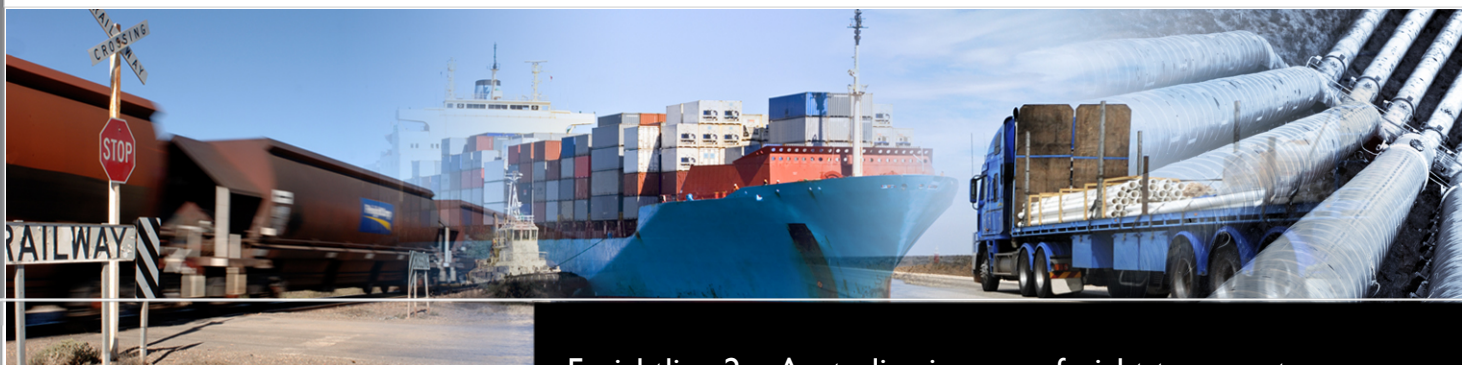




Australian Government

Department of Infrastructure and Regional Development

Bureau of Infrastructure, Transport and Regional Economics



Freightline 2 – Australian iron ore freight transport

At a glance

The *Freightline* series aims to provide information about where freight moves in Australia. This issue focusses on the transport of iron ore in Australia in 2011–12 and briefly considers the transport infrastructure implications of projected iron ore export demand growth to 2017.

- Iron ore is Australia's largest export commodity, accounting for 23.7 per cent of exports by value (\$62.7 billion) in 2011–12 and approximately 56 per cent by mass in 2011–12 (around 502 million tonnes).
- Over 94 per cent of Australia's iron ore exports are sourced from the Pilbara region in north west Western Australia (WA), with the majority of this (449 million tonnes) supplied by three companies—Rio Tinto, BHP Billiton and Fortescue Metals Group (FMG).
- These three companies, in cooperation with their joint venture partners, own and operate separate dedicated rail transport infrastructure to transport iron ore from mines to port. Based on the transport costs used to derive the freight estimates (see Appendix), rail transport costs are estimated to be around 3.5 per cent of the total price of exported ore.
- BITRE estimates the total domestic iron ore freight task measured approximately 198.7 billion tonne kilometres (tkm) in 2011–12. Rail accounted for approximately 170.6 billion tkm (86 per cent), road 3.6 billion tkm (2 per cent) and coastal shipping 24.1 billion tkm (12 per cent).
- The two domestic steel and steel product manufacturers in Australia—Arrium and BlueScope Steel—between them used approximately 6.5 million tonnes of domestic iron ore in 2011–12. Arrium (Whyalla) produced approximately 1.1 million tonnes of steel, using iron ore sourced predominantly from the Middleback Ranges in South Australia. BlueScope Steel (Port Kembla) produced approximately 3.5 million tonnes of finished steel products, using a combination of iron ore sourced from Mt Newman (Western Australia) and Savage River (Tasmania), and recycled steel products.
- The potential growth in future iron ore freight volumes are considered under two alternative iron ore export volume growth scenarios. Under the first scenario, based on BREE's (2012a) projections, total Australian iron ore exports are assumed to grow to 779 million tonnes, by 2017, out of a total 787 million tonnes production. Under this scenario, BITRE estimates the domestic iron ore transport task could grow to around 290 billion tonne kilometres by 2017, a 65–75 per cent increase over 2011–12. Under the second scenario, based on planned and prospective new iron ore projects (Barber et al. 2013) slated to commence operation by 2017, total production could potentially increase to over 1000 Mtpa by 2017 if all projects come on stream. Under this scenario, BITRE estimates the domestic iron ore transport task could double to around 345 billion tonne kilometres by 2017.
- New and expanded port and rail infrastructure will be required to support the projected increase in iron ore exports, and plans are in place across most of the larger proposed mining projects such that capacity should be adequate to meet potential future needs by 2017. In particular, planned new port capacity at Port Anketell, Cape Preston and Oakajee, and expansion of iron ore export berths/facilities at Port Hedland, Esperance, Geraldton and Whyalla would provide over 1200 Mtpa of total port capacity by 2017, of which there would be over 1100 Mtpa at Pilbara ports.

Introduction

The Freightline publication series aims to provide enhanced up-to-date analysis and estimates of Australian freight movements for selected commodities and significant freight tasks. This issue focuses on where and how Australia's iron ore production is transported from mines to ports for export, and the smaller volumes of ore transported within Australia for domestic steel production. Estimates of iron ore freight movements for 2011–12 are presented, along with estimates of potential future iron ore freight movements based on projected potential total iron ore exports in 2017.

A note on the estimates

Data on regional freight movements in Australia are quite limited and often unavailable, either due to the cost of collection or confidentiality concerns of commercial operators. In the absence of detailed movement data, the estimates presented here are based on modelled movements of iron ore from mines to ports and steel processing facilities. Modal shares of iron ore movements are based on a combination of modal availability and approximate transport costs. The estimates include the small volume of iron ore moved around the coast by ship.

In deriving these freight task estimates, BITRE has compiled estimates of mine production, export volumes and domestic usage for each iron ore mine, port and steel producer in Australia, from mining company annual reports, annual port trade statistics and steel manufacturer annual reports. Unless otherwise stated the estimates presented here are on an Australian financial year basis (i.e. year ending 30 June). Differences in reporting periods used by different companies—e.g. financial versus calendar year—and unspecified differences in reported volumes—e.g. 'wet' versus 'dry' tonnes, production versus sales—may account for slight differences between the aggregate volumes reported here and official Australian Government production and export statistics reported by BREE (2013a). There may also be slight differences between volumes received and exported at ports accounted for by changes in port stocks. These differences are generally less than 5 per cent of total iron ore production and exports and so have only a minor impact on the size of the estimated transport task. (The various statistical sources used in preparing this information sheet are briefly discussed in the appendix.)

Australian iron ore production and use

Australia has the world's largest share of Economic Demonstrated Resources (EDR) of iron ore, with 37.8 billion tonnes¹, or 22 per cent of the world's EDR of iron ore in 2011 (GA 2012a). In 2012, Australia was also the world's largest iron ore exporter (USGS 2013), supplying approximately 40 per cent of total world iron ore demand. Iron ore has also been Australia's highest earning export commodity since 2011, worth \$62.7 billion in 2011–12 (DFAT 2013). In 2011–12, Australia produced over 500 million tonnes of iron ore (BREE 2013a) and BREE (2012a) projected that by 2017 total Australian iron ore production could increase to just below 800 million tonnes.

Production and reserves

Based on mining company annual reports, BITRE estimates that Australia produced approximately 509.8 million tonnes of iron ore, from across 47 separate operating mines, in 2011–12. Western Australian mines accounted for approximately 96 per cent of total iron ore extracted in 2011–12, with approximately 96 per cent of that sourced from mines in the Pilbara region. According to GA (2012), Western Australia also accounted for 94 per cent of Australia's total iron ore EDR in 2012. Table 1 lists iron ore production in 2011–12 by mining company and region, and Figures 2 and 3 show the location of iron ore mines operating in 2011–12. (Figures 2 and 3 also show several mines that either commenced mining operations after June 2012 or did not begin shipping ore off-site until after June 2012. These include Peculiar Knob, Solomon Hub and Balmoral Central.)

The four 'major' iron ore companies—Rio Tinto, BHP Billiton, Fortescue Metals Group (FMG) and Hancock Prospecting (operating in joint venture with Rio Tinto)—produced approximately 465 Mt of iron ore, or 91 per cent of Australia's total iron ore production, in 2011–12. Smaller ('junior') iron ore mining companies accounted for a further 45 million tonnes of iron ore output in 2011–12.

1. EDR of 37.8 Gigatonnes (i.e. billion tonnes).

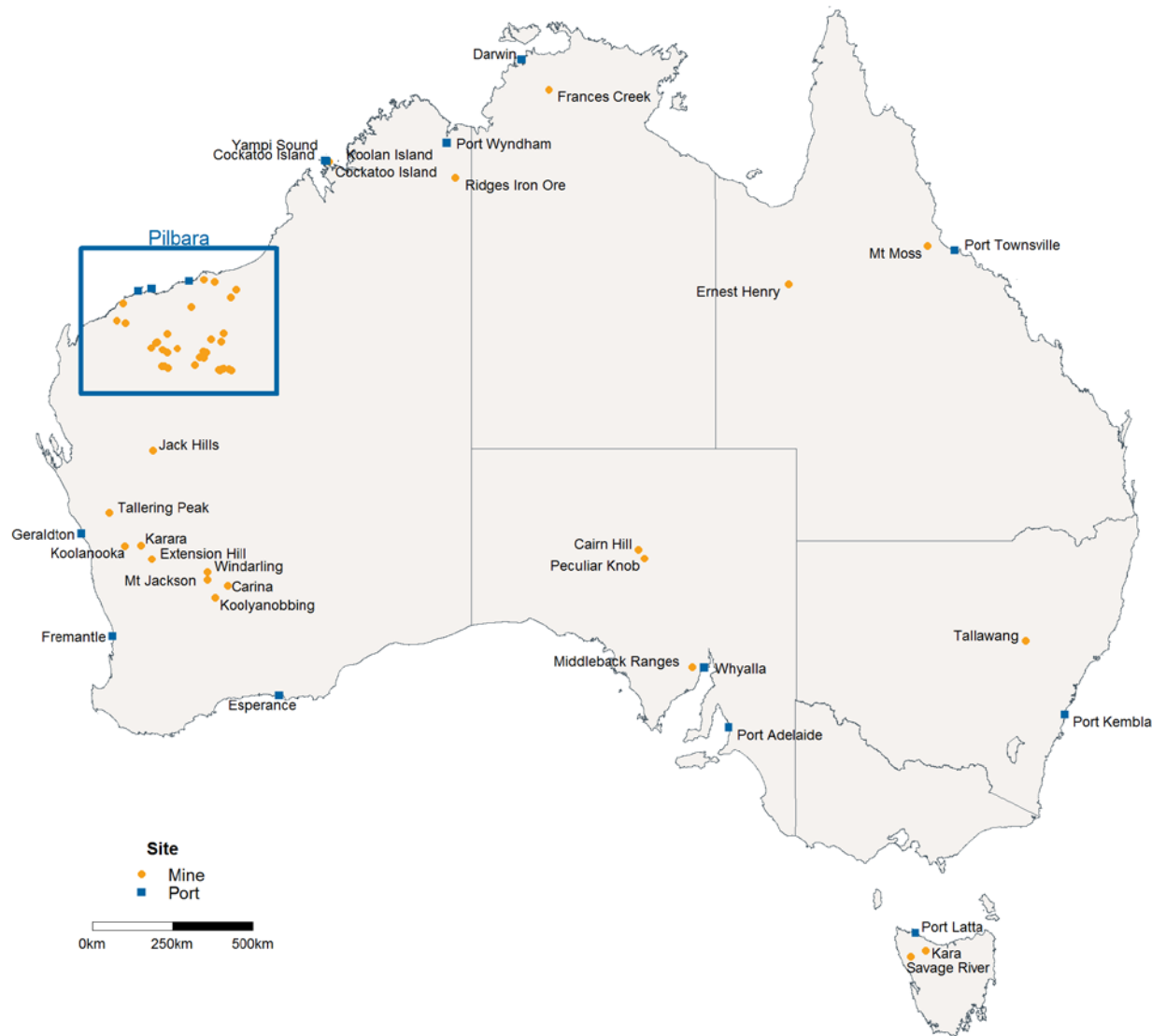
Table 1: Australian iron ore production, by company and region, 2012

Company	State	Region	Production (Mt)
'Majors'			
BHP Billiton	WA	Pilbara	173.95
FMG	WA	Pilbara	55.49
Rio Tinto	WA	Pilbara	203.99
Rio Tinto & Hancock Prospecting	WA	Pilbara	31.27
'Juniors'			
Arrium	SA	Middleback Ranges	7.87
Atlas Iron Limited	WA	Pilbara	5.45
BC Iron Ltd	WA	Pilbara	3.48
CITIC Pacific Ltd	WA	Pilbara	0
Cliffs Natural Resources	WA	South West (WA)	8.9
Cliffs Natural Resources ^a	WA	Cockatoo Island	0.60
Crosslands Resources	WA	Mid West (WA)	1.5
Curtain Brothers	Qld	Flinders	0.17
Grange Resources	Tas.	Tasmania	2.07
IMX Resources Ltd	SA	Central SA	1.73
KMG	WA	Kimberley	1.5
Midwest Corporation	WA	Mid West (WA)	1.31
Mineral Resources Ltd	WA	South West (WA)	1.82
Moly Mines Limited	WA	Pilbara	0.99
Mount Gibson Iron	WA	Mid West (WA)	2.5
Mount Gibson Iron	WA	Koolan Island	2.96
Tasmania Mines Limited	Tas.	Tasmania	0.36
Territory Resources Ltd	NT	Katherine	1.09
Unimin Australia Ltd	NSW	Tallawang	0.07
Total			509.8

a. Cockatoo Island mine subsequently acquired (1 August 2012) by Pluton Resources.

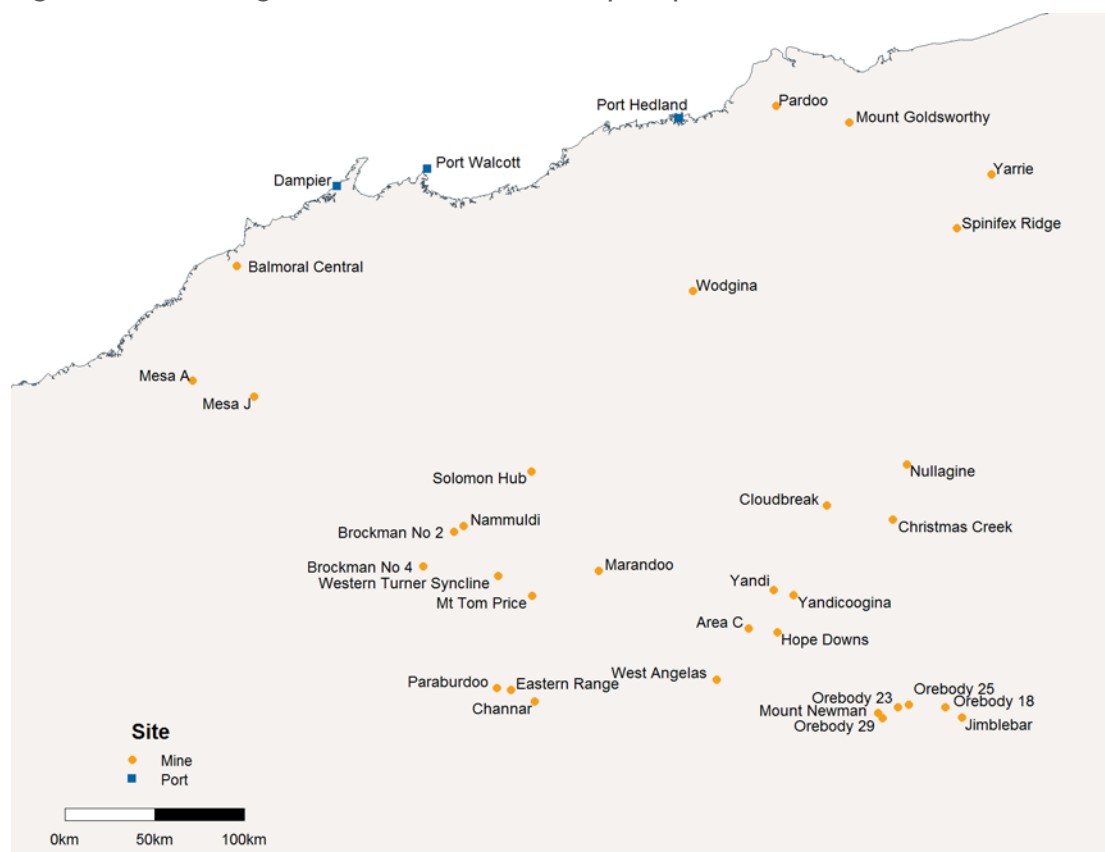
Source: GA (2012).

Figure 1: Australian iron ore mines and export ports, 2012



Source: BITRE, based on GA (2012).

Figure 2: Pilbara-region iron ore mines and export ports, 2012



Source: BITRE, based on GA (2012).

Exports

In 2011–12, Australian iron ore exports totalled around 502 million tonnes.² The three ports in the Pilbara—Port Hedland, Dampier and Cape Lambert (Port Walcott)³—together accounted for over 93 per cent of total Australian iron ore exports in 2011–12. Exports through Port Hedland were approximately 239 million tonnes, exports through Dampier 146 million tonnes and exports through Cape Lambert approximately 82 million tonnes. In 2011, Port Hedland and Dampier were among the top 20 largest ports in the world by total volume (in metric tonnes). Table 2 shows estimated port trade volumes through Australian ports in 2011–12.

Of the other ports handling iron ore, exports through Whyalla were 6.2 million tonnes in 2011–12, Esperance 8.9 million tonnes, Geraldton 5.3 million tonnes, Port Latta (Tasmania) 2.1 million tonnes, Port of Fremantle 1.8 million tonnes and Port Adelaide 1.7 million tonnes. Exports through ports at Koolan Island, Cockatoo Island and Wyndham were 3.0, 0.6 and 1.5 million tonnes, respectively.

2. Sources include Arrium (2012), Cliffs Natural Resources (2013), Grange Resources (2013), KMG (2011), Mt Gibson Iron (2012), Port of Townsville (2013), Ports Australia (2012) and WA DOT (2012).

3. The port facilities at Cape Lambert lie within the administrative area of Port Walcott (BITRE 2013d). While port-related statistics generally refer to the port as Port Walcott, the port is more commonly referred to as Cape Lambert and that convention is adopted here.

Table 2: Australian iron ore export and coastal shipping port output, 2012

Port	State	Exports	Domestic flows	Total
			(Mt)	
Port Adelaide	SA	1.7		1.7
Whyalla	SA	6.3		6.3
Fremantle	WA	1.8		1.8
Cockatoo Island (Yampi Sound)	WA	0.6		0.6
Esperance	WA	8.9		8.9
Geraldton	WA	5.3		5.3
Port Hedland	WA	234.8	4.1	238.9
Koolan Island (Yampi Sound)	WA	3.0		3.0
Cape Lambert (Port Walcott)	WA	82.2		82.2
Port Latta	Tas.	1.3	0.8	2.1
Darwin	NT	1.1		1.1
Dampier	WA	145.7		145.7
Port Kembla	NSW	0.1		0.1
Townsville	Qld	0.9		0.9
Wyndham	WA	1.5		1.5
Total		502.4	4.9	507.3

Note: Figures may not add to totals due to rounding.

Sources: Ports Australia (2012), Arrium (undated), Mt Gibson Iron (undated), WA DOT (2012), Grange Resources (2012), Port of Townsville (2012), KMG (2011), Mt Gibson Iron (2012) and BITRE estimates.

Domestic use

Australian iron ore is also used domestically to produce iron and steel products, primarily for the Australian market, at two locations—Port Kembla, operated by BlueScope Steel, and Whyalla operated by Arrium—previously OneSteel (Energetics 2012). In 2011–12, BlueScope Steel's Port Kembla facility produced approximately 3.5 million tonnes of finished steel products, using approximately 4.9 million tonnes of iron ore sourced from Mt Newman and Savage River (Tasmania), and ferrous metals from recycled steel products. Ore supplied from these mines is transported via ship to Port Kembla. Arrium's Whyalla operation produced approximately 1.1 million tonnes of steel in 2012, for which it used approximately 1.58 million tonnes of iron ore sourced primarily from mines in the Middleback Ranges (Arrium 2012), transported to Whyalla via railway. Arrium also exports iron ore sourced from the Middleback Ranges and Peculiar Knob (near Coober Pedy) in central South Australia.

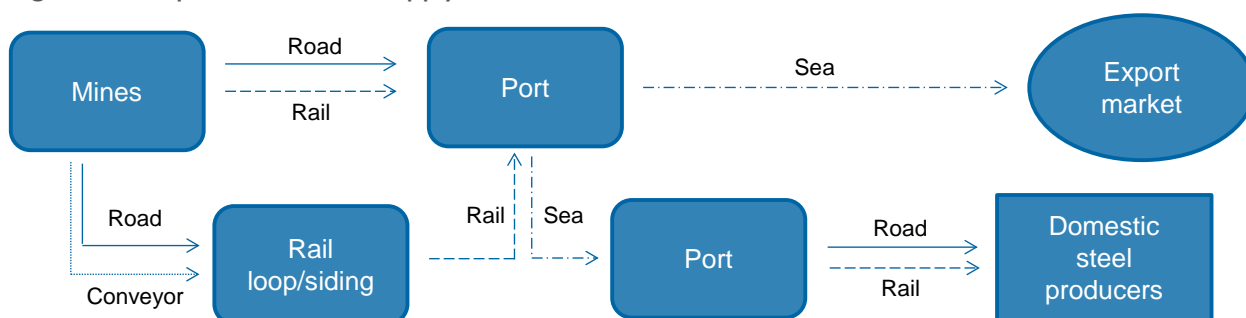
Iron ore supply chains and transport infrastructure

Iron ore supply chains

Australian iron ore transport supply chains are relatively simple, and Figure 3 provides a schematic diagram of the main elements. At most of the larger iron ore mines in Australia, ore is transported direct from mine to export port by rail, and then loaded on bulk carriers for export. For mines where rail infrastructure is not available, the transport task may involve an intermediate movement, by road or conveyor, to nearby rail infrastructure and subsequent rail transport to port. At other, smaller mines, where ore volumes would not support construction of dedicated rail infrastructure, ore is often moved direct by road to port for export, typically in large road trains using bespoke trailers. 'Blending' of ores of differing quality, sourced from different mines, is often required to meet customers' specifications, and is generally undertaken at the port, but may also be done further back up the supply chain.

Supply of ore to domestic steel producers involves a mix of surface transport modes. Ore used in Arrium's Whyalla facility is moved by a mix of road and rail only. Ore supplied to BlueScope Steel's Port Kembla facility is first transported from mine to port, shipped around the coast and thence to the steel smelter.

Figure 3: Simplified iron ore supply chain



Source: BITRE.

Iron ore transport infrastructure

Australian iron ore mines are generally located well inland and involve significant surface transport from mine to port and/or production facility. In 2011–12, transport infrastructure facilitated the movement of ore between 47 operating mines, 15 ports and 2 domestic steel manufacturing facilities.⁴

The majority of Australia's iron ore production (474 million tonnes in 2012) is transported to three Western Australian ports: Port Hedland, Dampier and Cape Lambert.

The 'major' iron ore mining companies operating in the Pilbara region each own and operate separate private rail networks to transport ore from the mines to the ports. Rio Tinto owns and operates the Hamersley and Robe River railways that span approximately 1400 kilometres, transporting iron ore mined from its twelve operating mines (including the Rio Tinto and Hancock Prospecting Joint Venture mines at Hope Downs) in the Pilbara region to Port of Dampier and Cape Lambert (Rio Tinto, 2011). BHP Billiton owns and operates the Mt Newman and Goldsworthy railways (WA DoP 2009, Appendix A – Maps 11 to 15), which together span approximately 800 kilometres and connect its ten iron ore mines to Port Hedland (GA 2012 and Ottaviano 2013). FMG owns and operates approximately 250 kilometres of rail line connecting its two mines at Cloudbreak and Christmas Creek to Port Hedland (Fortescue Metals Group 2013).⁵ In addition, BC Iron has contractual arrangements with FMG to use the latter's rail infrastructure to transport iron ore from its Nullagine mine to Port Hedland. In 2012, approximately 467 Mt of iron ore was transported using these privately operated rail networks. Figure 4 shows existing (and planned) rail infrastructure in the Pilbara region in 2011–12.

As well as these, development of the Hancock Prospecting's joint venture Roy Hill iron ore mine involves constructing 340 kilometres of railway to Port Hedland while Rio Tinto's planned Koodaideri iron ore mine would involve an additional 167 kilometres of rail infrastructure linking the mine to Rio Tinto's existing Mt Tom Price line (both shown in Figure 4).

There are also short conveyors linking several iron ore mines in the Pilbara to nearby rail facilities. In particular, ore from Rio Tinto's Channar mine is moved approximately 20 kilometres by conveyor to Rio Tinto's rail infrastructure at Paraburdoo, ore from its Western Turner Syncline mine is moved approximately 21 kilometres by conveyor to Mt Tom Price for loading on rail, and ore from its Yandicoogina mine involves 8 kilometres of conveyor to nearby rail infrastructure.

Nineteen other iron ore mining companies use the road network or a combination of rail and road to transport approximately 45 million tonnes of iron ore from 23 iron ore mines to 15 ports across Australia.

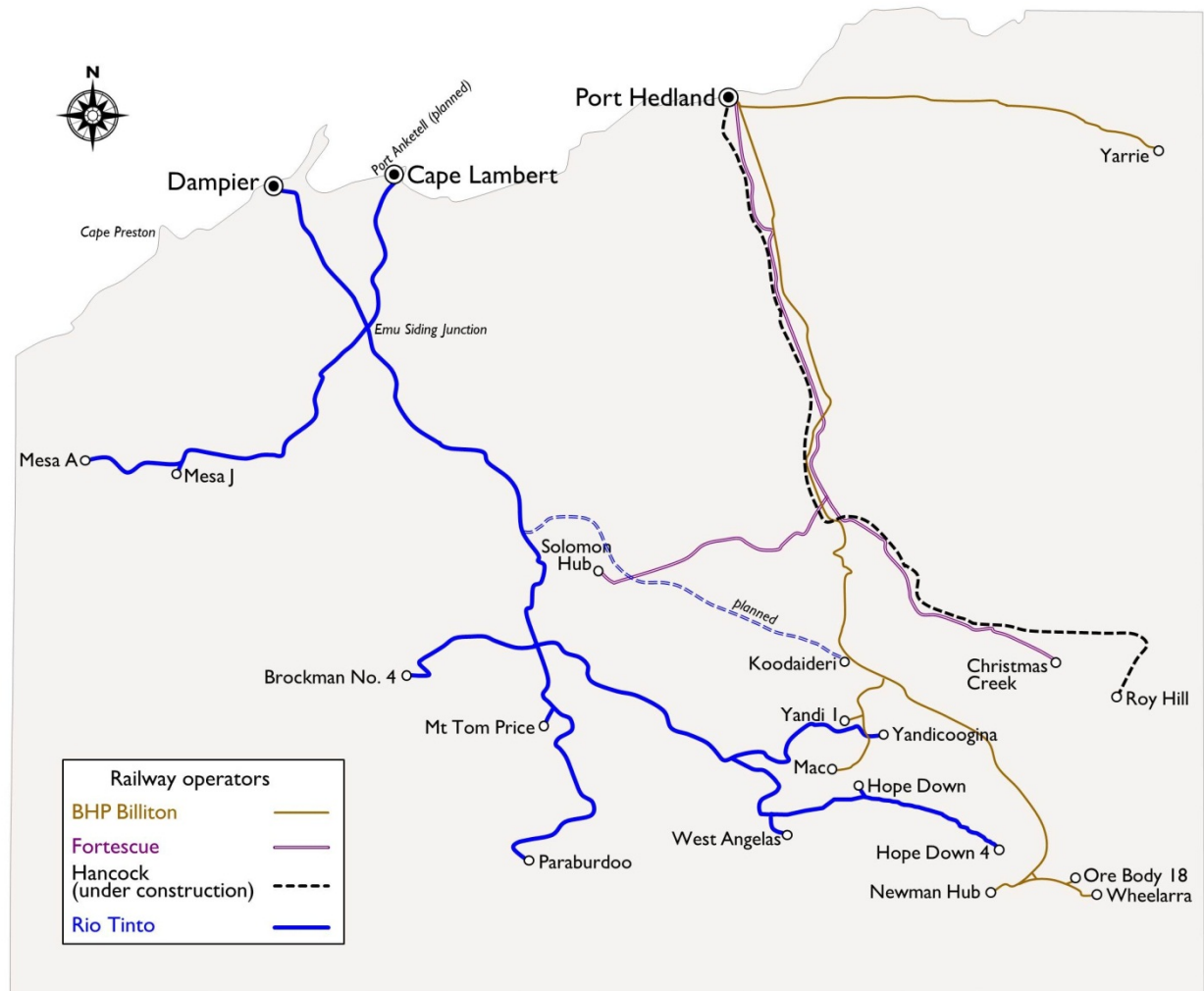
Rail infrastructure and capacity

Australia's iron ore transport supply chains are relatively simple, with a high volume of iron ore of 467 million tonnes (92 per cent of total Australia's iron ore production) transported annually by private rail networks owned by Rio Tinto, BHP Billiton and FMG in the Pilbara region.

4. The transport supply chains involved in further downstream processing of finished steel products, such as flat sheet, plate and coil, are not considered here.

5. FMG has also recently commenced operations from its Solomon Hub facility in the Pilbara (see Figure 4).

Figure 4: Rail network in the Pilbara region



Source BITRE.

Rio Tinto's Pilbara rail network comprises the two formerly separate systems—Robe River to Cape Lambert (Port Walcott) and the former Hamersley Iron's network to Port Dampier (see Figure 4). The systems now connect those mines to two ports: Port Dampier and Cape Lambert (connecting at Emu Siding Junction). As of 2012, each train on Hamersley Iron's railway was approximately 2.4 kilometres long and had a capacity of around 26 000 tonnes (BITRE 2013d). Overall, Rio Tinto has 132 locomotives and 37 sets of wagons, with each train rake comprising between 163 and 234 wagons (Rio Tinto undated). An analysis conducted in 2008 by Simulation Modelling Services found that there was sufficient capacity at the Emu Siding Junction for iron ore volumes of up to 346 million tonnes per annum, but beyond this volume the junction would, without additional works, become a potential bottleneck (Simulation Modelling Services 2008). (Rio Tinto produced approximately 220 million tonnes of iron ore in 2011–12.)

Based on publicly available data, BHP Billiton owned more than 80 locomotives and 3400 wagons in 2005. It operated 14 to 16 trains a day on its Newman line and 4 trains a day on its Goldsworthy line. (BHP Billiton has since—early 2014—suspended mining operations at Yarrie, on the Goldsworthy line.) Each train on the Newman line was able to carry up to 37 000 tonnes using 312 wagons, while each train on the Goldsworthy line was able to carry up to 7600 tonnes using 90 wagons (Darby 2005). Excluding the Goldsworthy line, BHP Billiton's rail network was upgraded to dual track in May 2011, and is now estimated to have more than 300 million tonnes per annum capacity for transporting iron ore from BHP Billiton-owned mines in the Pilbara to Port Hedland (Ottaviano 2013). (BHP Billiton produced 174 Mt of iron ore in Pilbara region in 2012.)

FMG currently has capacity to operate 11 train services a day, each hauling up to 33 000 tonnes of ore from its iron ore mines at Cloudbreak and Christmas Creek to Port Hedland (Herb Elliott Port), equivalent to

approximately 132 Mt annual capacity. FMG is implementing plans to increase its rail capacity to 156 Mt per annum with an additional 2 train services per day (Fortescue Metals Group, 2013) (FMG produced 56 Mt of iron ore in 2012). FMG has also recently commenced operations from its Solomon Hub facility in the Pilbara.

A number of mining companies operating in the Mid West region of Western Australia use rail infrastructure owned by the Western Australian Government, but leased to Brookfield Rail, to transport ore to Geraldton port for export. In 2013, the Mid West rail network had capacity for transport of up to 25 million tonnes per annum (Mtpa), with potential capacity to well beyond 75 Mtpa (MWDC 2013 and Brookfield Rail 2012). The Western Australian Planning Commission (WAPC), in 2011, also identified as 'flagship priority projects' new rail lines from northern Mid West region mines to Oakajee as well as new and upgraded rail lines from southern Mid West region mines to Geraldton (WAPC 2011). The latter projects have since been completed with a new railway from line Tilley to Karara Hill and upgrade of the existing rail line from Morawa to Mullewa.

Road infrastructure and capacity

Road transport is much less cost effective for transport of large volumes of iron ore over significant distances. Consequently, road transport is generally only observed where iron ore volumes are relatively small (generally fewer than 5 Mtpa) and/or rail infrastructure is not available. For example, Atlas Iron transported approximately 1.7 million tonnes of iron ore from its Mt Webber mine, at Pardoo in the Pilbara, to Utah Point, Port Hedland in 2012, in bespoke road trains. The task typically involves around 50 full vehicle movements per day (an average of 2 vehicle movements per hour), in areas where overall traffic volumes are relatively light. Consequently, road capacity is generally not an issue. Of course, heavy road transport of ore produces additional transport costs, through increased road wear and potential safety implications from increased truck movements in Port Hedland (SKM 2007), but these are not considered here.

Port infrastructure and capacity

BITRE (2013d) provided an overview of port infrastructure and capacity at Australia's major bulk ports, including the major iron ore export ports at Port Hedland, Dampier and Cape Lambert. Further details on port facilities and capacity are provided there.

Port Hedland is the world's largest bulk export port (PHPA 2012a, p. 2) and, obviously, Australia's largest iron ore export port. The port currently has 12 exclusively iron ore loading berths (PHPA 2014a, p. 30), one common user berth servicing bulk minerals (including iron ore) and another 3 berths handling other bulk cargoes and containers. The combined iron ore loading capacity of the existing berths is just over 360 Mtpa (PHPA, 2012b). A further 4 new iron ore berths are planned, to service Hancock Prospecting's Roy Hill mine and emerging iron ore mines in the Pilbara (PHPA 2014b), adding up to 105 Mtpa additional iron ore export capacity to the port.

The port of Dampier is the second largest iron ore port in Australia, but also provides port services for the salt, oil, gas and fertiliser industries. The port has 5 separate iron ore loading berths, all operated by Rio Tinto, with a total handling capacity of approximately 150 Mtpa (BITRE 2013d, p 30). There are no plans to expand iron ore handling capacity within the existing port of Dampier precinct, but the Western Australian Government has announced plans to establish a multi-user, multi-commodity deep-water port capable of exporting at least 350 Mtpa of iron ore at Port of Anketell, 30 kilometres east of Karratha (DPA 2014).

Cape Lambert is the third largest Australian iron ore exporting port, also operated exclusively by Rio Tinto. In 2012, the port had 4 operating berths, with a total capacity of approximately 80 Mtpa. A further 53 Mtpa capacity (2 berths) was added during 2013, with another 50 Mtpa capacity (2 berths) to be added by mid-2015 (BITRE 2013d).

As well as these ports, CITIC Pacific Mining has developed port infrastructure facilities at Cape Preston, approximately 67 kilometres west of Karratha, to service its magnetite mine 100 kilometres to the south, and magnetite concentrate processing facilities. As with Whyalla (below), the ore is transported by barge offshore for loading onto vessels for export. Several other companies also have plans to mine magnetite in this region and export via Cape Preston.

The next largest iron ore handling ports are Esperance, Geraldton and Whyalla. Esperance Port's current iron ore facilities (handling ore from the Yilgarn region) have capacity for 11.5 Mtpa, and the port authority has commenced a process to develop a multi-user iron ore facility, to add up to 12 Mtpa to capacity in the near term (Esperance Ports 2013). The Port of Geraldton currently has two dedicated iron ore loading berths each with a nominal loading capacity of 5 000 tonnes per hour (GPA 2013), or up to 32 Mtpa across

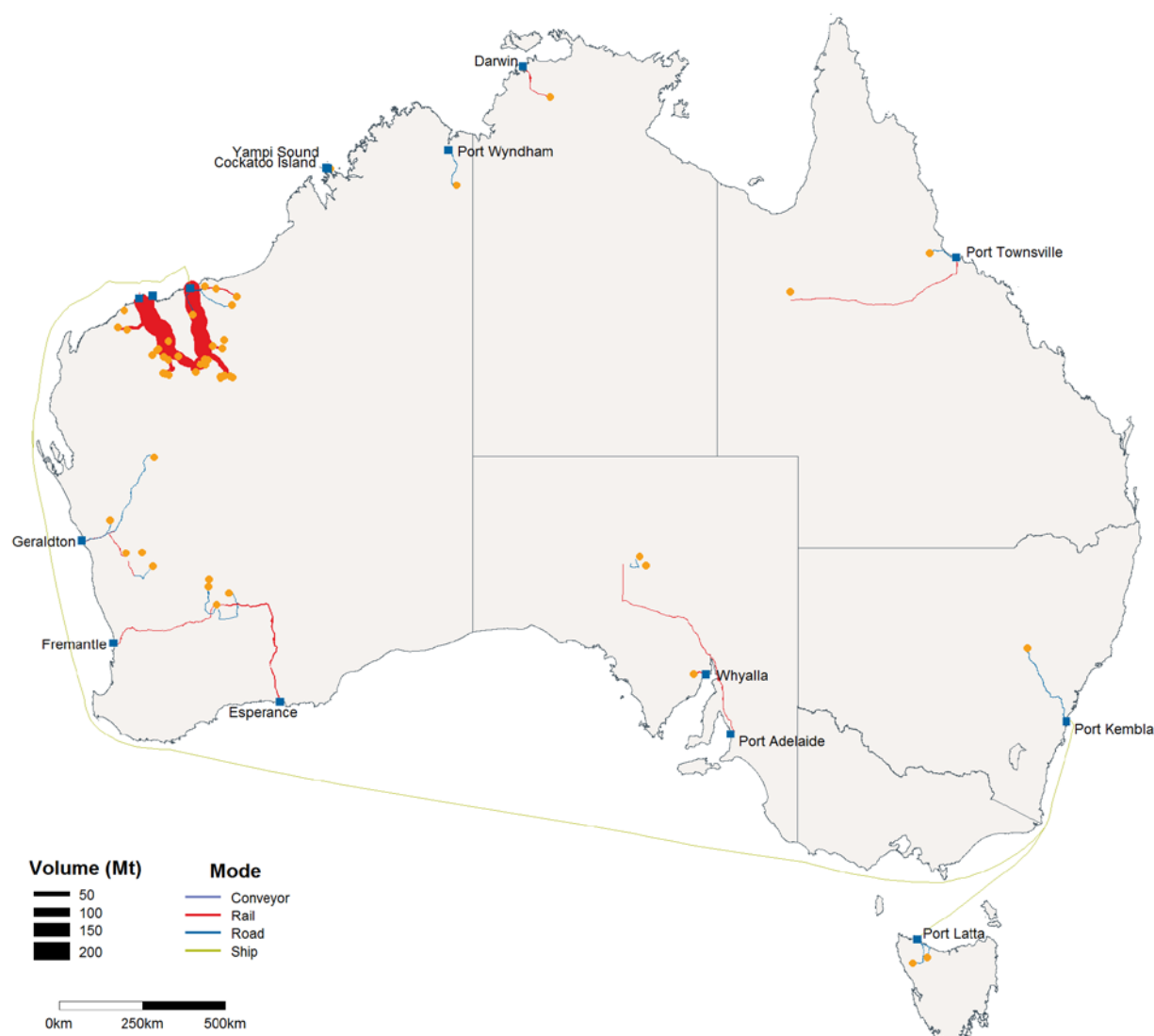
the two berths. There are also plans to establish a new bulk loading facility at Oakajee, 24 kilometres north of Geraldton, with an initial capacity of up to 45 Mtpa, but expandable up to 70 Mtpa (GPA 2011). Development is subject to iron ore demand and Mid West WA mine development. The Whyalla bulk ore facility, which is wholly owned and operated by Arrium Limited, has recently been expanded from 6 Mtpa pre-2013 to 13 Mtpa capacity, based on barging the ore to deep offshore sites accommodating Cape-size vessels. There are no plans to further expand export capacity at Whyalla in the near future.

Iron ore freight movements

Domestic movements

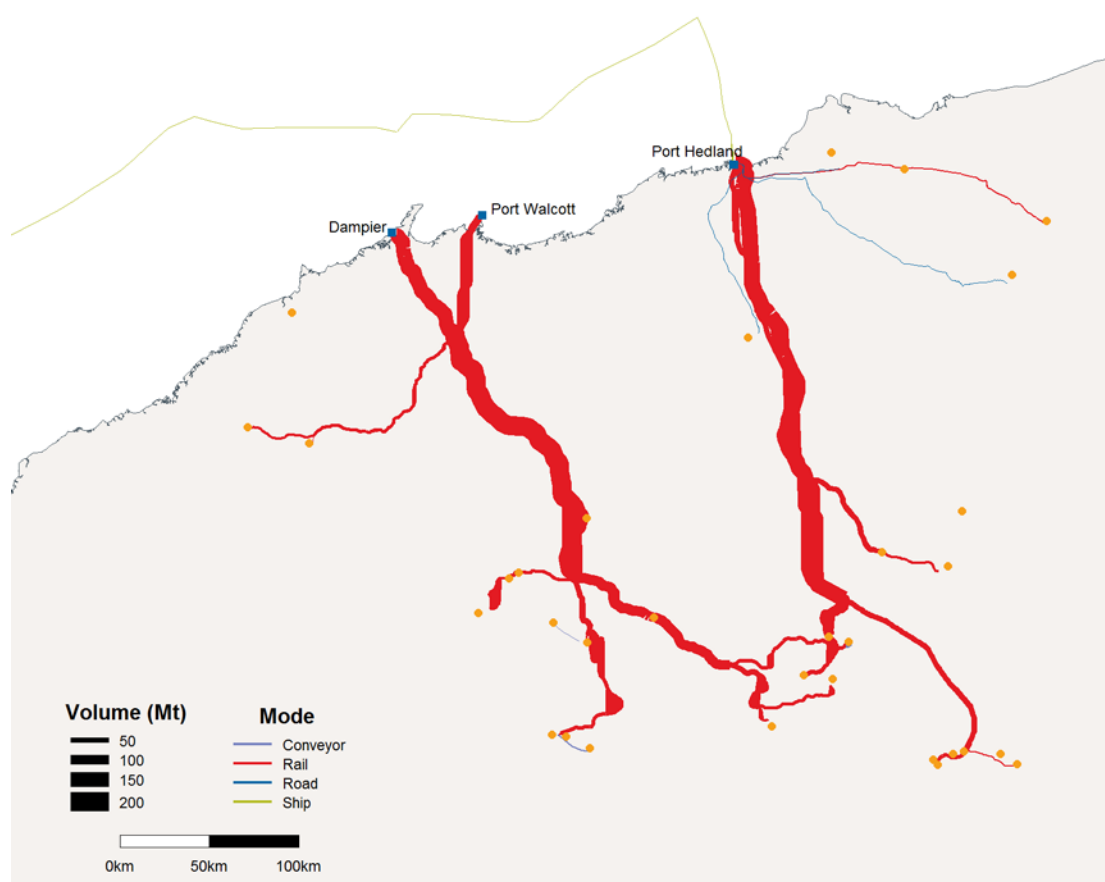
Figure 5 shows estimated iron ore freight volumes in 2011–12 across Australian rail, road and coastal shipping networks, and Figure 6 shows a more detailed view of estimated Pilbara-region iron ore freight volumes. The estimates have been derived by modelling flows between mines, export ports and domestic steel production facilities, taking into account transport costs and infrastructure capacity.

Figure 5: Estimated iron ore freight movements, 2011–12



Source BITRE estimates.

Figure 6: Estimated Pilbara-region iron ore freight movements, 2011–12



Source BITRE estimates.

The estimates imply 494.7 million tonnes of iron ore was transported by rail in 2011–12 and 13.8 million tonnes by road. The total rail iron ore freight task was estimated to be approximately 170.6 billion tonne kilometres in 2011–12⁶—approximately 86 per cent of the total domestic iron ore freight task—and the road freight task approximately 3.6 billion tonne kilometres. Coastal shipping accounts for a further 24.1 billion tkm, comprising 4.1 million tonnes of iron ore moved from Port Hedland to Port Kembla and 0.8 million tonnes from Port Latta to Port Kembla (illustrated in Figure 5).⁷

The Pilbara rail lines accounted for 95 per cent of the total rail iron ore transport task in 2011–12—61.1 billion tonne kilometres are estimated to have been hauled across BHP Billiton’s rail lines in 2011–12, 84.6 billion tonne kilometres across Rio Tinto’s rail lines and 15.9 billion tonne kilometres across FMG’s rail lines.

The smaller volume iron ore movements shown in Figure 5 include:

- Combined multi-modal (road and rail) movement from Cairn Hill (mid north SA) to Port Adelaide. Combined multi-modal (road and rail) movement from Carina mine (Southern WA) to Fremantle and from Cliffs Natural Resources’ mines, near Koolyanobbing (WA), to Esperance for export.
- Rail movement of ore from Ernst Henry and road movement from Mt Moss to Townsville for export.
- Road movement of ore from Jack Hills (Mid West WA) to Geraldton, Ridges iron ore mine to Port Wyndham in the Kimberley and from Savage River and Kara in northern Tasmania to Port Latta.

⁶ By way of comparison, ARA (2013) report that total iron ore rail volumes of 496.3 million tonnes and 175.4 billion tonne kilometres in 2011–12 (ARA 2013, pp. 22, 27). Assumptions about the exact distribution of mineral output across BHP Billiton and Rio Tinto’s mines, and approximation of actual rail distances using digital network data are expected to account for most of the difference in the estimated rail freight tonne kilometre volumes.

⁷ Grange Resources and BlueScope Steel had a one year agreement for supply of 800 kilotonnes of iron ore pellets from Savage River to BlueScope Steel’s Port Kembla blast furnace (Grange Resources 2011). Following expiration of this agreement, all of Savage River’s iron ore production (approximately 2 million tonnes in 2012–13) was destined for export to China.

Table 3 shows BITRE estimated road and rail iron ore freight volumes in 2011–12, by jurisdiction and transport mode. (Appendix Table A2 provides estimates of interregional origin–destination iron ore freight volumes in 2011–12.)

Table 3: Estimated iron ore freight transport flows, by jurisdiction^a and transport mode

Jurisdiction	Road	Rail	Sea	Other	Total	Road	Rail	Sea	Other	Total ^b
	(billion tkm)					(million tonnes) ^a				
New South Wales	0.03	0	0	0	0.03	0.074	0	0	0	0.074
Queensland	0.02	0.51	0	0	0.53	0.17	0.68	0	0	0.85
South Australia	0.13	1.87	0	0	2.00	1.73	9.6	0	0	9.6 ^c
Western Australia	3.09	167.99	23.62	0.44	195.14	9.73	483.33	4.1	53.9	491.6 ^c
Tasmania	0.33	0	0.44	0	0.77	2.07	0	0.8	0	2.07
Northern Territory	0	0.20	0	0	0.20	0	1.09	0	0	1.09
Total	3.62	170.57	24.06	0.44	198.67	13.77	494.7	4.9	53.9	505.3

a. Jurisdictional allocation of road, rail and other transport volumes based on administrative boundaries. Jurisdictional allocation of sea freight transport volumes based on port of loading.

b. Tonnages presented on a total uplift/discharge basis. Modal volumes do not sum to total tonnages.

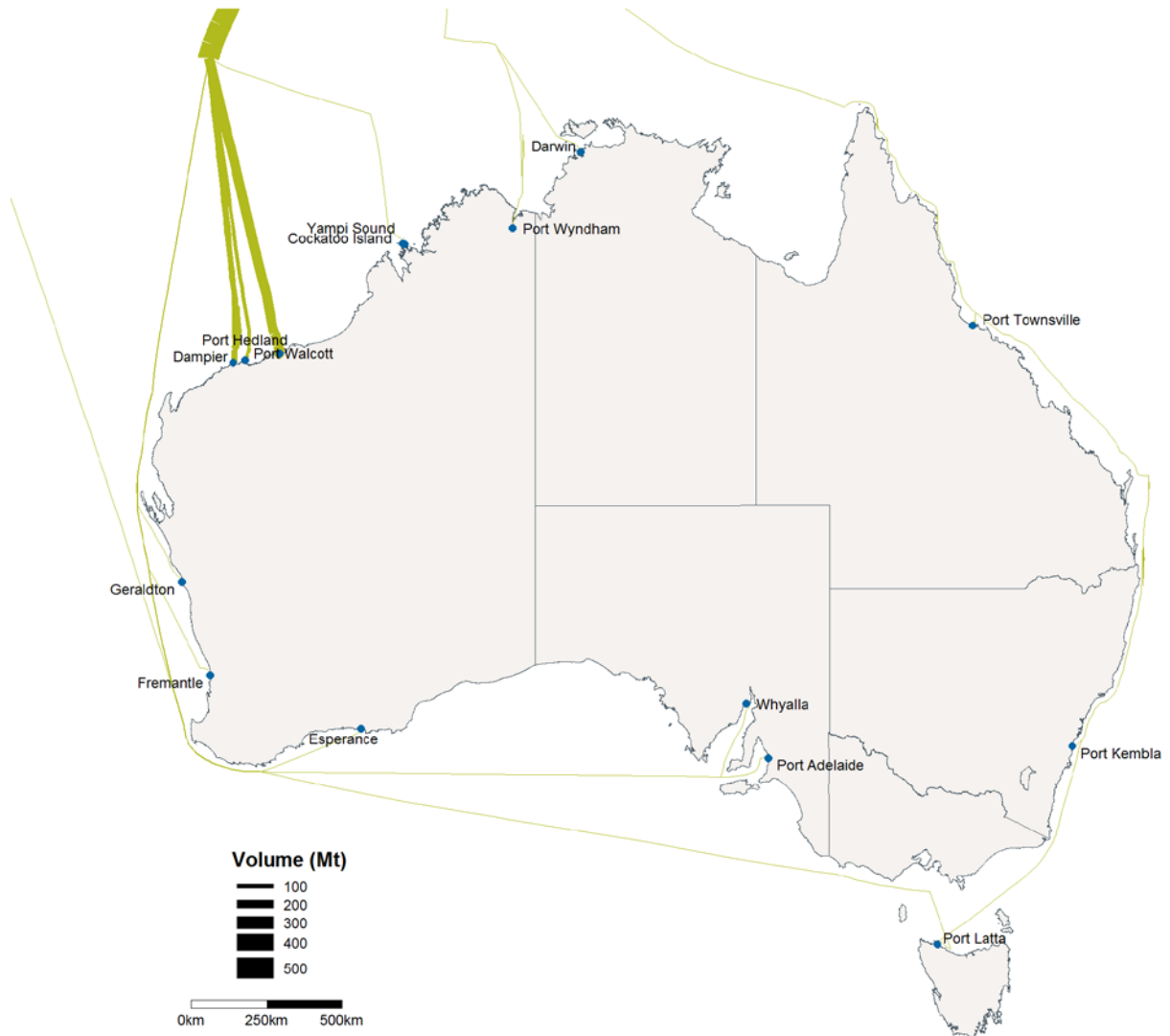
c. Intermodal transport counted only once in the total.

Source: BITRE estimates.

Export movements

The model also facilitates estimation of export flows, from Australian ports to overseas ports, along main international shipping routes. Figure 7 illustrates estimated iron ore export movements from Australian ports out of Australian international waters along major shipping routes. Transport of ore from the major Pilbara-region exports ports—Port Hedland, Dampier and Cape Lambert (Port Walcott)—to north and south east Asia predominate.

Figure 7: Estimated iron ore export freight volumes, 2011–12



Source BITRE estimates.

Projected future iron ore transport volumes

Australian iron ore production has increased significantly over the last decade, from around 168 Mt in calendar 2000 to 504 Mt in financial year 2012 (BREE 2013a). BREE (2012a) projected that Australian iron ore export demand would continue to grow over the next five years, driven by continuing growth in Asian (particularly Chinese) demand, to nearly 780 million tonnes in 2017, an implicit average annual export growth rate of 9.6 per cent over that period. Table 4 shows actual and projected future estimates of iron ore exports, domestic use and production between 2010 and 2017. The actual and projected iron exports are sourced from BREE (2012a), while projected future domestic iron ore use is based on assumed unchanged use at BlueScope Steel's Port Kembla and Arrium's Whyalla steelworks between 2012 and 2017.⁸

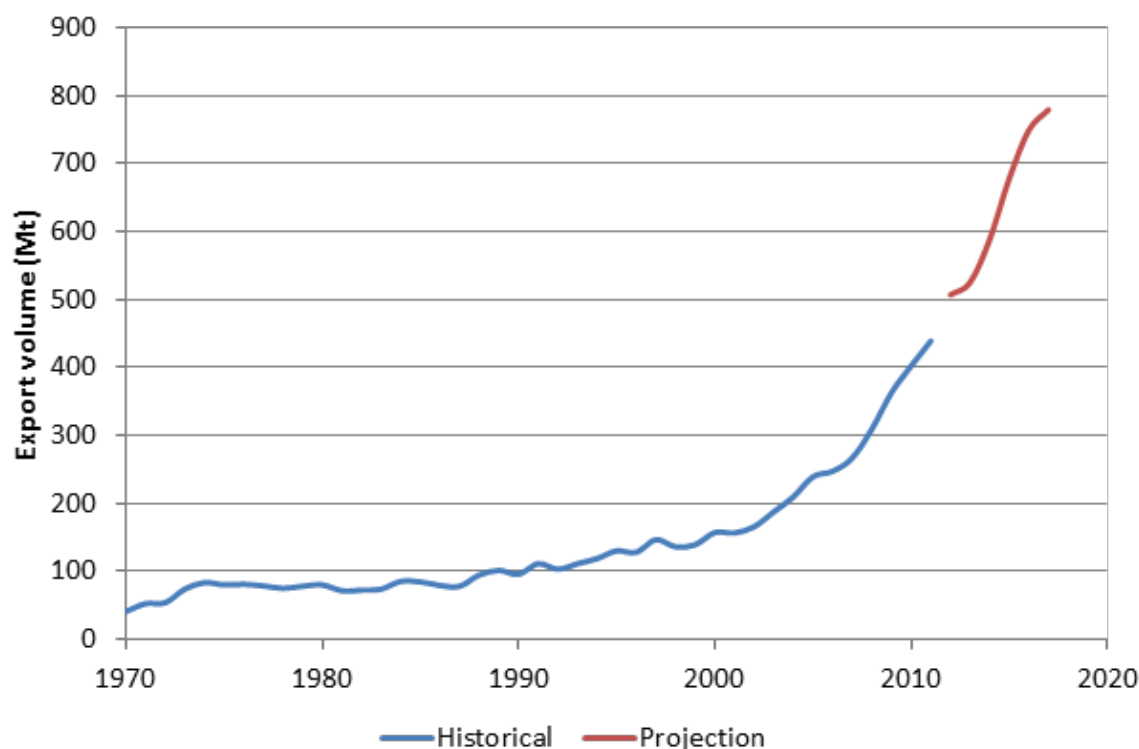
⁸ BlueScope Steel reduced its domestic steel production capacity in 2011, closing one of its then two operating Port Kembla blast furnaces in October 2011. The remaining blast furnace has a total steel production capacity of 2.6 million tonnes per annum.

Table 4: Historical and projected future Australian iron ore production

	Actual		Projections					
	2010	2011	2012	2013	2014	2015	2016	2017
	(million tonnes)							
Exports	402	439	493	525	588	678	749	779
Domestic use	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Production	409.75	446.75	500.75	532.75	595.75	685.75	756.75	786.75

Source: BREE (2012a).

Figure 8: Historical and projected future Australian iron ore exports



Source: ABARES (2010, p. 285) and BREE (2012a).

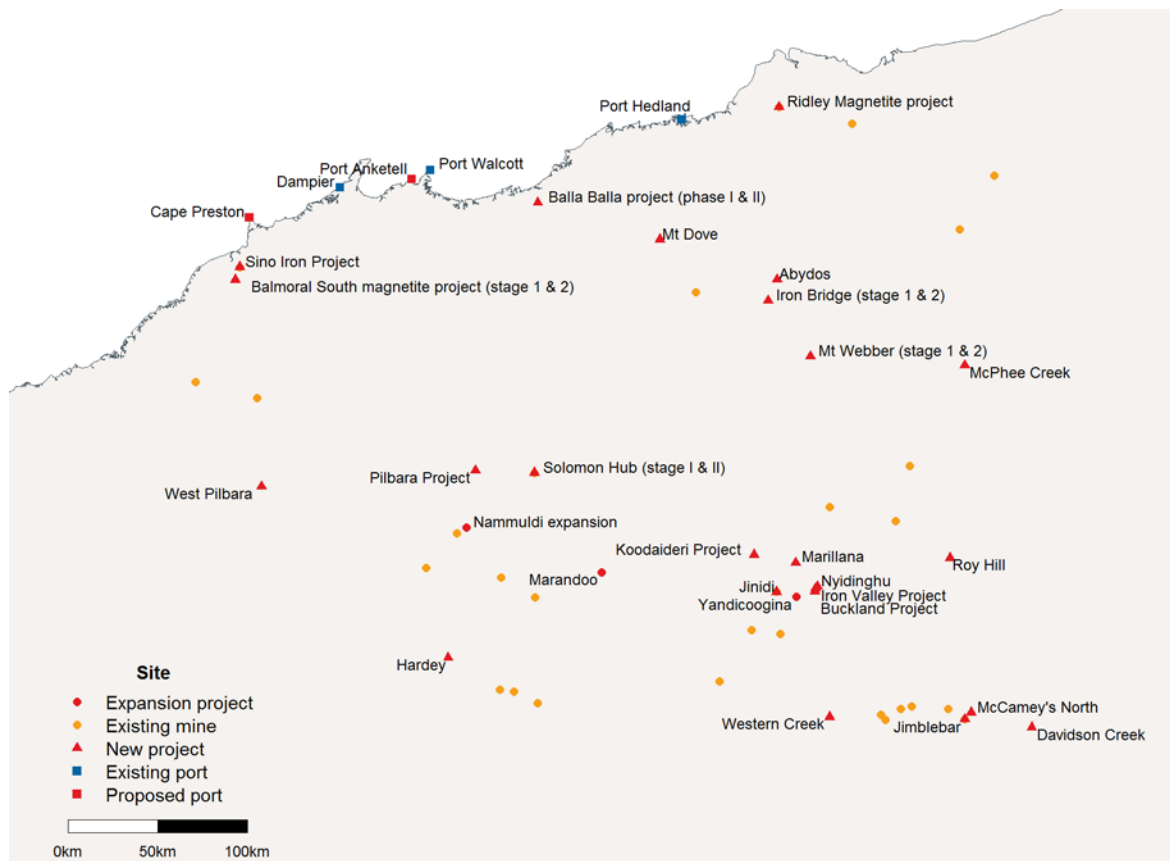
From a supply-side potential perspective, BREE's most recent list of major resource and energy projects (Barber et al. 2013) provides details of 43 separate new iron ore mining projects (including several multi-phase projects). Of these, 29 projects are estimated to commence production by 2017, adding up to an additional 474 million tonnes of iron ore production annually—comprising approximately 391 Mtpa hematite and 83 Mtpa magnetite. Approximately 365 million tonnes of the planned new mining capacity is located in the Pilbara and the majority will involve movement of ore by rail to port for export. (Figure 9 shows the location of planned new mining projects in the Pilbara.) Planned new projects include the following major developments:

- Rio Tinto's planned 70 Mtpa Koodaideri mining project—part of Rio Tinto's Australian iron ore production target of around 360 Mtpa by 2017, which includes increased production at existing mines, including Brockman 2 and Brockman 4, Yandicoogina, Paraburdoo and West Angelas (Rio Tinto 2013).
- BHP Billiton's planned 60 Mtpa Jinidi mine and newly operating Jumblebar mine (30 Mtpa capacity)—part of BHP Billiton's planned increase in their Australian iron ore mining output to around 260 Mtpa by 2017 (Ashby 2012).
- Hancock Prospecting's Roy Hill, capacity 55 Mtpa (wet tonnes).

As well as these, since 2011–12 mining operations have also commenced at Fortescue Metals Group's 60 Mtpa Solomon Hub mine.

In addition to new mining projects, BREE's project list implies up to 50 Mtpa of planned additional production capacity at existing mines, over 2011–12 levels, implying a total potential production increase of up to 525 Mtpa by 2017, over 2011–12 levels. Combining existing production levels with potential production capacity at planned new mines, and allowing for some slight reduction in production across existing mines, implies a total Australian production capacity of potentially up to 1000 Mtpa by 2017. (The combined planned production targets of just the four major Australian iron ore producers would account for around 790 Mt by 2017.)

Figure 9: Planned and prospective new iron ore projects, Pilbara-region, October 2013



Source Barber et al. (2013) and BITRE estimates.

Potential future domestic iron ore movements and infrastructure capacity

The development and timing of production at different mines, and the domestic freight implications will, ultimately, depend on world demand for iron ore and iron ore prices. Assuming that total Australian iron ore production were to reach 1000 Mtpa by 2017, BITRE estimates that likely domestic transport arrangements for these new projects would imply an additional 173 billion tonne kilometres of iron ore movements—comprising around 158 billion tonne kilometres by rail, 14.4 billion tonne kilometres by road and 5.7 billion tonne kilometres by combination of conveyor and pipeline—more than doubling the total domestic iron ore freight task. Alternatively, were domestic production to be approximately 780 Mtpa by 2017, BITRE estimates the additional domestic transport task could be between 107 and 127 billion tonne kilometres in 2017, with the majority by rail, a 65–75 per cent increase in the size of the domestic iron ore transport task between 2011–12 and 2017. Irrespective, both scenarios imply a significant increase in the size of the domestic iron ore transport task.

Many of the planned and prospective new mining projects will involve construction of new transport infrastructure to expedite export and many already have detailed infrastructure plans and/or have commenced development (e.g. Hancock Prospecting's Roy Hill project). The remaining new mines would use existing road and rail infrastructure. In summary then, current and planned future road, rail and other surface transport infrastructure appear to be more than adequate to meet likely future aggregate production and export volumes.

Table 5: Estimated and projected total iron ore freight transport flows, by transport mode

Year (scenario)	Road	Rail	Sea	Other ^a	Total
<i>(billion tkm)</i>					
2011–12	3.60	170.57	24.1	0.4	198.7
2017					
a) 1000 Mtpa	18.0	329.0	28.2	0.5	375.7
b) 790 Mtpa	5.0	278–298	28.2	0.5	311.7–331.7

na Not applicable

a. Other includes conveyor and pipeline movements.

Source: BITRE estimates.

Announced port development plans will also add significant iron ore port export capacity by 2017, raising total capacity from over 750 Mtpa in 2011–12 to over 1230 Mtpa by 2017. Pilbara ports accounted for almost 700 Mtpa iron ore export capacity in 2011–12 (over 90 per cent of then total Australian port capacity), and this would increase to over 1100 Mtpa by 2017 with development of new ports at Port Anketell and Cape Preston, and expansion at Port Hedland. (Table 6 lists 2011–12 and planned 2017 iron ore export capacity at selected ports.) Consequently, BITRE does not foresee, at least at an aggregate level, significant infrastructure capacity issues in servicing Australia's iron ore export task in the near term.

Table 6: Current and planned future iron ore export port capacity, selected ports

Port	Jurisdiction	2011–12	2017
<i>(Mtpa)</i>			
Existing ports			
Port Hedland	WA	360	465
Cape Lambert (Port Walcott)	WA	80	183
Dampier	WA	150	150
Esperance	WA	11.5	23
Geraldton	WA	32	32
Fremantle ^a	WA	5	5
Whyalla	SA	6	13
New ports			
Port Anketell	WA	–	350
Cape Preston	WA	–	20
Oakajee	WA	–	45
Total		745	1233

a. Fremantle port planned 2017 iron ore export capacity assumed to be unchanged from the 2012 level.

Note: Figures might not add to totals due to rounding.

Source: BITRE (2013d) and BITRE estimates.

Concluding remarks

This Freightline issue has outlined the size and scope of the iron ore freight task in Australia, and provided estimates of domestic iron ore freight volumes in 2011–12. The estimates presented in the paper are based on modelled movements of iron ore from mines to domestic users and ports for export, based on assumptions about transport costs and infrastructure availability. Consequently, the flows are indicative estimates only and may not reflect the actual pattern and volume of iron ore movements in 2011–12. The paper also provides perspectives on the impact on domestic transport volumes and infrastructure capacity of potential future growth in total Australian iron ore exports between 2011–12 and 2017. The model developed to estimate iron ore freight movements also has broader application to, for example, consideration of future infrastructure requirements or the potential implications of network outages and/or supply disruptions.

Appendix

Comparison of iron ore production and export volume estimates

The iron ore production and export estimates used to estimate the domestic iron ore transport task differ slightly from official Bureau of Resource and Energy Economics (BREE) statistics. Table A1 provides a comparison of the alternative iron ore production and export estimates.

BREE (2012b) reports total iron ore production was 503.8 million tonnes in 2011–12. In comparison, data sourced from mining company annual reports by BITRE implies total production of approximately 509.8 million tonnes in 2011–12. However, while the major iron ore miners generally appear to report ‘dry’ production volumes (as opposed to ‘wet’, see Box A1, below), it is not clear from many smaller company annual reports whether stated production volumes are reported ‘wet’ or ‘dry’. Such differences in reporting might account for some of the difference between the estimates used here and BREE’s (2012b) estimate. In estimating transport volumes, ‘wet’ measures would provide a truer measure of actual freight transport task, but ‘dry’ measures provide a more accurate representation of usable ore moved. BITRE has relied on the mining company sourced data because only it provides the detail necessary to model the transport flows.

Box A1: Iron ore transport characteristics

Lump, fines and pellets

Iron ore may be transported in a variety of forms. Australian hematite ores are generally transported as lump ores or fines. Lump ore is generally 6.3 to 31.5 millimetres in size and fines comprise particles up to a maximum size of 6.3 millimetres. For further processing, iron ore input typically have to be sized between 10 and 30 millimetre for blast furnaces and 6 to 18 millimetre pellets in direct reduction plants. Iron ore pellets are produced by agglomeration of fines or magnetite concentrate.

‘Wet’ and ‘dry’ iron ore

Iron ore fines are typically transported ‘wet’, with a typical ‘free moisture’ content of anywhere between 3 and 7 per cent, to suppress dust and reduce loss. For both safety and also for economic reasons, there is a limit on how much free moisture will be included in iron ore being transported—for safe ocean transport, Transportable Moisture Limits (TML) are imposed to prevent liquefaction of iron ore cargo and every percentage point increase in moisture content increases the cost of transport.

Table A1: Comparison of alternative iron ore production and export volumes, 2011–12

Source	Production 2011–12	Exports 2011–12 ^b
	(million tonnes)	
BITRE estimates ^a	509.8	502.0
BREE (2012b)	503.8	470.1
Ports Australia (2012) ^c	..	403.6
ABS (2012)	..	521.2

.. not applicable.

a. BITRE production estimates based on mining company published production statistics. BITRE export estimates based on Ports Australia data and iron ore export figures from other ports.

b. Includes lump, pellets, sinters, fines and run of mine (BREE 2012b).

c. Ports Australia’s trade statistics do not enumerate nearly 100 Mt of iron ore exports through Cape Lambert (Port Walcott) (≈ 82 Mt), Whyalla (≈ 7 Mt), Yampi Sound (≈ 3.6 Mt), Port Latta (≈ 2.1 Mt) and Townsville (≈ 0.85 Mt) in 2011–12.

Sources ABS (2012), BREE (2012b), Ports Australia (2012) and BITRE estimates.

Three separate published sources of iron ore export volumes are also available in Australia—ABS (2012), BREE (2012b) and Ports Australia (2012). BREE (2012b) reports total iron ore export volumes of 470 Mt in 2011–12. Ports Australia (2012) reports total iron ore export volumes of 403.6 Mt in 2011–12, however, it did not enumerate exports through Cape Lambert (Port Walcott), Whyalla, Yampi Sound, Port Latta and Townsville in 2011–12, which, according to other sources, accounted for an additional approximately 100 Mt of iron ore exports in 2011–12. The ABS (2012) estimates, which include total volumes, and value, of

exports by port, implies total iron ore exports of 521.2 Mt in 2011–12. Again part of the explanation may likely be different measures (i.e. wet versus dry), part may be differences in measurement scope, and part could be due to ABS (2012) adjustments to ensure commercial confidentiality. For the transport task estimates presented herein, BITRE has used the ABS (2012) iron ore export volumes, and assumed the estimates include free moisture.

Freight transport costs

The estimated iron ore transport volumes shown in Figures 5 and 6 are based on modelled transport flows. The relative transport costs for road and rail, and to a lesser extent ship and conveyor, heavily influence the estimated modal assignment of the modelled flows. Transport costs for iron ore movement are typically commercially sensitive and not publicly available. For the results presented in this information sheet, BITRE has made assumptions about modal transport costs based on available public information and its own best judgement about relative costs.

For rail, BITRE assumed average rail transport costs of between 1 and 2 c/ntkm (cents per net tonne kilometre) for Pilbara railways and slightly higher costs elsewhere. This estimate includes the empty backhaul component. The estimates are based roughly on those of Laird et al. (2005) who reported average *operating costs* of around 1–2 c/ntkm (cents per net tonne kilometre) for Pilbara iron ore railways (Laird et al. 2005, p. 3) and 2.5 c/ntkm for other bulk railways. The low average operating cost of Pilbara rail networks are attributed to world class track (good alignment, excellent formation, complete with sleepers and weight of rail capable of high axle loadings), up-to-date locomotives and well-maintained wagon fleets, as well as high average energy efficiency (e.g. 0.002 litres of diesel per 1 tonne kilometre of iron ore). Pilbara Infrastructure's (2008) submission to the National Competition Council (NCC) also estimated average rail operating costs in the Pilbara of around 1 c/ntkm. For other iron ore rail operations, BITRE assumed slightly higher average transport costs.

For road, BITRE assumed an average road transport cost of between 15 and 20 c/ntkm. This is based on an estimated average operating cost of between 10 and 15 c/ntkm for a fully laden road train, plus the cost of the empty return leg. By way of comparison, Pilbara Infrastructure's (2008) submission, assumed an average long-haul road transport cost of 15 c/ntkm for movement of iron ore from the Pilbara to ports.

Interregional freight volumes

Table A1 summarises the estimated interregional iron ore freight volumes for 2011–12, by ASGS 2011 SA3-level region pair and transport mode. The estimates imply movements within the Pilbara comprised over 92 per cent of total interregional iron ore movements in 2011–12.

Table A2: Estimated regional origin–destination iron ore freight volumes, 2011–12^a

Origin – SA3 region	Destination – SA3 region											Total
	Daly - Tiwi - West Arnhem	Esperance	Illawarra Catchment Reserve	Kimberley	Mid West	Outback - North and East	Pilbara	Port Adelaide - West	Townsville	West Coast	Wheat Belt - North	
Road (million tonnes)												
Charters Towers - Ayr - Ingham									0.17			0.17
Dubbo			0.07									0.07
Kimberley				1.50								1.50
Mid West					1.45							1.45
Outback - North and East						1.73						1.73
Pilbara							6.78					6.78
West Coast										2.09		2.09
Total			0.07	1.50	1.45	1.73	6.78		0.17	2.09		13.79
Rail (million tonnes)												
Katherine	1.08											1.08
Mid West					5.26							5.26
Outback - North									0.68			0.68
Outback - North and East						7.87		1.73				9.60
Pilbara							467.35					467.35
Wheat Belt - North		8.90									1.82	10.72
Total	1.08	8.90			5.26	7.87	467.35	1.73	0.68		1.82	494.69
Sea (million tonnes)												
Pilbara			4.10									4.10
West Coast			0.80									0.80
Total			4.90									4.90
All modes (million tonnes)												
Charters Towers - Ayr - Ingham									0.17			0.17
Dubbo			0.07									0.07
Katherine	1.08											1.08
Kimberley				1.50								1.50
Mid West					6.71							6.71
Outback - North									0.68			0.68
Outback - North and East						9.60		1.73				11.33
Pilbara			4.10				474.13					478.23
West Coast			0.80							2.09		2.89
Wheat Belt - North		8.90									1.82	10.72
Total	1.08	8.90	4.97	1.50	6.71	9.60	474.13	1.73	0.85	2.09	1.82	513.38

a. ASGS 2011 SA3-level regions (ABS 2011).

Source: BITRE estimates.

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