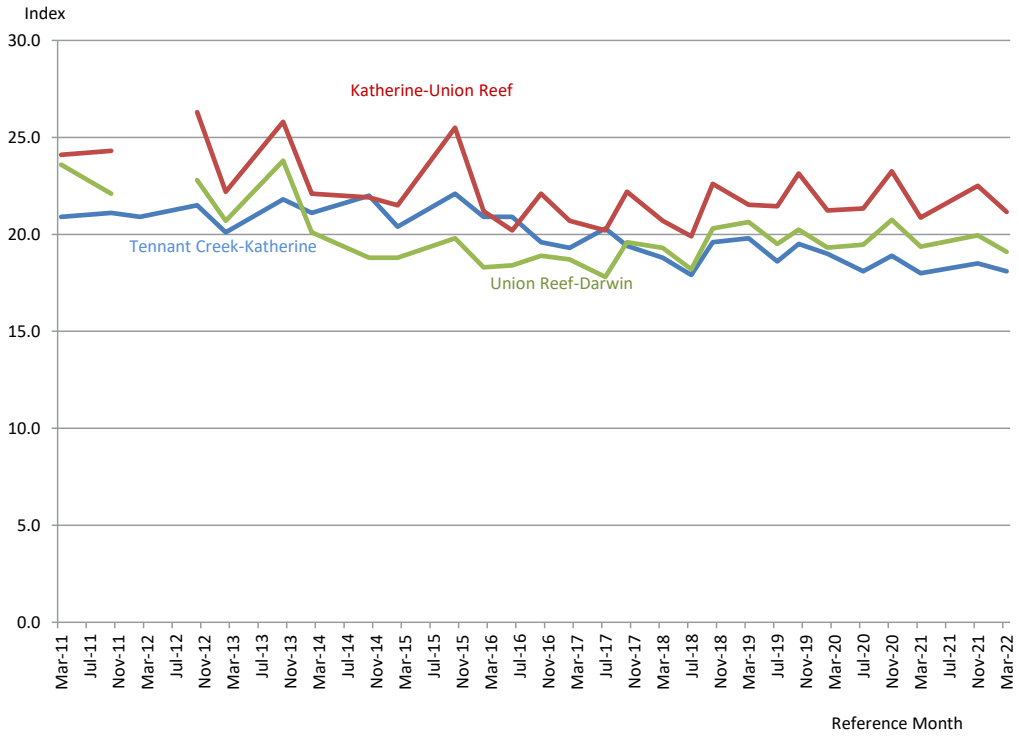
Figure 53 ARTC track quality index, East—West corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

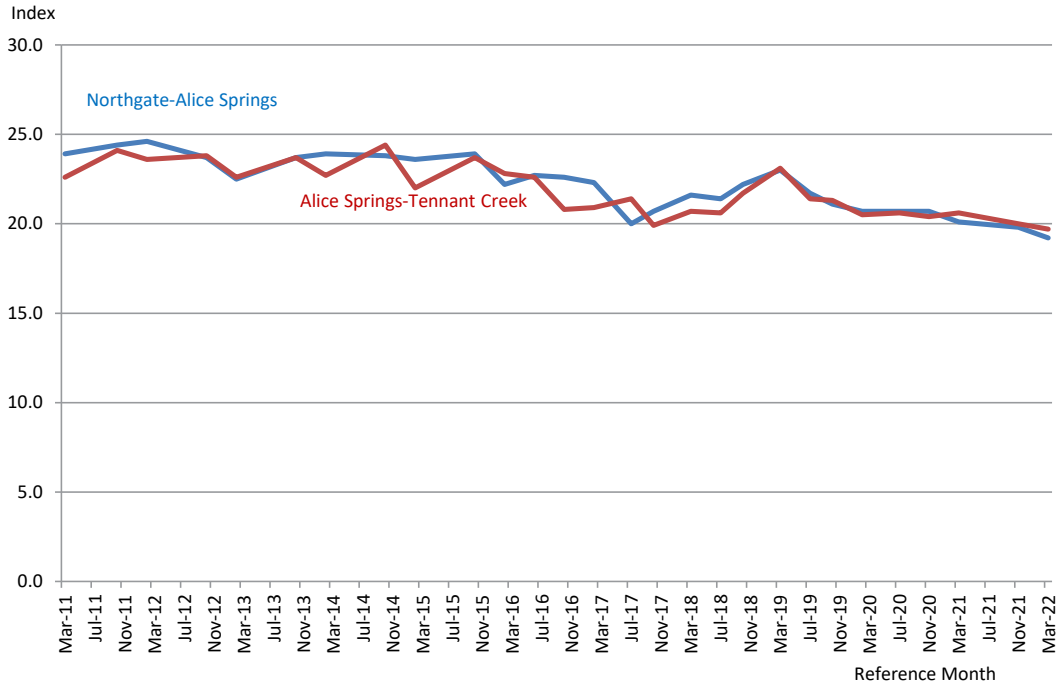
Figure 54 One Rail Australia (now Aurizon) track quality index, Darwin—Tennant Creek



Note: Lower indices indicate higher track quality.

Source: Data Provided by One Rail Australia (Aurizon).

Figure 55 One Rail Australia (now Aurizon) Track Quality Index, Tennant Creek—Northgate



Notes: Northgate is the start of the One Rail Australia (Aurizon) track. It is located shortly north of Tarcoola, where it diverges from the ARTC track.

Lower indices indicate higher track quality.

Source: Data Provided by One Rail Australia (Aurizon).

Box 6 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 One Rail Australia's (Aurizon) 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.

Urban heavy rail passenger networks

Australia's urban heavy rail networks are extensive, even if the network coverage is not dense (see Table 27). 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. In December 2022, Australia had an estimated 1506 route kilometres of operational urban heavy railways.

Table 27 Network characteristics of urban passenger heavy railways, December 2022

	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)		36	220	128	127	188
Shared metropolitan freight/ passenger lines (km)	n/a	-	181	268	-	1
Total route length (km)	357	36	401	396	127	189
Electrified route length (km)	357	36	364	396	44	189
Metropolitan stations (number)	169	13	221	152	88	75
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	62	10.2	-	53
Gauge	Standard	Standard	Broad	Narrow	Broad	Narrow

Notes: Distances are an estimate of 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; Data provided by Adelaide Metro; Data provided by Aurizon; Advice from Public Transport Authority of Western Australia.

Some specific characteristics of the various networks are as follows:

- **Sydney Metro.** Sydney Metro Northwest opened on 26 May 2019 and provides driverless services from Rouse Hill to Chatswood; the first driverless passenger rail service in Australia. The Metro trains operate on a 'turn up and go' basis rather than by timetable. Construction to expand Sydney's Metro line to the Sydney CBD and Bankstown is underway.
- **Brisbane and Perth's** geographical scope arguably includes interurban traffic, in addition to purely urban traffic. This is because the two operators, City Train and Transperth respectively, operate services beyond the greater city areas. This includes services to the Gold Coast in Queensland (approximately 88 kilometres from Roma Street Station) and services to Mandurah in Western Australia (approximately 70 kilometres from Perth Underground Station). By way of comparison, these are the approximate distances from Melbourne to Geelong and Sydney to Gosford, which are served by the non urban rail operators V/Line and Trainlink respectively.
- **Network form.** Perth's system is also distinctive relative to the other Australian networks due to the nature of its new railways. Perth's network is 30 per cent longer than Adelaide's, but has 13 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 30). 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 urban passenger traffic from almost all 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 (narrow gauge), and steel products from Long Island to Melbourne, via the Frankston urban line (broad gauge). 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[34] 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 operations began on the Seaford and Tonsley lines in 2014, and in 2022 on the Gawler line.

Light rail passenger networks

Australia has approximately 326 route kilometres of operational light rail. The technological and operational differences between tramways, light rail and heavy rail are increasingly blurred[35]. 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 networks in Melbourne, Sydney and Adelaide.

By route distance, Melbourne has the world's largest light rail network. There are smaller operations in the other cities that have light rail (see Table 28).

Table 28 Network characteristics of light railways, December 2022

	Gold Coast	Sydney	Melbourne	Adelaide	Canberra	Newcastle
Total route length (km)	20.3	24.7	250	16.6	12	2.7
Segregated right of way	segregated	largely segregated	24% segregated	largely segregated	segregated	segregated
Routes (no.)	1	3	24	1	1	1
Number of stops (no.)	19	42	1 717	29	13	6
Route length under construction (km)	6.7	12			1.6	

Sources: Currie and Burke (2013); Advice from Yarra Trams; G:link (2022); Canberra Metro (2020); Advice from Department of Planning, Transport and Infrastructure; Advice from Transport for NSW; Parramatta Light Rail (2022); Department of Transport and Main Roads (2022); BITRE estimates.

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

35 Tramways generally have short spacing between stations and operate on roads, often sharing a right-of-way with road traffic. Light rail is considered to largely have its own right-of-way with more widely spaced stations. Melbourne's extensive system, in particular, illustrates the flexibility of light rail and its consequent definitional blurring. 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.

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 make light rail traffic average speeds significantly lower than the 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 to 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 now has three light rail routes. The L1 line starts at Sydney Central Station and runs to Dulwich Hill via Pyrmont, and Lilyfield. The line runs along a former freight heavy rail corridor, with a small segment of on-road (largely segregated) operation between Haymarket and Central Railway Station. The L2 and L3 lines, which commenced operations in December 2019, run from Circular Quay to Centennial Park, via Sydney Central Station on shared track. At Centennial Park the lines diverge. The L2 line continues on to Randwick, while the L3 line continues to Kingsford. The L2 and L3 lines are all new construction and are largely on road segregated. In 2022, Stage 1 of the Parramatta Light Rail, connecting Westmead to Carlingford via the Parramatta CBD and Camellia was underway with expected completion in 2024. (Parramatta Light Rail, 2022)

The Gold Coast light railway runs between Helensvale and Broadbeach South. The line runs along roads but the space is generally not shared with road traffic. The line runs along a dense retail corridor. In 2022, construction of Stage 3, a 6.7km extension of the line from Broadbeach South to Burleigh Heads, was underway, with revenue services expected to commence in 2025. (Gold Coast Light Rail Stage 3, 2022)

Light railways opened in Canberra and Newcastle in 2019. The Canberra light railway runs from Canberra city to Gungahlin. Relatively long distances between stops and traffic signals priority enables Canberra's light rail to have the highest point to point average speed – 30 kilometres per hour. In late 2022, construction of Canberra's light rail Stage 2A 1.7 kilometre extension, from the Canberra CBD to Commonwealth Park, began. (Light Rail to Woden, 2022)

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 networks

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 Melbourne.

Table 29 Network coverage of non-urban passenger rail services, December 2022

	Queensland Rail	NSW TrainLink	V/Line	Transwa	Journey Beyond
Electrified route kilometres	728	445	-	-	-
Total route kilometres	4 380	4 261	1 763	836	9 972

Notes: This is a revised estimate of route kilometres. The revised total now includes Journey Beyond's 'Great Southern' service from Brisbane to Adelaide via Melbourne. Shared corridors by multiple services by the same operator 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. Conversely, the Sydney-Armidale estimate only includes the section from Maitland to Armidale. Shared corridors by separate operators are counted separately. For example, Transwa's estimate includes the East Perth-Kalgoorlie corridor, which is counted separately to Journey Beyond's estimate that also includes East Perth-Kalgoorlie.

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.

Chapter 6
Rollingstock

Locomotives

Due to an ongoing lack of data provision from some above-rail operators, BITRE is unable to report a current estimate of the total number of operational locomotives in Australia. According to its previous estimate in September 2021, there were approximately 2100 operational locomotives in Australia[36].

According to its 2020/21 annual report, TasRail had the following 27 operational locomotives:

- 17 TR Class;
- Eight 2000 (DQ) Class; and
- Two 2050 Class (TasRail, 2021, p.9).

Table 30, below, shows utilisation of the fleet, as measured by the net tonne kilometres of freight hauled.

Table 30 TasRail locomotive usage

Year	Number of locomotives	Task (net tonne kilometres)
2020–21	27	18 838 436
2019–20	27	17 763 845
2018–19	27	17 887 179

Source: TasRail, (2021), p. 9.

36 For details of the September 2021 estimate, see BITRE (2022b), pp. 61-63

Figure 56 TasRail locomotive

Note: The image above shows TasRail 2000 class unit 2010 in wintery condition on the Bell Bay line. Photo courtesy of Steve Kimpton and TasRail.

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).

Heavy rail rolling stock

"Multiple unit" stock using permanently coupled carriages provide all 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. Melbourne's new HCMT train, which began entering service in December 2020, operate as seven car sets. 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 two-car and three-car operations in Perth.

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.

Table 31 Operational urban heavy rail rolling stock, July 2022

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Vehicles (no.)	888	1833	1415	122	330
Carriage format	Single-deck	Double-deck and single-deck	Single-deck	Single-deck	Single-deck
Multiple-unit format	75 six car 146 three car	22 six car 187 four car 120 eight car	205 six car 26 seven car	One and two car sets	48 two car 78 three car
Common train formations	EMUs coupled as either three-car or six-car sets	EMU eight-car sets and six-car sets for Metro units	EMUs coupled as six-car sets and seven 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: The Brisbane total includes interurban rollingstock, while the Sydney totals exclude it. This is due to structural differences between operators in each state.

The Sydney total includes the Alstom Metropolis metro cars.

The Perth figures are what was current in 2021, as reported in its 2020–21 annual report.

Sources: Data provided by Queensland Rail, Transport for NSW, Public Transport Victoria, and Adelaide Metro; and Public Transport Authority WA, (2021), p.16.

BITRE estimates that in July 2022, Australia had 4 588 urban heavy rail cars (both electric and diesel, formed into multiple unit sets). There were either no or only minor changes to operational fleet numbers since 2021 except for the following:

- In Melbourne, the number of ageing Comeng class vehicles has reduced by 156, while 182 newly built HCMT cars have entered service; and
- In Adelaide, the number of ageing diesel powered 3000/3100 cars has reduced by 26 while 18 new electric multiple unit (EMU) cars have entered service, following electrification of the Gawler line.

Light rail rolling stock

In 2022, there were no changes to Australia's light rail fleet numbers since 2021. BITRE estimates there were 631 light rail vehicles in service.

Over the past 30 years, there has been a progression towards longer, higher capacity vehicles, using vehicle articulation rather than the coupling of vehicles, although all of Sydney's new Citadis X05 vehicles now operate as coupled two car sets. Melbourne's E class vehicle, introduced from 2013, is more than twice the length of the earlier Z and A classes. Similarly, rollingstock 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. Alstom manufactures the Australian built E class vehicles at its Dandenong plant in Victoria. Imported vehicles are made in Spain, Germany, and France.

Melbourne's light rail fleet is much larger and more varied than the other cities. 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.

Table 32 Operational light rail rolling stock, July 2022

City	Vehicle type	Length (metres)	No. vehicles
Gold Coast	Flexity 2	43	18
Sydney	Urbos 3	33	12
	Citadis X05	33	60
Sydney total			**72**
Melbourne	A1 class	15	27
	A2 class	15	42
	B2 class	23.6	130
	C1 class	23	36
	C2 class	32.5	5
	D1 class	20	38
	D2 Class (Combino)	29.9	21
	E Class	33.5	100
	Z3 class	16.6	87
	W class	14.2	13
Melbourne total			**499**
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, Adelaide Metro, Transdev NSW, and 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);
- The average speed of services (with faster operations requiring fewer train sets); and
- Modernisation and replacement.

There is a wide range of non-urban passenger services in Australia. Thus, rolling stock, designed for individual markets and service types, vary. BITRE estimates there were 1105 non-urban cars and carriages in service and 86 locomotives in service.

Table 33 Operational non-urban passenger rolling stock, by type and operator, July 2022

	Queensland Rail	NSW TrainLink	V/Line	Transwa
Electric multiple unit cars (no.)	12	425	-	-
Diesel multiple unit cars (no.)	5	65	321	14
Locomotives (no.)	35	19	32	-
Carriages (no.)	82	60	121	-
Total cars/vehicles	124	569	474	14

Notes: Unlike what was reported in *Trainline* 9, the V/Line diesel multiple unit figure excludes vehicles under construction/test/commissioning, hence the lower number reported above.

The Queensland Rail total excludes the electric multiple unit cars that serve destinations outside Brisbane as services to these destinations form part of an integrated urban/interurban network. The 12 cars listed above are the electric tilt trains. For details of the Queensland Rail's electric multiple unit fleet see Table 24. The 10 diesel multiple unit cars are of the *Gulflander* 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 Transwa figures are what was current in 2021, as reported in its 2020–21 annual report.

The above lists individual vehicles rather than sets.

No data is available for Journey Beyond's trains.

Sources: Data provided by Transport for NSW, Queensland Rail, and Public Transport Victoria; Public Transport Authority WA (2021), p20.

NSW TrainLink and Queensland Rail have large electric multiple unit (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. Victoria and Western Australia have no EMU non-urban trains. Other medium-distance regional/commuter services are increasingly diesel multiple unit (DMU) operated. Transwa uses DMUs for all its rail services.

The use of locomotive hauled passenger trains in Australia continues to be in decline. In Victoria, the expanding fleet of VLocity DMU sets is replacing many previous locomotive hauled trains. This includes standard gauge sets which began entering service on the Albury line in December 2021. Remaining locomotive hauled trains are primarily used for long-distance routes although V/Line still uses them for Melbourne—Bacchus Marsh services. Some Queensland long-distance services are of the traditional locomotive hauled type. New South Wales uses both XPT trains and Xplorer DMU trains on its long distance services. The XPTs are of the same fixed format structure as Queensland's diesel tilt trains. The New South Wales Government is replacing the XPT and Xplorer fleet and the first trains are expected to enter service in the mid to late 2020s.

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. While the diesel tilt train is technically locomotive hauled, it differs from traditional locomotive hauled trains by virtue that the power cars (locomotives) are in a fixed format setting as part of a single train set, with one power car at each end of the trains, similar to the XPT sets. This arguably gives them the appearance of a DMU train. (BITRE 2014d, p. 60 and pp. 161–162, discusses the nature of the tilt-train services and the principles of tilt trains.)

Most modern medium and long-distance DMU passenger trains in Australia are capable of and are timetabled in places to travel at speeds of 130-160 km/h, but they can only do so where the infrastructure used can facilitate such speeds.

Figure 57 VLocity train

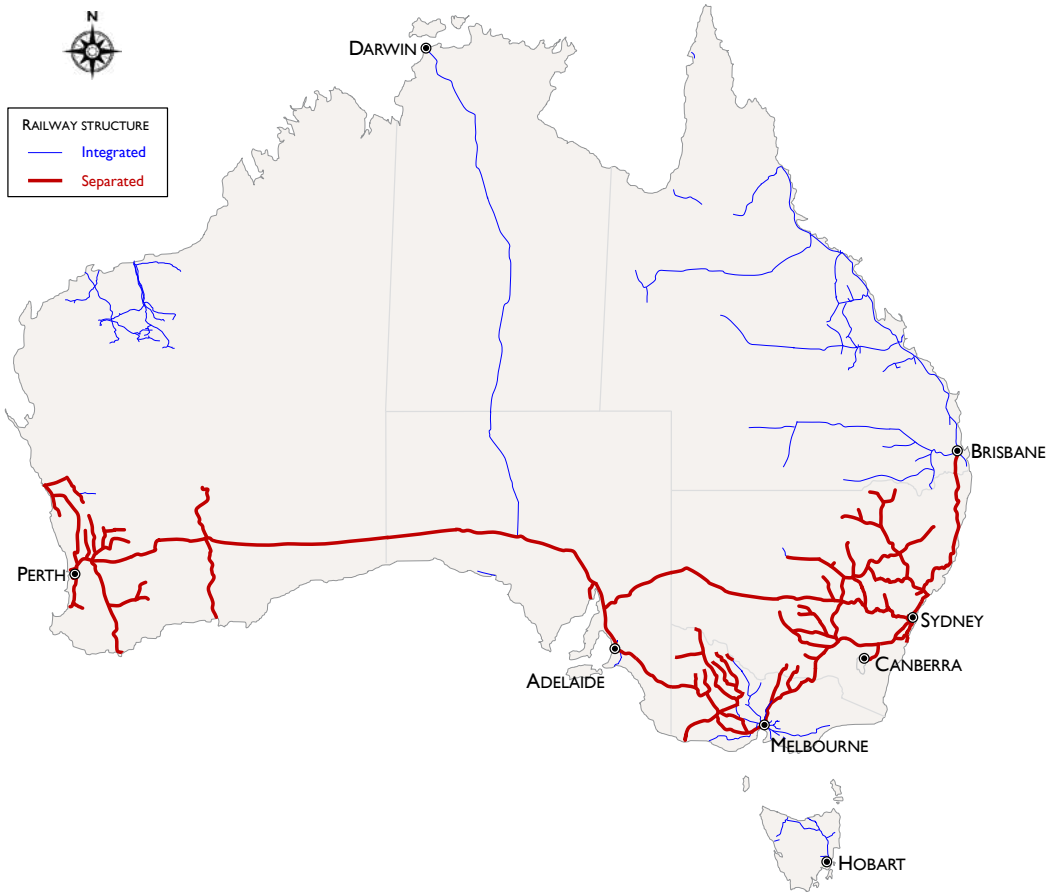
Note: The image above shows a newly built V/Line standard gauge VLocity train at Chiltern, Victoria, March 2022. Photo courtesy of Rodney Avery.

Chapter 7

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. In vertically-integrated railways the infrastructure manager both manages the infrastructure and runs revenue earning services on it. Vertically-integrated railway managers may provide "third-party access" to (other) train operators, such as in the Central Queensland Coal Network.

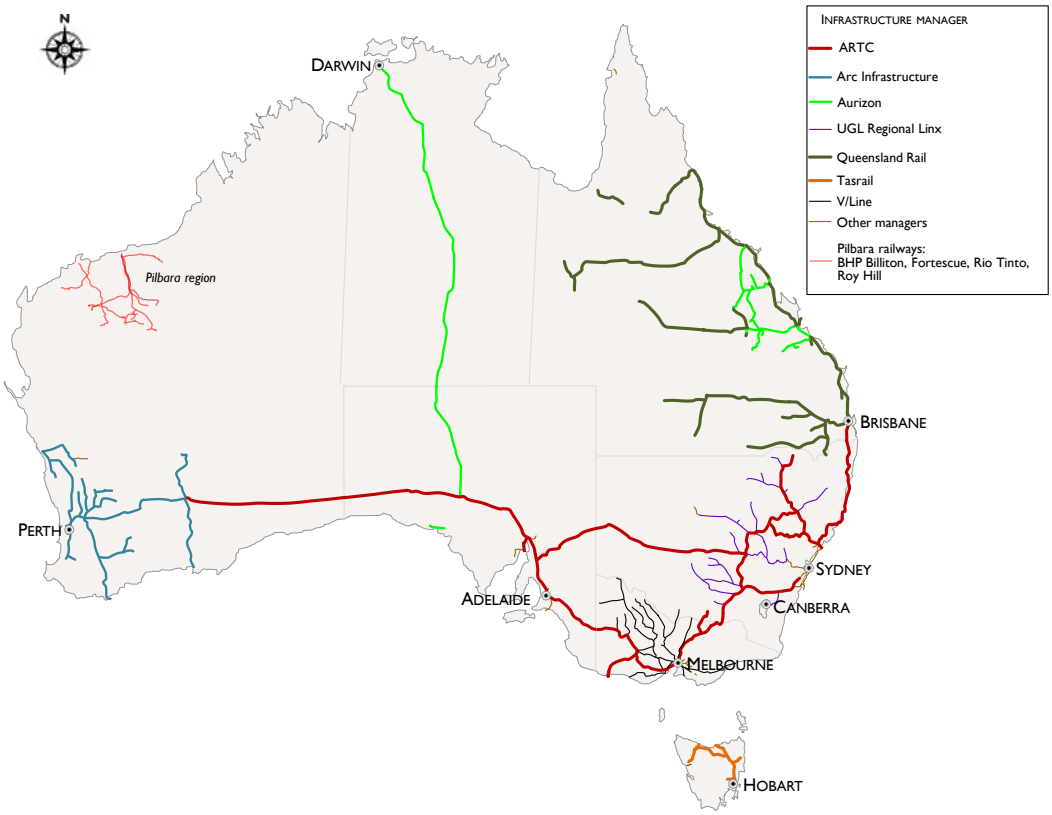
Figure 58 Australian rail industry structure, 2022



Infrastructure management

Australia's infrastructure managers are diverse in structure and operation. Figure 59 shows Australia's railway system by network manager.

Figure 59 Australian railways, by network manager, December 2022



Notes: 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. Aurizon owns (long lease) the Tarcoola—Darwin line as a vertically-integrated railway. Sydney—Perth trains that travel via Lithgow use UGL Regional Linx (UGLRL)-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 UGL Regional Linx 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, UGL Regional Linx), Victoria (V/Line)[37] and Western Australia (Arc Infrastructure). Aurizon operates as a vertically-integrated operator in parts of South Australia.
- **Passenger.** Urban systems are vertically-integrated. Non-urban passenger operations are a mix of vertical-integration and separation.

Table 34 Principal infrastructure managers of Australian railways, December 2022

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
Aurizon	Integrated	Intermodal, ores, passenger
UGL Regional Linx	Separated	Intermodal, steel, grain, coal, passenger
Intrastate		
Aurizon (Queensland)	Integrated	Coal
Queensland Rail	Integrated and Separated	Passenger (integrated), grain, coal, cattle, ores, intermodal (separated)
UGL Regional Linx	Separated	Intermodal, grain, ores, 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, quary products, intermodal
ARTC (Victoria, Maroona-Portland)	Separated	Grain
TasRail	Integrated	Intermodal, coal, ores, timber
Aurizon (South Australia)	Integrated	Grain, gypsum, ores
Arc Infrastructure Rail (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	Passenger
MTM (Metro Trains Melbourne)	Integrated	Passenger
Keolis Downer (Adelaide)	Integrated	Passenger
Transperth	Integrated	Passenger

Note: There are a number of other, smaller, infrastructure managers, including heritage railways, totalling an estimated 511 route-kilometres.

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

Above rail operators

- **Heavy rail urban passenger** operators are largely vertically-integrated. Most are publicly-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, and Keolis Downer which similarly operates trains and manages the Adelaide network on behalf of the South Australian Government.
- **Non-urban passenger services** government operated except Journey Beyond, 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.** These include Pacific National, SCT Logistics, QUBE Logistics, Aurizon, and Southern Shorthaul Railroad.
- **Regional rail freight operators.** These include Pacific National, SCT Logistics, QUBE Logistics, Aurizon, Southern Shorthaul Railroad, TasRail, and Watco.
- **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 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 35 Principal train operators in Australia, December 2022

Train operator	Infrastructure network used	Primary tasks
Aurizon	Aurizon, Queensland Rail, ARTC, Arc Infrastructure	Coal, ores, minerals, cattle, grain, mixed bulk, agricultural produce intermodal (Adelaide-Darwin)
Pacific National	Aurizon, Queensland Rail, ARTC, V/Line, UGL Regional Linx, Sydney Trains, Arc Infrastructure, Metro Trains Melbourne	Coal, ores, intermodal, steel, grain, mixed bulk
SCT Logistics/Specialised Bulk Rail	ARTC, Arc Infrastructure, Sydney Trains	Intermodal, steel, grain, iron ore
QUBE Logistics	ARTC, V/Line, Sydney Trains, UGL Regional Linx, Metro Trains Melbourne	Intermodal, steel grain, mixed bulk
Watco	Aurizon, Queensland Rail	Grain, livestock
Southern Shorthaul Railroad	ARTC, Sydney Trains, UGL Regional Linx, V/Line, Metro Trains Melbourne	Coal, grain, intermodal, infrastructure works
TasRail	TasRail	Intermodal, coal, ores, timber
Fletcher International	ARTC, UGL Regional Linx, 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, UGL Regional Linx, 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)
Journey Beyond Rail Expeditions	Sydney Trains, UGL Regional Linx, ARTC, Arc Infrastructure, Aurizon	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)
Keolis Downer (Adelaide)	Keolis Downer	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
Sydney Metro	Metro North West Line	Fully automated rapid transit passenger

Chapter 8
Safety and Environment

Safety

The Office of the National Rail Safety Regulator (ONRSR), which has regulatory safety oversight for all of Australia[38], stated in its 2021–22 annual report there were 74 notified fatalities on railways regulated under *Rail Safety National Law (2012)*; down from 84 the previous financial year and 100 the financial year before that. Table 36, below, gives details of these fatalities.

Table 36 Rail related fatalities by jurisdiction 2021–22

Jurisdiction	Suspected suicide	Trespasser struck by train	Slips, trips and falls	Level crossing collisions	Rail Accidents	Other	Total
ACT	0	0	0	0	0	0	0
SA	4	0	0	1	0	0	5
TAS	0	0	0	0	0	0	0
NT	0	0	0	0	0	0	0
NSW	11	4	1	0	1	0	17
VIC	25	4	1	1	2	2	35
QLD	8	1	1	1	0	0	11
WA	5	0	0	1	0	0	6
Total	**53**	**9**	**3**	**4**	**3**	**2**	**74**

Notes: Slips trips and falls includes members of the public involved in incidents on or in the vicinity of railway infrastructure/operations such as stations and station accesses. Does not include rail safety workers.

Rail accidents includes events such as collisions between trains and persons being struck by trains (excluding level crossing collisions, suspected suicides and trespassers).

The Victorian figures includes slips, trips and fall occurrences on Melbourne's extensive light rail network.

Source: ONRSR, 2022, p.21.

Similar also to the previous two financial years, Victoria had the most fatalities, almost half the national total. Suicide continues to be the dominate cause of deaths in the state.

Under Rail Safety National Law, rail transport operators must report occurrences. Category A occurrences must be reported immediately. Category B occurrences must be reported within 72 hours of the occurrence. Details of Category A and Category B occurrences and serious injuries for the 2019–20 and 2020–21 financial years are shown below.

38 Each Australian state and territory has legislated nationally consistent rail safety law, which ONRSR administers.

Table 37 Category A and Category B occurrences injuries by jurisdiction 2021–22

Jurisdiction	Category A	Category B	Fatalities	Serious Injuries
ACT	1	79	0	1
SA	28	3552	5	3
TAS	4	270	0	0
NT	2	69	0	0
NSW	61	11798	17	15
VIC	126	10243	35	44
QLD	47	8030	11	7
WA	37	4063	6	14
Total	**306**	**38104**	**74**	**84**

Source: ONRSR, 2022, p.20.

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 and subject to revision.

Changing requirements, such as higher performance and, for passenger rail, air-conditioning and on-board electronics, may increase emissions intensity. Table 38 shows BITRE's revised most recent full fuel cycle carbon dioxide equivalent emissions estimate by transport mode since 2011–12[39]. These CO_2 equivalent values use updated Global Warming Potentials, and this slightly alters the estimated levels from previous BITRE estimates; and the full fuel cycle element, of the emission estimation, uses recent updates to the Scope 3 emissions factors in the National Greenhouse Accounts. This somewhat increasing most estimated levels from those in previous releases).

According to the current estimate, emissions have increased by approximately 18.5 per cent since 2011–12. As Figure 60 (which expresses the emissions shown in Table 38 in percentage terms) shows, however, while rail transport has had a greater increase in emissions than road transport, road transport's total emissions have been approximately 94 per cent greater than rail's on average each year.

39 Table 11.9 of BITRE, 2022, shows full estimates dating back to 1974-75.

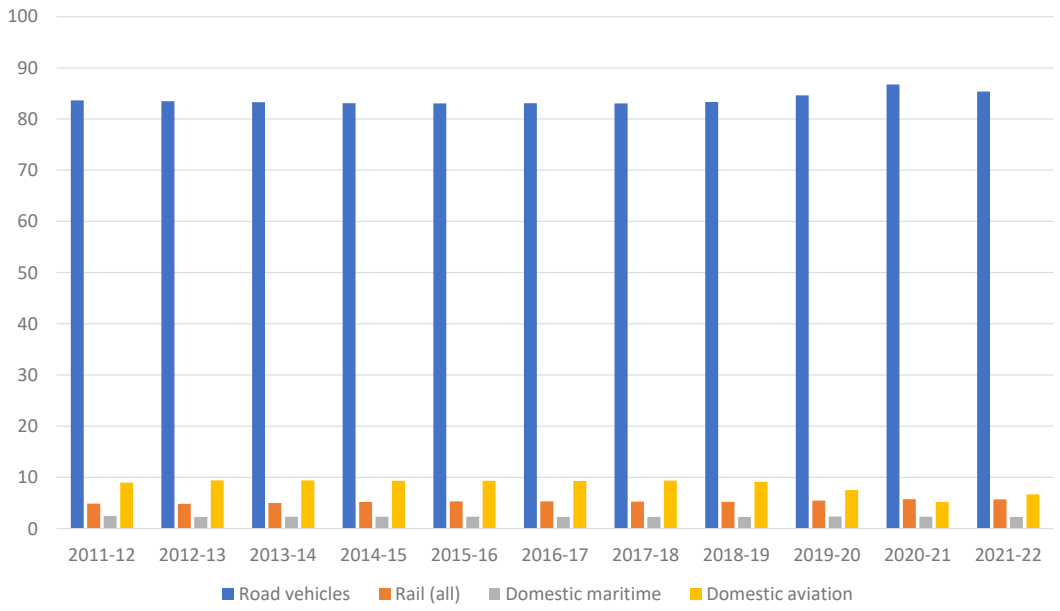
Table 38 Transport full fuel cycle greenhouse gas (carbon dioxide equivalent) emissions, by transport mode

Financial year	Road vehicles	Rail (all)	Domestic maritime	Domestic aviation	Total (direct)
			gigagrams of CO_2 equivalent		
2011–12	96 356	5 626	2 851	10 361	115 195
2012–13	97 911	5 687	2 662	11 042	117 302
2013–14	98 898	5 918	2 751	11 180	118 747
2014–15	99 439	6 232	2 793	11 186	119 649
2015–16	101 250	6 466	2 844	11 378	121 939
2016–17	102 456	6 555	2 835	11 466	123 312
2017–18	103 951	6 595	2 882	11 716	125 143
2018–19	104 257	6 576	2 878	11 429	125 140
2019–20	100 249	6 497	2 784	8 922	118 453
2020–21	101 108	6 687	2 701	6 046	116 542
2021–22	99 877	6 662	2 652	7 819	117 010

Source: BITRE, 2022b, Table 11.9.

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 60 Proportion of greenhouse gas emissions by transport mode – full fuel cycle



Case study

Port Kembla rail operations

Located approximately 75 kilometres due south from Sydney and nestled along the narrow coastal strip between the Illawarra Escarpment (Illawarra Range) and the South Pacific Ocean is the strategic NSW port of Port Kembla. Just offshore are international ships arriving for their turn at the port, either to load bulk produce brought to the port or to offload their freight onto Australian shores. On the landside, Port Kembla is served both by rail and road. Rail dominates the transport of bulk freight (grain and coal) for export, while road dominates for imported goods coming in to the port, such as motor vehicles and large project cargo like wind turbines and electrical transformers. Cement Australia also imports clinker, which is transported by regular rail services to its end destinations. The port forms part of the greater, privately owned NSW Ports, which also manages Port Botany in Sydney, the Enfield Intermodal Logistics Centre, and Cooks River Intermodal Terminal (both in Sydney) under a 99-year lease from the NSW Government.

To stand somewhere high within the port you see around you what to the unaccustomed eye looks like a maze of rail lines and various trains in different corporate logos, either moving slowly within the port, or at rest, having completed their job of delivering to the port and waiting to head out again for more. Amongst the scene also, there is a deep shipping channel and berths at which ships are being escorted into or out of the harbour or berthed alongside. For grain and coal in particular, it is a place where transport by rail meets transport by sea.

Figure 61 **Port Kembla**

Note: Aerial view of Port Kembla industrial precinct. Image supplied by NSW Ports.

The port's history centres on coal and dates back to 1865, when the first coal was mined at nearby Mount Kembla. Mount Kembla Coal and Oil Company opened a railway from their mine on Mount Kembla to the first jetty at Port Kembla in 1882. In 1885, a decision was made to develop the port as the deep-water port for the southern coalfields instead of nearby Wollongong Harbour. Today, NSW Ports describes Port Kembla as an international trade gateway for bulk agricultural, construction, mining and motor vehicle industries. It is New South Wales' largest motor vehicle import hub and home to the east-coast's largest grain export terminal and second largest coal export port.

Today, rail's scope of operations at the port primarily focus on bringing grain from deep inside the NSW interior and coal from the southern NSW coalfields. It has grown to the strategic port seen today, with a network of rail lines serving the various segments of the port. It serves exporters' needs as an exit point for Australian grain and other agricultural products, and thermal coal. The port has two grain terminals, operated each by GrainCorp and Quattro (QUBE).

For rail, there are two access points to Port Kembla for freight trains: down the Illawarra Escarpment via Moss Vale on the Main South Line in the Southern Highlands to Unanderra, and via Sydney and the South Coast line through Wollongong. Most grain traffic by rail takes the Moss Vale—Unanderra line, while most coal trains travel over the Blue Mountains and through suburban Sydney on to the South Coast Line.

Port Kembla regularly receives grain from across the Central West and Riverina Regions of NSW, and as far as more distant places such as Coonamble and Nyngan. A train from Coonamble travels approximately 700 kilometres to the port, travelling through the state's interior, over the Blue Mountains, through suburban Sydney, then down the South Coast line through Wollongong.

According to advice from NSW Ports, approximately 2.73 million tonnes of grain and 2.33 million tonnes of coal was transported to the port by rail in the 2021–22 financial year. This task was accomplished by 1196 grain train and 701 coal train services. For grain this was an approximate 26 per cent increase from the previous financial year, while for coal the increase was approximately nine per cent. The significant grain increase followed consecutive bumper harvests.

Rail operations within the port, while interfacing with the Transport for NSW network, are a discrete operation. The port rail infrastructure consists of approximately 26 track kilometres, which Pacific National manages on NSW Ports' behalf, including track maintenance and train control. While Pacific National also uses the port rail infrastructure as an above-rail operator, its below-rail role as infrastructure manager is entirely separate, to ensure fair and equitable access and use of the infrastructure. There are four main above-rail operators serving the port – Pacific National, QUBE, Southern Shorthaul Railroad, and Aurizon.

Figure 62 Port Kembla rail activity

Note: Pacific National (one of the port's above-rail operators) train servicing Port Kembla. Image supplied NSW Ports.

NSW Ports has a development approval for the reclamation of additional land in Port Kembla's Outer Harbour. According to NSW Ports, this area will support Port Kembla's development as the state's second container terminal, in line with long-standing NSW Government policy. NSW Ports says Port Kembla offers the lowest overall costs and highest overall benefits for a second container port in NSW, once Port Botany nears capacity. As NSW container trade is import dominant, NSW Ports further says that locating container terminals closest to Greater Sydney reduces supply chain costs, environmental impacts of distribution and taxpayer investment in road/rail infrastructure.

According to advice from NSW Ports to BITRE, rail is integral to Port Kembla's operations and its future growth and expansion to serve additional industries. NSW Ports states that port volumes are expected to grow, and that rail connections to/from the port require further investment for resilience and capacity to meet this growth and reduce the growth of truck movements. Opportunities exist to grow future volumes in bulk commodity imports/exports such as cement, copper concentrate and new mineral exports. QUBE operated steel trains also use the port's network to access Bluescope's Port Kembla Steelworks. Expanding their future operations would also rely on investment in rail connections to the port.

Port Kembla currently has two rail access routes (from Moss Vale and from Sydney). If one route goes offline, trains must take the alternative route, which is costly both in time and money. For example, the Moss Vale—Unanderra line was closed from March to October 2022, following adverse weather events, which forced the line's closure at difficult to access and repair locations. This meant all grain traffic by rail from central NSW had to take the longer and costlier route through Sydney and Wollongong. This route is also limited in freight train path availability due to high volumes of passenger rail transport demand. In April 2022, the line from Sydney was also cut for several weeks, due also to track damage caused by adverse weather, leaving Port Kembla completely cut off by rail. Another constraint is track access capacity, particularly through the already highly utilised Sydney network where freight trains have limited access due to sharing the network with passenger trains.

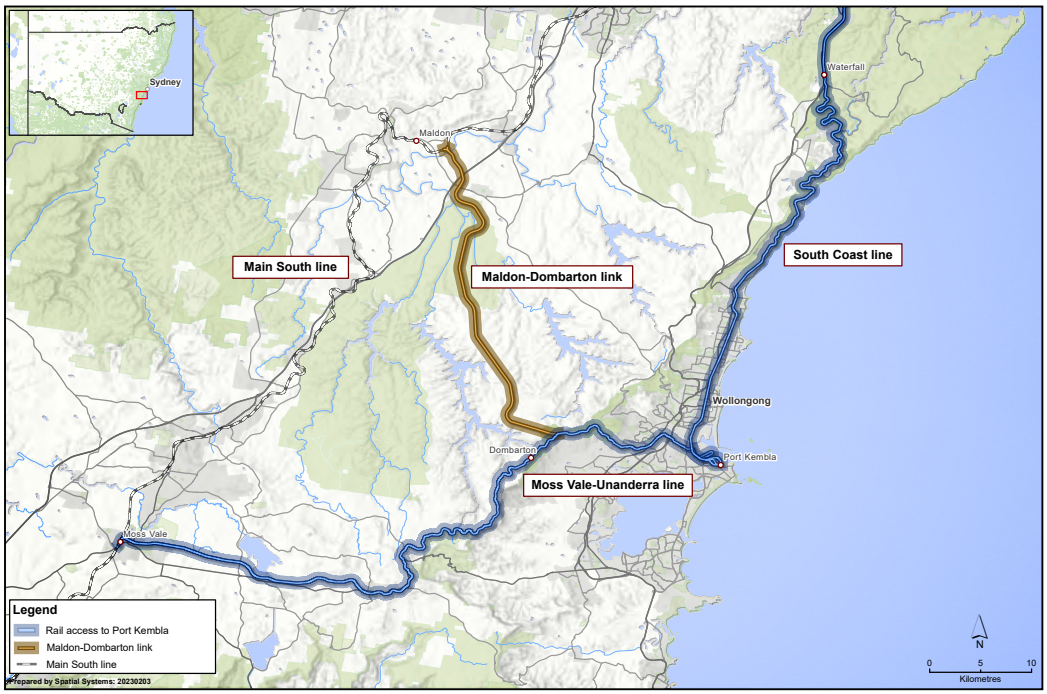
As such, NSW Ports sees completion of the Maldon—Dombarton rail link (also known as SWIRL (South West Illawarra Rail Link)) as its highest priority. The proposed rail link is a 35-kilometre railway connection from the Main South line at Maldon in the NSW Southern Highlands to the Moss Vale—Unanderra line at Dombarton, near Port Kembla. NSW Ports says this will provide a more direct (hence more efficient and cost effective) rail access between the port, the growing region of Western Sydney, and regional NSW. It would also add capacity and resilience. Construction of the rail link began in 1983 but was ceased in 1988 due to economic conditions at the time. (Transport for NSW, 2018). According to NSW Ports, completion of the rail link "...would improve the resilience of rail connections to Port Kembla for freight and provide additional capacity for future trade growth. This same line can be shared with passengers initially, connecting the Illawarra with the growing region of western Sydney and the Western Sydney Aerotropolis."

A 2020 University of Wollongong SMART Infrastructure Facility report[40] argues completion of SWIRL would have a benefit to cost ratio of 1.13-1.56 over 50 years, where it is assumed the line would be electrified and also used for passenger services. (University of Wollongong, 2020, p.17). The report further recommends "That Infrastructure Australia updates its priority initiative (0–5 year) for 'Freight Rail Access to Port Kembla' and acknowledges the SWIRL-Maldon corridor as a future "alternative rail alignment to the port." (University of Wollongong, 2020, p.4)

40 The report is titled *Assessing the economic impacts of better connecting the Illawarra to Greater Sydney and the Western Sydney Aerotropolis*

The NSW State Infrastructure Strategy 2022–2042 identifies the need for Transport for NSW to undertake transport planning to support the future second container port at Port Kembla, including road and rail linkages to major logistic hubs such as Western Parkland City. (Infrastructure NSW, 2022, p.63) While completion of the link is not a current state or Commonwealth government priority, it does feature at Transport for NSW as a potential future project. The NSW Government Future Transport Strategy 2056 identifies a future freight rail line along the corridor (Transport for NSW, 2018a, p.121). Transport for NSW, in its most recent update about the project in 2018, states Infrastructure Australia found the project to be unviable. At the state government level, it states the project, while still an option for possible completion in the future, would need ongoing state government financial and policy support to make it commercially viable. (Transport for NSW, 2018)

Figure 63 Rail links to Port Kemba – existing and proposed



Other infrastructure priorities for Port Kembla NSW Ports identifies are as follows:

- Junee North Triangle: Reinstatement of the north side of the triangle would enable trains on the Griffith—Junee line travelling to Port Kembla or Port Botany to enter the Main South line directly at Junee, thus avoiding the time and cost for trains to turn and shunt at Junee yard, as is current practice.
- Stockinbingal connection: To deliver improved connectivity to Port Kembla and Port Botany, through connections between the new Inland Rail line from Illabo (when completed) and the existing Main South line to Sydney and Port Kembla.
- Griffith to Stockinbingal upgrade: Increasing total axle load to boost the total weight each wagon could transport from regional NSW to Port Kembla.
- Track upgrades and bi-directional signalling to improve access to and the resilience of the Main West line connecting Greater Sydney to Western NSW, across the Blue Mountains.

- More rail-based bulk receival sites for construction material in Western Sydney, the demand for which has risen due to our increasing population and associated housing needs. Cement is currently transported from Port Kembla by rail, but further growth cannot occur unless there are additional terminals that are able to receive the railed products such as new terminals in western Sydney.

Figure 64 Junee North Triangle

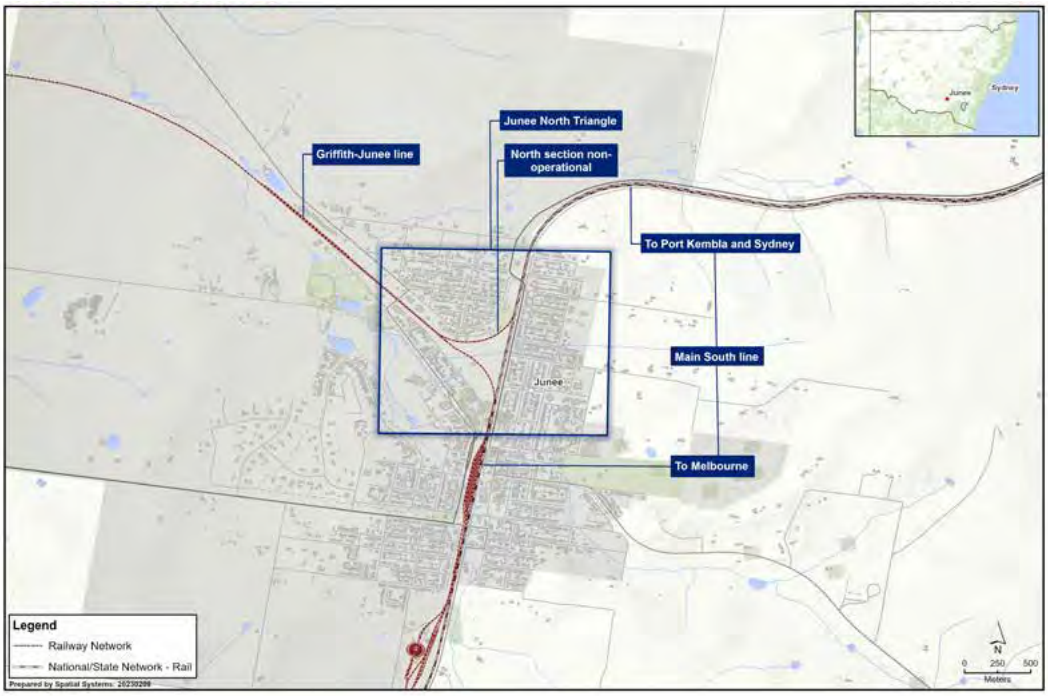


Figure 65 **Port Kembla map**

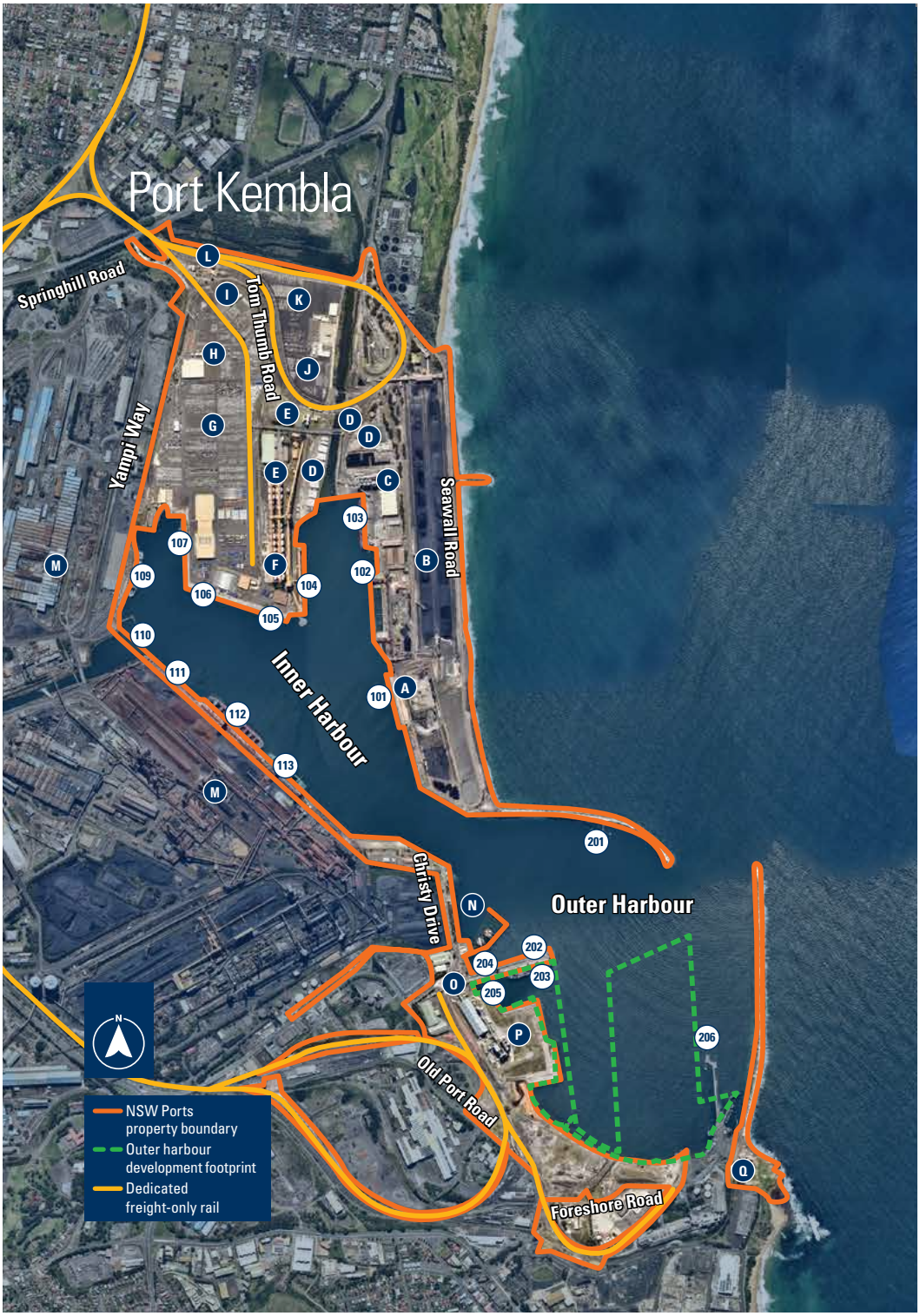


Table 39 Port Kembla Map Legend

1,2,3 etc.	Berth numbers
A	Australian Industrial Energy
B	Port Kembla Coal Terminal
C	Quattro
D	TQ Holdings
E	GrainCorp
F	Falcon Cement
G	Australian Amalgamated Terminal (AAT)
H	Autocare
I	PrixCar
J	AutoNexus
K	Ceva Logistics
L	Pacific National
M	BlueScope
N	Svitzer
O	Port Kembla Gateway
P	Cement Australia
Q	NSW Ports – Maritime Centre

Appendix A

Significant railway events since 2017

Date	Event	Description
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
14 Dec 2019	Sydney Light Rail	L2 line commences operations
January 2020	GWA Sale	GWA's assets and operations sold to investors, including Brookfield Infrastructure Partners LP and Singapore sovereign-wealth fund GIC. Company is renamed One Rail Australia.
3 Apr 2020	Sydney Light Rail	L3 line commences operations
22 Oct 2021	Aurizon acquisition of One Rail Australia	Aurizon announces acquisition of One Rail Australia, at $2.3 billion, expected to be concluded in April 2022.
29 Dec 2021	Standard gauge VLocities	Newly built standard gauge VLocity trains start revenue service on Melbourne – Albury line.
January 2022	NSW CRN	UGL Regional Linx starts 10 year contract managing NSW CRN, replacing John Holland Rail
1 January 2022	Bluescope contract	QUBE Logistics and SCT Logistics start contract with Bluescope for the transportation of its steel products, replacing the former contract holder, Pacific National.
29 July 2022	One Rail Australia sale	Aurizon completes its $2.35 billion acquisition of One Rail Australia
9 October 2022	Forrestfield-Airport Link	Newly constructed Perth Forrestfield-Airport Link line open to revenue services

Appendix B

Significant network route additions since 2000

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
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

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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 – Manor (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	NSW	Standard	3.5	Grain
	Byerwen branch line	Qld	Narrow	5	Coal
2018	Baralaba (Moura System)	Qld	Narrow	6	Coal
	Mernda Line Extension	Vic	Broad	8	Urban Passenger
2019	Sydney Metro Northwest	NSW	Standard	36	Urban Passenger
	Inland Rail North West Connection	NSW	Standard	5	Interstate and Intrastate freight
2020	Flinders Link Project	SA	Broad	.65	Urban Passenger
	Western Hub (Eliwana)	WA	Standard	143	Iron Ore
2021	Tamworth Intermodal Rail Line	NSW	Standard	6	Intermodal
2022	Forrestfield – Airport Link	WA	Narrow	8.5	Urban Passenger

Note: Does not include light rail/tramways.

Appendix C
Aurizon Traffic 2016–17 to 2020–21

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

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**

Period	Coal	Bulk[41]	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**
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**
Sep-19	12.4	n/a	n/a	n/a
Dec-19	12.4	n/a	n/a	n/a
1HY-19	24.8	n/a	n/a	n/a
Mar-20	12.2	n/a	n/a	n/a
Jun-20	13	n/a	n/a	n/a
2HY-20	25.2	n/a	n/a	n/a
Full year 2019–20	**50**	**n/a**	**n/a**	**n/a**

41 Aurizon reports bulk as including iron ore, agricultural products, and mining and industrial inputs.

Period	Coal	Bulk	Freight	Total
Sep-20	11.7	n/a	n/a	n/a
Dec-20	12	n/a	n/a	n/a
1HY-20	23.7	n/a	n/a	n/a
Mar-21	11.4	n/a	n/a	n/a
Jun-21	11.9	n/a	n/a	n/a
2HY-21	23.3	n/a	n/a	n/a
Full year 2020–21	**47**	**n/a**	**n/a**	**n/a**

Note: Net tonne-kilometre data for 2021–22 not available.

Sources: Previous editions of Trainline, drawing published data from Aurizon.

Appendix D

Urban heavy rail network maps – December 2022

Figure 66 **Adelaide**

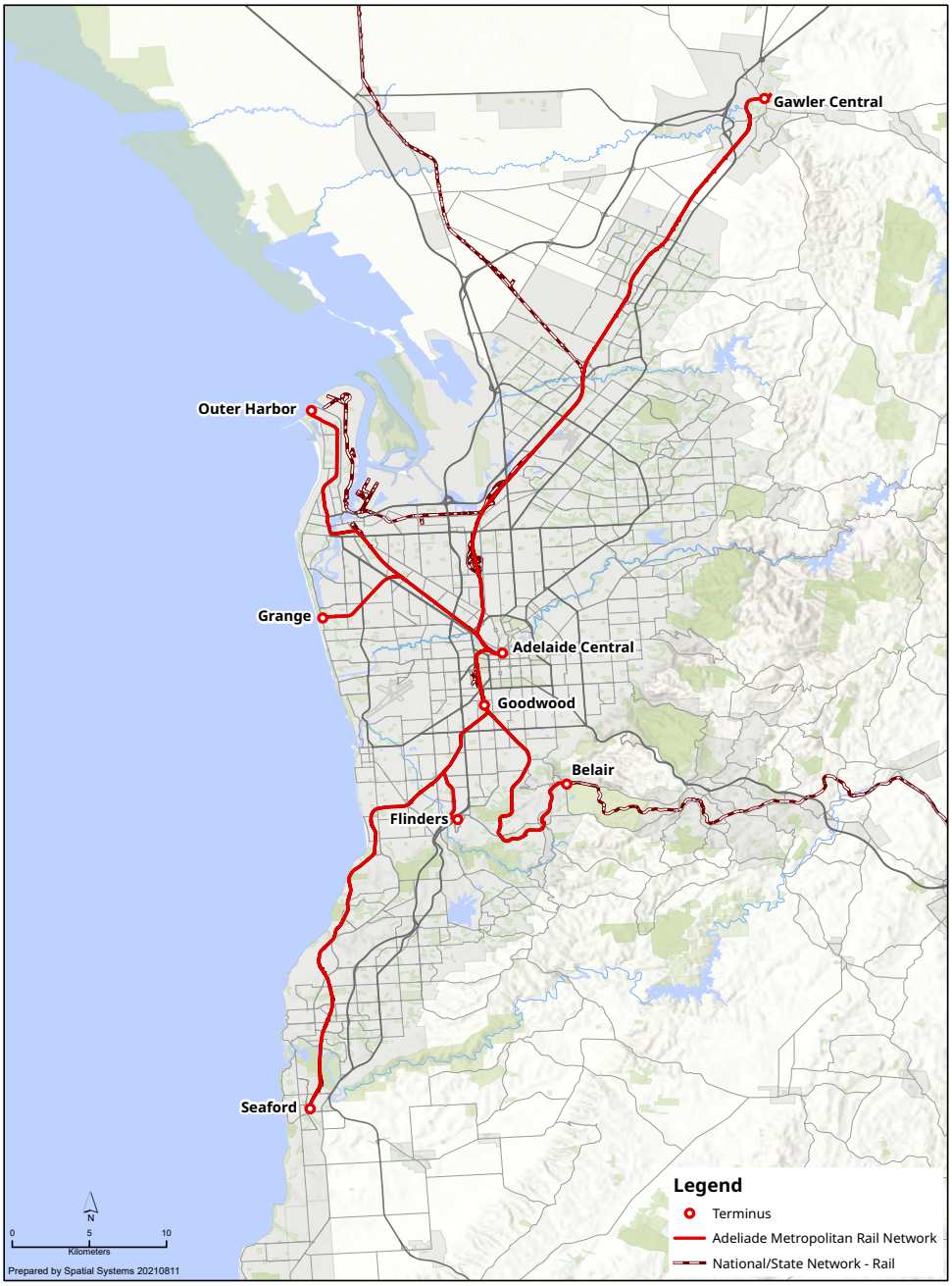


Figure 67 Brisbane

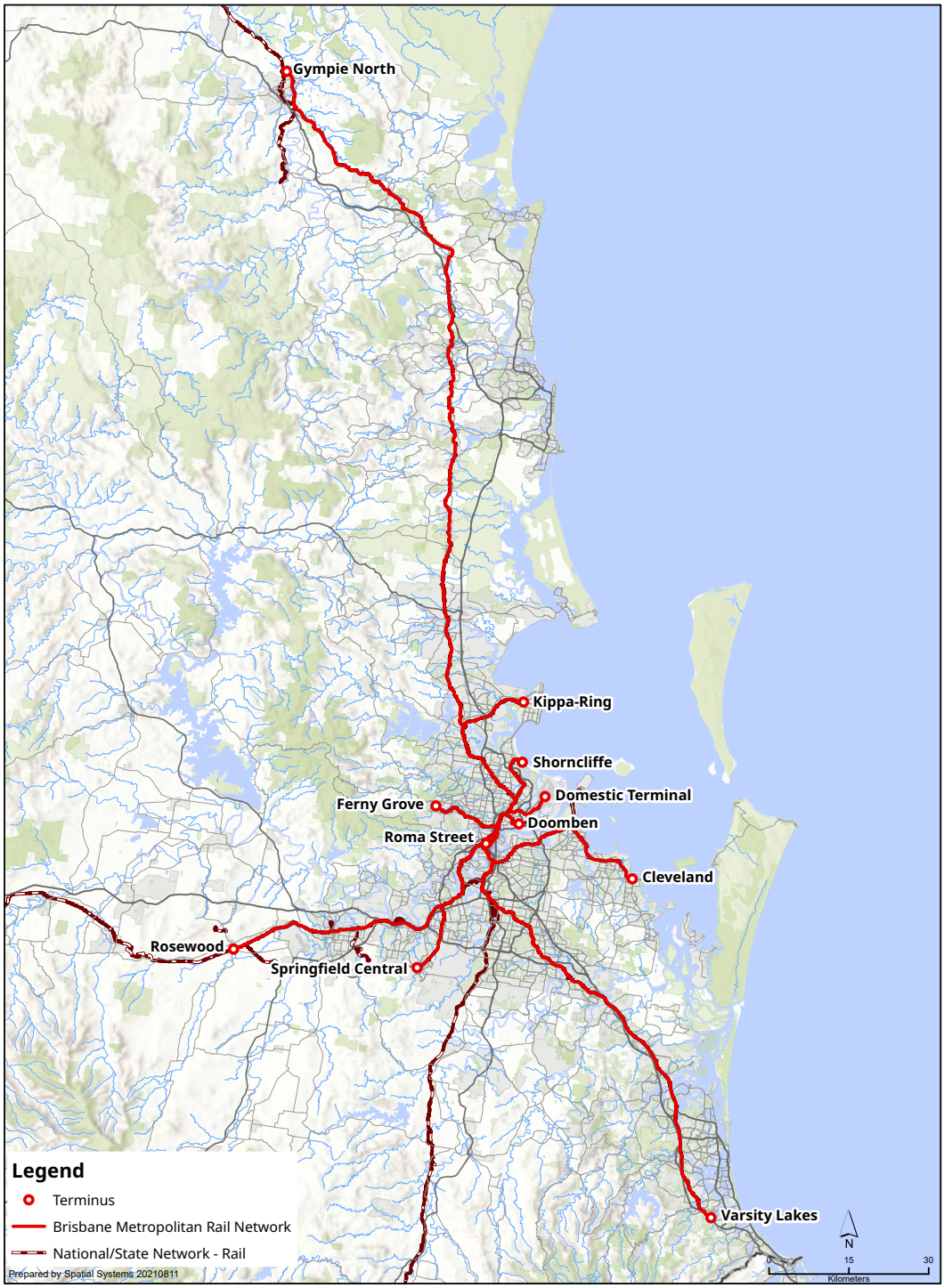


Figure 68 Melbourne

Figure 69 Perth

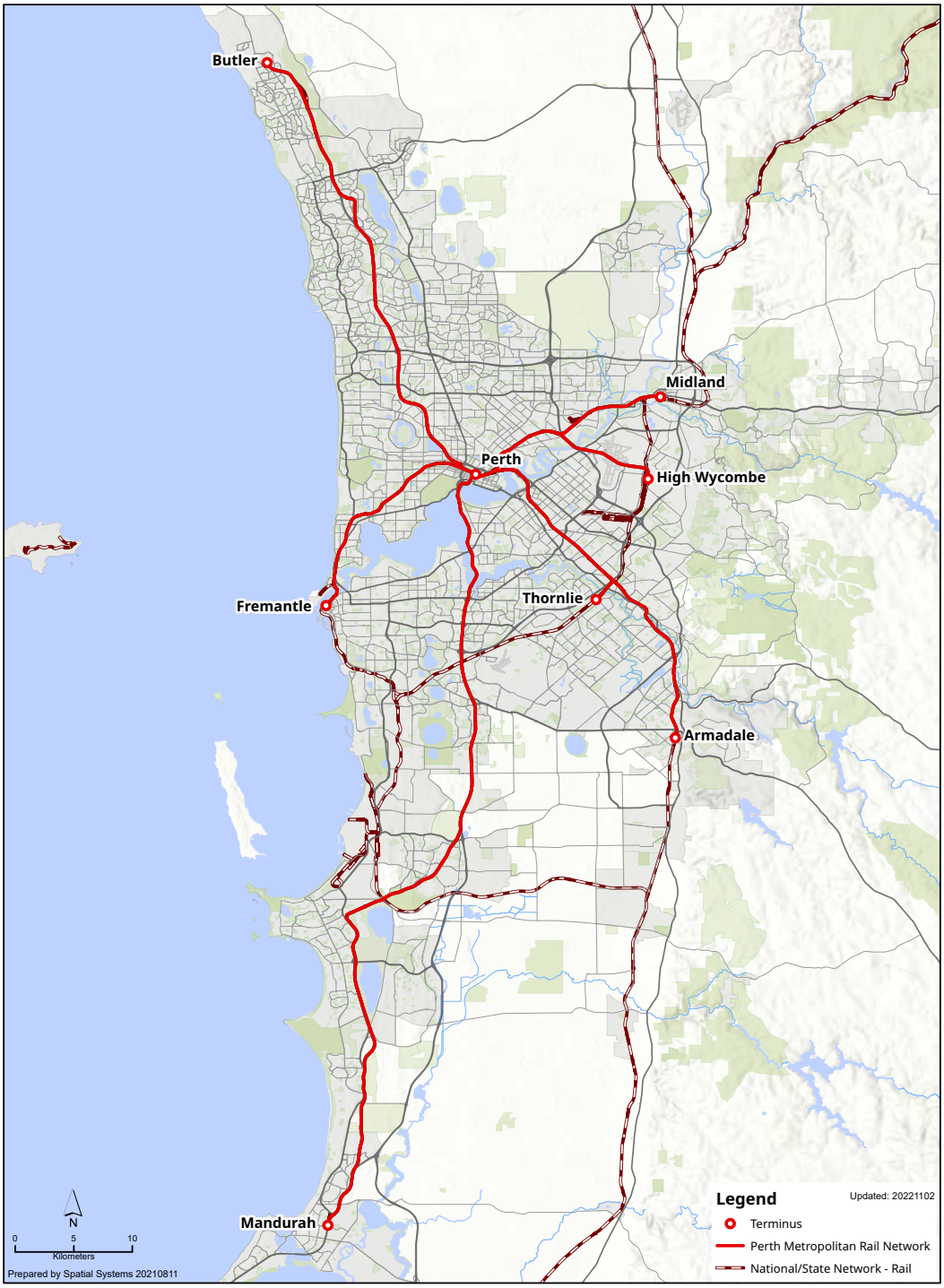
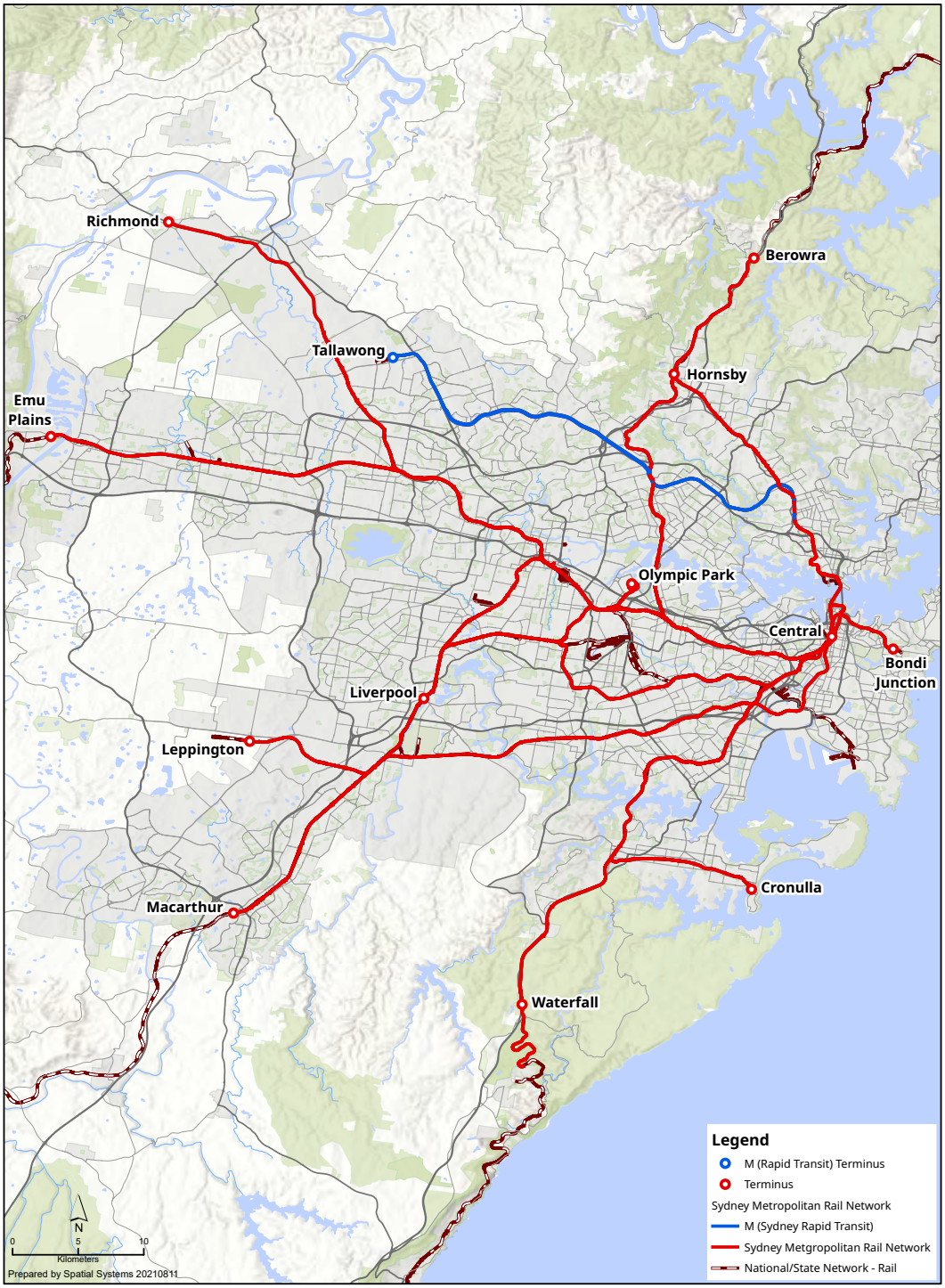


Figure 70 Sydney



Appendix E

Light rail network maps – December 2022

Figure 71 **Adelaide**

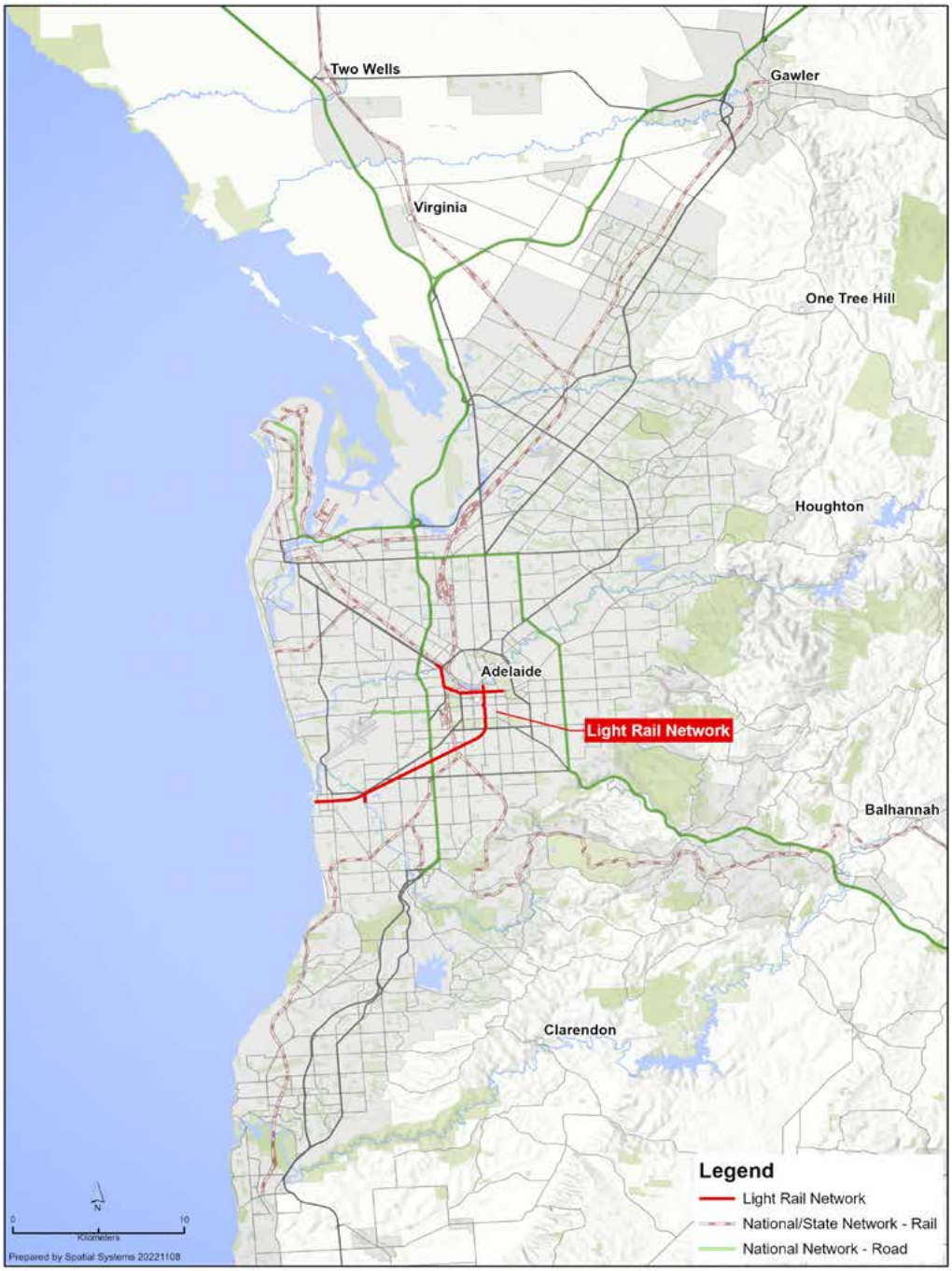


Figure 72 Canberra

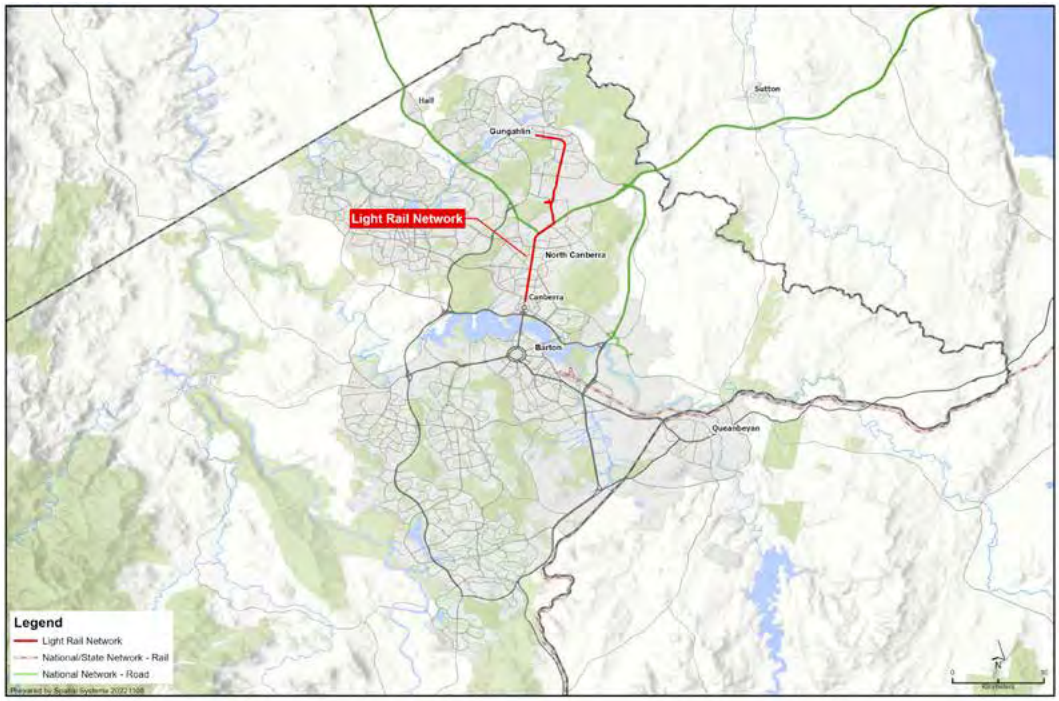


Figure 73 Gold Coast

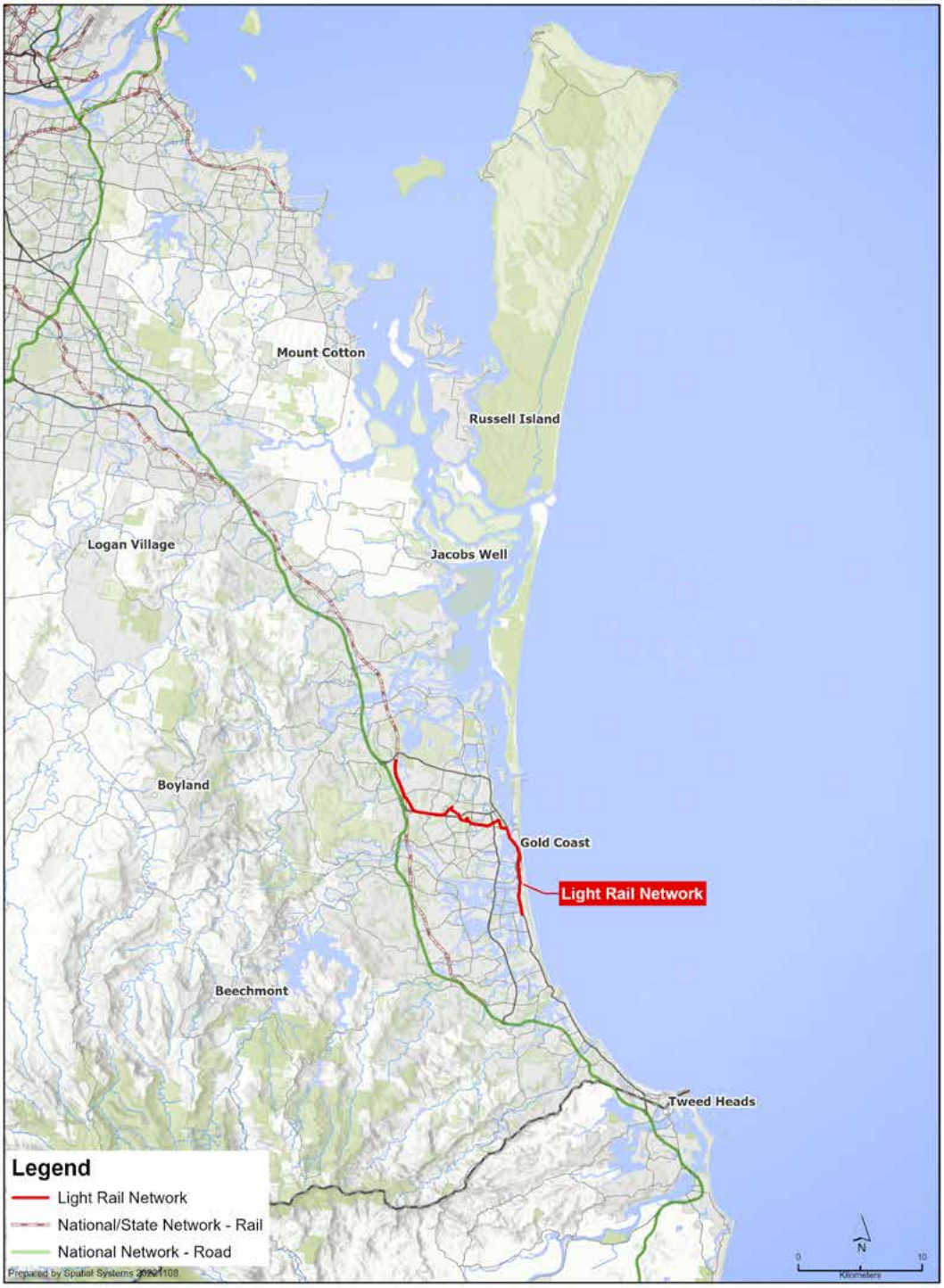


Figure 74 Melbourne

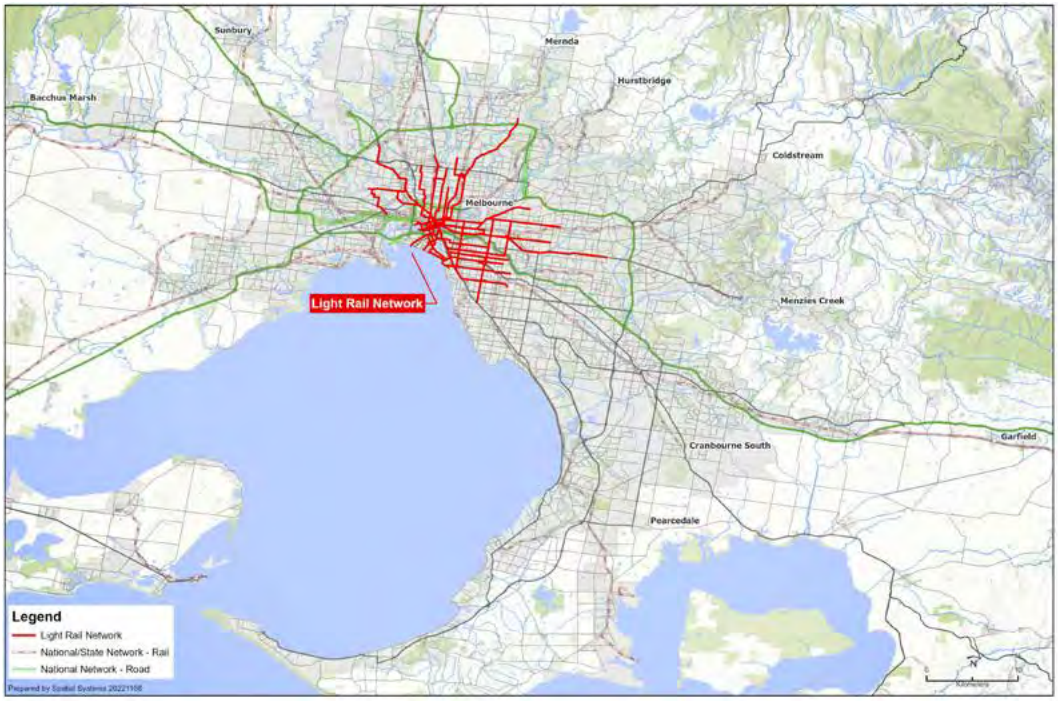


Figure 75 Newcastle

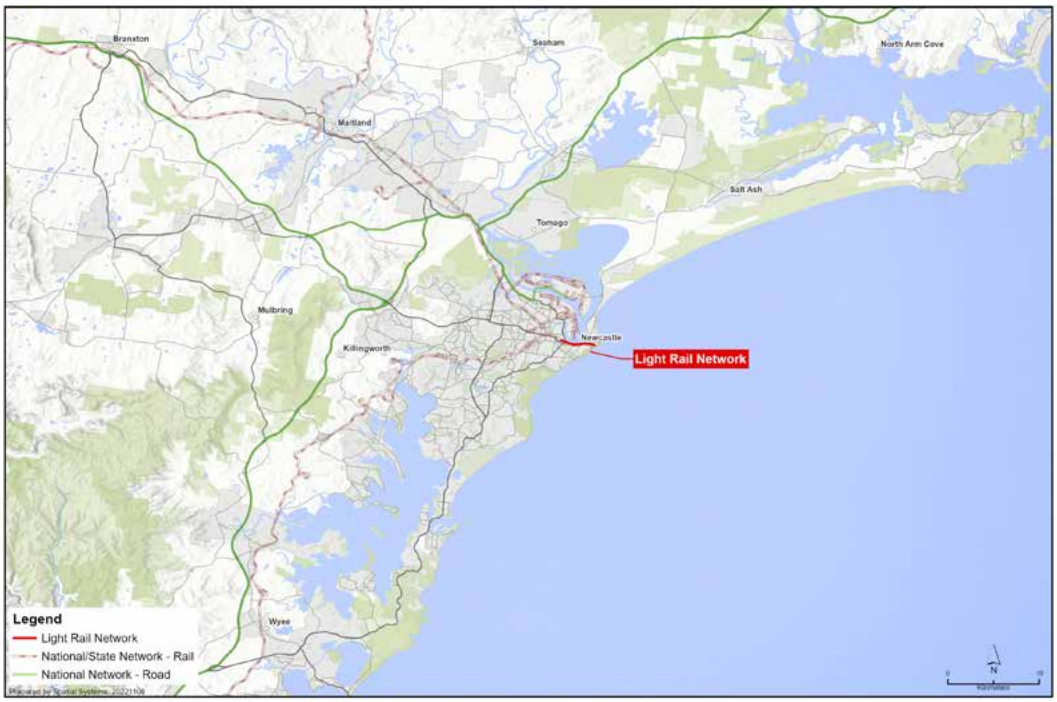
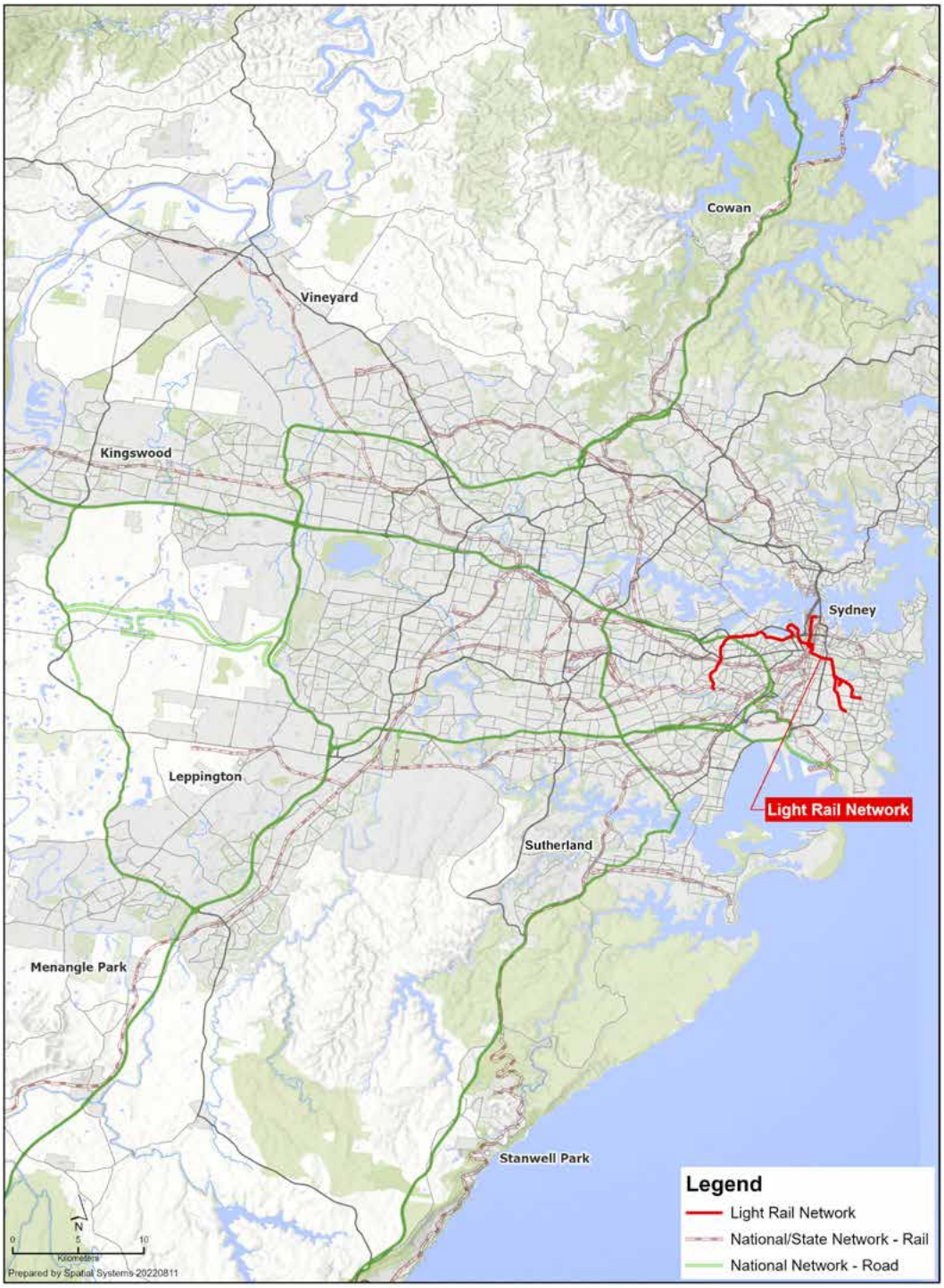


Figure 76 Sydney



References

ABS – see Australian Bureau of Statistics

Adelaide Metro (2022), Timetables, <https://www.adelaidemetro.com.au/plan-a-trip/timetables?num_ranks=20&f.routemodes%7croutemode=0>

ARTC – See Australian Rail Track Corporation

Aurizon (2020), *19/20 Annual Report*, <https://aurizon.com.au/search?q=annual+report>

Aurizon (2022), *Central Queensland Coal Network Information Packs* <https://www.aurizon.com.au/what-we-deliver/coal>

Aurizon (2022), *FY2022 Results Presentation*, <https://www.aurizon.com.au/investors/documents-and-webcasts/2022>

Australasian Transport News (2021), *Salta Details Dandenong South Intermodal Operations*, <https://www.fullyloaded.com.au/logistics-news/2110/salta-details-dandenong-south-intermodal-terminal-operations>

Australian Bureau of Statistics (2022), <https://www.abs.gov.au/census/find-census-data/search-by-area>

Australian Export Grains Innovation Centre (2018), *Australia's grain supply chains costs risks and opportunities*, <https://www.aegic.org.au/wp-content/uploads/2019/01/FULL-REPORT-Australias-grain-supply-chains-DIGITAL__.pdf>

Australian Rail Track Corporation (n.d,) <www.artc.com.au> (search 'Hunter Valley Network Key Performance Indicator Report'

Australian Rail Track Corporation (2022), *2022 Hunter Valley Corridor Capacity Strategy*, <https://www.artc.com.au/uploads/2022-HVCCS-FINAL.pdf>

BITRE—see Bureau of Infrastructure, Transport and Regional Economics; and Bureau of Infrastructure and Transport Research Economics

Bureau of Infrastructure, Transport and Regional Economics (2009), *Road and rail freight: competitors or complements*, <https://www.bitre.gov.au/publications/2009/is_034>

Bureau of Infrastructure, Transport and Regional Economics (2012), *Trainline 1*, <https://www.bitre.gov.au/publications/2012/train_001>

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

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

Bureau of Infrastructure, Transport and Regional Economics (2014), *Freightline 1 – Australian Freight Transport Overview*, <https://www.bitre.gov.au/publications/2014/freightline_01>

Bureau of Infrastructure, Transport and Regional Economics (2014a), *Freightline 2 – Australian Iron Ore Freight Transport*, <https://www.bitre.gov.au/publications/2014/freightline_02>

Bureau of Infrastructure, Transport and Regional Economics (2014b), *Urban transport: updated passenger trends, Information Sheet 59* <https://www.bitre.gov.au/publications/2014/is_059>

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

Bureau of Infrastructure, Transport and Regional Economics (2014d), *Improving regional passenger rail services, Research report 137*, <https://www.bitre.gov.au/publications/2014/report_137>

Bureau of Infrastructure, Transport and Regional Economics (2015), *Trainline 3*, <https://www.bitre.gov.au/publications/2015/train_003>

Bureau of Infrastructure, Transport and Regional Economics (2016), *Freightline 4*, <https://www.bitre.gov.au/publications/2018/Freightline_06>

Bureau of Infrastructure, Transport and Regional Economics (2016a), *Why short-haul intermodal rail services succeed* <https://www.bitre.gov.au/publications/2016/rr_139>

Bureau of Infrastructure, Transport and Regional Economics (2017), *Trainline 5* <https://www.bitre.gov.au/sites/default/files/train_005.pdf>

Bureau of Infrastructure, Transport and Regional Economics (2018), *Freightline 6 – Australian rice freight transport*, <https://www.bitre.gov.au/publications/2018/Freightline_06>

Bureau of Infrastructure, Transport and Regional Economics (2018a), *Freightline 7 – Australian aluminium industry freight transport*, <https://www.bitre.gov.au/publications/2018/Freightline_06>

Bureau of Infrastructure and Transport Research Economics (2022), Australian Infrastructure and Transport Statistics – Yearbook 2022, <https://www.bitre.gov.au/publications/2022/australian-infrastructure-and-transport-statistics-yearbook-2022>

Bureau of Infrastructure and Transport Research Economics (2022a), *Waterline 68*, <https://www.bitre.gov.au/publications/2022/waterline-68>

Bureau of Infrastructure and Transport Research Economics (2022b), *Trainline 9*, <https://www.bitre.gov.au/sites/default/files/documents/trainline-9.pdf>

Canberra Metro (2020), <https://www.canberra-metro.com.au/stage-1/>

Canberra Metro Operations, <https://cmet.com.au/about/operational-performance/>

Department of Infrastructure, Transport, Regional Development and Communications (2022), *Inland Rail Supply Chain Mapping Project: Reference Case Modelling* <https://www.inlandrail.gov.au/understanding-inland-rail/publications-and-reports/inland-rail-supply-chain-mapping-project-reference-case-modelling>

Department of Infrastructure, Transport, Regional Development, Communications and the Arts (2023) <https://investment.infrastructure.gov.au/projects/062827-15vic-pkg>

Department for Infrastructure and Transport (2021), *2020–21 Annual report*, <https://www.dit.sa.gov.au/annual_report>

Department of Transport, Victoria (2021), *Department of Transport Annual Report 2020–21*, <https://transport.vic.gov.au/about/governance/reporting#annualreports>

Department of Transport, Western Australia (2020) <https://www.transport.wa.gov.au/Freight-Ports/revitalising-agricultural-region-freight-strategy.asp>

Department of Transport and Main Roads (2021), *Annual Report 2020–2021*, <https://www.publications.qld.gov.au/ckan-publications-attachments-prod/resources/dc7464bf-d2f0-43dc-a001-58fd31daad38/department-of-transport-and-main-roads-annual_report-2020-2021-signed1.pdf?ETag=2127294e35f65b27537b526088e737b4>

Fremantle Ports (2021), <https://www.fremantleports.com.au/news/new-rail-bridge-will-help-minimise-truck-impacts-in-the-community>

Fremantle Ports (2022), <https://www.fremantleports.com.au/news/more-then-24-of-containers-on-rail-in-march>

Gladstone Ports Corporation (2022), <https://www.gpcl.com.au/ports-and-trade/port-of-gladstone/>

G:link (2022), <https://ridetheg.com.au/get-up-to-date/>

G:link (2022a), <https://ridetheg.com.au/%ef%bf%bcriding-the-g/time-table/>

Gold Coast Light Rail Stage 3 (2022), <https://www.gclr3.com.au/goldlinq/gclr3>

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

Infrastructure NSW (2022), <https://www.infrastructure.nsw.gov.au/media/3503/state-infrastructure-strategy-2022-2042-full-report.pdf>

Journey Beyond Rail Expeditions (2022), <https://www.journeybeyondrail.com.au/guest-information/fares-and-timetables/>

Light Rail to Woden (2022), <https://media.caapp.com.au/pdf/u9gcrv/1310236c-4e20-4aff-9b3d-ef7a9346d20f/Fact%20Sheet%20-%20Stage%202A.pdf>

Mees, P and Dodson, J (2011), *Public transport network planning in Australia: assessing current practice in Australia's five largest cities*, Griffith University, Brisbane

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

Mid West Ports (2021), *Mid West Ports 2020/21 Annual Report.* <https://www.midwestports.com.au/Profiles/midwestports/Assets/ClientData/Documents/AnnualReport/mwpa-annual-report-2020-2021.pdf>

Minister for Transport; Planning; Ports, (2020), <https://www.mediastatements.wa.gov.au/Pages/McGowan/2020/09/Business-case-to-be-prepared-for-Tier-3-grain-lines.aspx>

Minister for Transport; Planning; Ports, (2022), <https://www.mediastatements.wa.gov.au/Pages/McGowan/2022/05/200-million-dollar-boost-for-Western-Australia%E2%80%99s-regional-rail-freight-network.aspx>

NSW Trains (2021), *Annual Report 20-21 Volume 1*, <https://www.transport.nsw.gov.au/news-and-events/reports-and-publications/nsw-trains-annual-reports>

NSW Ports (2023), <https://www.nswports.com.au/port-kembla>

North Queensland Bulk Ports Corporation (2021), *Annual Report 2020/21*, <https://nqbp.com.au/__data/assets/pdf_file/0024/37707/NQBP-Annual-Report-2020_21_-Final_PDF-Print.pdf>

Office of the National Rail Safety Regulator (ONRSR) (2022), *Annual Report 2021-2022*, <https://www.onrsr.com.au/publications/corporate-publications/annual-report>

Parramatta Light Rail (2022), <https://www.parramattalightrail.nsw.gov.au/>

Pilbara Ports Authority (2022), <https://www.pilbaraports.com.au/about-ppa/news,-media-and-statistics/port-statistics>

Port of Brisbane (2022), <https://www.portbris.com.au/operations-and-trade/trade-development/>

Port of Newcastle (2022), *Trade Report 2021*, <https://www.portofnewcastle.com.au/wp-content/uploads/2022/04/2021-Trade-Report.pdf>

Public Transport Authority of Western Australia (2021), *Public Transport Authority Annual Report 2020–21*, <https://www.pta.wa.gov.au/about-us/priorities-and-performance/annual-reports>

Public Transport Victoria (2022), Timetables, <https://www.ptv.vic.gov.au/timetables>

Queensland Rail (2016), South Western System Information Pack, <https://www.queenslandrail.com.au/pages/results.aspx?k=South%20Western%20System%20Information%20Pack%20-%20Issue%203%20-%20October%202016>

Queensland Rail (2021), *Queensland Rail 2020–21 Annual Report*, <https://www.queenslandrail.com.au/aboutus/governance/annualreports>

Queensland Rail (2022), <https://www.queenslandrail.com.au/forbusiness/the-regional-network>

Queensland Rail Travel (2022), <https://www.queenslandrailtravel.com.au/Planyourtrip/timetable>

Rail Express (September 2020), *Patrick and Port of Melbourne sign agreement for rail terminal at East Swanson Dock*, <https://www.railexpress.com.au/patrick-and-port-of-melbourne-sign-agreement-for-rail-terminal-at-east-swanson-dock/?>

Rio Tinto (2018), <https://www.riotinto.com/en/news/releases/2018/world-first-autonomous-trains-deployed>

Salta (2022), <https://www.salta.com.au/company/news/salta-properties-celebrates-milestone-at-dandenong-south-inland-port/>

Southern Ports (2020), *Southern Ports 2020 Annual Report*, <https://www.southernports.com.au/annual-reports>

Southern Ports (2021), *Annual Report 2021 Southern Ports*, <https://www.southernports.com.au/annual-reports>

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

Sydney Metro (2021), *Sydney Metro Annual Report 2020–21*, <https://www.sydneymetro.info/sites/default/files/2021-12/Sydney_Metro_Annual_Report_2020–21.pdf>

Sydney Trains (2021), *Sydney Trains Annual Report 20-21*, <https://www.transport.nsw.gov.au/news-and-events/reports-and-publications/sydney-trains-annual-reports>

TasRail (2021), *2020–21 Annual Report*, <https://www.tasrail.com.au/client-assets/TasRail%20Annual%20Report%202020-21.pdf>

Translink (undated), <https://translink.com.au/about-translink/reports-and-publications/performance>

Translink (2022), <https://jp.translink.com.au/plan-your-journey/timetables/train>

Transperth (2022), <http://www.transperth.wa.gov.au/Timetables>

Transport for NSW (undated), <https://www.transport.nsw.gov.au/data-and-research>

Transport for NSW (2018), *Maldon to Dombarton Railway Line*, <https://www.transport.nsw.gov.au/projects/current-projects/maldon-to-dombarton-railway-line>

Transport for NSW (2018a), *Future Transport Strategy 2056*, <https://media.opengov.nsw.gov.au/pairtree_root/9a/76/83/89/3b/f3/45/7c/a5/a2/97/82/13/55/89/18/obj/168352.pdf>

Transport for NSW (2021), *Transport for NSW Annual Report 2020–21* <https://www.transport.nsw.gov.au/news-and-events/reports-and-publications/transport-for-nsw-annual-reports>

Transport for NSW (2022), <https://transportnsw.info/routes/train>

Transport for NSW (2022a), <https://www.transport.nsw.gov.au/projects/programs/fixing-country-rail>

Transport for NSW (2022b), <https://www.transport.nsw.gov.au/news-and-events/media-releases/70-million-riverina-rail-revival>

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

Transwa (2022), <https://transwa.wa.gov.au/tickets-times/train-timetables>

The Urban Developer, (2020), <https://theurbandeveloper.com/articles/salta-state-federal-gov-ink-rail-freight-deal-dandenong-south>

University of Wollongong (2020), <https://documents.uow.edu.au/content/groups/public/@web/@eis/documents/doc/uow268091.pdf>

VicSig (2020), Track Class <http://vicsig.net/index.php?page=infrastructure&article=track-class>

Victoria's Big Build (2023), <https://bigbuild.vic.gov.au/projects/murray-basin-rail-project>

V/Line (2021), *Annual Report 2020–2021*, <https://corporate.vline.com.au/About-V-Line/Publications>

V/Line (2022), <https://www.vline.com.au/Timetables>

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