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Australia's bulk ports

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Foreword

The dramatic growth in bulk commodity flows, and commensurate growth in importance to the economy, has reinforced the pivotal role of ports in underpinning that trade. This report provides a profile of Australia's principal bulk ports and the logistics chain that delivers commodities through those ports. Amongst these facilities is Port Hedland, the world's largest bulk export port. It follows that efficient logistics are essential for these volumes, requiring substantial infrastructure and underlying investment, and co-ordination of the different links in the logistics chain.

The report aims to provide an appreciation of the tasks involved in making those throughputs happen and to support the implementation of the National Ports Strategy.

The research was undertaken by Peter Kain, in the Infrastructure and Surface Transport Statistics Section. Comments by David Mitchell and Pearl Louis are acknowledged.

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Gary Dolman
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June 2013

At a glance

- Australia's bulk ports have witnessed extraordinary growth in the last decade, with tonnage rising by over 75 per cent; mining exports account for most of this growth.
- Six ports dominate the export task: three iron ore ports (Port Hedland, Dampier and Cape Lambert) and three coal ports (Newcastle, Hay Point and Gladstone). Ongoing development of ore and mineral reserves is propelling the expansion of these, and other ports such as Brisbane, Abbot Point, Esperance and Geraldton and several proposed ports.
- Enhanced infrastructure and efficient logistics chains are central to achieving this growth. Bulk port facilities have been expanded greatly, notably with a five-fold increase in iron-ore export capacity at Port Hedland, the world's largest bulk export port. The world's largest coal export port is Newcastle, where coal terminal capacity more than doubled in the 7 years to 2012–13 and with further expansion underway. Such expansion includes additional jetties and berths that take larger vessels, additional stockyards for blending stocks and additional, higher-capacity shiploader equipment.
- It is also essential to expand the infrastructure of the upstream logistics chain which, in terms of high-volume dry bulk, means railways. For example, early Pilbara lines operate trains hauling around 9 000 tonnes of ore while recently-opened Pilbara railways run with trains hauling up to 33 000 tonnes, with the world's heaviest wagons (carrying around 130 tonnes of ore per wagon). New railways, new signalling, new and longer passing loops, double- and triple-tracking have added railway capacity.
- LNG exports are increasing, notably as reserves in Western Australia and Queensland are tapped and the world market for LNG grows. The gas chain is very different from dry bulk logistics, involving movements from gas fields to processing plant to vessels by pipeline. Offshore processing and loading of gas is also changing the perception of a port.
- Bulk ports are also central to Australia's domestic activities, such as for handling the importing, exporting and domestic distribution of crude- and refined-oil around the country; for handling cement materials and for shifting bauxite-based commodities between mining areas, refineries and smelters.
- The growth in tonnage along the logistics chain has increased the importance of systems for logistics co-ordination, particularly where there are multiple mines, common-user railways and shared-use port terminals. Formal systems for infrastructure-planning and day-to-day operations have matured in the last decade, such as the Hunter Valley Coal Chain Co-ordinator. This company, co-owned by mining companies and infrastructure and service providers, aims to maximise efficient throughput of coal from the Hunter Valley coal fields to and through Newcastle, with long-term capacity planning and day-to-day oversight.
- By contrast with container ports, bulk ports typically incorporate a production task—the commodity may be crushed, screened or blended (as with iron ore and coal) or is processed (as with bauxite, alumina, crude oil and gas).

- Diverse bulk commodity logistics chains and production processes at or near the port means that there is no single measure that describes the challenges and success of a logistics chain.

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CHAPTER 1
Introduction

This report provides a profile of the logistics chain for the largest Australian ports handling bulk commodities. Ports can be large in that they handle commodities with high value (such as, at the time of writing, copper). The ports considered here, however, are those distinguished by their high tonnage volume rather than their high value.[1]

The logistics of handling high volumes require high levels of infrastructure and underlying investment. The logistics also require high managerial standards of coordination, especially where export commodities with differential specifications are assembled or blended for outgoing shipments.

Objectives

The impetus for this report was set out in the April 2009 issue of BITRE's *Waterline*[2]. As was noted at that time, *Waterline* provides a useful overview of containerised port activity but does not consider non-containerised, largely bulk freight, trade. In 2006–07, non-containerised trade was 97.5 per cent of the weight of trade and 70.5 per cent of the trade value.

This report therefore seeks to redress that gap. With the surge in bulk exports—especially in iron ore and coal—there is a need to gain a national perspective on bulk port logistics. These perspectives include port tasks and throughput, logistics linkages and activity levels.

The research aims to complete the picture of port activities, facilitating broad stakeholders' understanding of infrastructure investment needs and supporting the implementation of the National Ports Strategy.[3]

We analyse existing and planned activities through a number of the current large bulk ports, while noting that a number of other ports have expansion plans that, if they come to fruition, will be major marine transport logistics centres; those plans are acknowledged in this report but not analysed.

1 Some commodities — especially propane and butane (LPG, Liquefied Petroleum Gas) and Liquefied Natural Gas —are high in cubic space volume but low in weight volume and so are under-represented in the port activities. The analysis draw outs LPG/LNG commodity flows through ports, where relevant.

2 BITRE 2009, pp. xi–xv.

3 Infrastructure Australia and the National Transport Commission have developed the National Ports Strategy, endorsed by the Council of Australian Governments in July 2012. Details of the Strategy can be found in Infrastructure Australia (2012) and National Transport Commission (n.d.).

Data sources

This publication draws on existing data sources, including:

- Ports Australia data
- Lloyd's Voyage Record data base (which underpins BITRE's *Australian sea freight analysis*[4]);
- public reports prepared for State and Commonwealth regulators;[5]
- port and terminal operator annual reports; and
- mining company annual reports.[6]

Each port and terminal reports different activity data, reflecting issues specific to each port. For instance, reporting "vessel queue" is relevant for regulatory oversight of highly-utilised common-user coal terminals but is unnecessary for low-utilisation, seasonal grain ports or owner-operated ports.

This report provides an overview of the broader logistics chain for each port's commodities. Data are presented to build up a picture of complementary activities that form port logistics chains. The report focuses on upstream (mine and railway) and downstream (shipping) activities as well as port activities. Because bulk ports are part of complex supply chains, understanding these logistics can facilitate an understanding of port performance.

This report also considers portside tasks. In some cases, especially petroleum, the bulk port fulfils the role in delivering crude oil to the port-based oil refinery, from whence much of the product is distributed broadly by land transport to local retailers. Similar port-based production, relying on input deliveries by sea, occurs for processed goods such as cement, steel, alumina and aluminium.

Finally, this report provides a review of the role of a range of quantitative activity measures along the logistics chain (described in Appendix A). Useful insight into freight task performance is achieved by providing quantitative description of activity along the different stages of the chain.

Complementary historical time series data are contained in the *Australian sea freight* publication, while forecasts of port activity are presented in Bureau Research Report 136, *Projected future port-related commodity freight demand and transport volumes.*

4 See BITRE's web site for the Australian Sea Freight time series data. <www.bitre.gov.au/statistics/maritime/australian_sea_freight.aspx>

5 For example, Queensland Competition Authority has oversight of performance at Dalrymple Bay Coal Terminal (at the Port of Hay Point) and the Australian Competition and Consumer Commission has oversight of activities of the open-access operations of Port Waratah Coal Services.

6 notably where the mining company owns terminal, berth and wharf facilities.

Figure 1 Shiploading

Source: Courtesy of North Queensland Bulk Ports Corporation.

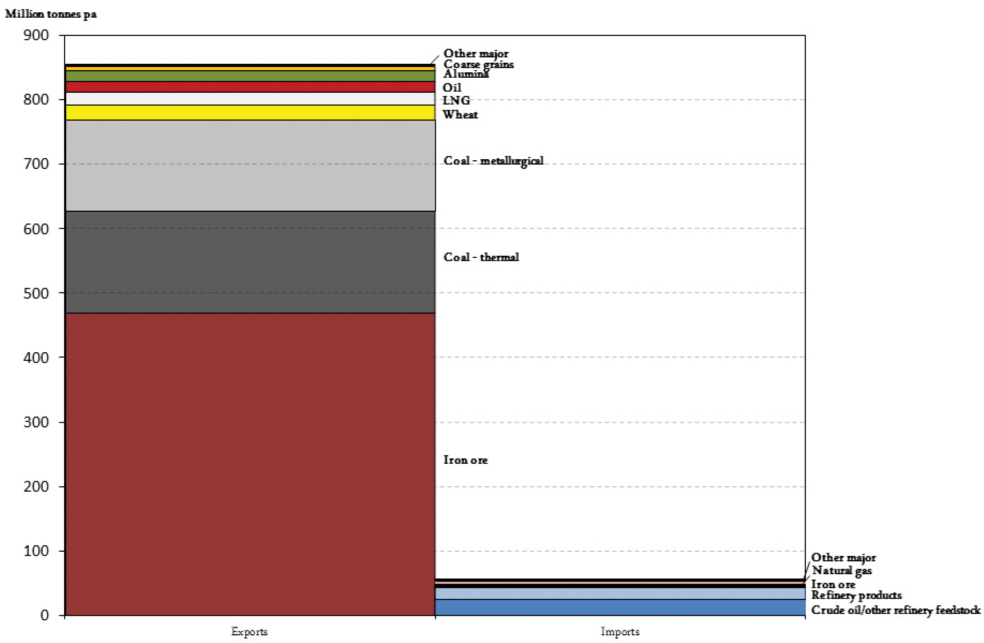
CHAPTER 2

Overview of bulk ports

This chapter provides an overview of Australia's principal bulk ports, profiling the largest bulk movements, by mass (tonnage) and not by monetary value or by cubic volume.

There is a broad range of bulk commodities moved through Australia's ports although, as shown in Figure 2, the mass is mainly exports and is dominated by iron ore and coal exports. The flow has evolved rapidly in recent years, notably in the growth of the iron ore and coal. That growth is set to continue; this is discussed further in the next chapter. Flows of other commodities are also set to grow rapidly, such as LNG exports.[7]

Figure 2 Composition of mass of principal imports and exports (tonnes)



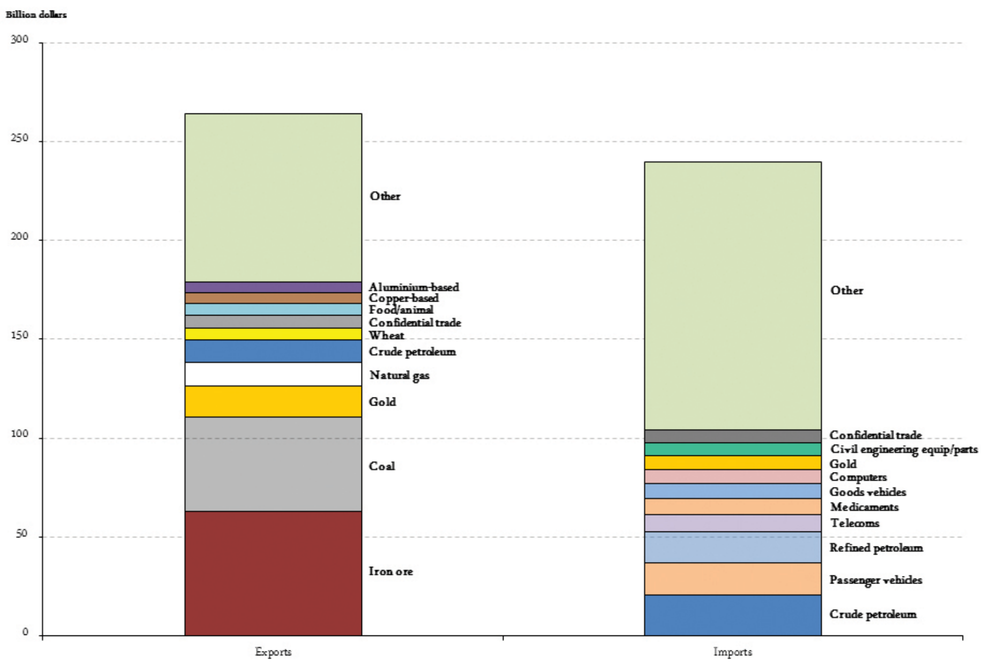
Sources: Australian Bureau of Agricultural and Resource Economics and Sciences, various issues; Bureau of Resources and Energy Economics, various issues.

Note: The weight of oil embodied in this chart was approximated, using an average conversion factor for all crude oil types, on the basis that 1.16 kilolitres of crude oil weigh one tonne. (Redstar Canada)

7 See, in particular, the report by the Bureau of Resources and Energy Economics, *Australian bulk commodity exports and infrastructure—outlook to 2025*

For the purposes of this report, which focuses on the port logistics chain, it is the mass of commodities, rather than their value, that is of primary attention. Nonetheless, the perspective of the value of the commodities should be appreciated—see Figure 3. The figure shows the value of bulk and non-bulk commodities, with iron ore, coal and gold being the principal commodity exports by value and petroleum and passenger vehicles being the principal imports by value. Bulk commodities dominate the mass (tonnage) of exports and the iron ore and coal exports account for almost one-half of the export value.[8]

Figure 3 Principal import and export commodities, by value, 2011–12



Source: Data from Department of Foreign Affairs and Trade 2012, pp. 151–153.

Definitions

Before reviewing bulk ports, it is appropriate to appreciate what we mean by terms such as "bulk" and "port". We also outline port and terminal facilities and landside logistics.

Bulk commodities

Ports Australia defines "bulk" cargo as being "homogenous unpacked cargo"; it cites coal, iron ore and grain as examples of such goods.[9] Such commodities are "dry" bulk. In addition, there are liquid commodities (such as oil and other petroleum-based products), called "wet" bulk or bulk liquids. Finally, there are related gas-based commodities (notably Liquefied Petroleum

8 For example, at Dampier, iron ore was 83 per cent of the port's export mass in 2010–11 but only 62 per cent of the throughput by value; by contrast, outputs from the gas fields represented 14 per cent of throughput by mass and 38 per cent of the value. (Export value data from Preston 2012, p. 10)

9 Ports Australia, web site, <www.portsaustralia.com.au/tradestats/>

Gas, LPG, and Liquefied Natural Gas, LNG), which are shipped in liquid form through cooling and compression.

Box 1 Gas logistics

As the weight of gas is relatively low, even under compression, the fully-laden tonnage of compressed-gas vessels is modest relative to dry-bulk vessels. This aspect of gas-based commodities means that for such trade, cubic volume or monetary value are more representative indicators of activity.

Major physical and financial resources are being applied in the gas logistics. The established North West Shelf Venture, drawing on the Carnarvon Basin gas and condensate (light crude oil) fields, has been the principal area of this trade. Gas is piped ashore from the North Rankin A, Goodwyn A and Angel platforms to the Karratha Gas Plant[10] and either shipped from there to various destinations or piped along the Dampier to Bunbury Natural Gas Pipeline. Another major gas project underway involves tapping coal seam gas (CSG) in western Queensland (including the Surat and Bowen Basins), piping it along a new 540 kilometre network, to Curtis Island (Gladstone), where it will be converted into Liquefied Natural Gas (LNG) and then shipped overseas[11].

Gas logistics also change perceptions of what is a port. For instance, oil is piped to the Okha Floating Production Storage and Offloading facility (FPSO), 135 kilometres out to sea from Dampier, from four nearby oil fields. Not only is the oil processed at the facility, but the facility also forms a port, with oil being loaded onto tankers and shipped directly to destinations. Gas extracted at the facility is piped to Karratha Gas Plant (near Dampier) for processing. The Prelude floating facility that is currently under construction (see page 113) will assemble, process and liquefy the gas and act as a port.

Bulk ports

It is important to appreciate the distinction between "port" and "terminal"

Typically, port authorities are in place to oversee the operations of individual entities within a defined port area. The distinction between ports and facilities within ports, such as terminals, wharves, jetties and berths, should be noted. Notable examples facilitate understanding these distinctions:

- **Dalrymple Bay** Common parlance is to refer to "Dalrymple Bay" as if it is a port in its own right. However, the "Dalrymple Bay Coal Terminal", together with the "Hay Point Services Coal Terminal", are coal-loading terminals within the Port of Hay Point.
- **Nelson Point, Utah Point, Finucane Island and Herb Elliot Port** refer to iron ore berthing facilities within Port Hedland. All such Port Hedland facilities are in the Inner Harbour of that port; BHP Billiton has had plans to expand its facilities beyond that area into a seaward-side Outer Harbour.

10 In 2012, the Pluto Gas Plant was build adjacent to the Karratha facility, processing gas from the Pluto, and its nearby, gas fields.

11 See page 60 for further discussion.

- **Port Waratah Coal Services** is a company operating coal-loading terminals at Kooragang and at Carrington within the Port of Newcastle. Similarly, **Newcastle Coal Infrastructure Group** is a company with a coal-loading terminal at Kooragang, also within the Port of Newcastle.
- **Cape Lambert** is an iron ore facility operated by Rio Tinto, within the WA proclaimed port area of **Port Walcott**.

Ports are typically associated with harbours that provide sheltered anchorage, protecting vessels from stormy weather; the harbours may be natural or have been built (such as with breakwaters or by dredging shipping channels). Ports and harbours may be sited in sheltered coastal inlets or entrances to rivers; or they may be sited in deep waters offshore, linked to the land by jetty.

There are a range of terms to denote mooring facilities within the port or harbour; the terms are often used interchangeably. The terms "dock", "wharf" and "quay" denote waterside interface areas where vessels are moored for loading or unloading vessels; a vessel will moor at a "berth" within such areas. A dock, wharf or quay may have multiple berths. The terms "pier" and "jetty" are used, in particular, to refer to facilities that link the landside with offshore deep-water mooring berths.

This report presents a range of port maps that shows current and planned port, terminal and berth facilities as well as related landside infrastructure. Railways, in particular, are essential elements in the logistics chain where there are substantial bulk movements between the hinterland and the port; the report presents relevant railway links.

Contrary to common perceptions, bulk commodities are not homogenous goods; they involve diverse qualities and attributes. Each commodity has varying attributes; commodities may therefore be conveyed in ways to keep them separate (e.g., using container boxes or separate bunkers in ships) or blended to form the downstream customer's commodity specification. Such blending is commonly undertaken for commodities such as iron ore and coal; the blending is part of the mining and logistics production process. By way of illustration, Box 2 provides a brief, simplified, discussion of the varying attributes of coal.

Box 2 Heterogeneous coal

There are different types of coal, with varying attributes, such as carbon and moisture content and levels of other elements; these impact on where and how that coal is used. As a generalisation, high-quality coal is black coal (and also called sub-bituminous coal, bituminous coal and anthracite); lower quality coal is brown coal.

An alternative classification of coal refers to the coal by how it is used: Thermal coal or Metallurgical coal.

Thermal, or "steaming", coal is generally used in power stations and is relatively low in carbon content and high in moisture content. A particularly low-quality (low carbon/high moisture) thermal coal is brown coal — also called lignite; its poor quality and high volatility means it is rarely transported long distances and so rarely exported.

Metallurgical, or "coking", coal is relatively high in carbon and low in moisture; typically it is used in steel production[12]. There are three main categories of metallurgical coal: hard coking coal, semi-soft coking coal, and PCI (Pulverised Coal Injection) coal; the PCI is not generally used for producing coking coal. As the relatively high-carbon/low-moisture attributes suggest, metallurgical coal is of inherently greater value than thermal coal.

Coal qualities vary across mining locations. Coal from different mines, with different carbon/moisture characteristics, can be blended (especially) at the port in order to meet a given customer's coal-standard specifications. When a port serves multiple mines — a "coal system" — it can increase the opportunities for such blending.

Most of the extracted coal is exported (around 90 per cent of Queensland's mined coal and 73 per cent of NSW mined coal). Of Queensland's exports, 72 per cent is metallurgical coal compared with only 25 per cent of NSW's exports.

Coal is extracted through a range of open-cut and underground mining processes; around three-quarters of Queensland's mines, and one-half of NSW mines, are open-cut.[13] The extraction sites are typically called "mines" but may alternatively be known — especially in NSW — by the British terminology, "collieries".

The important message to arise from this heterogeneous attribute of the commodities is that the logistics task in moving the commodity from the point of origin to the vessel can involve a range of activities. Such activities lead to either keeping the different types of commodity separate from each other throughout the logistics chain (including having different parcels/bunkers within the vessel) or blending different types of the commodity to form a composite product by the time the commodity is loaded onto the vessel. The former can apply, in particular, to grains and the latter to different ores of iron.

12 The high quality of metallurgical coal relative to thermal coal means that its price is somewhat higher. In 2011–12, the average value of metallurgical coal was $216/tonne and was $108/tonne for thermal coal. See BREE (2012a, p. 7) for underlying volume and value data.

13 Department of Natural Resources and Mines 2012; NSW Government, undated.

Import and export of commodities

Port authority/corporation nomenclature for unloading commodities from vessels, and loading of commodities to vessels, often refers to the activity as importing, and exporting, of the commodity, respectively. This term is applied irrespective of whether the goods have come to or from elsewhere in Australia, or to or from a non-Australian port. This terminology needs to be appreciated, therefore, when interpreting the data; often a port authority does not distinguish between domestic and foreign locations. To avoid mis-interpretation, we use the terms loaded and unloaded unless we are referring specifically to foreign-origin or -destination cargo, which is referred to as imports and exports, respectively.

Terminal activities

Landside terminal activities often involve both production and supply chain activities. That is, activities extend beyond the obvious task of conveying commodities between a vessel and the terminal. For instance, while iron ore and coal are stockpiled at terminals awaiting export, the process of stockpiling or the process of loading often involve blending of different types of the ore or mineral. This blending is undertaken to provide the downstream customer (such as the steel manufacturer or power station operator) with a specified commodity standard. While it may be possible for the blending to be undertaken at an individual mine, more commonly the specified ore or mineral characteristics can be achieved only through blending output from two or more mines.

Thus, the transfer of commodities can involve direct supply chain activities (mine to train to terminal to vessel) and production activities (notably, the product blending). For that reason, the port stockpiles are generally used for cargo assembly (with blending) rather than as dedicated product stockpiles; the latter require larger (scarce) surface areas at ports to be able to operate and this is particularly problematic at multi-product, multi-user terminals. See Box 3 for further discussion.

Box 3 The role of terminal stockyards

The role of ore or mineral stockyards at ports should not be presumed to exclusively represent a stock buffer. Stockyards are typically used as a location to undertake blending of different-sourced material in order to establish the quality demanded by the end-customer; when the commodity is blended on the stockpile it can be bed-blended in different ways (such as Windrow, Chevron or Cone Shell Type methods).[14] The blending may also occur at the mine-end of the logistics chain. Finally, blending can be undertaken when the commodity is being loaded on the vessel: the blending occurs when the commodity is reclaimed from separate stockpiles, with the actual blending occurring as each reclaimed component is shifted along conveyor belts. It is also possible for the commodity to be blended through combinations of these separate methods to obtain a composite product.

As Terminal throughput rises, with limited land area around the terminal, it becomes more difficult to segregate areas of the stockyard to stockpile differential commodity qualities, and segregate each terminal users' stockpiles (at multi-user terminals). The system of allocating space within stockyards may be influenced by whether the facility is a common-user terminal or whether terminal usage is restricted to owner-miner members.[15]

Thus, while it would be ideal to use stockyards for stock buffering, the need to allow for differential product blending and the need to accommodate multiple terminal users make it difficult to find adequate space for "dedicated stockpiling" of specific blends. For these reasons, "cargo assembly" (or "build-to-order") stockpiling is commonly undertaken, where the stock is railed to the port only when a time has been nominated for the recipient vessel.

It has been noted that the cargo-assembly approach is also important where there are product parcels (blends) that take time to assemble or are not in great demand; by contrast, unblended coal that is in high demand can be assembled and loaded quickly. Therefore, as throughput increases at multiple-product, multiple-user, terminals, the cargo-assembly stockyard is a preferred approach.[16]

A dry bulk stockpile is illustrated (and described) in Figure 4.

14 Note that a commodity is also defined by its grade—how coarse/fine the size of the commodity is. Thus, even where a commodity does not require blending at the port, it will be subject to screening, to separate large and small grades. (The commodity may be blended at the mine—see BHP Billiton Iron Ore 2008, p. 15.

15 The NCIG terminal in Newcastle is used (only) by the coal-mining companies that collectively own the facility; each stockpile in the facility is dedicated to a specific miner. Dedicated stockpiles are used rather than cargo-assembly stockpiling (as used at the other two (PWCS) Newcastle coal terminals. (Kirkwood 2009)

16 This issue is discussed in a report by Connell Hatch (at Appendix A of the Dalrymple Bay Coal Terminal (2009) report (pp. 1–3). See, also, BBI (DBCT) Management Pty Ltd 2008, p. 4, for a discussion of stockyard performance and performance measures.

Figure 4 Stockyard at coal terminal*, Port of Newcastle

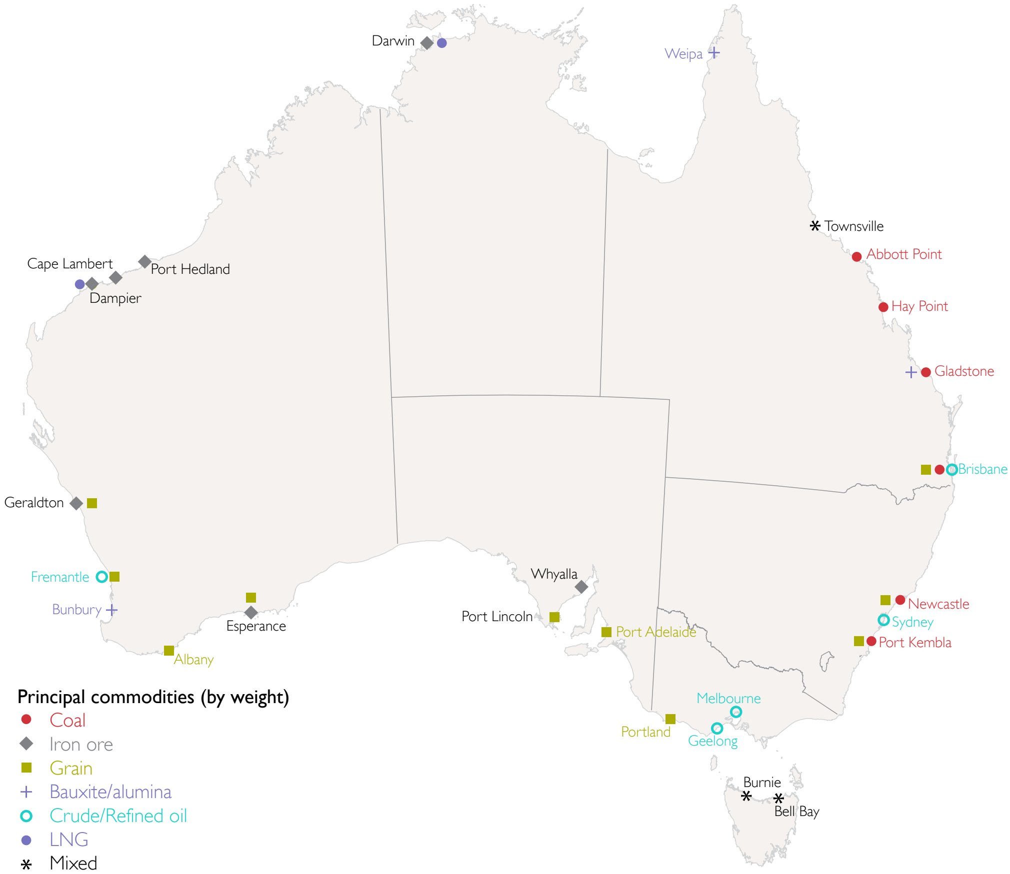
Source: Photograph is courtesy of Newcastle Port Corporation.

Note: * Various aspects of dry bulk handling and port production processes can be seen in the photograph. In the foreground, water is sprayed over a stockpile to reduce dust. Lines of stockpiles are seen, with two fully-automated stockpile stacker/reclaimer machines—the two white-coloured (80-metre high) machines feed coal from conveyors onto stockpiles as well as reclaim coal (using scoop buckets) back onto conveyor belts and thence to shiploaders. A yellow shiploader can be seen at the dockside in the middle-left, discharging coal into the vessel. The vessels themselves have multiple holds (marked by hatches along the top of the vessel); such holds can be used to separate different blends/brands of a commodity (that is, into different "parcels" of the commodity).

Principal bulk ports

Figure 5 is a map showing the major bulk ports (in terms of the highest volume throughput and principal commodity handled). The commodities handled are predominantly for export, with exceptions including crude/refined oil, the import of nickel ore at Townsville (for processing there) and the import of bauxite at Gladstone (from Weipa) and alumina to Bell Bay (from Gladstone).

Figure 5 Principal Australian bulk ports, by volume



Trends in port throughput inevitably depend on supply and demand factors. For instance, in the case of grain throughput, the weather variations from year to year impact on grain yields. The largest ports are the iron ore ports, where strong export sales of this raw material to China, especially, have led to very substantial growth at the largest ports in recent years. At Port Hedland, throughput (mostly iron ore) rose by over 64 per cent between 2004–05 and 2009–10; at Dampier, over the same period, throughput (again, mostly iron ore) rose by over 78 per cent.

Figure 6 illustrates the changes in port throughput between the years 2001–02 and 2010–11. It is notable that, in the decade to 2011–12, Australia's bulk port throughput rose by over 75 per cent. Most of the bulk port activity is exports (or "loading"), as indicated in Figure 6.[17] Unloaded bulk commodities include the bauxite and alumina flows, iron ore from the Pilbara to Port Kembla, LPG from the Pilbara, and crude and refined petroleum products.

17 Note that some of the ports (especially Brisbane and Fremantle) additionally have a considerable non-bulk (container) task.

As is evident from the figure, six ports dominate the throughput task, three being iron-ore dominated ports:

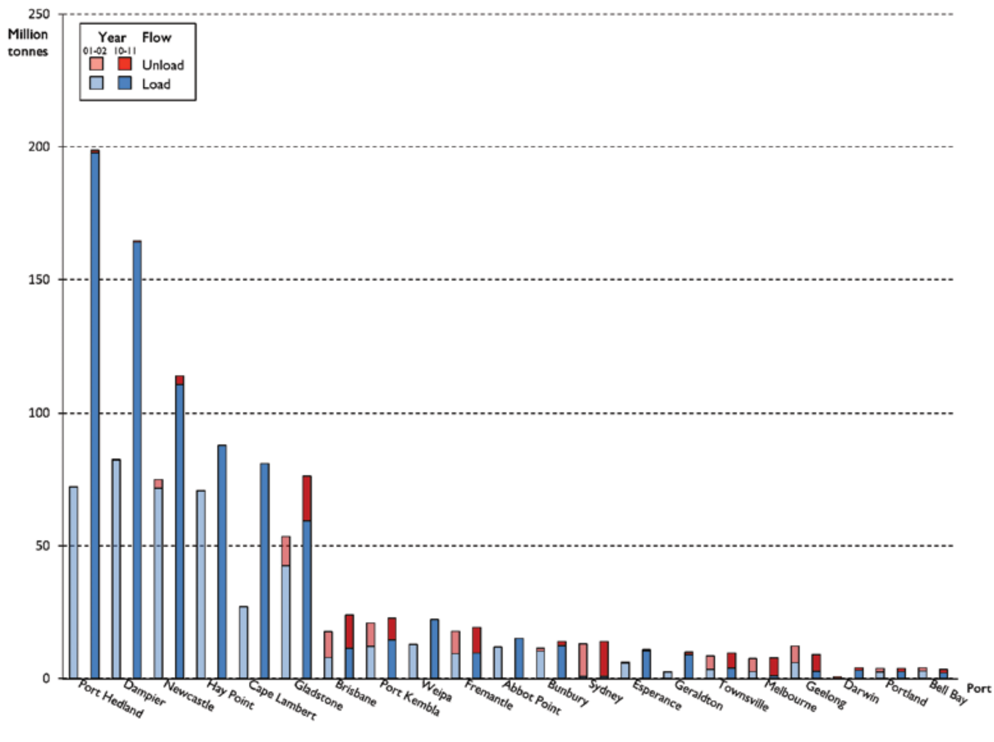
- Port Hedland
- Dampier
- Cape Lambert (Port Walcott)

and three being coal-dominated ports:

- Newcastle
- Hay Point
- Gladstone.

There has been very strong growth at these ports, particularly so at the three iron ore ports, where tonnage growth was 175 per cent, 98 per cent and 200 per cent, respectively, between 2001–02 and 2010–11.

Figure 6 **Bulk port throughput, loading and unloading, 2001–02 and 2010–11**



Sources: Ports Australia (undated); Darwin Port Corporation, 2009; Government of Western Australia, 2009; BITRE, , various issues; North Queensland Bulk Ports Corporation, 2010; Gladstone Ports Corporation, undated; Government of Western Australia, 2011.

Notes: Tonnage for total port throughput (bulk, general and containerised cargo) is shown here.

This report focuses on the first twelve bulk ports in Figure 6, while noting that there are substantial flows through other ports, including substantial growth (such as at Esperance and Geraldton). If realised, new bulk ports—such as proposed for Anketell, Dudgeon Point and Port Bonython—will introduce substantial new bulk logistics chains.

CHAPTER 3
Bulk ports logistics

This chapter reviews the activities of the principal bulk ports outlined in the previous chapter. The analysis is presented by port, split first by principal commodity and then in descending order of bulk tonnage throughput. The analysis begins with iron ore, led by Port Hedland, the world's largest export port.

Appendix A provides a background review of the various activity measures used in this chapter, together with the attributes and deficiencies of those measures; it is apparent that different activity data sets provides different aspects of the port and a complete picture of the port relies upon multiple data sets. Understanding bulk port logistics relies on appreciating the levels and patterns of movement of commodities along each commodity's logistics chain as well as the production processes that occur at the ports.

Logistics chain

Box 4 provides an overview of a mining bulk commodity production and logistics chain through to the vessel.[18] The actual shiploading stage — something that is often thought of as being the task performed at the port — is actually just one stage in a production and logistics chain. Physically, the landside port facilities normally dwarf those at the wharf—see, for example, Figure 7.

Figure 7 Port of Hay Point

Source: Courtesy of North Queensland Bulk Ports Corporation

Note: The photograph shows the Dalrymple Bay Coal Terminal (on the left) and the Hay Point Coal Terminal (upper-right). The railway serving the Hay Point Coal Terminal runs across the middle of the picture, forming a balloon loop for dumping coal near the terminal. The Dalrymple Bay Coal Terminal's stockyard is to the middle-left of the picture, being fed by rail wagons (out of view to the left); coal that is blended in the stockyards is then reclaimed and sent by conveyor belt along the jetty and onto the vessel.

18 Blending can occur at the mine, as the commodity is stockpiled or as the commodity is shipped.

Box 4 Stages of the landside logistics chain

Each element of this chain involves differing handling (and, thus, capacity) rates, depending on capital and labour inputs and productivity. The logistics chain from the mine head involves a range of tasks, including:

- The consolidation of ores and minerals from the mine site to the railhead, using heavy vehicles; some blending may occur at this point along with crushing and screening.[19]
- A range of loading mechanisms are then used to load rail wagons via the top of the wagon, which is usually an open-topped "hopper" wagon.
- Trains then convey the goods to the terminal at the port.
- At the "rail receival station" at the terminal, the commodity is removed, usually by "bottom-discharge", where the floor of the wagon can be opened to enable the ore/mineral to drop to a pit below the tracks.
- After it is then conveyed to the stockpile, a "stacker" places it in stockpile rows.
- At this stage "Windrow" (or other forms of) blending of different grades of the commodity may occur.
- Stacker/reclaimer machinery then recovers the ore/mineral.
- It is then conveyed by "outloader" machinery to the berth-side; blending may also occur at this stage.
- At the berth the "shiploader" transfers the commodity to the vessel.
- Each different brands/blends/grades — or "parcel" — of the commodity is placed in different holds of the vessel. The more parcels that have to be loaded into a vessel, the longer it takes to load the vessel.[20]

Thus, it is important to appreciate that the ports are anything but an isolated, independent transport activity. Rather, the ports are typically a part of a complex supply chain and that the logistics chain and the chain also incorporates production processes.

19 For example, BHP Billiton's Newman Hub facility, near Mt Newman, enables the crushing and screening of iron ore near the mine (shielded from populated areas at the port) than on scarce port land.

20 Experience at Dalrymple Bay Coal Terminal indicates that a multi-parcel vessel may take approximately 30 to 50 per cent longer to load than a single-parcel vessel—see Aamodt 2009.

1. Iron ore ports

This section reviews Australia's principal iron ore ports and their logistics chains. We consider Port Hedland, Dampier and Cape Lambert.

Port Hedland

Port overview

The Port is set in a natural anchorage inlet in the coastline — the Inner Harbour — using wharf berths. The development of Port Hedland began in 1896, with large-scale developments taking place from 1965 with the commencement of iron ore exports. The port is managed by the Port Hedland Port Authority.

Port Hedland snapshot

- Loaded iron ore
- Landside deliveries of iron ore by rail
- Production of blended ores at the port
- Additional Inner Harbour berths committed and landside rail logistics planned

Port Hedland is the world's largest bulk export port[21]. The port's trade is predominantly in iron ore exports, but there is a range of other bulk flows, including manganese (Mineral Resources; Consolidated Minerals) and salt (Rio Tinto's Dampier Salt).

Harbour and landside facilities

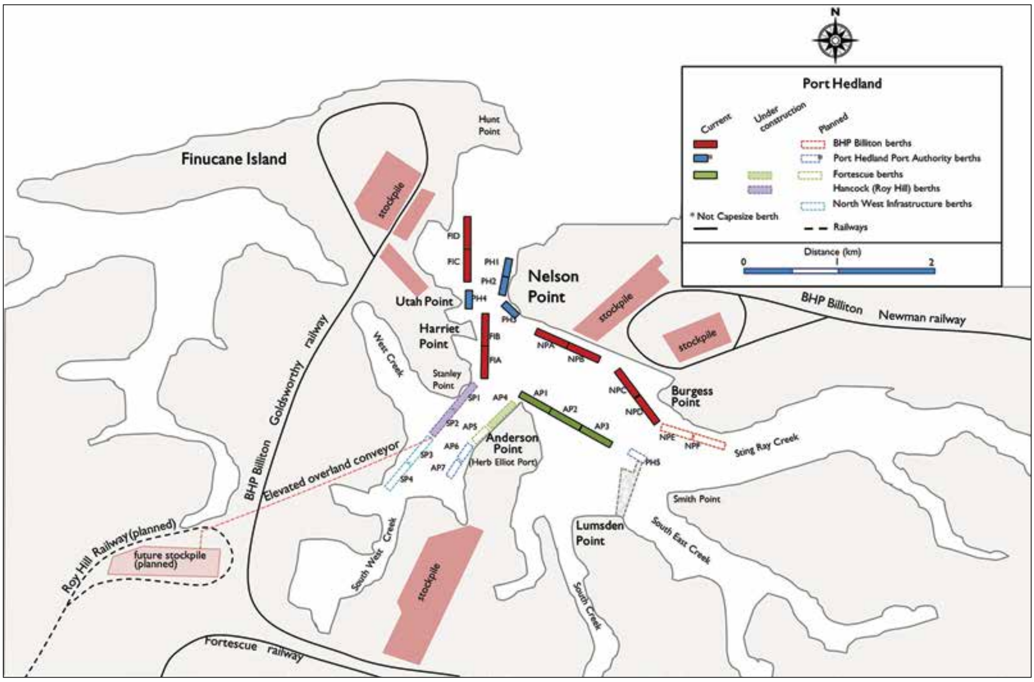
Major maritime and landside infrastructure facilities are shown in Figure 8. The berths are situated within the Inner Harbour[22]. The harbour is tidal-constrained for deep-draughted vessels, that is, the largest vessels (usually on — loaded — departure) must go through the channel from the Inner Harbour when the tide is in. The channel does not permit vessels to pass each other. (BHP Billiton Iron Ore 2008, p. 15)

The berths are at locations such as Finucane Island, Nelson Point, Burgess Point, Anderson Point (Herb Elliot Port), Utah Point and South West Creek. Currently-open berths labelled PH1 through PH4 are common-user berths; the remaining berths are allocated to the iron ore exporters (BHP Billiton, Fortescue, Hancock [forthcoming], North West Infrastructure [a joint venture of Atlas Iron with Wah Nam Holdings, forthcoming]). Most of the berths are "Capesize", meaning that a berth is capable of accepting some (or all) of the largest class of bulk vessels.

21 Port Hedland Port Authority 2012, p. 2.

22 BHP Billiton, through its Western Australia Iron Ore company, has long-term plans for an Outer Harbour facility, extending seaward beyond Finucane Island.

Figure 8 Inner Harbour, Port Hedland



The logistics of the iron ore export chain requires landside facilities at the port for stockpiling the bulk commodities (as marked in Figure 8) and, for iron ore, the blending of ores from different locations to form a specified composition of blended ore. This results in large stockpile areas at, or adjoining, sites at the port when the ore is dispensed from the railway wagons (with "car dumper" equipment). At the stockpiles, excavators then extract the final blended product; conveyor systems and ship-loading equipment are then used to transfer the ore to vessels.

There has been considerable expansion of berthing and landside facilities at the port in recent years: the harbour had 4 iron ore berths in 2005 but there were 12 berths in 2012. This berthing increase includes the new common-user facilities at Utah Point (with one berth) and new facilities at Anderson Point (Herb Elliot Port, with three berths), Harriet Point (with two berths), Burgess Point (with two berths). Dockside facilities include additional stockpiles (with additional reclaimers and shiploaders) and car dumpers. BHP Billiton's logistics infrastructure[23] within the Inner Harbour aim to achieve export capacity of 240 million tonnes per annum in 2013 while Fortescue aims to achieve throughput of 155 million tonnes per annum by mid-2013. To put these objectives in context, that total throughput aspirations of 395 million tonnes compares with iron ore capacity of 80 million tonnes in 2002. (BHP Billiton 2002, p. 2)

Iron ore exports are undertaken at the port a number of mining companies, including:

- **BHP Billiton** (8 berths in total; 2 berths at each of Nelson Point, Burgess Point, Harriet Point and Finucane Island)
- **Fortescue** (3 berths, with an additional berth under construction; at Anderson Point—otherwise known as Herb Elliot Port)

23 BHP Billiton's Port Hedland activities are managed through its Western Australia Iron Ore company.

- **Mineral Resources** (using common-user berths at Utah Point and Nelson Point)
- **Nullagine Iron Ore Joint Venture** [between BC Iron and Fortescue] (using Fortescue's three berths at Anderson Point)
- **Atlas Iron** (using the common-user berth at Utah Point and with two future berths in South West Creek, with Wah Nam Holdings in the North West Infrastructure joint venture).

with iron ore exports in the future by:

- **Roy Hill Iron Ore** — Hancock (using Hancock's two new South West Creek berths under construction).

The opening, in 2009, of BHP Billiton's first consolidated processing facility in the mining area, Newman Hub, transferred crushing and screening from the port. This facility shifts dusty and noisy tasks from the Port Hedland township area and reduces the need for scarce port land as production increases.

Proposed and current port capacity expansions

Figure 8 includes planned port facilities within the Inner Harbour. Current capacity expansion is concentrated in South West Creek, with two berths under construction for the Roy Hill iron ore exports (SP1, SP2), two berths planned for use by the North West Infrastructure alliance for iron ore exports (SP3, SP4) and a further berth (AP5) planned for Fortescue. At Burgess Point, BHP Billiton have received approval for construction of a further two berths (NPE, NPF).

Beyond the infrastructure shown (with common-user berthing proposed for Lumsden Point), there is limited additional berthing capacity that can be accommodated within that Harbour. Until 2012, the strategy adopted by BHP Billiton was to expand capacity by construction of an Outer Harbour by constructing a 2.8 km jetty into the sea from Finucane Island; the facilities would have been an Outer Harbour at the port.

Apart from berthing capacity issues, the port faces shipping channel capacity issues, which the Outer Harbour facility would have circumvented.[24] One way that throughput can be raised through the channel is by increased flexibility in capacity allocation. Thus, a 2012 update of the Port Authority's Vessel Movements Protocols has included a clause that permits a company to increase use of the shipping channel if other companies fell below their monthly allocated capacity.

BHP Billiton has re-assessed these capacity issues, however, and concluded that additional capacity could be extracted from the Inner Harbour before the Outer Harbour (with an estimated construction cost of $20 million) was required. BHP Billiton identified "substantial latent capacity in the Inner Harbour".[25] Fortescue believe that the Inner Harbour could handle more than 600 million tonnes per annum[26] (allowing for factors such as cyclones and neap

24 With a 30-minute vessel separation, in January 2013 the Port achieved a record throughput of over one million tonnes, shifted by 6 Cape-sized vessels, on one tide along this channel.

25 BHP Billiton 2013, p. 4. The company stated that relevant capacity factors included "These included: (1) an increased understanding of the potential capacity of the Port Hedland Harbour, along with greater clarity as to how unutilised capacity will be allocated; (2) the Port Hedland Port Authority granted us the option to develop two new berths in the Inner Harbour; and (3) … with installed car dumper, ship loader, and rail capacity now approaching around 300 million tonnes per annum, the significant debottlenecking and optimisation potential that exists in the Inner Harbour has only become more clear."

26 See The West Australian, 25 February 2013.

tides), which would be more than double the port throughput achieved in 2011–12 — see Figure 10, below.

Landside logistics

In common with the other Pilbara ports (Dampier and Cape Lambert), the landside logistics is an integrated ownership and operation (mine, railway/train, port terminal) by respective major mining companies. The mining companies therefore undertake their own planning and day-to-day logistics associated with their terminals. From seaside of the wharfside, however, actions must be co-ordinated with other port users and the port authority.

The iron ore that passes through Port Hedland is mined predominantly by BHP Billiton and Fortescue, with mines being up to 425 kilometres from the port. Virtually all the ore is shifted to the port by trains. The railways are owned by the mining companies/joint-venture companies who also operate the trains (directly or via subsidiaries). Fortescue also shifts ore from the Christmas Creek area from the mine developed in its joint venture with BC Iron.

There are two independent railway networks to Port Hedland, as shown in Figure 9 (including the Rio Tinto networks to Dampier and Cape Lambert); the lines are built to standard (1 435 mm) gauge. The existing two railway networks, with preliminary works on a third network, are:

- BHP Billiton's Goldsworthy railway (from Yarrie) and Newman railway (from a range of mines, including Mac and Newman Hub);
- Fortescue's Christmas Creek railway and Fortescue Hamersley [Solomon] railway; and
- the proposed Hancock's Roy Hill railway, with contracts let but construction deferred.

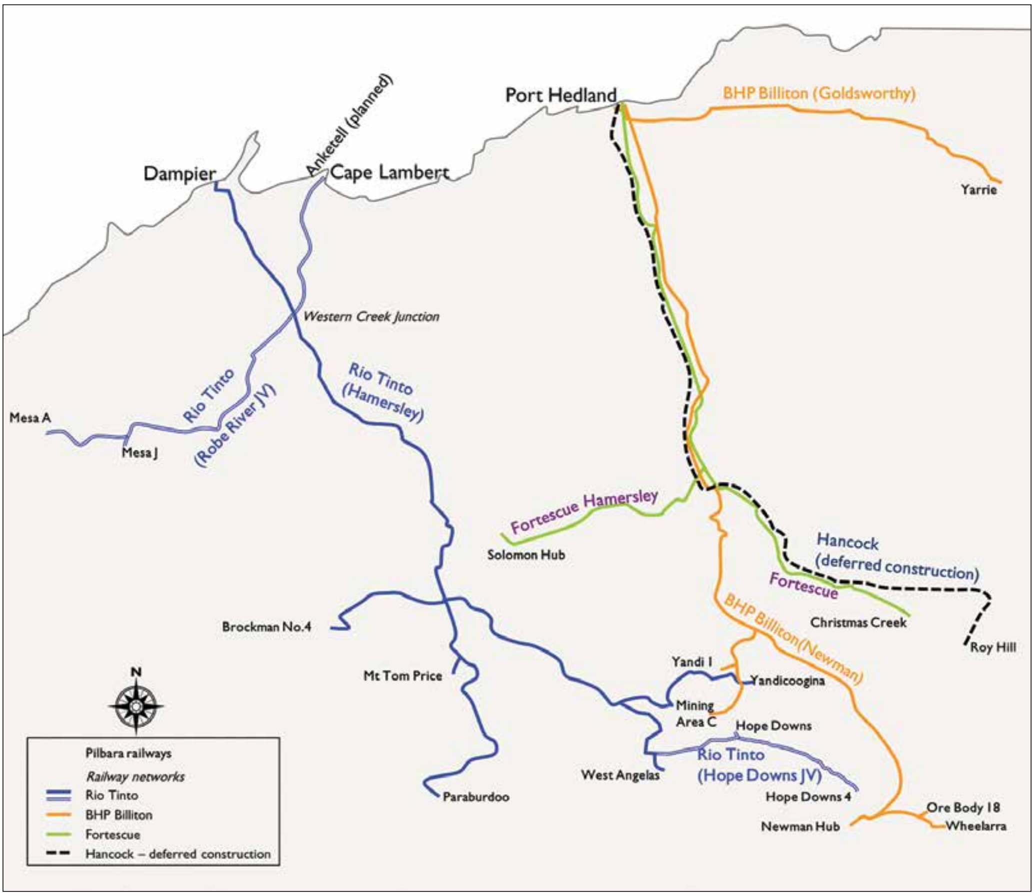
In addition to the new railways built by Fortescue, in the last decade the landside infrastructure has also been upgraded to expand capacity. In particular, BHP Billiton has substantially double-tracked its Newman railway while Fortescue has double-tracked around 39 per cent of its Port Hedland – Christmas Creek railway)[27].

A smaller mining company, Atlas Iron, uses road haulage for conveying its iron ore from its Pardoo Mine (75 kilometres east of the port) and its Wodgina Mine (100 kilometres south of the port); the company uses the Utah Point common-user berth at the port.[28] The company shipped around 5.6 million tonnes of iron ore in 2011–12. The company has been exploring new rail infrastructure-based options with Aurizon as well as use of Fortescue's railway network.

27 BHP Billiton has restructured its Newman operations into three logistics hubs: the Eastern [or Newman] Hub (around Mt Newman), the Central Hub (around Mining Area C) and the Yandi Hub (around Yanid).

28 Atlas Iron expects to commence production at its Mt Dove Mine (70 kilometres from the port) and its Abydos Mine (130 kilometres from the port) during 2013. In both cases, road haulage will be used. (Atlas Iron, undated)

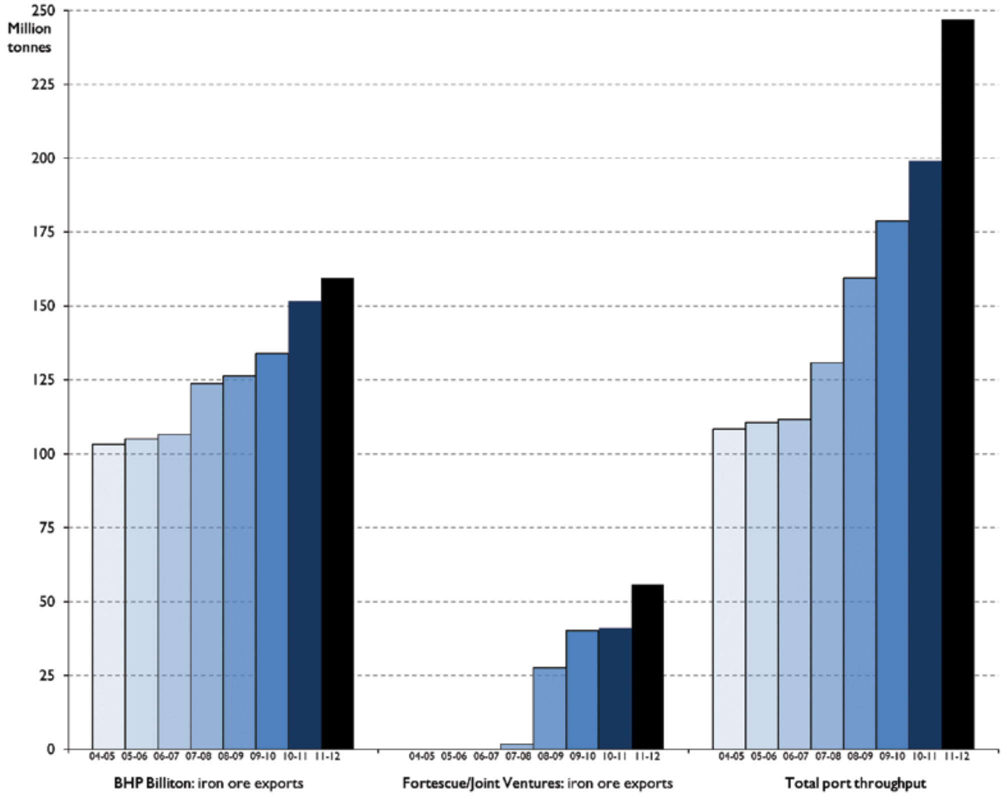
Figure 9 Principal Pilbara ports and supporting railways



Port utilisation

Port Hedland, the world's largest export port, has experienced rapid throughput growth in recent years, as illustrated in Figure 10. Throughput increased by 83 per cent between 2004–05 and 2010–11; in the 2011–12 financial year, the throughput rose by a further 24 per cent. That expansion of throughput has resulted from strong growth in overseas demand (especially from China) for iron ore, triggering exploitation of ores at new mining sites. This has led to the installation of new Cape-size berths (and landside facilities) at the harbour sites at Burgess, Anderson, Harriet and Utah.

Figure 10 Port Hedland throughput



Source: Annual reports: Port Hedland Port Authority (various years), Fortescue Metals Group (various years), Ports Australia (n.d.), BHP Billiton 2012.

Note: BHP Billiton and Fortescue iron ore exports are separately identified; other loaded and unloaded commodities are included within the total port throughput.

Port activities

As key focal points in logistics chains, bulk ports involve a range of waterside and landside activities. A range of these measures for Port Hedland is presented in Table 1.

Table 1 Port Hedland activity parameters, by year

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11
Landside							
Train capacity (tonnes, maximum)							
BHP Billiton (Goldsworthy)							11 340
BHP Billiton (Newman)							26 000
Fortescue							32 880
Wharf turnover (tonnes/linear metre of berth face) (iron ore, '000)							
Nelson Point berths	101	99	104	103	92	na	na
Finucane Island berths	62	67	64	77	90	na	na
Anderson Point berths	-	-	-	2	36	na	na
Wharf							
Total number of vessels through port	895	925	897	1 037	1 223	1 303	1 460
Number of dry-bulk vessels with Gross Registered Tonnage size greater than 100 000	129	103	133	151	172	208	257
Berth utilisation (% of time utilised)							
Nelson Point	84	87	87	86	85	84	82
Finucane Island	61	62	58	80	86	85	81
Anderson Point	-	-	-	68	67	57	57
Average cargo tonnes lifted per vessel (iron ore, '000)							
Nelson Point	143	155	166	166	166	na	169
Finucane Island	156	124	161	166	170	na	173
Anderson Point	-	-	-	152	169	na	168
Utah Point	-	-	-	-	-	-	87
Beyond							
Distribution of iron ore export tonnage (principal countries, percentage of total)							
China	34	53	48	51	67	na	70
Japan	37	22	25	24	16	na	13
South Korea	15	14	14	16	11	na	11
Iron ore as proportion of total throughput (percentage)	95	95	95	96	97	97	97

Source: Port Hedland Port Authority (various years); Ports Australia (n.d.).

These activity parameters can be considered in their own right (as a percentage of the total) and as a trend. In this context, then, it is noted:

- **rising train tonnages.** Each mining railway has progressively raised average train payloads, with the newest railway, owned by Fortescue, involving trains up to 33 000 tonnes, with 234 wagons; this compares with trains on the older Goldsworthy–Yarrie line having loads of around 8 800 tonnes, with 110 wagons (BHP Billiton Iron Ore 2008, p. 19). For new railways, and within existing railways, the trend has been to raise the payload level per wagon, to raise the wagon payload relative to tare (unladen) weight, and to increase train length. Fortescue's 40 tonne axle load limit (160 tonne gross wagon weight) is the heaviest weight permitted on any railway in the world[29].
- **"high" berth utilisation.** It is not possible to fully utilise a berth because of the inevitable downtime incurred in piloting vessels into the Inner Harbour and to the berth, the process of mooring and sailing and then clearing the berth and Harbour on a favourable tide prior to the arrival of the next vessel. Thus, current berth utilisation at the BHP Billiton iron ore facilities (Nelson Point and Finucane Island) of over 80 per cent can be regarded as close to, or at, full capacity (on current systems). In recent years, capacity has been expanded in response to increased demand for iron ore, such as new berths at Burgess Point, Harriet Point, Utah Point and Anderson Point.
- **average vessel size/tonnage has increased markedly.** While the port throughput has risen by 83 per cent, the number of vessels going through the port rose by only 63 per cent. The average tonnage lifted per vessel rose during this time, with larger vessels calling. As the table shows, the number of dry-bulk vessels of 100 000 Gross Registered Tonnage or larger virtually doubled between 2004–05 and 2010–11, reflecting this trend in vessel size and in rising port throughput. (This is also reflected in rising numbers of these larger vessels that have been piloted within the Inner Harbour over the period.)
- **port activities are predominantly iron ore.** Virtually all the port's activity is applied to the export of iron ore.
- **the trade is now dominated by iron ore exports to China.** By contrast, in 2004–05, the largest destination for the ore was Japan; this share has fallen by around two-thirds and overall tonnage to the country has fallen by around one-third.

29 Fortescue 2012, <www.fmgl.com.au/UserDir/FMGReports/Documents/FACT%20SHEET%20Fortescue%20Rail%20Operations%20Feb%202012129.pdf >

Box 5 Data sources, Port Hedland

- Port Hedland Port Authority, *Port Handbook,* <www.phpa.com.au/docs/PHPA_Handbook_Dec_2011.pdf> Port specifications, such as berth capacities; port maps.
- Port Hedland Port Authority, *Annual Report,* <www.phpa.com.au/document_library.asp> ,Tonnage throughputs, by commodity, cargo and utilisation rates by terminal (Nelson, Finucane, Anderson, Utah).
- Port Hedland Port Authority, *Shipping movements,* <www.phpa.com.au/ships_movements.asp>, Current vessels anchored or in, approaching, leaving the port, by vessel name and specifications.
- Port Hedland Port Authority, *Cargo by destination summary,* <www.phpa.com.au/cargo_destination.asp>, Cargo by commodity type by upload and discharge of origin or destination. Monthly
- Port Hedland Port Authority, *Cargo DWT, GRT by cargo type,* <www.phpa.com.au/cargo_stats.asp>, Cargo tonnage, by vessel, by upload or discharge, by day.
- Port Hedland Port Authority, *Cargo statistics and port information,* <www.phpa.com.au/docs/CargoStatisticsReport.pdf>, Annual tonnage throughput, by commodity. Time series. Berth specifications.
- Ports Australia, *Trade statistics,* <www.portsaustralia.com.au/tradestats/>, Dry and Liquid bulk annual tonnages, vessel calls.
- BHP Billiton, *Annual report,* Presentations, Production report, <www.bhpbilliton.com/home/investors/reports/Pages/default.aspx>, BHP Billiton's annual landside tonnage haulage, capacity measurements, quarterly production report by commodity.
- Fortescue Metals Group Ltd, *ASX announcements,* <fmgl.com.au/investors_and_media/ASX_Announcements>, Fortescue Metals Group's shipments through its Anderson Point (Herb Elliot Port) facility (various reporting periods).
- Geoproject Solutions, Pilbara Railways, <www.geoproject.com.au/>

Dampier

Port overview

The port of Dampier is based offshore, with jetties; it was developed from 1963, in conjunction with iron ore mining at Mt Tom Price. The Dampier Port Authority has oversight of the facilities in the vicinity of Hampton Harbour (the Mistaken Island salt wharf, the East Intercourse Island and Parker Point iron ore jetties); the facilities south of Withnell Bay on the Burrup Peninsula (the North West Shelf energy jetties); and the Ashburton North port (with North West Shelf energy facilities) around 300 kilometres south of Dampier. The towns of Dampier and Karratha support the port activities.

Dampier snapshot

- Loaded iron ore, salt, LNG and LPG
- Landside deliveries of iron ore by rail
- Piped LNG/LPG gas deliveries
- Production of blended ores at the port

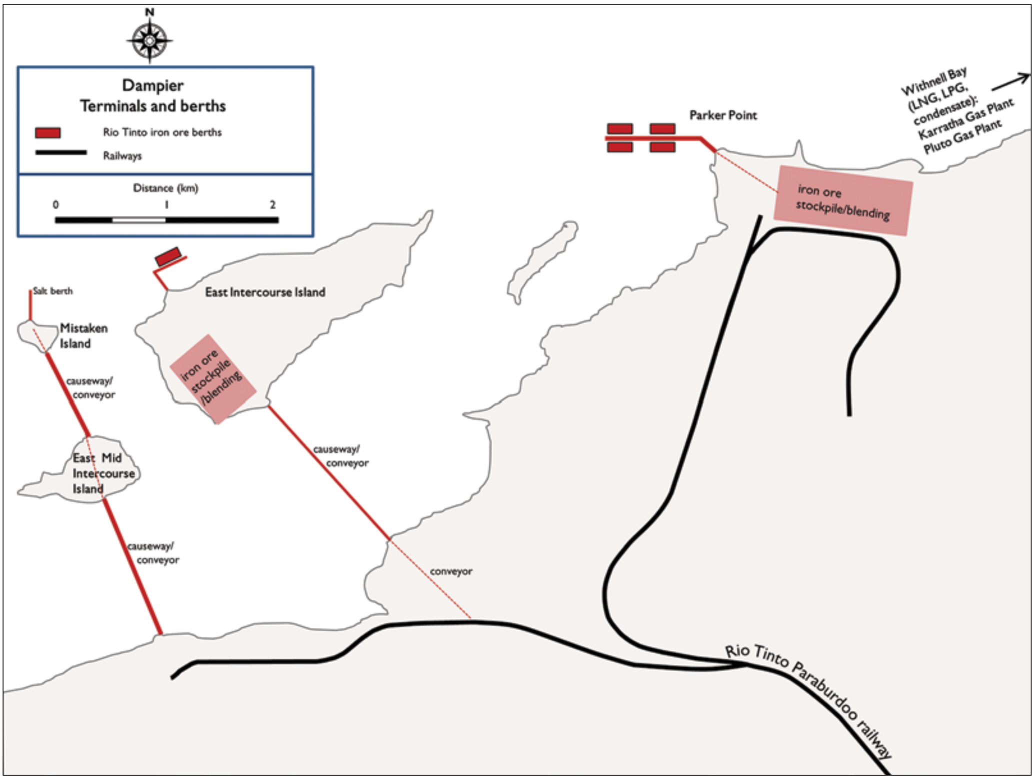
The port activities are export-based and focus on dry bulk and energy commodities. Dry bulk activity is primarily iron ore exports (with 83 per cent of throughput in 2010–11) and salt exports (Dampier Salt, majority-owned by Rio Tinto, with 3 per cent of the port's throughput).

Dampier is also the onshore production and processing centre for North West Shelf energy. Outputs from the gas fields on the Shelf total 14 per cent of Dampier's throughput.

Harbour and landside facilities

Major maritime and landside infrastructure associated with iron ore and salt exports are shown in Figure 11.

Figure 11 The port of Dampier, showing iron ore and salt facilities



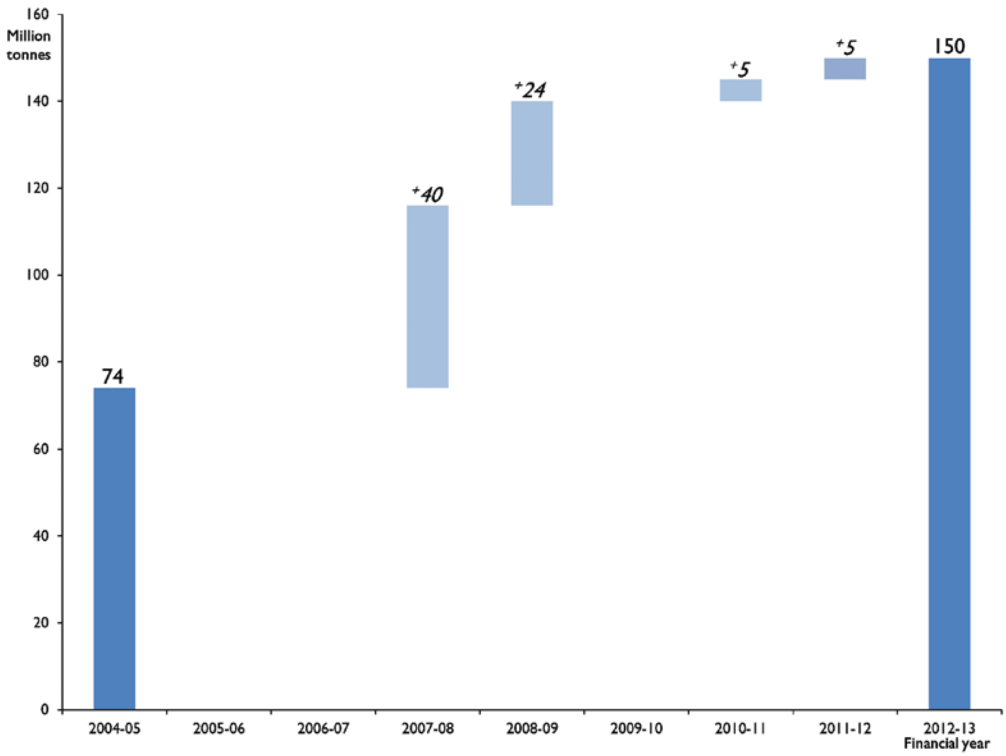
Dampier's port facilities include the following major production and logistics operations:

- **Rio Tinto's iron ore exports.** This operation uses 5 berths in total, with 4 berths at Parker Point and one berth at East Intercourse Island.
- **Dampier Salt exports (Rio Tinto),** extracted from nearby dried salt pans. The salt is shipped from one berth at Mistaken Island.
- **Woodside Energy's Karratha Gas Plant,** which processes the gas for domestic markets (via pipelines); and export, using 3 adjacent berths at Withnell Bay on the Burrup Peninsula.
- **Woodside Energy's Pluto Gas Plant** (next to the Karratha Gas Plant), which processes the gas for domestic markets, and export using 2 adjacent berths.

The iron ore capacity at Parker Point was increased in stages from two, to four, berths from 2005. It is notable that the East Intercourse Island berth is capable of accommodating vessels in excess of 250 000 deadweight tonnes. Berths at Parker Point are capable of handling vessels up to approximately 230 000 deadweight tonnes.

Figure 12 illustrates the growth in nameplate iron ore export capacity,[30] which has more than doubled in the last nine years.

Figure 12 Nameplate iron ore export capacity at Dampier



Source: Dampier Port Authority (various years); Rio Tinto (2008).

The Withnell Bay facilities handle LNG/LPG gas that is brought ashore by pipeline from various locations on the North West Shelf. Two pipelines supply gas from North Rankin while the Pluto pipeline (from the Pluto and Xeno gas fields) supplies the Pluto Gas Plant (which opened in 2012). The Karratha Gas Plant and the Pluto Gas Plant process the gases for shipping or for piping along the Dampier to Bunbury Natural Gas Pipeline. Jetties have been built nearby to serve these facilities.

The King Bay Supply Base at Dampier provides an range of facilities to support the North West Shelf project.

The iron ore jetties, and the salt berth on Mistaken Island, share a common sea channel, through Mermaid Sound, to the north. The approach to Woodside Energy's liquefied gas berths at Withnell Bay is also via that channel.

30 Nameplate capacity refers to the design, maximum technical, or rated capacity of a facility.

Proposed port capacity expansion

As noted above, the port's iron ore facilities have been expanded in recent years. The expansion of the North West Shelf activities have also led to additional gas berths. Woodside Energy added a second liquefied gas berth at Withnell Bay. Jetty LNG1 is for LNG and condensate, jetty LNG2 is for LNG only, and jetty LPG is for LPG and condensate.

After recent major capacity expansion at the port, there are scheduled to be relatively small iron ore projects at the port to provide incremental capacity expansion. Rio Tinto's major commitments for further iron ore capacity expansion in the Pilbara have shifted to the company's Cape Lambert operations (see below).

Landside logistics

In common with the other Pilbara ports (Port Hedland and Cape Lambert), the landside iron ore logistics is undertaken using integrated ownership and operation (mine, railway/train, port terminal, by Rio Tinto/Joint Ventures). Rio Tinto therefore undertake its own planning and day-to-day logistics for its terminal; it interacts with other terminal operators' logistics and the port authority for port-side activities.

As shown in Figure 9 and Figure 11, the port is served by Rio Tinto's (Hamersley Iron) iron-ore railway from Paraburdoo, with a number of branches to other iron ore mines, including Yandi, Hope Downs (a Rio Tinto joint venture with Hancock), Brockman No.4 mine, West Angelas and Mt Tom Price. The landside movement of the iron ore occurs entirely on Rio Tinto's Hamersley Iron Railway; they do not originate from mines on the Robe River network—see the Pilbara railway networks in Figure 9.[31]

Hamersley Iron railway trains are approximately 2.4 kilometres long and each train carries around 26 000 tonnes.

Salt is brought by road from nearby salt pans (replenished by drawing in sea water); the roads include Dampier Salt's own private roads. The salt is carried out to stockpiles on Mistaken Island by conveyor belt.

Output from the gas fields is brought to the port by three trunk pipelines; gas is processed at the Karratha Gas Plant at the Withnell Bay Terminal near Dampier and, from 2012, at the Pluto Gas Plant. A consortium of companies owns the North West Shelf Shipping Service Company Pty Ltd, which operates a fleet of seven vessels, transporting LNG and LPG to discharge terminals in North Asia (Dampier Port Authority 2009a).

Port utilisation

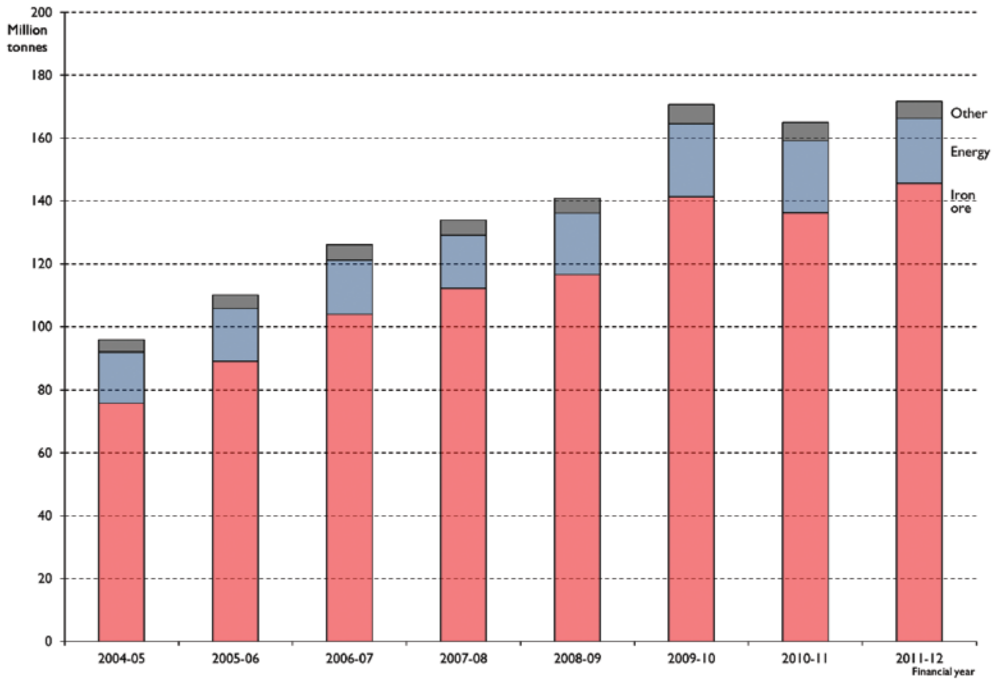
Dampier is Australia's second largest bulk port after Port Hedland. As is evident from Figure 13, there has been strong growth in throughput, predominantly in exports, of which iron ore is the main commodity. Energy product exports (condensate, LNG, LPG) form the next major throughput, with LNG being the dominant product, with three-quarters of energy tonnage in 2011–12. Total energy exports were 20.6 million tonnes, this being a 12 per cent throughput

31 Mines feeding iron ore to Dampier include Brockman 2/Nammuldi, Brockman 4, West Angelas, Mt Tom Price mines, Greater Paraburdoo (Paraburdoo, Channar and Eastern Range mines), Marandoo and Hope Downs.

share. The strong iron ore export growth has seen energy's share decline in recent years31F[32]. The opening of the Pluto Gas Plant in April 2012 should lead to increased energy exports.

Blending of iron ore from the different mines is undertaken at the port to produce a range of different products (or brands or standards). Rio Tinto's iron ore exports through Dampier normally consist of "Pilbara Blend" lump (large particles) and fines (small particles) and, occasionally, the "Yandicoogina" fines product.

Figure 13 Dampier throughput, 2004–05 to 2011–12



Note: "Energy" consists of condensate, LNG and LPG. The predominant commodity is LNG, which grew from 11.3 million tonnes in 2004–05, to 17.1 million tonnes in 2010–11 (before dipping to 15.6 million tonnes in 2011–12).

Source: Dampier Port Authority, (n.d.)

Port activities

Table 2 lists the primary activity parameters for the port. The focus is on bulk export commodities, with imports forming less than 0.5 per cent of throughput in 2010–11. It should be noted from this table that:

- iron ore is the principal throughput at the port. Other major commodities include energy-based exports (around 14 per cent of port throughput in 2010–11) and salt (around 2.5 per cent of port throughput).
- the number of large dry-bulk vessels (over 100 000 GWT) has risen over the review period.
- there has been a near-doubling of bulk liquid vessel calls.

32 Energy products had a 16.9 per cent share in 2004–05 and a 12.0 per cent share in 2011–12.

There is no information on utilisation of facilities nor destinations of commodities.

Table 2 Dampier activity parameters, by year

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Landside								
Payload per train (tonnes, maximum)							28 080	
Wharf								
Bulk liquid vessel calls	209	234	260	265	346	371	398	375
Total vessel arrivals (number)	2 669	3 062	3 403	4 029	4 007	4 657	6 003	6 269
Number of dry-bulk vessels with Gross Registered Tonnage size greater than 100 000	75	94	115	125	103	152	125	118
Iron ore percentage as proportion of total throughput (percentage of tonnage)	79	81	82	84	83	83	83	85

Sources: Ports Australia (n.d.); Dampier Port Authority (various years).

Box 6 Data sources, Dampier

- Government of Western Australia, *Port Handbook*, <www.transport.wa.gov.au/mediaFiles/WA_Ports_Handbook.pdf>, Annual port throughput, berth specification, split of tonnage by commodity.
- Dampier Port Authority, *Annual report*, <www.dpa.wa.gov.au/Annual-Reports.aspx>, Annual throughput by commodity, vessels through port (numbers, gross registered tonnage).
- Dampier Port Authority, n.d., *Cargo statistics*, <www.dpa.wa.gov.au/Port-Operations/Cargo/Cargo-Statistics-(2).aspx>
- Ports Australia, *Trade statistics*, <www.portsaustralia.com.au/tradestats/>, Dry and Liquid bulk annual tonnages, vessel calls.
- Dampier Port Authority, n.d. (2), *Port reference maps*, <www.dpa.wa.gov.au/About-the-Port/Port-Reference-Maps.aspx>. A range of maps showing Dampier and Ashburton, sea channels and the location of commodity resources.

Cape Lambert (Port Walcott)

Port overview

Cape Lambert snapshot

- Loaded iron ore
- Landside deliveries of iron ore by rail
- Iron ore blending at the port

The port facilities at Cape Lambert lie within the administrative area of Port Walcott (which includes other separate, but minor, port facilities). The port is served by offshore berths linked by jetties. The Cape Lambert facilities were commissioned in 1972. The facility is operated by a Rio Tinto joint venture.[33] The port was declared under the Western Australia Government's *Shipping and Pilotage Act 1967*, receiving limited guidance from the State Government as a non-port authority port.

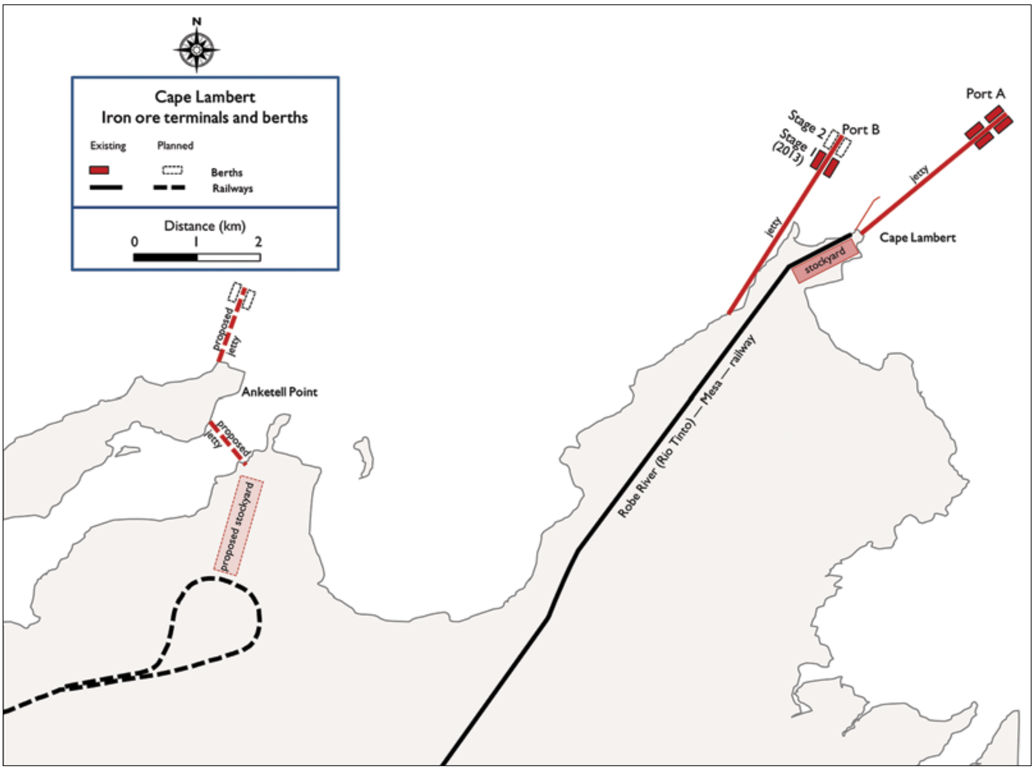
The port draws in iron ore deposits from Rio Tinto mining operations as well as Rio Tinto joint venture companies (including the Robe River Joint Venture and the Hope Downs Joint Venture with Hancock). The iron ore products exported through Cape Lambert are Rio Tinto's Yandicoogina fines, and Robe Valley lump (large particles) and Robe Valley fines (small particles).

Harbour and landside facilities

Major existing and prospective maritime and landside facilities at Cape Lambert are shown in Figure 14, including the "Port B" Rio Tinto facilities that are being completed in 2013 (with additional stockyards and rail dumper equipment), the subsequent Stage 2 development and the proposed Anketell Point facilities.

33 The Cape Lambert facilities are owned by a joint venture between Rio Tinto (53%), Mitsui (33%), Nippon Steel (10.5%) And Sumitomo Metal Industries (3.5%).

Figure 14 Cape Lambert (Port Walcott), including proposed Anketell Point



Rio Tinto's existing Cape Lambert offshore facility is a 2.7 kilometre jetty, with four berths. These berths, with complementary landside infrastructure, provide the potential for throughput of 80 million tonnes per annum, following investment that increased capacity from 55 million tonnes per annum during 2009.

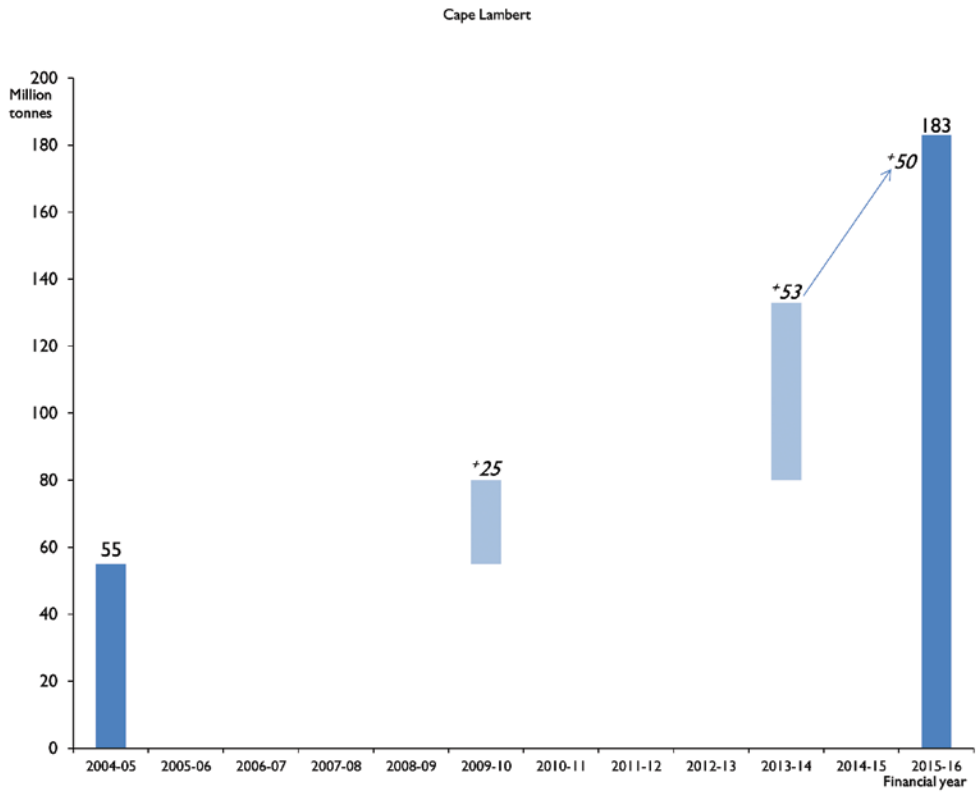
Committed supplementary capacity

The Port B facility (shown in Figure 14) adds two berths in Stage 1 and a further two berths in Stage 2, linked by a new 1.8 kilometre jetty. The new berths will be capable of accommodating vessels of the Very Large Ore Carrier class, which can carry up to 250 000 tonnes.

The Stage 1 berths will be commissioned by the fourth quarter of 2013. This work, with complementary landside capacity enhancements, will add capacity of 53 million tonnes per annum. Stage 2 adds a further two berths to the new jetty, again involving ancillary landside capacity expansions. This increment, scheduled for completion in the first half of 2015, will add capacity of 50 million tonnes per annum. This will raise the facility's potential throughput to 183 million tonnes per annum.

Figure 15 illustrates the capacity increments at the facility.

Figure 15 Nameplate iron ore capacity at Cape Lambert



Source: Data obtained from Rio Tinto (2008, 2008a).

Landside logistics

In common with the other Pilbara ports (Port Hedland and Dampier) Cape Lambert has a single landside logistics system through Rio Tinto's integrated ownership and operation (mine, railway/train, port terminal). The company therefore undertakes its own planning and day-to-day logistics.

Cape Lambert was built to serve the export of iron ore along the Rio Tinto (joint venture) 192 km Robe River railway, from the Mesa J mine at Pannawonica — see Figure 9; lines are built to standard gauge (1 435 mm). In 2010 a 49 km branch line from that Robe River (joint venture) line was opened to a new mine at Warramboo (Mesa A). The port facility also takes ores from the Yandicoogina mining operations (served by the Hamersley Iron Railway network), using the Western Creek Junction to switch from the Hamersley network to the Robe River line to Cape Lambert. Additional port and landside logistics capacity will enable the expansion of extraction rates at existing mines and new mining sites.

Each Robe River train (of which there are six) is approximately 1.6 kilometres long and carries around 18 000 tonnes; Hamersley trains (destined mainly for Dampier, but also to Cape Lambert) are typically around 2.4 kilometres long and carry around 26 000 tonnes each (Rio Tinto 2012, p.10).

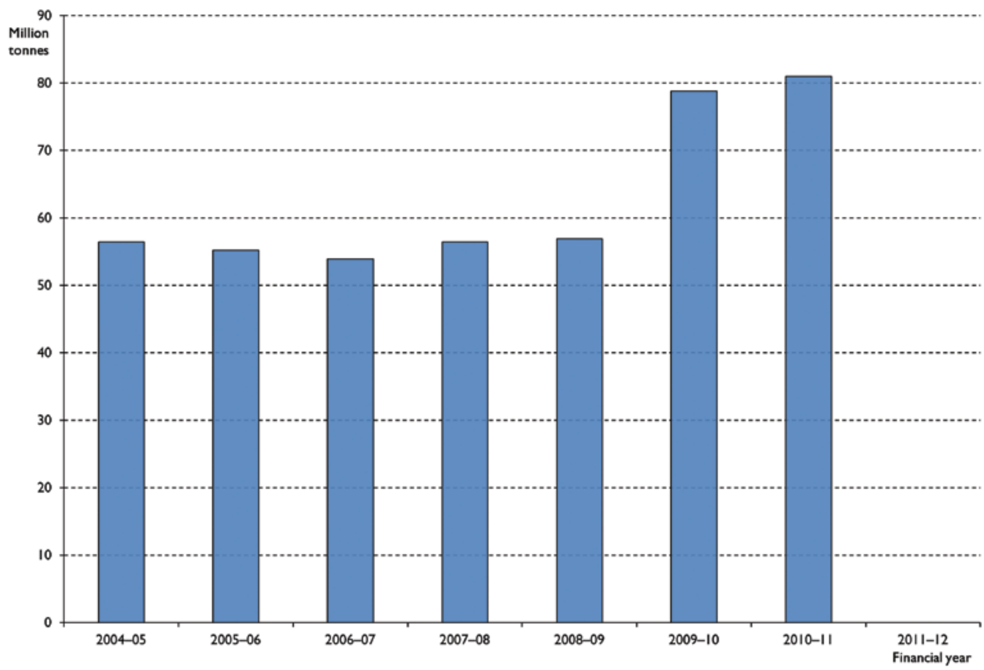
A key landside logistics expansion that is underway is Rio Tinto/Joint Venture's investment in introducing driverless trains, called AutoHaul™; this operation will be introduced in 2014. The company indicates that driverless trains will expand railway capacity by bringing greater flexibility to train scheduling and removing driver changeover times. (Rio Tinto 2012a)

Port utilisation

Cape Lambert, lying within the area of Port Walcott, is Australia's third-largest iron ore port facility. Apart from a negligible input of mixed goods, the port is dedicated to the export of iron ore, through facilities owned by Rio Tinto/Joint Venture.

The port facility has grown rapidly in recent years. In 2001–02, the facility handled 27 million tonnes per annum and by 2010–11 the throughput had tripled, to 81 million tonnes per annum. Indeed, it is notable that the logistics system at the time was rated at 80 million tonnes per annum (Figure 15) so the system was effectively at capacity in that latter year. As noted above, construction is underway to more-than-double the capacity of the facility by the end of the first half-year of 2015.

Figure 16 Cape Lambert (Port Walcott) throughput



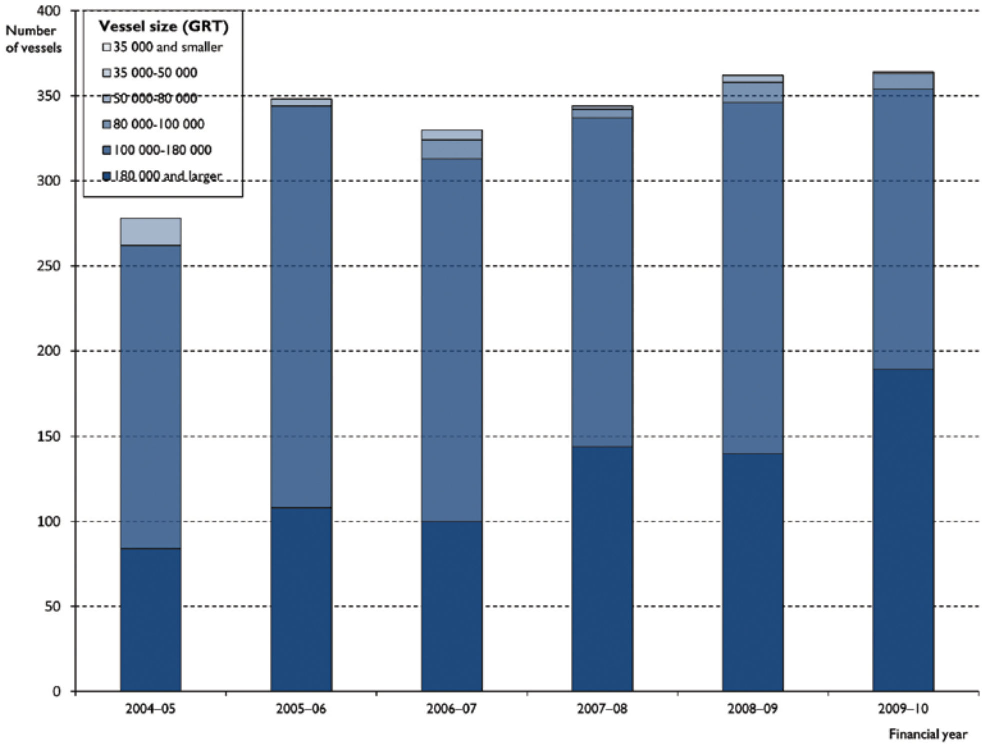
Source: Australian Bureau of Statistics, (n.d.).; Rio Tinto, n.d.

Note: Data for 2011–12 was not available at the time of publication.

Port activities

There is limited information on vessels or facility loading rates for the port facilities. Figure 17 shows the number of dry bulk vessels visiting the facility, together with the vessel size classification. The number of vessels rose from 278 in 2004–05 to 364 in 2009–10, with the proportion of vessels of size 180 000 tonnes or greater rising from 30 per cent to 52 per cent. It is apparent (especially for the latter years) that the increased throughput has been achieved through increased use of the largest vessels.

Figure 17 Vessel visits at Cape Lambert, by vessel size



Source: Lloyd's List Intelligence, n.d.

2. Coal ports

In this section we review Australia's principal coal ports and their logistics. Substantial quantities of other commodities are also shifted through Newcastle, Gladstone and Port Kembla.

Newcastle

Port overview

The port of Newcastle is based around a harbour at the mouth of the Hunter River; it uses wharves. The port dates from 1799, when coal exports commenced. Activities are overseen by the Newcastle Port Corporation.

Newcastle snapshot

- Loaded coal, grain, aluminium
- Rail deliveries of grain, rail and road deliveries of coal
- Production of aluminium at nearby smelter; coal blending at port

The port is the world's largest coal export port[34] and coal dominates the task undertaken: in 2010—11, the coal represented more than 94 per cent of tonnage. Around 80 per cent of this coal is thermal (or "steaming") coal, as used in power stations. Of the remaining 5 per cent of tonnage, there is a broad range of commodities (particularly alumina and grains); in aggregate these goods represent a higher value, comprising around 22 per cent of throughput value (Newcastle Port Corporation 2011, p.11).

Figure 18 The port of Newcastle

Source: Photograph courtesy of Newcastle Port Corporation

Note: The photograph is looking east along the Hunter River [south arm], with the NCIG Kooragang coal terminal in the foreground, with the coal stockpiles on the left and the berths on the immediate right. The PWCS Kooragang stockpile is on the upper left-edge of the picture, with the berths across at the river edge where there is a cluster of vessels. The Carrington coal terminal is in the upper-right side of the pucture, with the grain terminals beyond.

Harbour and landside facilities

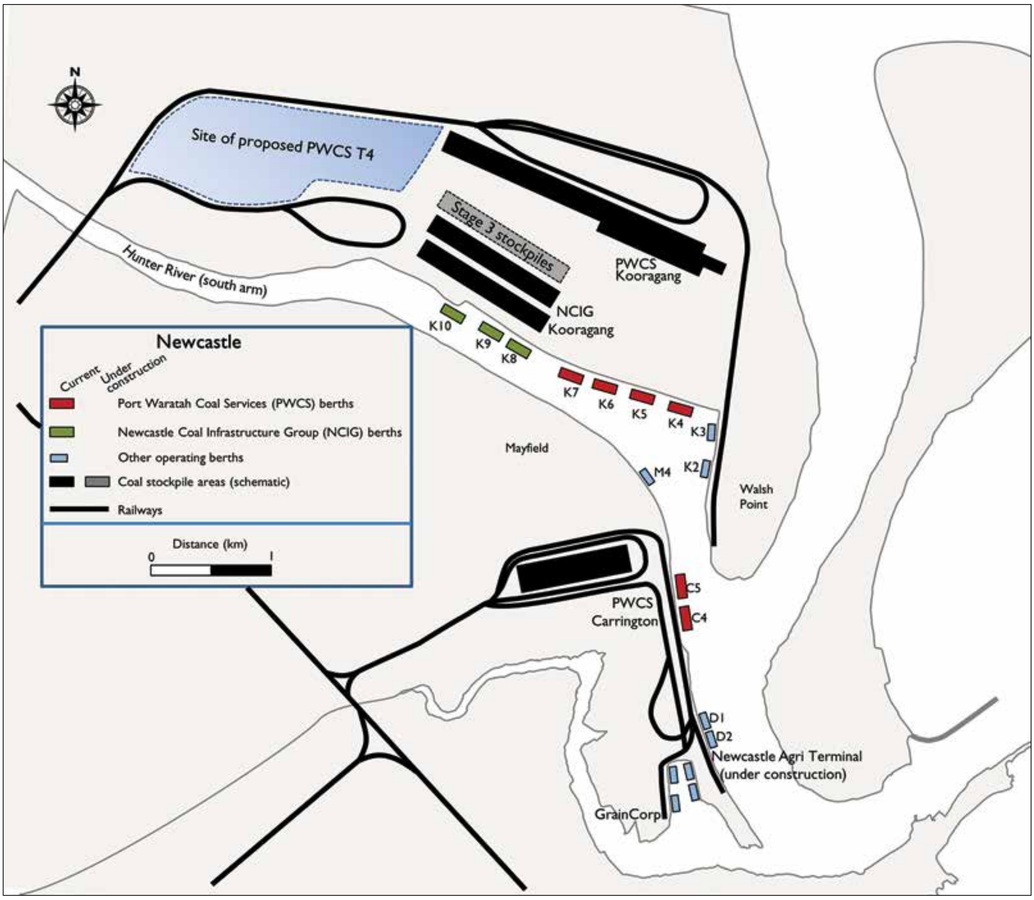
Major coal and grain facilities at the port, located on the south arm of the Hunter River, are shown in Figure 19. Coal berths and coal stockpile (or lay-down) areas are shown; these are located at three terminals. Port Waratah Coal Services (PWCS) has two berths at Carrington and four berths across the Hunter River at Kooragang. Newcastle Coal Infrastructure Group (NCIG) has a terminal at Kooragang, with three berths.

34 Newcastle Port Corporation 2013, p. 5.

The PWCS Kooragang terminal is a common-user facility, used by the consortium behind PWCS as well as third parties.[35] The NCIG terminal is used by the coal-mining parent companies that own the Group. The two sets of operations use fundamentally different stockpiling systems, with PWCS using "cargo-assembly" (drawing coal from mines as vessels arrive) and NCIG using permanent stockpiling (topping up permanent stockpiles as they are depleted); this means different logistics dynamics for the two operations. (Kirkwood 2009)

GrainCorp has a grain terminal at Carrington. In addition, in October 2012 construction commenced on the Newcastle Agri Terminal at Carrington. Grain exporters investing in this facility are Glencore Grain, Olam and CBH Grain. Infrastructure for both grain terminals is based around rail receival.

Figure 19 The Port of Newcastle, showing coal and grain facilities



Coal terminal facilities have been expanded in recent years, with expansion at PWCS's Kooragang terminal and the opening of the NCIG terminal at Kooragang. Further expansion

35 The Common User Provision is a term of PWCS's lease from the NSW Government, requiring equal access to the Kooragang facility. ACCC oversees that term. Background to this, and the Capacity Framework Arrangements lodged by PWCS, Newcastle Coal Infrastructure Group, and the Port of Newcastle, are set out in the ACCC determination. (ACCC 2009)

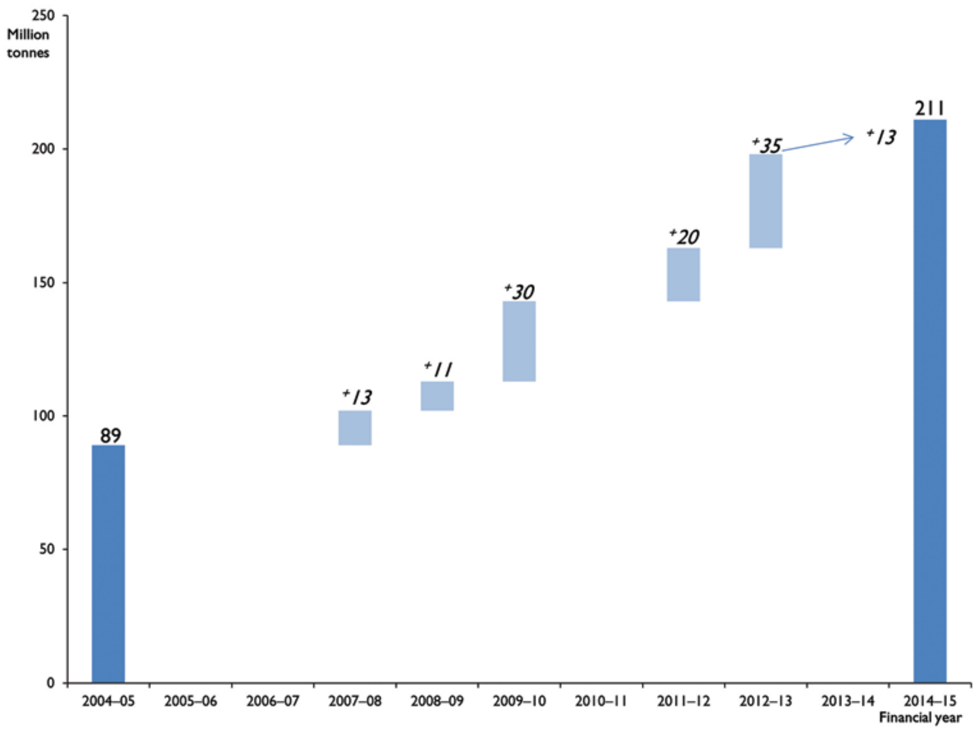
is underway at the NCIG Kooragang terminal (Stage 3 of the facility). The historical and committed (under construction) nameplate coal terminal expansions are shown in Figure 20.

Proposed capacity

In 2013, the Newcastle Port Corporation released a long-term strategic plan, identifying port infrastructure enhancement areas and individual terminal/berth developments.[36]

On the basis of further coal export growth, PWCS have planned a new terminal in the Kooragang precinct—see Figure 19. The additional terminal capacity brought by the proposed Terminal 4 would bring (with complementary mine expansion and landside logistics capacity) the port's coal export capacity to 280–330 million tonnes per annum. (Newcastle Port Corporation 2013, p. 17) Newcastle Port Corporation forecasts that, in the period to 2025, coal exports through the port could peak at around 270 million tonnes per annum. (Newcastle Port Corporation 2013, p. 16) The trend in nameplate coal export capacity at the three existing terminals is shown in Figure 20.

Figure 20 Nameplate coal export capacity levels and projections, Newcastle



Source: Newcastle Port Corporation, various years, Annual Report; Port Waratah Coal Services, (various years). Newcastle Coal Infrastructure Group 2012.

36 Newcastle Port Corporation, 2013.

Landside logistics

The mining and logistics entities within the coal export trade have formed the Hunter Valley Coal Chain Coordinator. This is particularly important because the communication links and conflicting objectives that come from the separate entities that own the coal mines, trains, tracks, terminals and port increases the challenges for avoiding capacity bottlenecks and ensuring that day-to-day coal movements are not impeded by competing demands on capacity.

The Hunter Valley Coal Chain Coordinator Limited (HVCCC) plans and co-ordinates the daily operation and long-term capacity alignment of the coal logistics chain.[37] Members of the Coordinator body includes Hunter Valley coal producers and the railway and port service providers. The Coordinator is pivotal in the efficient and reliable landside logistics task and capacity planning. The information flow can facilitate the timely arrival of vessels and efficient dispatch of loaded vessels.

The co-ordination of infrastructure expansions can be undertaken to deliver timely capacity expansions while minimising bottlenecks.[38] Thus, for example, as far as possible, track capacity expansions are timed to coincide with terminal expansions.

The landside–port logistics chain for coal and grain are based around the Hunter Valley rail lines via Muswellbrook; the lines are predominantly managed by Australian Rail Track Corporation (ARTC). These lines are illustrated in Figure 22; all lines shown are built to standard gauge (1 435 mm). Additional lines (not shown) serve coal-fired power stations in the region. Coal trains from the hinterland average between 6 000 and 7 000 tonnes each; grain trains have average weight of around 2 200 tonnes.

Coal trains are operated by four train operating companies: Pacific National Coal[39] (with a 60 per cent market share in NSW—see Asciano 2013, p. 15), Aurizon,[40] Freightliner Australia,[41] and Southern Shorthaul Railroad.[42]

37 See HVCCC web site for more details: <www.hvccc.com.au/Pages/welcome.aspx>

38 The Coordinator entity is an evolution of The Hunter Valley Coal Chain Logistics Team (dating from 2003), itself established in 2003 as the Hunter Valley Coal Chain Planning Group. The objectives and activities are set out in Department of Industry, Tourism and Resources (2005, p. 25). The legal establishment (in 2009) of the Co-ordinator included expansion of the membership from Service Providers, to include coal producers. See Hunter Valley Coal Chain Coordinator (2009).

39 This is a division of Asciano.

40 Formerly known as QR National.

41 Freightliner has an alliance with Xstrata [coal miner], with Xstrata providing rolling stock and Freightliner providing the train crews. The alliance is known as XRail. <www.smh.com.au/business/xstrata-launches-its-own-rail-service-20100921-15k6e.html>

42 This is an alliance between Southern Shorthaul Railroad, a train operator, and Centennial Coal; Centennial provides the rolling stock and Southern Shorthaul provides the train crews. <southernshorthaulrailroad.com.au/coal_train_operations>

Figure 21 Coal haulage from Gunnedah Basin to Newcastle

Source: Photograph courtesy of John Hoyle

In landside logistics capacity, increased coal throughput at the terminals will be facilitated by through a range of investments, including signalling enhancements and track capacity amplifications to deliver capabilities for more trains, and longer, heavier trains. (Australian Rail Track Corporation 2011, p. 8; Australian Rail Track Corporation 2012, pp. 9–11 for oversight and passim.) Australian Rail Track Corporation has an access undertaking for its Hunter Valley lines; the 2011 undertaking has been accepted by the regulator, the ACCC.[43]

43 See ARTC 2011b and ACCC 2011.

Figure 22 Railway routes conveying coal to Newcastle (Hunter Valley coal system)

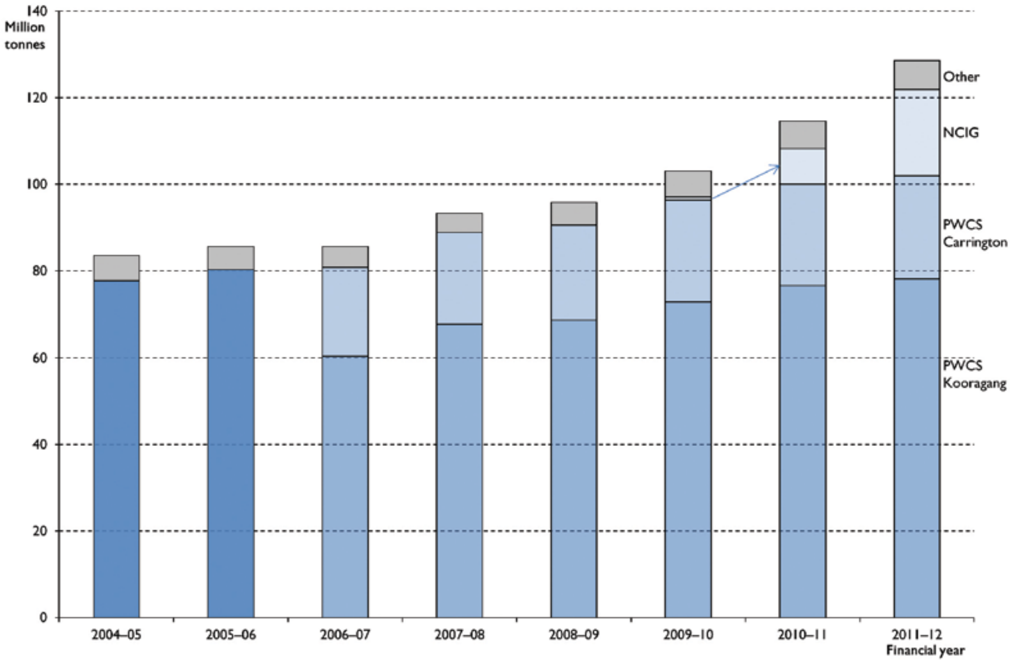
A small proportion—around 0.5 million tonnes per annum—is shifted by road, "due to the operating requirements" of the mine. (Newcastle Port Corporation 2012, p. 14) The road deliveries are made only to the Carrington terminal.

Port utilisation

Newcastle's coal throughput has increased substantially in recent years, in line with experience at other eastern seaboard coal ports. Buoyant overseas demand, in concert with expanded mining and logistics chain capacity, have led to strong growth in throughput.

Figure 23 presents tonnage throughput at the port, showing tonnage for each of the coal terminals. Increased tonnage from the PWCS Kooragang terminal has been possible as a result of the infrastructure expansion at the terminal (and in the logistics stream upstream). The increased throughput as a result of the opening of the NCIG Kooragang terminal is also apparent.

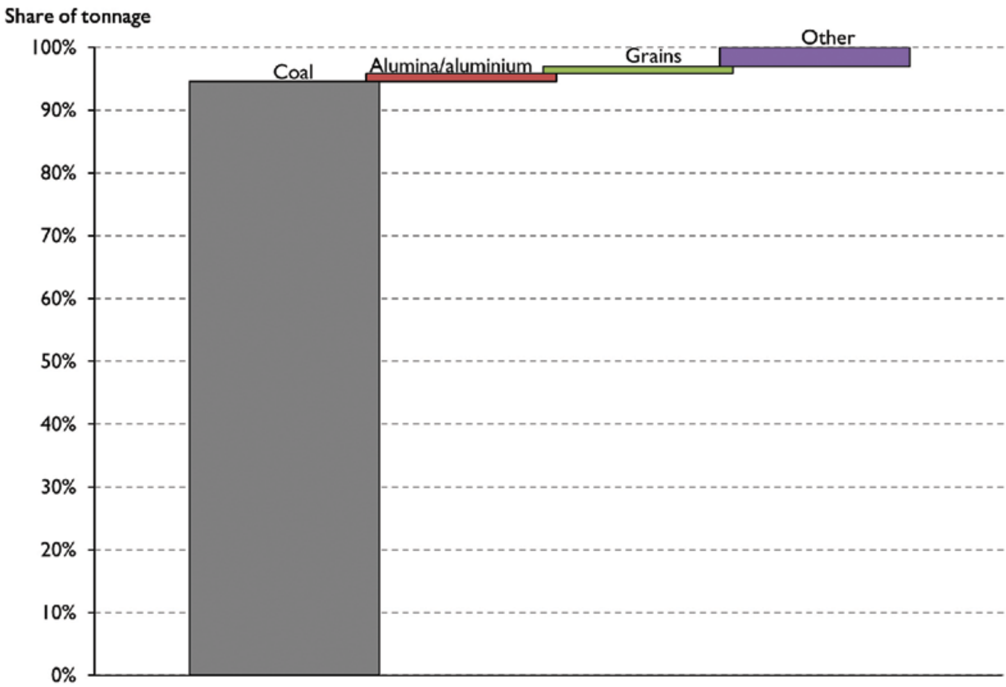
Figure 23 Newcastle throughput, coal and other commodities



Source: Newcastle Port Corporation, various years, Annual Report; Port Waratah Coal Services, n.d.

The port commodities are predominately exports, of which coal is the primary commodity (Figure 24). The balance of coal is approximately 80 per cent thermal (steaming) coal and 20 per cent coking (metallurgical) coal. There is a broad range of grains exported through the port. The alumina/aluminium products are associated with the Tomago and Kurri Kurri Smelter facilities (with the latter being closed in 2012).

Figure 24 Newcastle commodities profile: share of tonnage 2010–11



Source: Newcastle Port Corporation (2011).

Port activities

Table 3 presents a summary of a range of published port activities; all indicators relate to coal activities at the Port Waratah Coal Services (PWCS) terminal. The Newcastle Coal Infrastructure Group (NCIG) terminal commenced operations in May 2010; the company is not required to publish its activities.

Table 3 Newcastle coal activity parameters, PWCS terminals, by year

	Calendar year							
	2005	2006	2007	2008	2009	2010	2011	2012
Gross unloading rate, coal (tonnes/hour)								
Kooragang	-	-	-	-	-	-	6 076	na
Carrington	-	-	-	-	-	-	3 092	na
Vessel gross loading rate, coal (tonnes/hour)								
Kooragang	-	-	-	-	-	-	5 190	na
Carrington	-	-	-	-	-	-	2 294	na
Throughput versus nameplate tonnage (percentage)								
PWCS, coal	-	-	-	89.6	91.0	84.2	86.5	na
Vessel requested shiploading* (million tonnes) — PWCS terminals	80.0	83.2	82.6	91.7	94.5	92.5	101.1	103.5
Vessel shiploading (million tonnes)—PWCS terminals	80.3	79.8	84.4	91.4	92.8	95.1	97.8	105.9
Average shipment size ('000 tonnes) — PWCS terminals	83.9	87.0	87.1	86.6	86.2	89.1	95.4	90.2
Vessels loaded (number) — PWCS terminals	957	918	969	1 056	1 077	1 067	1 025	1 174
Vessel load time (average hours)								
Kooragang	-	-	-	-	21	21	20	18
Carrington	-	-	-	-	34	32	30	30
Vessel turnaround time (days) — PWCS terminals	7.4	10.4	22.6	12.9	12.1	16.6	12.2	11.0
Average vessel queue — PWCS terminals	15	23	56	33	32	44	31	30

Source: Port Waratah Coal Services, n.d., PWCS Operating Statistics; Port Waratah Coal Services, various years, *Annual Report;* Hunter Valley Coal Chain Coordinator, various years, *Monthly Performance Report.*

Note: * This statistic is labelled "vessels arrived (tonnes)" in the *PWCS Operating Statistics* publication.

The level and rate of throughput at the coal terminals is a function of the performance of the entire coal logistics operation, not simply the coal loading at the terminals. As is evident from Table 3, the coal unloading rate at the Carrington terminal is around one-half that at Kooragang, reflecting different equipment and different access modes; Carrington receives some coal by road whereas Kooragang's deliveries are exclusively by rail. Vessel loading rates also vary between the terminals, reflecting different standards and numbers of shiploading equipment.

The table presents a measure of the throughput tonnage relative to the terminal nameplate capacity tonnage; the measure is approximate given that the nameplate capacity is an estimate and because additional capacity may come online part-way through a year. Nonetheless, the figures illustrate the very high terminal utilisation levels. Such terminal utilisation levels are influenced by other players (mines, track/train and port/vessels) in the logistics chain.

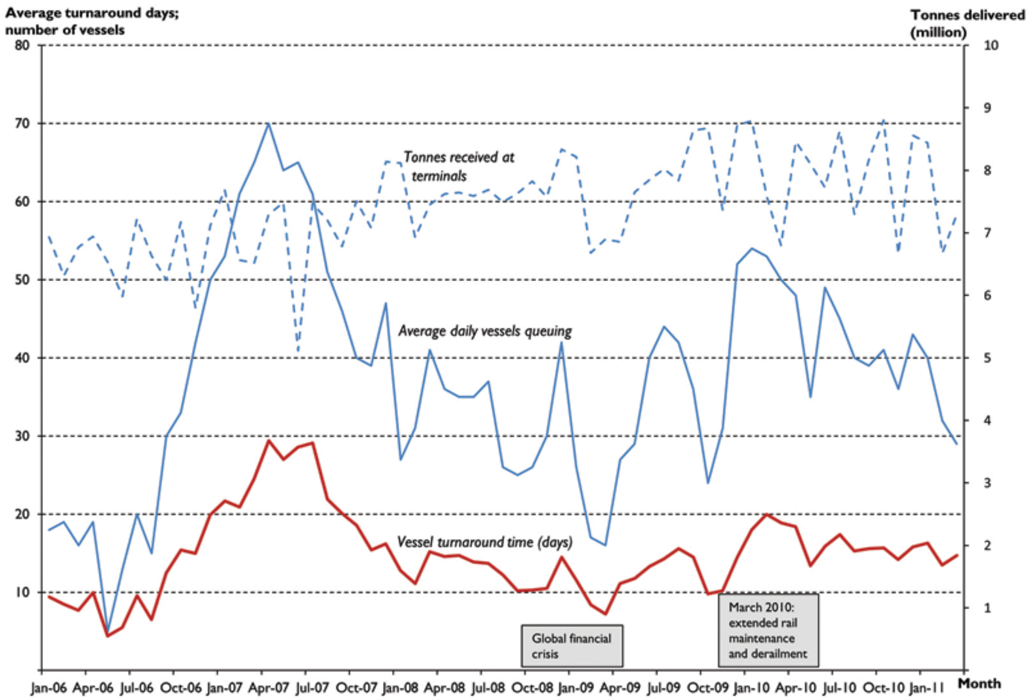
Other activity measures that are notable for the PWCS terminals include:

- the rise in tonnage of vessel arrivals;
- the rise in average shipment size, reflecting increasing vessel size;
- the differential vessel loading times between Kooragang and Carrington, reflecting the different loading rates (noted above) and differences in vessel sizes at the respective terminals;
- variations in vessel turnaround times, resulting from a range of vessel arrival rates and logistics chain issues;
- the average vessel queue waiting to load coal at the terminals changes directly with changes in turnaround times.

Figure 25 charts the landside tonnage delivered (predominantly by rail), vessel queue length and vessel turnaround time at the PWCS terminals. The figure shows the difficulty in interpreting logistics performance by use of a single activity measure. (This is discussed further in Appendix A.) For example, in the first half of 2007 there were relatively "high" vessel queues and turnaround times despite there appearing to be nothing untoward in rail's delivery rate of coal to the port. The chairman of the Hunter Valley Coal Chain Logistics Team concluded that the queue arose "mostly [as] a result of the natural peaks and troughs in demand experienced by coal ports all over the world. There has been an increase in arrival rates of vessels sent by large coal consuming countries".[44]

44 House Standing Committee on Transport and Regional Services, 2007, p. 41.

Figure 25 Port Waratah Coal Services — tonnes delivered, turnaround time and vessel queue



Source: Port Waratah Coal Services, n.d.

Box 7 Data sources, Port of Newcastle logistics

- Newcastle Port Corporation, Weekly operations report. *Vessel traffic information centre.* <www.newportcorp.com.au/site/index.cfm?display=111672> A weekly update of port throughput, highlighting coal shipments, vessels entering the port, and average waiting time.
- Newcastle Port Corporation, "Coal exports through Port of Newcastle will not exceed 275Mtpa before 2025", [Coal export projections], <www.newportcorp.com.au/client_images/1052740.pdf> Analysis of port capacity.
- Newcastle Port Corporation, *Trade statistics,* <www.newportcorp.com.au/site/index.cfm?display=111694> Summary of port commodity throughputs. Monthly, year-to-date, annual data.
- Hunter Valley Coal Chain Co-ordinator, *Weekly [and Monthly] Performance Report.* <www.hvccc.com.au/DailyPlanning/Pages/SummaryPerformanceReports.aspx> Weekly, and monthly, reports of performance of Hunter Valley coal chain logistics, with throughput at the coal terminals, landside delivery of coal to terminals, dispatch of coal in vessels (PWCS terminals only), vessel queue for PWCS terminals and vessel arrivals.
- Port Waratah Coal Services Limited, *PWCS operating statistics,* <www.pwcs.com.au/pages/about/stats.php> Landside delivery of coal to terminals, by mode; level of shiploading, by terminal; vessel queue; vessel tonnage arrivals; average shipment size.

Hay Point

Port overview

Hay Point snapshot

- Loaded coal
- Landside deliveries of coal railed
- Coal blended at the port

The Port of Hay Point uses offshore berths linked by jetties. The port was developed as a coal port from 1971, with the opening of the Hay Point Services Coal Terminal; the other port facility, the adjacent Dalrymple Bay Coal Terminal, opened in 1983. The port is one of the world's largest coal export ports. (See Figure 7, above, for a photograph of the port.) The port is managed by North Queensland Bulk Ports Corporation Limited.

The coal exported through the port is largely metallurgical coal (as used in steel blast furnaces). In 2010, the port's throughput represented around one-third of the country's coal exports.

Harbour and landside facilities

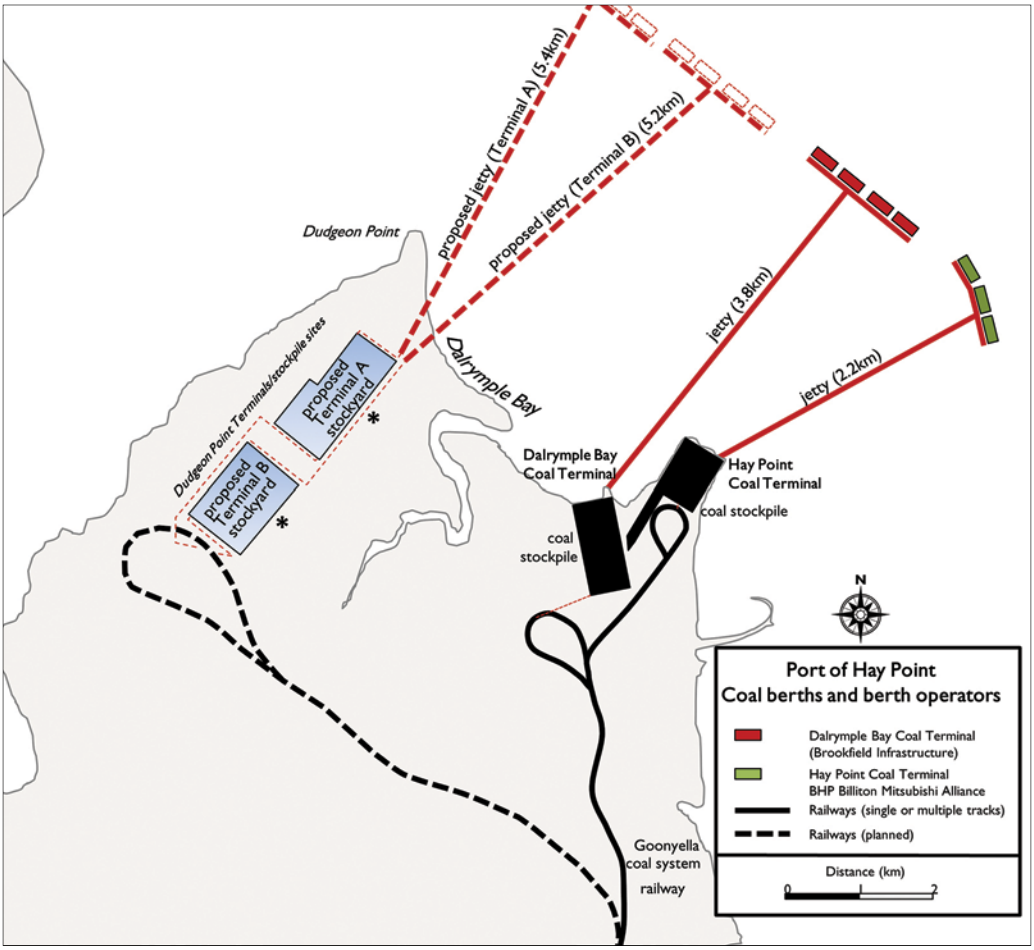
The major maritime and landside infrastructure facilities at the Port of Hay Point are shown in Figure 26. The Dalrymple Bay Coal Terminal has four berths and the adjacent Hay Point Services Coal Terminal has two berths (with a third berth under construction). Figure 26 also shows the proposed terminal at Dudgeon Point. In 2009, approximately 60 per cent of the railway capacity was allocated to the Dalrymple Bay terminal.[45]

The primary terminal facilities are for the receival of the commodity, its stockpiling and blending, the reclaimers to retrieve the coal from the stockpiles and conveying to the vessel. Blending can be undertaken within the stockpiling process or (using multiple reclaimer machinery) during the conveyance to the vessel. It is important to note that the two terminals operate differently. With fewer coal companies using its facility, the Hay Point Services Coal Terminal uses the principle of "dedicated stockpiling", where blended coal is already stockpiled, and then drawn down on arrival of the vessel. By contrast, with the common-user Dalrymple Bay terminal the principle is "cargo assembly", where the arrival of a vessel triggers the assembly of coal products from the upstream mines.[46]

45 The allocation of capacity will vary with expansion activies at each terminal—see, for instance, Dalrymple Bay Coal Terminal (2009, p. 33).

46 At Dudgeon Point, the approach to stockyard management will differ again. The stockyard volume at Dudgeon Point will be 8.3 million tonnes, or a ratio of stockyard volume to annual throughput of 5.0 per cent to 5.5 per cent. "This high stockyard ratio is to ensure that the stockyards can operate efficiently within the Goonyella coal chain by ensuring sufficient storage area to prepare cargoes from several mines for shipping". Aurecon (2012, p. 18).

Figure 26 Port of Hay Point (showing proposed Dudgeon Point terminal facilities)



Note: * An alternative ("long") stockyard arrangement involves parallel, long, stockyards rather than the adjacent ("short") stockyards shown here.

The existing terminals have been expanded in recent years—see Figure 27. The Dalrymple Bay terminal uses three conveyors to shift coal from the coal dumpers or from the stockpiles to its jetty. A further three conveyors shift the coal along a 3.8 km jetty to a 1.7 kilometre-wide wharf. At that location there are three shiploaders serving four berths. The Hay Point terminal also uses a conveyor system, to a wharf at the end of a 2.2 km jetty; at that wharf it has two shiploaders that serve two berths. Both terminals accept vessels up to Cape size.[47]

The terminals have separate logistics chain coordination, with Hay Point Services Coal Terminal being an integral part of the BMA Coal Logistics Chain; the terminal is owned and operated by the BHP Billiton Mitsubishi Alliance, serving its own coal export requirements.

47 Maximum deadweight tonnage of 250 000 at the DBCT, 200 000 deadweight tonnage at Hay Point Berth 2, 180 000 deadweight tonnage at Hay Point Berth 1. (Maritime Safety Queensland 2009).

The Dalrymple Bay Coal Terminal's coal export logistics are co-ordinated by Integrated Logistics Company Pty Ltd;[48] it is a common-user facility. The terminal manager is Brookfield Infrastructure, which leases the terminal from the Queensland Government (through its North Queensland Bulk Ports Corporation). The terminal is regulated by the Queensland Competition Authority, QCA. The terminal's day-to-day operations and maintenance are sub-contracted to Dalrymple Bay Coal Terminal Pty Ltd, which is a consortium of five of the eight mining companies that use the terminal facilities. Customers at this terminal include Anglo Coal, Macarthur Coal, Peabody Energy, Xstrata and ANCI. The exported coal is metallurgical coal (for steel-making) although some PCI and thermal coal may be exported.

Supplementary capacity

Hay Point Coal Terminal is currently being expanded, adding capacity of 11 million tonnes per annum, bringing the port capacity from the two existing terminals to 140 million tonnes per annum—see Figure 27. Further expansion at this site is being considered[49].

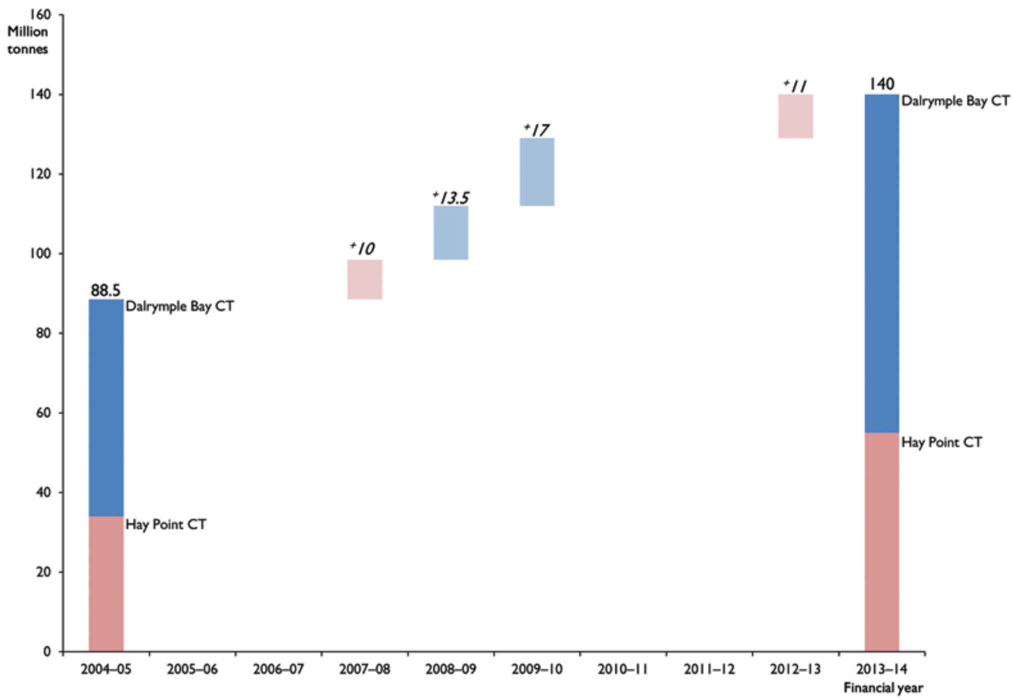
Two additional terminals within the port are planned at Dudgeon Point, 4 kilometres to the north of the Dalrymple Bay Coal Terminal—see Figure 26,. These two terminals, with eight berths in total and each with up to 90 million tonnes per annum, would have the capacity for up to 180 million tonnes per annum; the capacity at the first stage would be 30 million tonnes per annum at each terminal. (North Queensland Bulk Ports 2011, p. 1) The lead project proponent is North Queensland Bulk Ports, with the other proponents being the future terminal operators, Dudgeon Point Project Management Pty Ltd[50] and the Adani Mining Pty Ltd.

48 The shareholders of this company include the mining companies and logistics service providers—see <www.ilco.com.au> .

49 Aurecon (2012, p. 13) notes "BHP Billiton is also currently investigating logistics solutions to accommodate future growth of its metallurgical coal assets. Expansion of the existing HPCT beyond 55 Mtpa is an option that is being considered by BHP Billiton / BMA as part of these investigations and such an expansion could occur within the ten year window of this Master Plan. BMA holds an existing Commonwealth approval under the EPBC Act for an expansion to 75 mtpa (EPBC No. 2009/4759) as detailed in the EPBC Referral for this project. This approval is valid to 2015."

50 Dudgeon Point Project Management Pty Ltd, was incorporated by its parent company, Brookfield Infrastructure, to progress development of a new coal terminal at Dudgeon Point; it is managed by DBCT Management. (North Queensland Bulk Ports Corporation 2012)

Figure 27 Nameplate coal capacity at the Hay Point terminals



Landside logistics

The coal exports logistics chain along the railway network for the Port of Hay Point is the Goonyella Coal System, even though each terminal operator has its own logistics system (as discussed above, page 41). The Goonyella system is based around Aurizon's railway infrastructure (with overhead electrification), bringing coal from the central Bowen Basin. The terms and conditions of access provided by Aurizon are set out in its Access Undertaking; the infrastructure provider is regulated by the Queensland Competition Authority.[51]

The Goonyella system is the largest of the coal logistics chains in Queensland (with the other systems being Newlands, Blackwater, Moura and Western). The Goonyella network is shown in Figure 28. This is a network of around 690 route-kilometres of narrow-gauge (1 067 mm) track which, in 2010, served 22 mines.

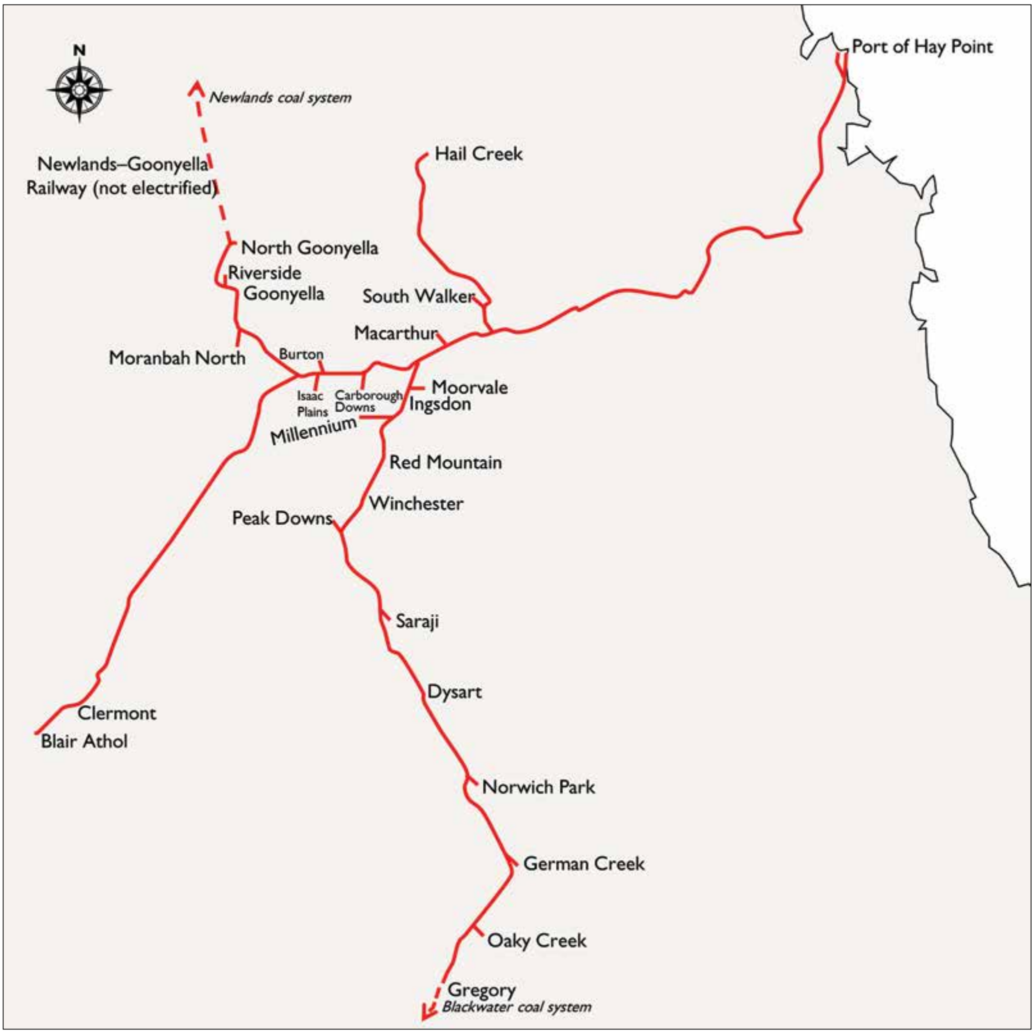
Train operations are undertaken by Aurizon and Pacific National Coal.[52] The maximum net train load on the Goonyella network is around 10 000 tonnes, with a 2.1 kilometre maximum train length (QR Network Pty Ltd 2009, p. 25) and wagon axle loads of 26.5 tonnes (Aurizon 2011, p. 1). A (non-electrified) railway that links the Goonyella and Newlands[53] coal systems was opened in 2011.

51 The 2010 Access Undertaking, which is due to expire in 2013, is set out on Queensland Competition Authority's web site, <www.qca.org.au/rail/2010-DAUamend/>

52 Aurizon is the name for the company formerly known as QR National. Pacific National Coal is a division of Asciano. See footnote 56 for details of where the latter company operates in Queensland; that haulage represents around 20 per cent of the rail haulage in the State, with Aurizon undertaking the other haulage.

53 The Newlands system is focused on the Port of Abbot Point—see page 50.

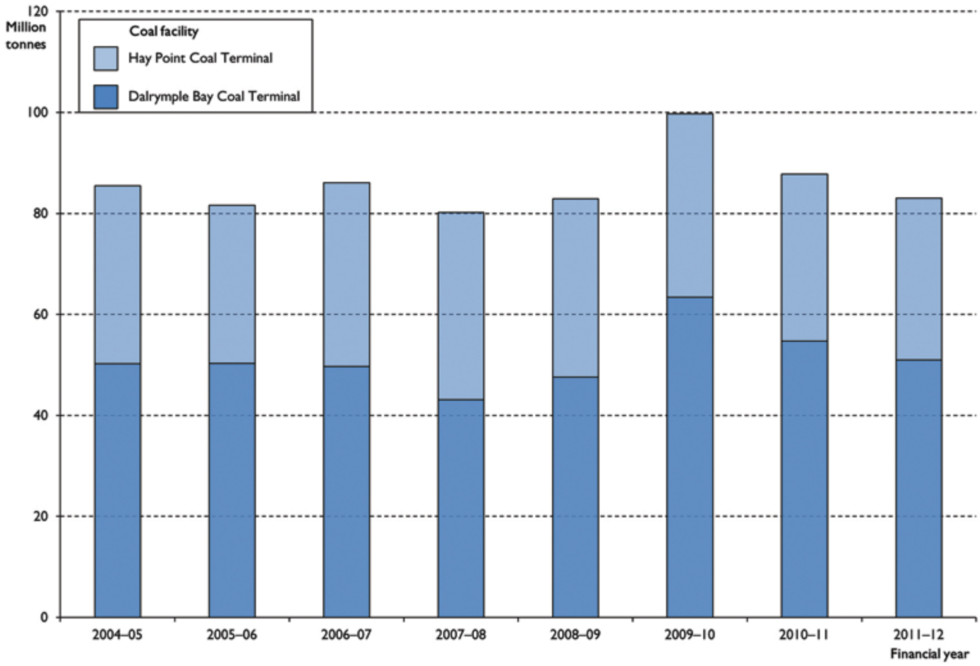
Figure 28 Coal railways ("Goonyella System") serving the Port of Hay Point



Port utilisation

The Port of Hay Point was, in 2011–12, the second-largest coal exporting port in Australia, after Newcastle. The port is a dedicated coal port. Since 2004–05, the port has had a steady throughput of around 80 million tonnes per annum, apart from 2009–10, when the throughput was around 100 million tonnes. The throughput was significantly impacted by flooding as a result of heavy rains across the State during the December 2010–January 2011 period. Mines were still impacted by the effects of the flooding throughout 2012. Throughput has progressively recovered since then and is expected to continue to grow incrementally up to capacity.

Figure 29 Hay Point throughput, by terminal



Sources: Dalrymple Bay Coal Terminal Pty Ltd, n.d.; North Queensland Bulk Ports Corporation, n.d.

Port activities

Table 4 presents a range of activity parameters; most of these relate to the DBCT facility. Points of note include:

- the number of vessels arriving at the port has generally been declining, apart from the financial year 2009–10. The pattern echoes the pattern in the throughput trend (Figure 29).
- At DBCT there has been a strong shift from the smaller (Handy, Panamax) bulk vessels to the larger (Japmax, Cape) vessels.
- Average tonnage per train serving DBCT (using the Goonyella rail system) has increased by over 4 per cent between 2005–06 and 2011–12.
- the pattern of DBCT "vessel queue" and "average days at anchor" statistics tends to reflect changes in throughput (Figure 29), albeit that a range of difficulties in logistics chain co-ordination and vessel arrival systems in 2007–08 resulted in the vessel queue/days at anchor rising from the previous financial year despite terminal throughput falling.
- the data series is not long enough to identify long-term changes in the distribution of recipient countries of the coal exports.

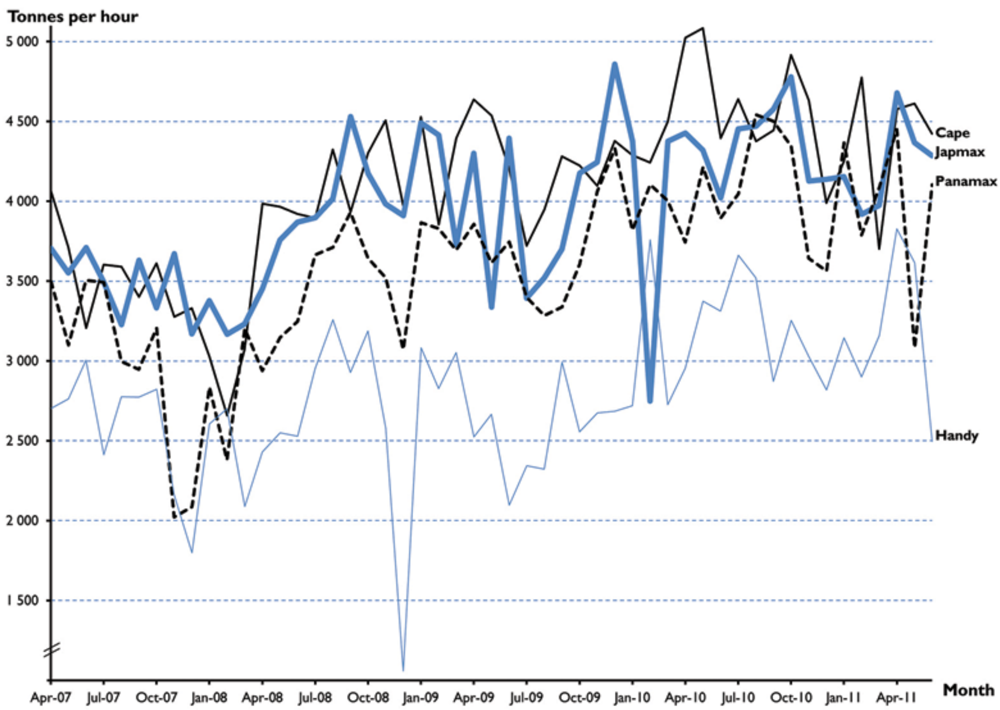
Table 4 Port of Hay Point activity parameters, by year

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Landside, Dalrymple Bay Coal Terminal								
Number of train deliveries to terminal (no.)			5 331	4 600	4 974	6 601	5 616	5 261
Average tonnage per train (tonnes)			9 371	9 461	9 610	9 566	9 772	9 784
Average train unload time (hours : minutes)			2:15	2:19	2:12	2:08	2:01	1:55
Average stock build time/parcel (days)			2.8	2.3	2.9	2.8	3.1	2.9
Wharf, Dalrymple Bay Coal Terminal								
Total number of vessels through terminal			580	524	553	727	538	492
DBCT: Vessel mix by size (percentage)								
Handy			22	24	19	15	10	6
Panamax			35	35	36	42	25	23
Japmax			13	18	17	19	25	23
Cape			30	23	28	24	40	47
Average daily total vessels in queue			25.8	30.2	15.1	53.9	33.5	15.4
Average daily vessels with unavailable cargo (no.)			na	na	na	na	24.3	16.4
Average days at anchor			15.8	18.5	11.5	29.0	24.6	11.8
Port								
Wharf: Total number of vessels arriving at port	1 015	933	962	954	950	1 127	897	831
Beyond: Distribution of coal export tonnage, (principal countries, percentage of total)								
Japan	-	-	-	-	-	29.4	27.5	25.8
Korea	-	-	-	-	-	16.4	19.2	18.4
China	-	-	-	-	-	14.6	11.2	15.6
India	-	-	-	-	-	12.9	12.1	11.7

Sources: Queensland Government, various issues, Queensland ship movements. Monthly status report. Dalrymple Bay Coal Terminal Pty Limited, n.d.

Figure 30 presents a time trend in vessel loading (tonnes per hour) at the DBCT facility. The loading rate varies from month to month, and across the four vessel sizes. The loading rate tends to be highest for the largest vessels and declines with shrinking vessel size (from Cape, to Japmax, to Panamax and Handysize). Shiploading at the terminal increased in 2009 because a third shiploader was introduced. (Maunsell 2004, p. 86)

Figure 30 Coal loading rate by vessel size, Dalrymple Bay Coal Terminal



Notes: A third shiploader was introduced in July 2009.

Box 8 Data sources, Hay Point

- Maritime Safety Queensland, *Queensland ship movements*. Monthly status report. <www.msq.qld.gov.au/Shipping/Shipping-movements.aspx> Gross tonnage of vessels arrived, number of vessel arrivals
- Maritime Safety Queensland, *Ship movements [by port]*, <www.qships.transport.qld.gov.au/Public/PublicMovements.aspx>, Current record of vessel movements (yesterday, today, future), by vessel name and berth.
- Ports Australia, *Trade statistics*, <www.portsaustralia.com.au/tradestats/>, Dry and Liquid bulk annual tonnages, vessel calls.
- Dalrymple Bay Coal Terminal Pty Ltd, *Shipping distribution*, <www.dbctm.com.au/_files/EOMReports/CountrySplit.pdf >, Monthly and cumulative financial year data on ship numbers and tonnages by destination of coal.
- Dalrymple Bay Coal Terminal Pty Ltd, *Daily shipping queue*, <www.dbctm.com.au/_files/ShipQueue.pdf>, Data for Dalrymple Bay Coal Terminal. Vessel arrivals itemised by vessel and coal availability, levels of coal tonnage orders, levels of stockpiles and outloading rates.
- Dalrymple Bay Coal Terminal Pty Ltd, *Performance indicators*. Operational performance, Terminal quarterly KPI reporting, <www.dbctm.com.au/aboutdbct/Reports.aspx>, Performance indicators for the Dalrymple Bay Coal Terminal, including railed tonnage to Terminal, terminal and train unloading times, coal parcel build times, shiploader utilisation and outloading rates, outloading rates by vessel class, vessel mix, vessels in queue and vessel days at anchor.
- Integrated Logistics Company, *Vessel tracking map*, <www.ilco.com.au/dnn/VesselMap.aspx>, live map showing positioning of offshore vessels.
- Integrated Logistics Company, *Statistics of Dalrymple Bay Coal Chain* <ilco.com.au/DNN/>, daily and monthly inbound (by rail) and outbound (shiploaded) coal movements through the terminal; current port stocks and vessel queue. Information is supported by detailed definitions, found at Integrated Logistics Company Pty Ltd 2012, DBCC daily performance overview KPI's, <www.ilco.com.au/dnn/Portals/0/DBCC%20Daily%20Performance%20Overview%20KPIs.pdf>
- North Queensland Bulk Ports, *Throughput*, <www.nqbp.com.au/hay-point/>, Monthly tonnages, by terminal.

Gladstone

Port overview

Gladstone's port is a sheltered site in the harbour named Port Curtis; the facilities are based around wharves, and the harbour is bounded by Curtis Island to the north and Facing Island to the east. As the sixth-largest of Australia's bulk ports, the Port of Gladstone is characterised by a diverse range of commodities, including a relatively high proportion of unloaded commodities, set along a geographically-sprawling port.

Gladstone snapshot

- Loaded coal
- Unloaded bauxite
- Railed landside deliveries of coal
- Portside production of alumina, aluminium and cement

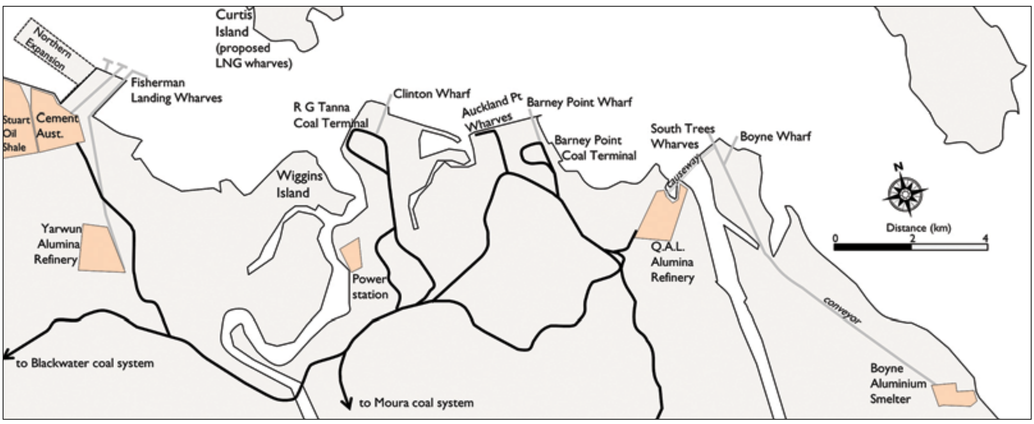
Gladstone's port has its origins with the development of the town in 1853; trade in coal — the principal commodity today — commenced in 1925. Exports through the Barney Point Coal Terminal began in 1967 and from the R G Tanna Coal Terminal in 1980.

In common with Newcastle, the port undertakes major production processes within the city beyond the coal export chain, notably in processing of bauxite at the refineries (and subsequent processing into aluminium at the local smelter). The South Trees wharf, handling a range of commodities (including unloading bauxite, caustic soda and bunker fuel oil and loading alumina), was opened in 1967; this was followed by the opening of the adjacent Boyne Wharf (serving the Boyne Island aluminium smelter) in 1982.

Harbour and landside facilities

The principal maritime and associated landside infrastructure facilities at the Port of Gladstone are shown in Figure 31. Principal railway lines are shown, along with the two major coal terminals. Associated with the diverse throughputs, there are a range of facilities for bulk liquids, grain, cement and various bauxite-based products (bauxite, alumina and aluminium). Processing of the bauxite is undertaken in Gladstone at Queensland Alumina Limited Refinery, the (Rio Tinto) Yarwun Alumina Refinery (both for making alumina) and at the Boyne Aluminium Smelter (for making aluminium).

Figure 31 Port of Gladstone: principal wharves, railways and landside bulk facilities



Note: Further detail on the coal facilities is shown below, in Figure 32.

The non-coal facilities are as follows:

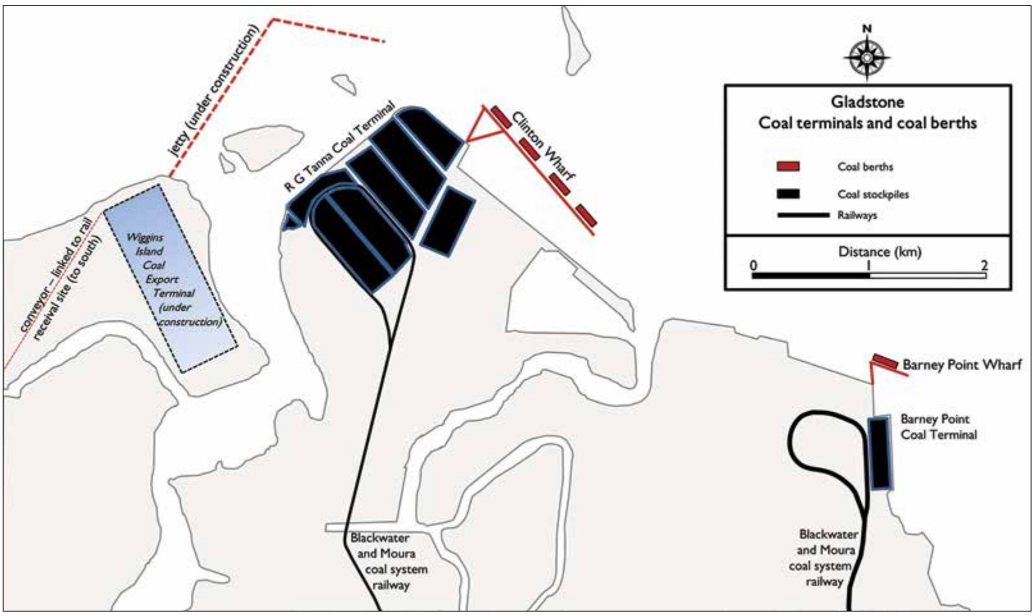
- The South Trees Wharves are owned by Queensland Aluminium Limited (QAL). The west wharf is used for unloading bauxite from Weipa; the east wharf is used for loading alumina for domestic and overseas destinations and for unloading fuel oil and caustic soda.
- The nearby Boyne Wharf, owned by the Gladstone Ports Corporation and operated by Boyne Smelters Limited, is principally used for the loading of aluminium.
- Fisherman's Landing No. 2 Wharf is owned by Rio Tinto Yarwun Alumina Refinery; bauxite from Weipa is unloaded along with caustic soda while alumina is loaded for domestic and overseas ports.

- The adjacent Fisherman's Landing No. 4 Wharf is owned by the Gladstone Ports Corporation, with bulk cement clinker, cement and fly ash being loaded.
- Fisherman's Landing No. 5 is a bulk liquids (ammonia) facility, for Orica Australia.
- The Auckland Point wharves (also known as Port Central) handle a range of commodities, including grain (Wharf No. 2), petroleum-based products and containerised and other cargo.
- Across the shipping channel lies Curtis Island, where LNG port facilities are being constructed.

Figure 32 focuses on the principal coal facilities at the port. The R G Tanna Coal Terminal (four berths) and the Barney Point Coal Terminal (one berth), and associated wharves, are owned by Gladstone Ports Corporation. Both terminals are common-user facilities, operated by the Gladstone Ports Corporation. Coal to the coal terminals is delivered by rail, albeit that a small proportion of Barney Point coal arrives by road.

There are extensive landside coal facilities, including 21 coal stockpiles at the R G Tanna terminal and approximately 9 stockpile zones at Barney Point. The R G Tanna terminal is capable of blending up to 4 varieties of coal during shiploading; the Barney Point terminal also undertakes (unspecified) blending during shiploading. The terminals handle more than 40 varieties of coal, from 10 mines.

Figure 32 Port of Gladstone: coal facilities



The R G Tanna facility can accommodate vessels up to 220 000 deadweight tonnes, with larger vessels being permitted subject to approval. The smaller terminal at Barney Point can accommodate vessels up to 90 000 deadweight tonnes, fully-loaded, and part-loaded up to 150 000 deadweight tonnes.

Proposed and committed capacity expansions

Figure 33 presents the levels of nameplate capacity at the two coal terminals. That capacity has expanded by more than two-thirds since 2004–05. Further coal export capacity is being constructed.

As indicated in Figure 32, a new coal terminal is under construction at Wiggins Island; the terminal would ultimately have six berths. Once this terminal is operational, the Barney Point Coal Terminal will be closed. Stage One of the Wiggins Island facility will have capacity up to 27 million tonnes per annum, with later expansion enabling throughput to increase to 84 million tonnes. The Gladstone Ports Corporation will operate the facility, the first stage being owned by eight companies (Aquila Resources, Bandanna Energy, Caledon Resources, Cockatoo Coal, Northern Energy Corporation, Xstrata Coal on behalf of the Rolleston Joint Venture, Yancoal Australia and Wesfarmers Curragh).

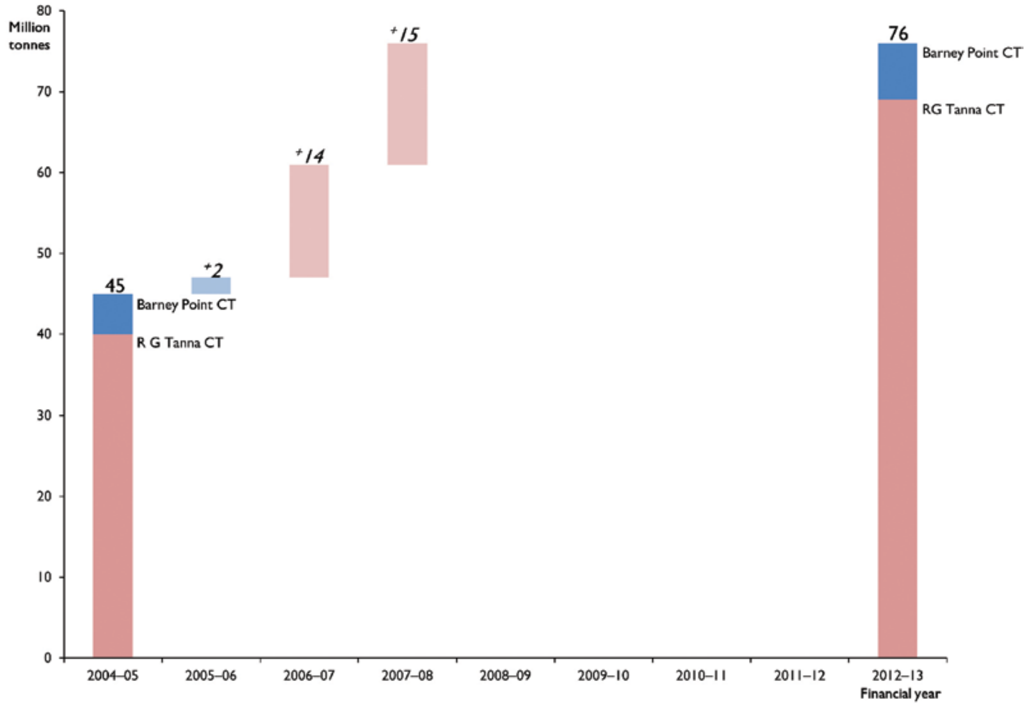
Land is being reclaimed at Fisherman's Island (in the Western Basin) to accommodate a further six wharves. The wharves would serve new industry in the vicinity. See the "Northern Expansion" area marked in Figure 31.

To the north of the port lies Curtis Island, with the south-west edge being zoned as the Curtis Island Industry Precinct. New wharves are being developed at four locations along that precinct water edge.[54] The new facilities are being developed on the island for LNG exports; coal-seam gas would be brought along a 540 kilometre pipeline network from inland locations within the Surat and Bowen (coal) basins.

Beyond the immediate port area lies another site to the north-west, at Balaclava Island, where a coal terminal is also planned. That proposed facility would be designed to cater for up to 35 million tonnes.

54 The wharves would serve four LNG plants that are in various stages of planning/environmental assessment or construction: Queensland Curtis LNG, GLNG (a Santos Joint Venture), Australian Pacific LNG and Arrow LNG (Shell Australia and PetroChina).

Figure 33 Nameplate coal capacity at the Gladstone coal terminals



Source: Data are from Gladstone Ports Corporation, various issues.

Landside logistics

The principal bulk landside logistics activities are associated with coal exports. The coal terminals are supplied by an extended network of narrow-gauge (1 067 mm) railway lines (owned by Aurizon), as illustrated in Figure 34.[55] Two separate coal mine–railway networks/logistics chains are involved, with the Blackwater coal system based around 727 route-km of (mostly) electrified lines that feed to the port from the west of Rockhampton; and the Moura system, with a non-electrified network route-length of around 221 km, feeding from the south-west of Gladstone.

Coal haulage by rail is undertaken by two train operating companies, Aurizon (called QR National until late 2012) and Pacific National Coal (a division within Asciano). Commencing its first haulage contract in the State in 2010, Pacific National Coal has a Queensland market share of around 20 per cent.[56] (Asciano 2013, p. 15)

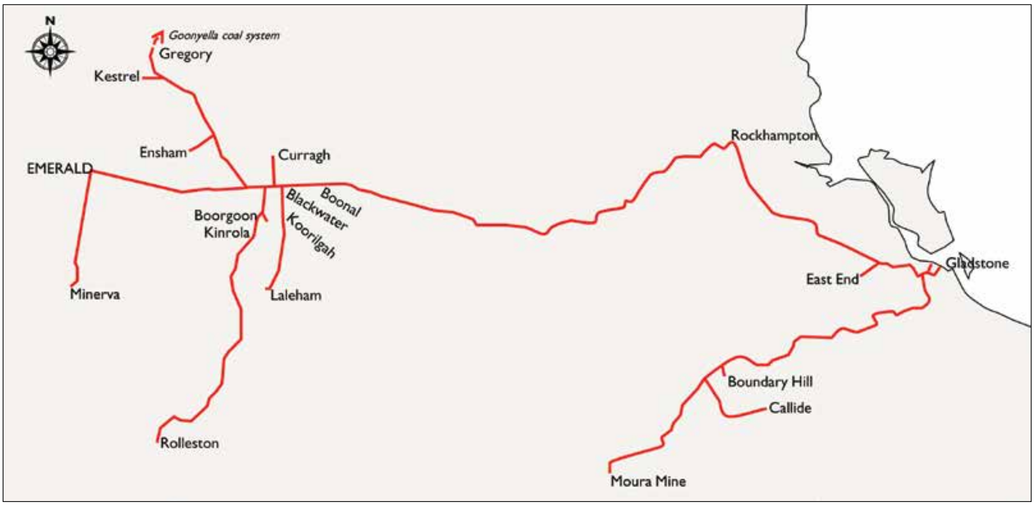
55 The terms and conditions of access provided by Aurizon are set out in its Access Undertaking; the infrastructure provider is regulated by the Queensland Competition Authority.

56 Pacific National Coal's mine-customers in Queensland include Blackwater System mines at Springsure Creek (from 2014, for Bandanna Energy) and Kestrel (for Rio Tinto Coal Australia); Goonyella System mines at Oakley Creek (for Xstrsta Coal), Foxleigh, German Creek and Moranbah North (all for Anglo American), Middlemount (for Middlemount Coal), Isaac Plains (for Isaac Plains Coal Management), Coppabella, Moorvale (both for Peabody Energy), Hail Creek (for Rio Tinto Coal Australia); and Newlands System/Goonyella mines at Goonyella, Riverside and Caval Ridge (all for BMC). See Asciano 2013a (p. 9). Other mines in the five coal systems (including the Moura and Western coal systems) are served by Aurizon.

The average train payload serving the R G Tanna Coal Terminal is 7 150 tonnes from Blackwater system trains and 4 200 tonnes from the Moura system (south of Gladstone). The average train payload serving the Barney Point Terminal is 6 500 tonnes from the Blackwater system trains (mostly with 26.5 tonne axle loads[57]) and 4 200 tonnes from the Moura system (with 20 tonne axle loads[58]) (Gladstone Ports Corporation 2011).

Coal from the Curragh mine (in the Blackwater coal system) supplies the Gladstone Power Station, which is Queensland's largest power station. The power station is part-owned by Rio Tinto Aluminium, a significant power user with the local refining and smelting facilities.

Figure 34 Railway routes conveying coal to Gladstone (Moura and Blackwater coal systems)



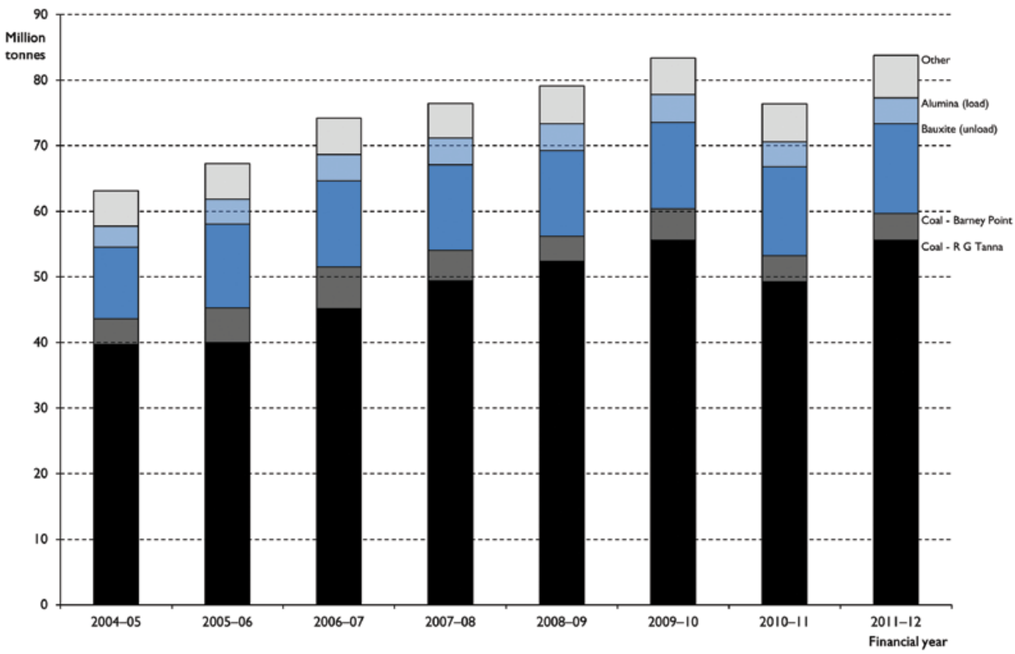
Port utilisation

Gladstone's port is the country's third largest coal-exporting port (after Newcastle and Hay Point), and the world's fourth largest coal-exporting port. In 2011–12, coal was 71 per cent of the total throughput.

In the same year, around 21 per cent of the port's throughput was unloaded (that is, imported from overseas and local destinations). A major commodity that was shipped in to Gladstone was bauxite (16 per cent of total throughput), serving the local Yarwun and Q.A.L. Alumina refineries; caustic soda is also shipped in to the port as part of the refining process. Some of the alumina output is then shipped from the port (around 5 per cent of the 2011–12 port throughput). Some of the alumina is processed at the Boyne Smelter and loaded onto vessels — as the final product, aluminium — for Australian and overseas destinations[59] (around 0.4 per cent of throughput tonnage but a much higher percentage of the value of throughput).

57 QR National 2012, passim.
58 Aurizon 2011b, p. 1.
59 China is the primary destination for alumina and aluminium that is produced.

Figure 35 Gladstone throughput, by commodity



Source: Port of Gladstone, various issues, Annual report; Gladstone Ports Corporation (n.d.); Department of Transport and Main Roads (various years).

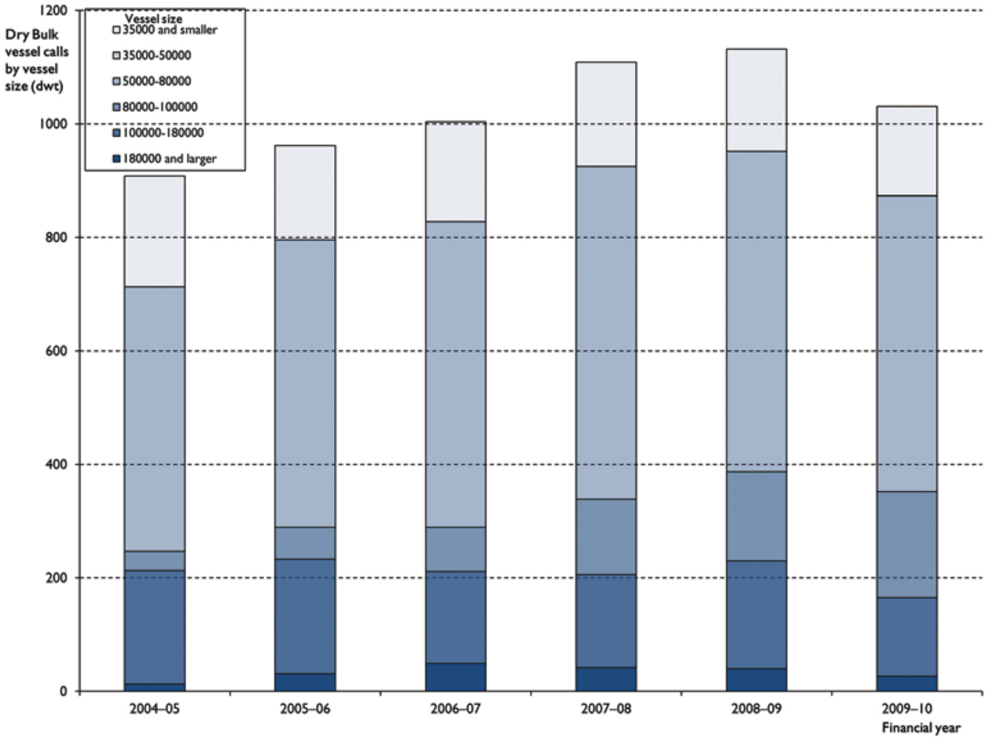
Figure 35 presents the throughput trend at the Port of Gladstone. Rising throughput has been driven by the expansion in coal exports. Coal throughput did dip in 2010–11: in common with other Queensland coal production, the Blackwater and Moura coal logistics chains were disrupted by floods and cyclones from late 2010 though to late February 2011.

The principal wharves for the trade were the R G Tanna and Barney Point coal terminals and the South Trees west (bauxite) and east wharves (alumina).

Port activities

Table 5 presents a summary of activities at the Port of Gladstone. Both dry bulk and liquid bulk vessel visits have increased over the review period. As is evident from Figure 36, much of the growth in port throughput has been achieved through use of larger vessels.

Figure 36 Number of vessel arrivals at the Port of Gladstone, by vessel size



Source: Lloyd's List Intelligence, n.d.

Table 5 Port of Gladstone activity parameters, by year

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Landside								
RG Tanna Coal Terminal								
Gross unloading train rate (tonnes per hour)	3 632	3 572	3 789	3 789	3 641	3 793	3 876	-
Gross vessel loading rate (tonnes per hour)		2 859	2 919	2 791	2 967	2 956	3 003	-
Blended coal (percentage)	63	67	67	-	62	-	-	-
Barney Point Coal Terminal								
Gross unloading train rate	-	-	-	1 842	1 970	-	-	-
Wharf								
Vessels arriving at port, total (number)	1 271	1 353	1 461	1 545	1 555	1 625	1 522	1 665
Vessels arriving at port, bulk liquids, inc. LNG (number)	127	146	88	164	116	151	175	
Vessels arriving at port, dry bulk (number)	943	1 030	1 127	1 123	1 224	1 235	1 087	
Gross vessel loading rate (tonnes per hour)	-	-	1 375	1 447	1 358	1 514	1 512	-
Beyond								
Distribution of loaded tonnage (principal countries, percentage)								
Japan	47	46	43	40	33	34	32	30
India	10	8	8	10	10	14	17	18
China	5	4	4	3	9	12	10	15
Korea	10	13	10	13	18	13	13	14
Distribution of unloaded tonnage (percentage of total unloaded)								
From elsewhere in Australia*	88	86	87	86	85	86	85	82

Source: Current data (fiscal year-to-date plus weekly data) are available—see Gladstone Port Corporation, n.d (2).
Note: * Unloaded tonnage from elsewhere in Australia is primarily bauxite shipped from Weipa.

There is limited information on landside logistics. Table 5 presents some figures on coal train unloading rates, with some patchy unloading rate enhancements. Similarly, coal loading rates onto vessels have shown some increase. Such changes are a function of a range of factors including equipment standards and vessel sizes.

Table 5 also shows the source of unloaded tonnage, with local ports being the principal origin; this reflects, especially, the unloading of bauxite, sourced from Weipa. The table also shows the principal countries where the uploaded commodities are destined. The commodities are dominated by coal. Volumes and export shares to China, in particular, have increased over the review period, with export growth also to India and Korea. Volumes (and market share) to Japan, dominated by coal, has declined.

Box 9 Data sources: Port of Gladstone

- Maritime Safety Queensland, *Shipping movements in Queensland,* <www.msq.qld.gov.au/Shipping/Shipping-movements.aspx> Vessel arrivals, gross tonnage of vessels arrived, by month.
- Gladstone Ports Corporation, *Cargo Statistics,* <www.cqpa.com.au/viewcontent/ShippingStatistics/CargoComparisonsSelection.aspx> Monthly cargo statistics: loaded and unloaded commodities, by origin or destination.
- Gladstone Ports Corporation, *Live shipping schedule, by wharf, vessel and tonnage,* <www.cqpa.com.au/webscripts/ShippingNotifications/ShippingSchedule.asp> Detailed tonnage loadings by vessel and wharf, scheduled and current.
- Gladstone Ports Corporation, *Summary of operations. Activity report.* <www.cqpa.com.au/Pages/Latest%20Stats/Summary%20of%20Operations/summary.pdf> Loading rate, loading time and sources of delays, of the two coal terminals and Auckland Point facilities. Weekly data (for previous 4 weeks) and current financial year.
- Gladstone Ports Corporation, *Port of Gladstone. Information Handbook 2011.* <www.gpcl.com.au/Portals/0/pdf/Handbook/Port_of_Gladstone_Information_Handbook_November_2011.pdf>Terminal cargo statistics, terminal blended coal, wharf specifications.
- Gladstone Ports Corporation, *Summary of operations. Activity Report,* <www.cqpa.com.au/Pages/Latest%20Stats/Summary%20of%20Operations/summary.pdf>, Weekly statistics for each coal terminal and Auckland Point wharves, including level and rate of coal and other commodity loading, effective loading time, classification of loading delays.

Port Kembla

Port overview

The port of Port Kembla is based around an inlet, with the harbour protected by two constructed breakwaters. The port was established in the 1890s to enable the export of coal, a major function that continues today, along with a diversified range of import and export commodities such as grain exports, iron ore imports and motor vehicle imports.

Port Kembla snapshot

- Loaded coal, coke, grain
- Landside unloaded deliveries of coal and coke by rail and road and grain by rail
- Portside steel production

In October 2012, the NSW Government introduced legislation into Parliament to enable the private sector to take a 99-year lease of Port Kembla Port Corporation's assets.

The port's bulk throughput is marked by a diversity of commodities, albeit dominated by coal and grain. The port is also marked by the relatively high level of the landside logistics that is undertaken by road, being around 40 per cent of the task (Port Kembla Coal Terminal, n.d.).

Harbour and landside facilities

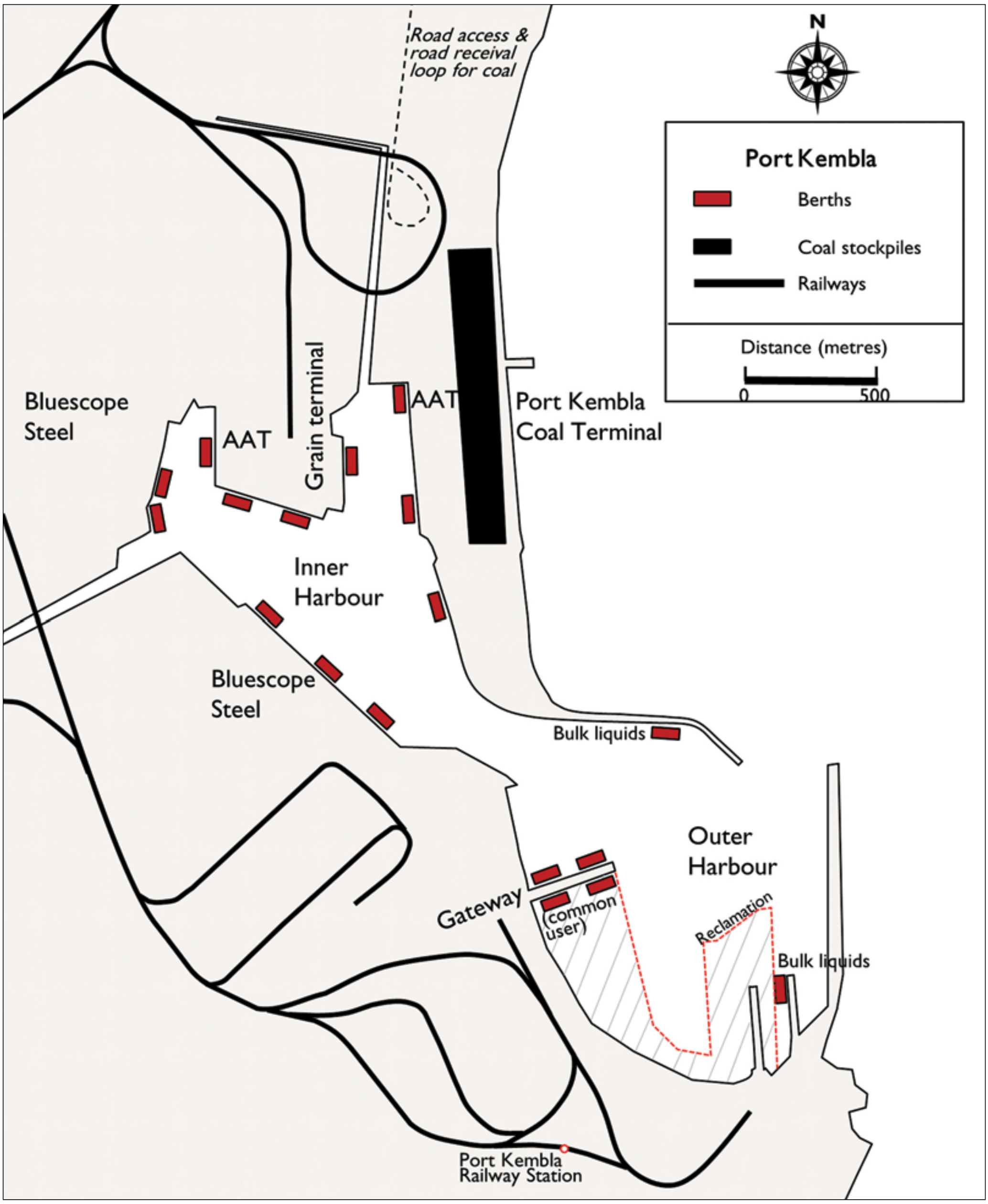
Figure 37 shows the principal maritime and landside infrastructure facilities at Port Kembla. The map shows the range of major bulk commodity facilities and operations at the port:

- Port Kembla Coal Terminal (operated by a consortium of six coal-producing companies[60] and managed by BHP Billiton), exporting coal and coke;
- Bluescope Steel's steelmaking plant (with blast furnace), unloading iron ore[61];
- Port Kembla Grain Terminal, managed by GrainCorp, for the export of grains;
- Port Kembla Gateway, for the export of copper concentrate, the unloading of fertiliser and a range of other commodities;
- AAT, the Australian Amalgamated Terminals, for a range of non-bulk and break bulk commodities.

60 The consortium is named Port Kembla Coal Terminal and the consortium members are BHP Billiton, Centennial Coal, Gujarat NRE, Peabody Energy, Tahmoor Coal (now part of Xstrata) and Xstrata.

61 Until October 2012, some steel was shipped from Port Kembla to the Bluescope Western Port facility at Hastings, east of Melbourne. Since that date, the steel has been shipped exclusively by rail. The export of steel ceased when Bluescope shut down its No. 6 blast furnace in 2011. Bluescope's No. 5 blast furnace is used for producing steel for domestic customers only. OneSteel operates Australia's other blast furnace, in Whyalla.

Figure 37 Port Kembla: principal terminals, railways and berths



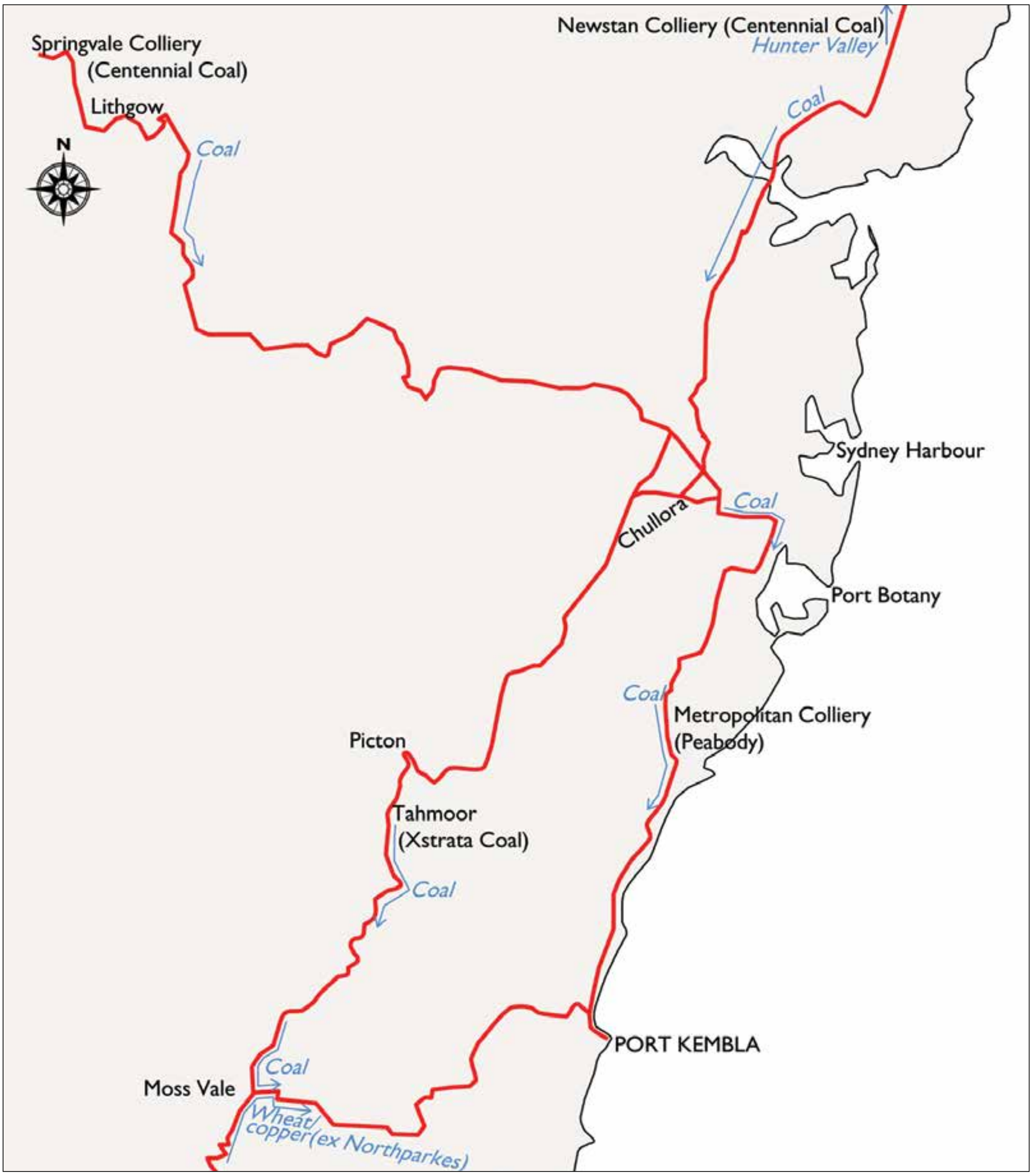
Capacity expansions

The port underwent expansion in the Inner Harbour between 2005 and 2008, particularly associated with the provision of roll-on, roll-off berthing at the AAT berths. Work on a phased construction of expansion of the Outer Harbour commenced in 2011. The site is on the southern side of the Harbour (shown in Figure 37). The first phase includes demolition of two jetties, reclamation of 42 hectares and construction of two berths. A multi-purpose terminal will be constructed in the first phase along with a container berth. Later developments that are envisaged include construction of a cement facility on the site with associated berth handling for unloading of raw materials and loading of cement products.

Landside logistics

The rail-based coal export logistics chain is very dispersed and extensive; the relevant railway routes are illustrated in Figure 38. (These tracks are managed by RailCorp, ARTC and John Holland Rail [Country Regional Network].) These exports go through the port's Port Kembla Coal Terminal. There is short-haul railed coal (such as from the "Southern Mine region" at Wongawilli Colliery, hauling coking coal). Other Southern collieries that export (coking) coal by rail to the port include Peabody's Metropolitan Colliery near Helensburgh and Xstrata's colliery at Tahmoor near Picton. Thermal coal is brought from the Western coal region in the Lithgow area — and at Kandos, north-west of Lithgow. The collieries include Centennial Coal's facilities at Springvale, Clarence and Ivanhoe No.2. Thermal and coking coal is also brought by rail to the port from Newstan Colliery in the Hunter Valley. In both Western and Hunter mining area logistics tasks, the trains are moved across Sydney. Coal trains are between 32 and 45 wagons in length, or a payload of between 2 500 and 3 600 tonnes (Port Kembla Coal Terminal 2008, p 50). The primary train operator is Pacific National.

Figure 38 Railway routes conveying bulk goods to Port Kembla



Other important bulk commodities include wheat, through GrainCorp's grain terminal; and copper concentrates, through the Port Kembla Gateway facility. Both grain and copper concentrates are moved by rail via the Moss Vale–Unanderra railway from locations south, west and north-west of the port. The Gateway facility is also used for the import of bulk commodities such as gypsum, soda ash, iron ore and fertilisers. The AAT (Australian Amalgamated Terminals) facility handles other general, and non-bulk (container) commodities, including motor vehicle imports.

The road haulage of coal to the port is short-distance (local, from coking-coal collieries near Port Kembla, including Appin, West Cliff, NRE No. 1 and Dendrobium). Similarly, road is now used exclusively for hauling coke from Illawarra Coke Company's operations at Coalcliff and Corrimal, north of the port. The road receival facility is shown in Figure 37.

Bauxite is a future commodity that would be exported through Port Kembla should the bauxite deposits around Taralga (west of Moss Vale) be developed. That proposal would include shifting the ore to the port by rail (Australian Bauxite Limited 2012).

There is consideration for investing in the proposed Maldon–Dombarton railway; this would connect Port Kembla with the main Sydney–Melbourne railway near Picton (a township shown in Figure 38). Construction of the railway commenced in 1983 but ceased in 1988 without the line being completed. Analysis of the viability of the railway has been undertaken.[62]

Port utilisation

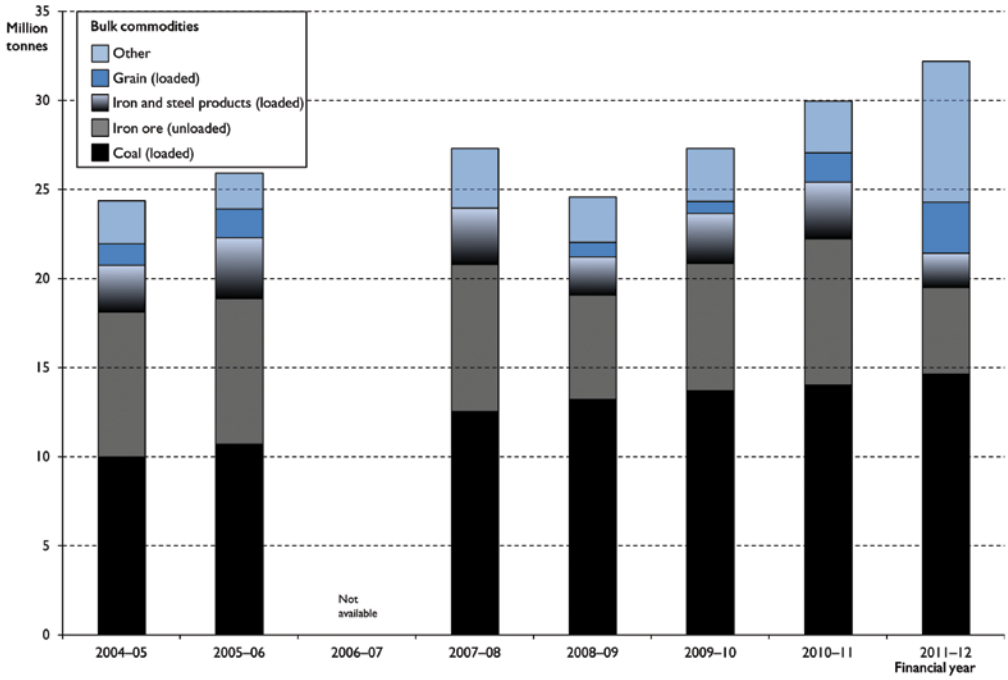
As noted above, Port Kembla has a diverse range of bulk commodities. Trends of these commodities is shown in Figure 39. Commodities used for steel production, or resulting from that production, are inter-related. As a result, trends in throughputs of commodities such as iron ore, dolomite, limestone and steel products tend to shadow each other.

As with other coal-exporting ports, Port Kembla's coal exports (coking and thermal coal) have grown, albeit relatively modestly. Two berths are allocated for coal, of which one berth is used for smaller vessels and handling a range of bulk goods (including coke).

As with other eastern grain-exporting ports, Port Kembla's grain exports were depressed during the protracted so-called "Millennium" drought of 2003–2010. Indeed, in 2007–08, the port actually unloaded wheat and maize.

62 See the Department of Infrastructure and Transport web site for publications relating to the appraisals and analysis of the line. <http://www.nationbuildingprogram.gov.au/publications/reports/>

Figure 39 Port Kembla throughput, by principal commodities



Source: Port Kembla Port Corporation, (various years); Port Kembla Port Corporation, n.d. (1).

Port activities

There is limited aggregated information on Port Kembla's activities. The Coal Terminal provides coal throughput information at the financial year-to-date, the month-to-date and the last 24 hours;[63] the current coal vessel queue and coal stocks are also cited. Similarly, the Port Kembla Port Corporation provides current and scheduled vessel arrivals and departures.[64]

The Port Corporation's annual report presents the annual number of ship visits, which has risen from 624 visits in 2004–05, to 1 010 in 2011–12. The annual reports also sometimes report berth utilisation levels. In 2008–09 the average utilisation at the port stood at 32 per cent; this rose to 36.4 per cent the following year and to 42 per cent in 2010–11.

63 <www.pkct.com.au/home/>

64 See <www.kemblaport.com.au/shipping_movements>

Box 10 Data sources, Port Kembla

- Port Kembla Coal Terminal, *Operational metrics,* <www.pkct.com.au/home/> Coal throughput at the terminal (year-to-date, monthly and last day) and current vessel queue.
- Port Kembla Port Corporation, *Shipping movements,* <www.kemblaport.com.au/shipping_movements> Current and projected vessel arrivals and departures, with vessel origin/destination
- Port Kembla Port Corporation, *Trade & cargo,* <www.kemblaport.com.au/page/port-operations/trade---cargo/> Annual (and financial year-to-date) port imports and exports, by commodity; vessel visits and vessel gross tonnage.

Abbot Point

Port overview

The port at Abbot Point is based around an offshore jetty projecting into deep water of the Coral Sea. Abbot Point is the northernmost of Australia's major coal ports. The port was constructed as part of the development of the coal extraction in the northern Bowen Basin coalfields. The port of Abbot Point was opened in 1984. The port management is undertaken by the Queensland Government's North Queensland Bulk Ports Corporation Limited.

Abbot Point snapshot

- Loaded coal (metallurgical and thermal)
- Currently one terminal; three further terminals planned
- Landside unloaded coal, by rail (Newlands coal system)

The port is dedicated to coal exports, with a single common-user terminal, the "T1" facility. That facility is operated and maintained by Abbot Point Bulkcoal Pty Ltd, a subsidiary of Xstrata. Mundra Port and Special Economic Zone Ltd (which is part of the Adani Group[65]) controls the terminal under a 99-year lease (commencing in 2011). The terminal is known as the Adani Abbot Point Terminal.

65 In January 2012, Adani Ports announced that it would be selling its stake in the terminal to the Adani family.

Figure 40 Abbot Point

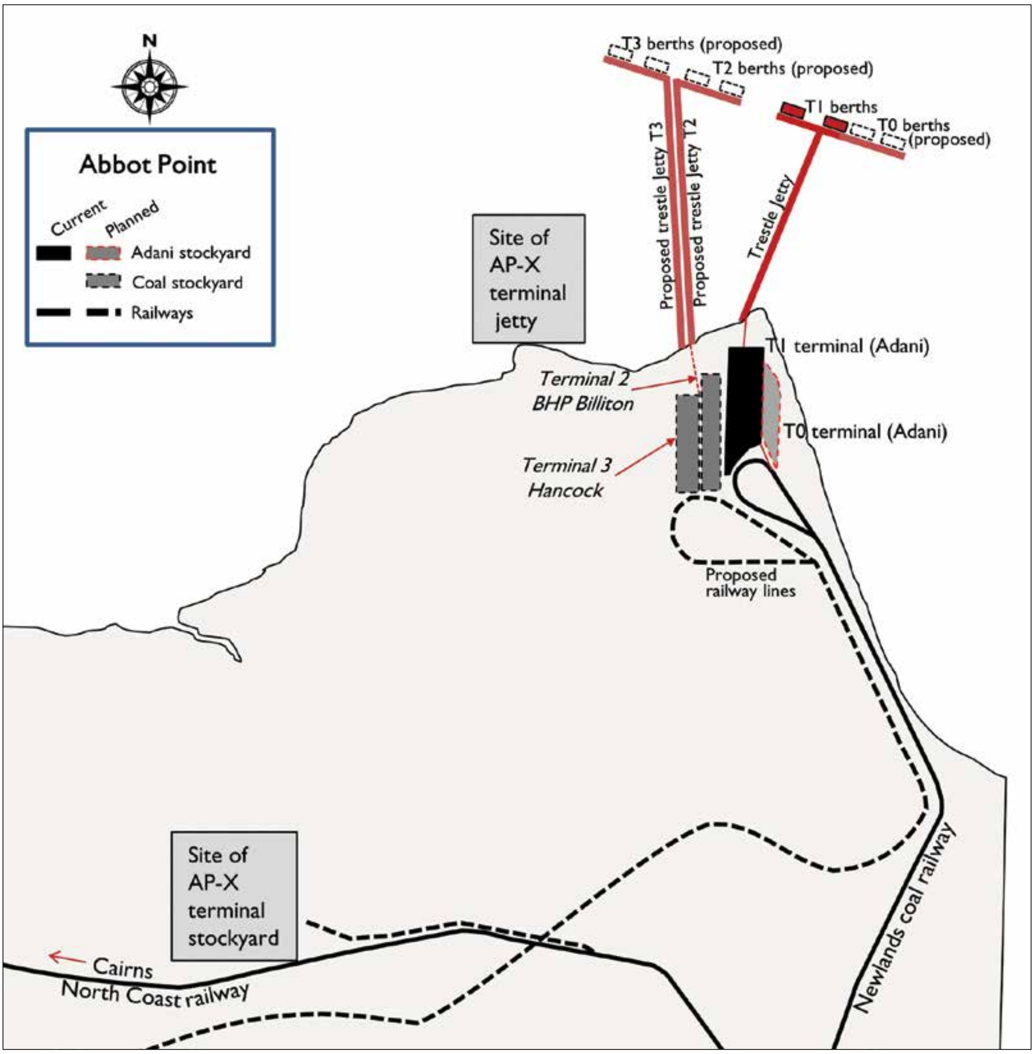
Source: North Queensland Bulk Ports Corporation.

Harbour and landside facilities

Figure 41 shows the major existing and planned facilities at the port. The landside infrastructure is based around the Adani terminal. Terminal 1 is served with two shiploaders and two berths at the end of a 2.8 kilometre trestle jetty (equipped with a conveyor).

In recent times the port has had substantial capacity expansions. In 2007, the X21 expansion expanded terminal capacity from 15 to 21 million tonnes per annum. In 2008, the X25 expansion increased terminal capacity to 25 million tonnes per annum. Most recently, the X50 expansion of 2010 doubled capacity to 50 million tonnes per annum.

Figure 41 Port of Abbot Point



Proposed capacity expansion

As shown in Figure 41, further coal terminals are planned, based around the extension of the Newlands line to link with the Goonyella system; and the new railway(s) linking the port with the Galilee coal basin. At the port itself, a trestle jetty (or jetties) for multiple berths is planned; onshore, three additional terminals are proposed. The T0 (Adani) terminal (with two off-shore berths) would be accommodated within existing, upgraded, track capacity while the T2 (BHP Billiton) and T3 (GVK Hancock) terminals would be complemented by new railways.

The new railways would provide access to mining in the Bowen coal basin but also in the more remote Galilee coal basin, with proposed mines at Carmichael (Adani), Alpha and Kevin's Corner (both GVK/Hancock) and China First (Waratah Coal). As distinct new railways serving specific coal mining areas, the railway proposals include construction to a standard gauge railway (1 435 mm) rather than the narrow railway Cape gauge (1 067 mm) currently used elsewhere in Queensland's coal systems. Such schemes would involve longer trains and heavier wagons.

To the extent that this major coal mining activity proceeds, there would be a case for additional terminals within the port area. A consequence is the proposed longer-term "AP-X" terminal, which would be to the west of the current site. This terminal would supply additional capacity and be supported by the existing and proposed new railways.

Port expansion proposals include development of an "Abbot Point LNG" export terminal.

Landside logistics

Conveyance of coal between the mines in the coal system[66] is undertaken by rail—see Figure 42. The primary landside logistics is the Newlands (non-electrified) Coal System using Aurizon's narrow-gauge railway.[67] The railway service providers are Aurizon and Pacific National Coal (a division of Asciano).

In 2011, a 69-kilometre railway was opened that links the Newlands and Goonyella Coal Systems. This link enables the northwards transfer of central Bowen Basin coal to Abbot Point, as an alternative to the Port of Hay Point. This option, by expanding the number of mines within a coal system, increases the opportunities for blending different standards of coal to meet a given customer's specifications and to enhance the flexibility and robustness of supply chains.

The length of haul from mines to the port is generally relatively low, with the Collinsville mine being 102 kilometres by rail from the port and the Newlands mine being 169 kilometres by rail from the port—see Figure 42.[68] Coal is also hauled 397 kilometres from the Lake Vermont mine, near Dysart in the Goonyella Coal System via the Newlands–Goonyella railway (Figure 28; Aurizon 2011a).

Compared with a number of other bulk haulage landside logistics, the coal trains are relatively modest in scale. The axle load on the railway is relatively low (20 tonnes per axle[69]) with a relatively low maximum train length (1 300 metres). (QR Network Pty Ltd, 2009) Newlands mine and Collinsville mine trains convey around 70 wagons, each with up to 62.5 tonnes of coal, with a train payload of 4 200 tonnes, with a maximum capacity of 4 600 tonnes. New coal railways that are planned to be built to the port will have significantly higher axle loads/payloads and longer trains.

At the port, coal is bottom-discharged from the wagons; stacker reclaimers then handle between 4 000 and 6 000 tonnes per hour for coal-stockpiling.

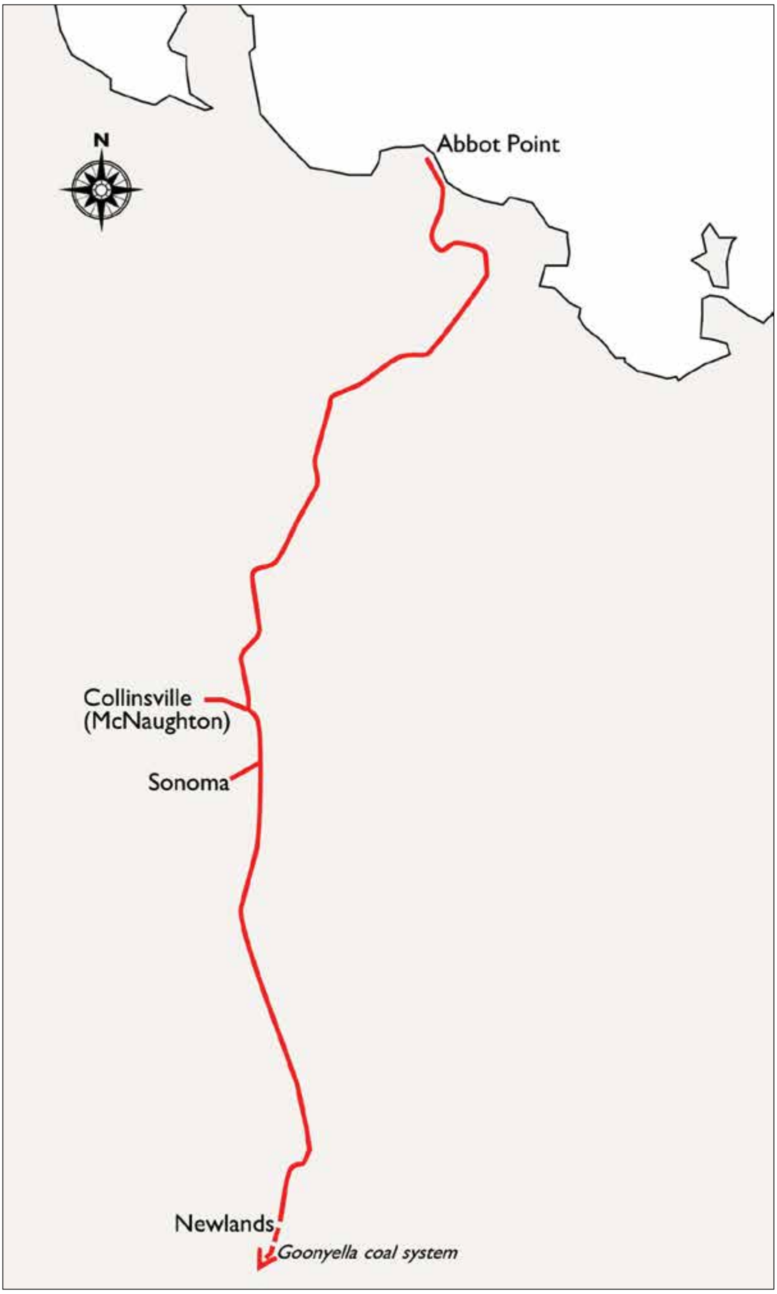
66 The Newlands system is almost entirely dedicated to conveying coal. Near Abbot Point, the Newlands corridor incorporates 7 kilometres of the main Brisbane–Townsville railway, where coal trains share trackage with other commodities.

67 The terms and conditions of access provided by Aurizon are set out in its Access Undertaking; the infrastructure provider is regulated by the Queensland Competition Authority.

68 The introduction of coal that is conveyed by rail from Goonyella coal mines will increase the port's trade reach. Also, other railways that are proposed to be built to Abbot Point (discussed below) will involve considerably longer distances—almost 500 kilometres — in accessing coal in the Galilee Basin.

69 (Aurizon 2011a, p. 1). By contrast, the Goonyella coal system has a 26.5 tonne axle load (Aurizon 2011, p. 1).

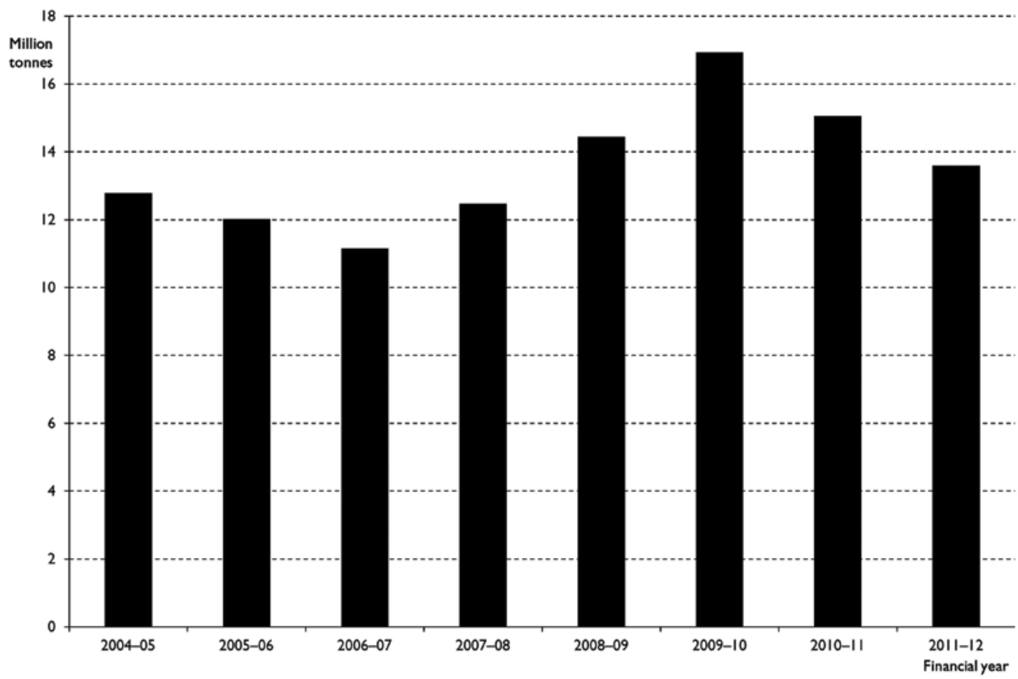
Figure 42 Railways conveying coal to Abbot Point (Newlands coal system)



Port utilisation

In common with other coal ports, Abbot Point's throughput has risen in recent years. In common with other Queensland ports, the coal exporting was severely disrupted by the extreme weather conditions in December 2010 – January 2011. This underlies the decline in 2010–11 from the previous year—see Figure 43.

Figure 43 Port of Abbot Point, throughput



Source: Department of Transport and Main Roads (various issues); North Queensland Bulk Ports, various issues, Annual Report; North Queensland Bulk Ports, n.d., (web site).

Considering the data presented in Figure 43, however, it is evident that expanded port capacity has run ahead of mining extraction. The 2011–12 actual throughput of 13.6 million tonnes is well below the terminal/berthing facilities nameplate throughput of 50 million tonnes. Greater demand for coal, coupled with higher mining extraction and diversion of Goonyella coal to Abbot Point (through expanded railway capacity), would enable that throughput to increase towards the port's capacity.

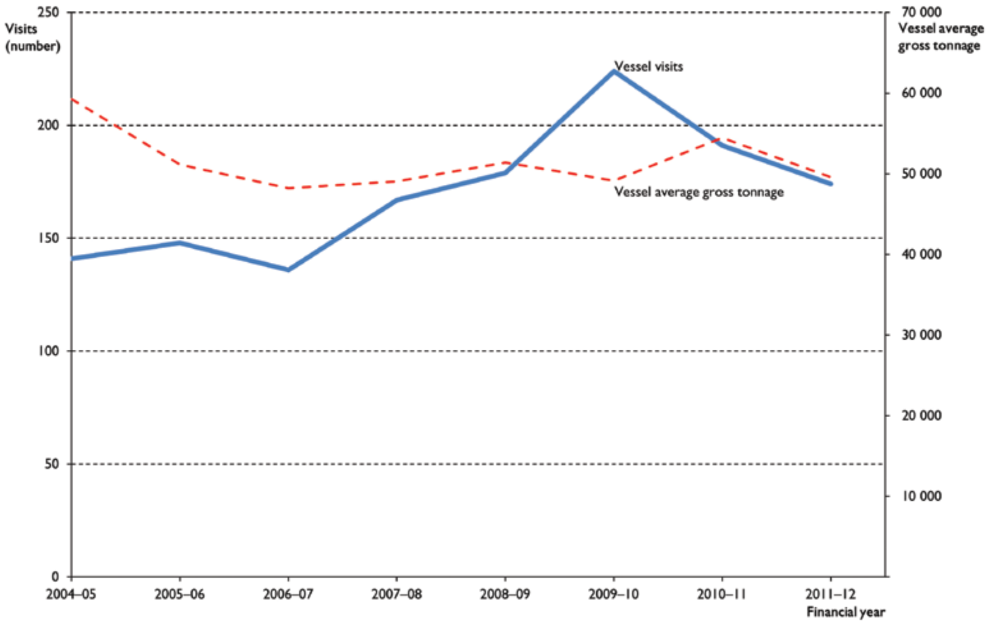
Port activities

There is limited data on port activity. Up-to-the-minute data[70] are available on vessel movements through the port. Data are also available on vessel movements through the port, as shown in Figure 44. The number of vessel visits has trended upwards as the port's throughput has risen.

70 Maritime Safety Queensland, n.d., (1).

Figure 44 also presents the average gross tonnage of the vessels arriving at the port. It might have been expected that the average vessel size would be increasing (reflecting trends in bulk carrier sizes). However, there is no discernible pattern in vessel average gross tonnage.

Figure 44 Port of Abbot Point vessel visits and average vessel gross tonnage



Source: Maritime Safety Queensland, n.d.

Box 11 Data Sources, Abbot Point

- North Queensland Bulk Ports Corporation, *Port of Abbot Point,* <www.nqbp.com.au/abbot-point/> Monthly tonnage throughput; charts of tonnage by broad commodity category.
- Maritime Safety Queensland, *Queensland ship movements. Monthly status report* <www.msq.qld.gov.au/Shipping/Shipping-movements/Ship-movement-statistics-2012.aspx> Vessel gross tonnage arrived at port; number of vessel arrivals (including piloted arrivals)

3. Bauxite ports

In this section we review Australia's principal bauxite-derivative[71] ports, Weipa and Bunbury, and their logistics. Substantial quantities of other commodities are also shifted through Bunbury.

Weipa

Port overview

The port at Weipa is on the western side of Cape York Peninsula, at the mouth of the Embley River. The primary function of the port is the loading of bauxite that is extracted by strip mining from the immediate hinterland; bauxite is used for the production of aluminium. The port is managed by the Queensland Government's North Queensland Bulk Ports Corporation Limited.

Weipa snapshot

- Loaded bauxite
- Landside unloaded bauxite by rail and road
- Depletion of bauxite resources in area will lead to bulk tasks at port ceasing.

The port was developed in connection with the commencement of mining in 1961. The loading of bauxite represented more than 99.5 per cent of the port's tonnage in 2009–10. Weipa's mining currently represents around one-third of the total Australian mining of bauxite.[72]

The bauxite mining is undertaken by Rio Tinto. Much of the bauxite is shipped to Gladstone (61 per cent of the shipped bauxite in 2010–11[73]), where it is an input for the Queensland Alumina Limited refinery and the Yarwun Alumina Refinery—see those facilities shown in Figure 31. Bauxite is also exported. (Figure 60 shows Weipa's bauxite trade, including unloading at Gladstone; the difference between the loading and unloading represents overseas trade which, as the figure shows, has been growing.)

There are irregular loadings of cattle at the port, for export. Oil and fuel and a range of non-bulk general cargo supplies are unloaded.

Harbour and landside facilities

The port facilities consist of four berths in Weipa Harbour—see Figure 45. There are two berths at Lorim Point (East Wharf; West Wharf) serving the loading of bauxite, with a berth at Evans Landing and one at Humbug Point for unloading fuel and general cargo, respectively. After the bauxite ore is cleaned of non-ore materials (in a process called "beneficiation") at Lorim Point, it is then stockpiled onsite at Lorim Point for later transfer to vessels by conveyor belt.

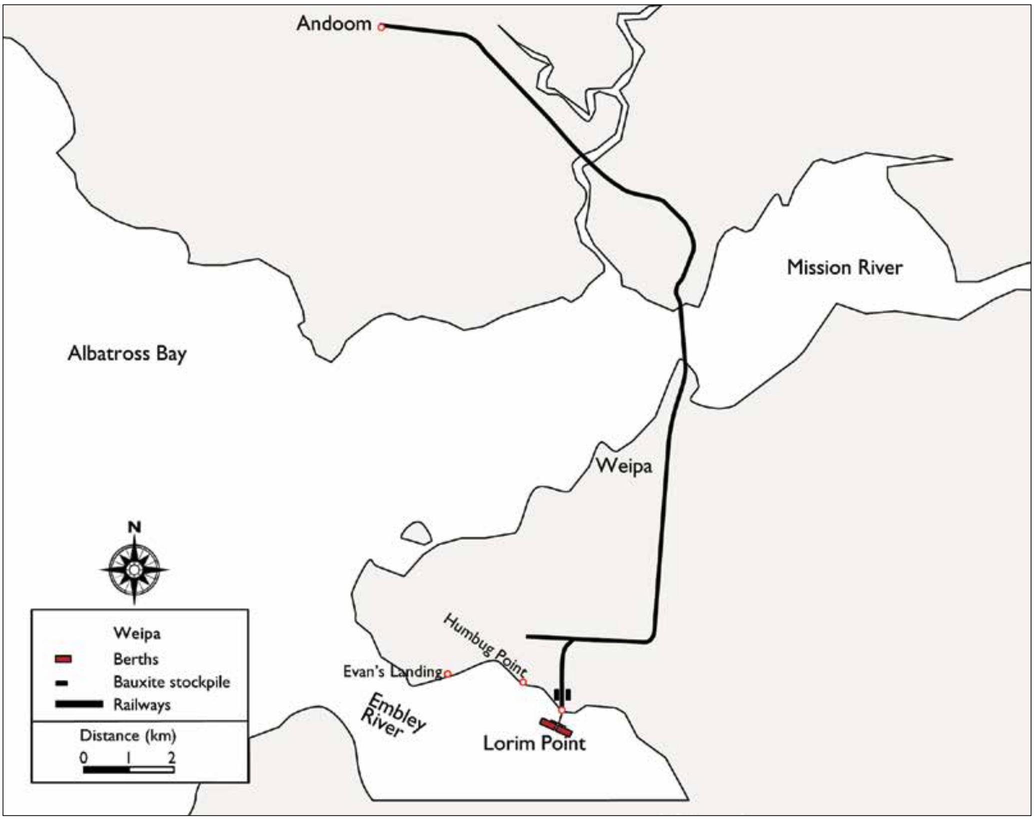
71 Bauxite is refined to produce alumina which can then be smelted to produce aluminium. Ports may ship or receive any of those three products. See the next chapter for a further discussion of the ports.

72 Other bauxite mining in Australia is at Gove (Northern Territory) and Boddington, Huntly and Willowdale (Western Australia).

73 Department of Transport and Main Roads 2011, Trade statistics for Queensland Ports 2011, p. 36. While the level of bauxite mined has increased, the level shipped to Gladstone has remained steady; the level of bauxite shipped to other locations has increased.

The bauxite terminal has two shiploaders; the second shiploader was commissioned in 2006, enabling an increase in shipping capability. The berths accept post-Panamax vessels. Five post-Panamax bulk vessels convey bauxite to Gladstone.

Figure 45 The port of Weipa, showing railway access



Port future

Bauxite is mined by Rio Tinto over an extensive area around the port, to the east (East Weipa) and north (Andoom) of the Embley River.[74] The exhaustion of these deposits—shipment of which forms the port's primary throughput—would end regular major bulk movements.

Bauxite mining proposals north and south of Weipa could lead to development of alternative ports. Rio Tinto is giving consideration to extending its mining area south of the Embley River; this would increase annual tonnage, rising from the existing port's current annual tonnage of around 20 million tonnes, to 50 million tonnes. The proposal is that the shipments would take place through a new port, which would be built at a location between Boyd Point and Pera Head (south of the Embley River, between Weipa and Aurukun).[75]

74 Additional high-grade bauxite deposits have been identified at Pisolite Hills, north of Weipa; Port Musgrave has been suggested as a location where it would be feasible to ship the extracted bauxite.

75 Rio Tinto Alcan Envornmental Impact Statement for South of Embley Project. Section 14. Transport. <www.industrycortex.com/tracking/outgoing_click/7747553/datasheet-profile-download>

Cape Alumina Limited has a separate bauxite development proposal for an area on western Cape York around Bauxite Hills, 95 kilometres north of Weipa. This development, also, would involve a new port.[76]

Landside logistics

Rio Tinto brings bauxite to the port along its own standard-gauge railway line, and also by road. The 19 kilometre Andoom – Lorim Point railway (shown in Figure 45) provides a core corridor for moving the bauxite. However, the bauxite is in a relatively-thin layer just below the surface so ore extraction (and surface subsequent remediation) occurs across a broad (rather than deep) basis. This extended extraction siting results in extensive road haulage to the railhead or directly to the port.

The train operation is based on three, 35-wagon sets available and, with 120 tonne gross wagons, this equates to 4 200 tonne trains shuttling between Andoom and Lorim Point.

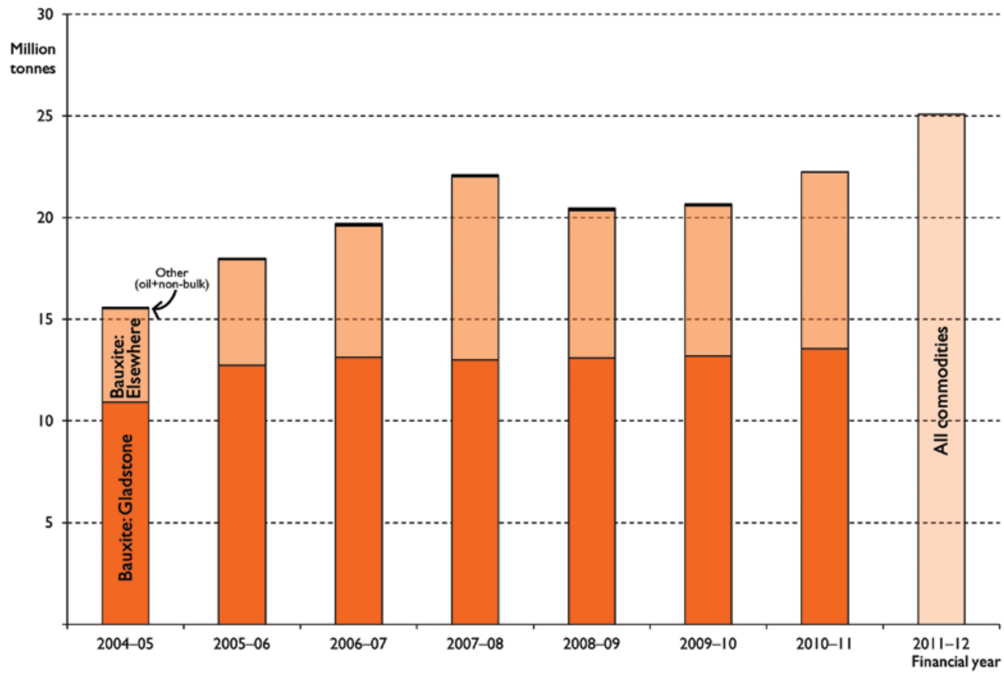
Port utilisation

Weipa is Australia's largest bauxite port. The landside logistics and production task is modest compared with the distances of coal and, especially, iron ore, and the product blending task for those commodities. However, the shipment of the bauxite around Cape York, to Gladstone, represents a significant national transport task.

A time series of the tonnage throughput at Weipa is shown in Figure 46, essentially representing the shipment of the bauxite ore away the port. Throughput has increased as the demand for the end-product, aluminium, has risen. Over the review period, bauxite shipments to Gladstone rose by 24 per cent, but bauxite shipments to other locations (notably, to China) rose by 89 per cent.

76 Cape Alumina Limited, "Developing Cape York bauxite projects". Presentation. <www.asx.com.au/asxpdf/20120418/pdf/425pfnybvl1s38.pdf>

Figure 46 Weipa port throughput

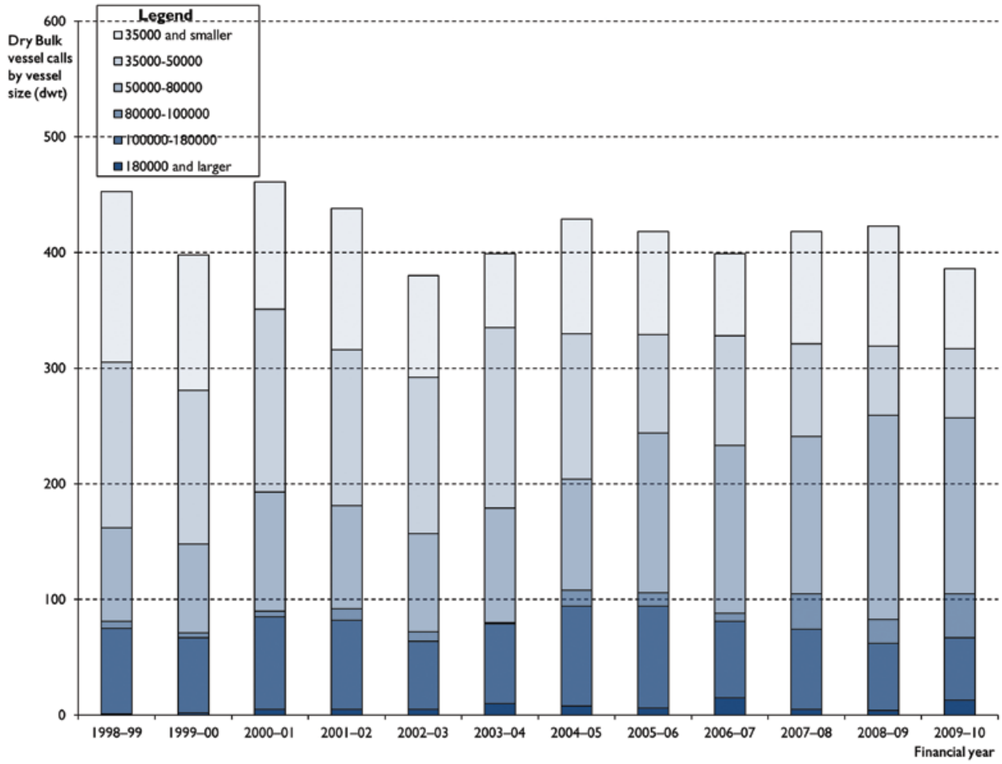


Source: Department of Transport and Main Roads, various issues; North Queensland Bulk Ports Corporation, various issues, Annual Report; North Queensland Bulk Ports Corporation, n.d., (web site).

Port activities

Data are not available regarding the landside logistics activities. At the dockside, however, the pattern of vessel arrivals has gradually changed, with the trend to larger vessels. This is illustrated in Figure 46. There is very limited data on the port activities, apart from statistics on the number and gross vessel size (tonnage) of piloted and unpiloted vessels (reported in Maritime Safety Queensland, n.d.).

Figure 47 Dry bulk vessel calls at Weipa



Sources: Lloyds Register, n.d.; Maritime Safety Queensland, n.d.

Note: Data for later years was not available at the time of publication

Box 12 Data sources, Weipa

- North Queensland Bulk Ports Corporation, *Weipa Port,* <www.nqbp.com.au/weipa/> Monthly tonnage throughput. Charts of tonnage by broad commodity category.
- Maritime Safety Queensland, *Queensland ship movements.* Monthly status report <www.msq.qld.gov.au/Shipping/Shipping-movements/Ship-movement-statistics-2012.aspx> Vessel gross tonnage arrived at port; number of vessel arrivals (including piloted arrivals)

Bunbury

Port overview

The port at Bunbury is based around a sheltered harbour in a sea inlet. Port facilities in Bunbury were started in 1864, with the construction of a timber jetty at the Outer Harbour. Operations in the Inner Harbour commenced in 1976, with the export of alumina.

The primary focus of the port is a diverse range of bulk commodities, loaded and unloaded. Alumina is the principal commodity handled by the port; in 2011–12 alumina was two-thirds of the total tonnage throughput.

Port of Bunbury snapshot

- Loaded alumina, woodchips, mineral/ silica sands, spodumene (lithium source)
- Unloaded caustic soda
- Growth in iron concentrate and prospects for coal, urea
- Rail movements of caustic soda from port and alumina to port
- Production of woodchips at port; mineral sands separation plant

The alumina is set by train on the Brookfield Rail network to the port from three alumina refineries:

- Worsley Alumina's refinery,[77] at Hamilton, north-east of Bunbury. The refinery is supplied with bauxite from the Boddington Mine in the Darling Range;
- Wagerup Refinery, owned by Alcoa World Alumina Australia, at Wagerup, north of Bunbury. The refinery is supplied with bauxite from the Willowdale Mine; and
- Pinjarra Refinery, owned by Alcoa World Alumina Australia, at Pinjarra, north of Wagerup. Pinjarra is supplied with bauxite from the world's largest bauxite mine at Huntly.

The alumina from the Worsley and Wagerup refineries is entirely exported through Bunbury, as is most of the Pinjarra alumina. The combined refineries' output has resulted in Bunbury being the world's largest alumina-exporting port.

The other principal commodity shipped through Bunbury is loaded woodchips. There are two wood mills at the port (WA Chip & Pulp; Bunbury Fibre Plantations[78]) and Diamond Chip Mill at Manjimup (south-east of Bunbury).

Harbour and landside facilities

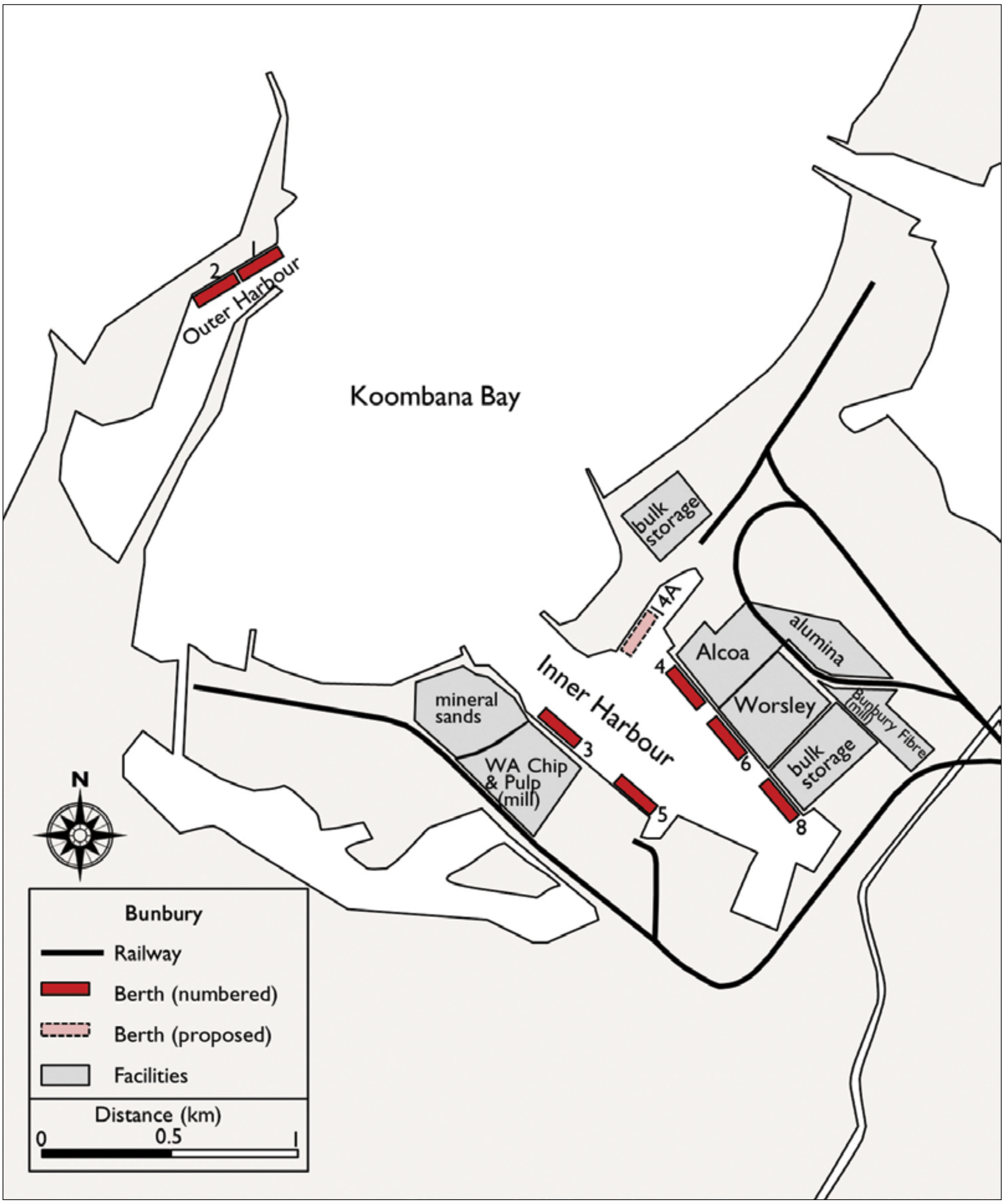
The principal port-related facilities at the Port of Bunbury are shown in Figure 48. Relevant railway lines are shown. The Alcoa and Worsley facilities for alumina are associated with storage; the respective companies' berths (numbered 4 and 6) are owned by the respective alumina producers.

Two woodchip mills operate at the port and are shipped from adjacent berths (numbers 3 and 8).

77 This company is owned by BHP Billiton (86%), Japan Alumina Association (10%) and Sojitz Alumina (4%).

78 WA Chip & Pulp, operating the Bunbury and Manjimup mills, is an operating company of WA Plantation Resources, owned by Marubeni Corporation. Bunbury Fibre Plantations is owned by Mitsui Bussan Woodchip Oceania.

Figure 48 Principal facilities at the Port of Bunbury



Proposed and committed capacity expansions

A project that is actively being pursued is the development of coal-loading facilities at the port; in the absence of the facility, the Collie coal is being loaded at the Port of Fremantle (Kwinana)—see pages 97 and 98. If implemented, the intention would be to add a rail coal loop adjacent to the existing loop (Figure 48), where a coal stockpile would be placed. A new berth, 14A, would be added (as shown in Figure 48) inside the entrance to the Inner Harbour.

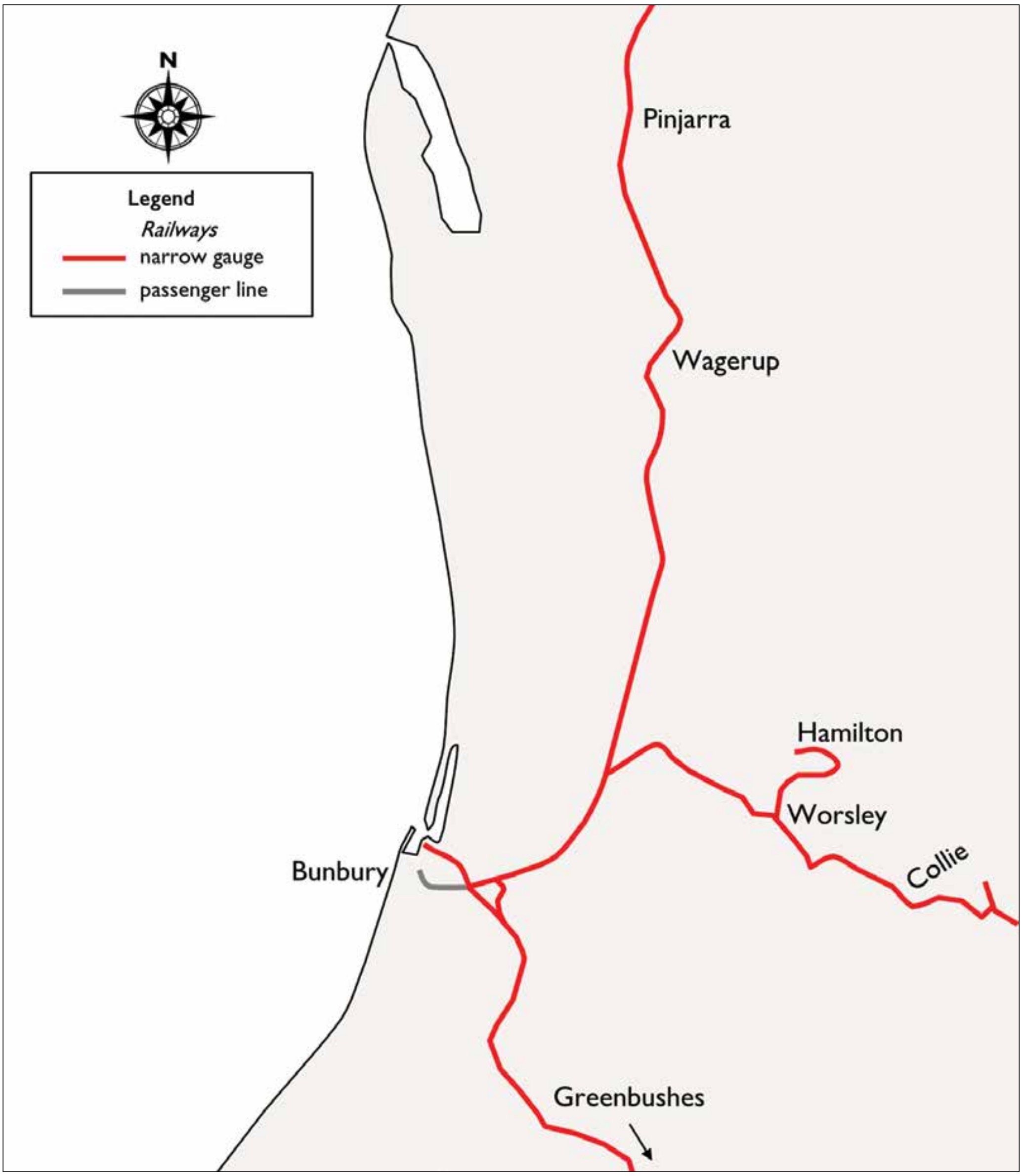
A further bulk freight movement proposal is to load urea at the port, railed from a new coal-to-urea plant near Collie (GHD 2009).

The Bunbury Port Inner Harbour Structure Plan was published in 2009; the plan foreshadows the provision of an additional seven berths, including container berthing and the coal berth (Bunbury Port Authority 2009).

Landside logistics

As noted above, the port's principal commodity, alumina, is railed to the port from the three local alumina refineries (Worsley, Wagerup, Pinjarra). The rail links, and the sites of alumina refineries, are shown in Figure 49. Caustic soda, used in the production of alumina, is unloaded at the port (having been imported, mainly from USA) and is railed to the refineries.

Figure 49 Railway routes serving the Port of Bunbury



Road freight is used for the other principal commodities:

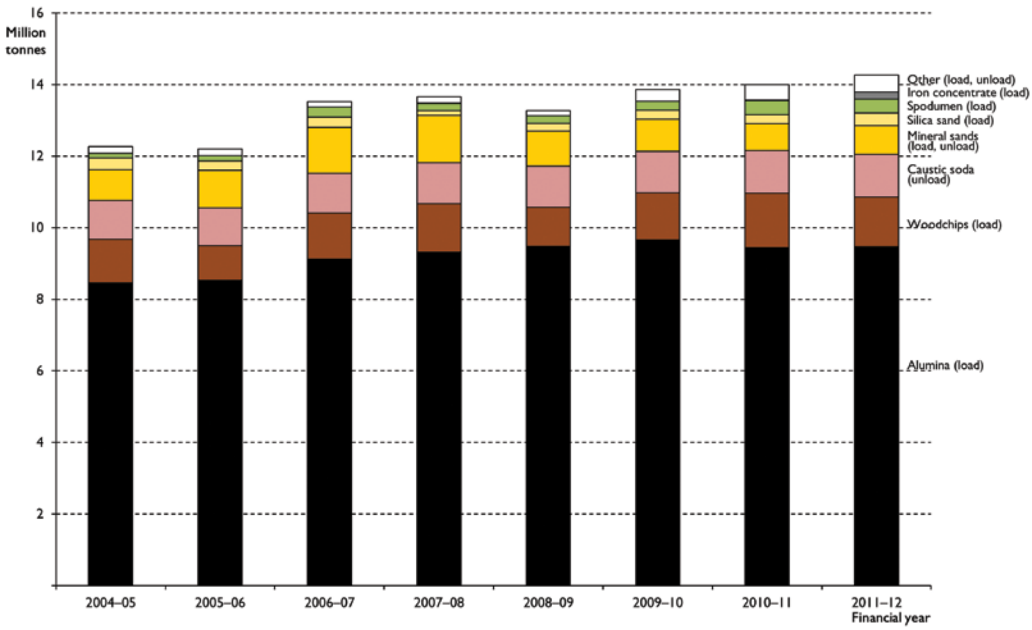
- Mineral sands are conveyed by road from a range of sites, including from Gwindinup, south of Bunbury, to the Bemax Mineral Separation Plant in Bunbury; some mineral sands are unloaded at the port for treatment.
- Silica sand comes by road from a site, Kemerton, 35 kilometres north of the port.
- Spodumene, a source of lithium (from the world's largest spodumene resource, Talison Mine, in Greenbushes, south-east of Bunbury), is sent by road to Bunbury.

- Iron concentrate, from Iluka's Capel kiln, south of Bunbury, is sent by road to the port for loading.
- The logs for the port's woodchip mills are supplied by road, as is the chipped wood from Manjimup.

Port utilisation

As noted above, Bunbury handles a wide range of bulk commodities; collectively, these have led to increased throughput at the port—see Figure 50. In 2011–12, more than 88 per cent of this trade was loaded commodities, notably alumina, woodchips and mineral/silica sands. In that year, caustic soda, used for alumina refining, was the predominant unloaded commodity, being almost three-quarters of the unloaded tonnage.

Figure 50 Port of Bunbury throughput, by commodity



Source: Bunbury Port Authority, various years.

Port activities

Table 6 presents a range of activity measures at the port of Bunbury, strongly influenced by changes in the demand for the underlying commodities. The alumina berths are relatively highly utilised. Changes in utilisation, turnaround times and cargo tonnes reflect a range of factors:

- changes in the mix of commodities handled at the port;
- higher utilisation as the flipside to longer vessel turnaround times; and
- changes in vessel loading procedures.[79]

Commercial vessel visits has risen in recent years; there are upside prospects for this activity based on additional trade in iron concentrates and coal and urea, but countered by uncertain mineral sands prospects.

Table 6 Port of Bunbury activity parameters, by year

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Berth utilisation (percentage)								
Outer Harbour, berths 1 and 2	-	-	-	-	-	-	7	14
Inner Harbour Alcoa/ Worsley, berths 4, 6	-	-	-	-	-	-	70	76
Inner Harbour, berth 3 (including woodchip)	-	-	-	-	-	-	21	23
Inner Harbour, berth 5	-	-	-	-	-	-	57	46
Inner Harbour, berth 8 (including woodchip)	-	-	-	-	-	-	43	71
Berth utilisation (all berths)	29	26	29	32	27	34	40	46
Vessel turnaround times (hours)	43	46	47	52	46	51	58	65
Average cargo tonnes per total vessel hour (tonnes)	856	826	809	783	856	696	581	533
Commercial vessel visits (number)	325	317	353	337	334	391	414	411
Gross Registered Tonnage of vessels (tons)	9.1	9.1	10.1	9.7	9.9	11.0	11.4	11.3
Vessel average gross tonnage (thousand tons)	28	29	29	29	30	28	28	27

Source: Bunbury Port Authority, various issues, Annual report.

79 Bunbury Port Authority notes that the decline in cargo tonnes per total vessel hour in the four years to 2011–12 was "due mainly to changes in loading types with varying cargoes to meet increasing environmental standards" (Bunbury Port Authority 2012, p. 24).

Box 13 Data sources, Bunbury

- Bunbury Port Authority, n.d., Monthly cargo statistics, <byport.com.au/cargoes.html> Monthly tonnage, unload and load, by commodity
- Bunbury Port Authority, n.d., Trade by country <byport.com.au/stats/ctry_fm.htm> Tonnage of unload and load, by origin/destination country
- Bunbury Port Authority, n.d., Bunbury Port — arrivals for month <byport.com.au/visits/f_visits.htm> itemised daily vessel arrivals and departures by vessel name, with each vessel's cargoes and tonnages loaded or unloaded, and previous/next ports visited
- Bunbury Port Authority, various years, Annual report <byport.com.au/annual/> Berth utilisation, vessel calls, vessel turnaround times
- Department of Transport (Western Australia) 2011, Ports Handbook, Western Australia 2011, <www.transport.wa.gov.au/mediaFiles/WA_Ports_Handbook.pdf>

4. Major mixed-commodity ports

Brisbane

Port overview

From its early days in European settlement, Brisbane's port in the Brisbane River grew in unison with the surrounding population. By the early 1970s, the growth in trade (bulk, plus new containerised traffic) had triggered the expansion of the port onto Fisherman Islands.

Port of Brisbane bulk snapshot

- Loaded refined oil, grain, coal, cement
- Unloaded crude oil, refined oil, cement clinker, gypsum
- Landside delivereies of grain, coal by rail
- Portside production of refined oil, cement

The infrastructure of the Port is managed by Port of Brisbane Pty Ltd, under a 99-year lease from the Queensland Government. The company is owned by the Q Port Holdings, a consortium of four infrastructure investors.[80]

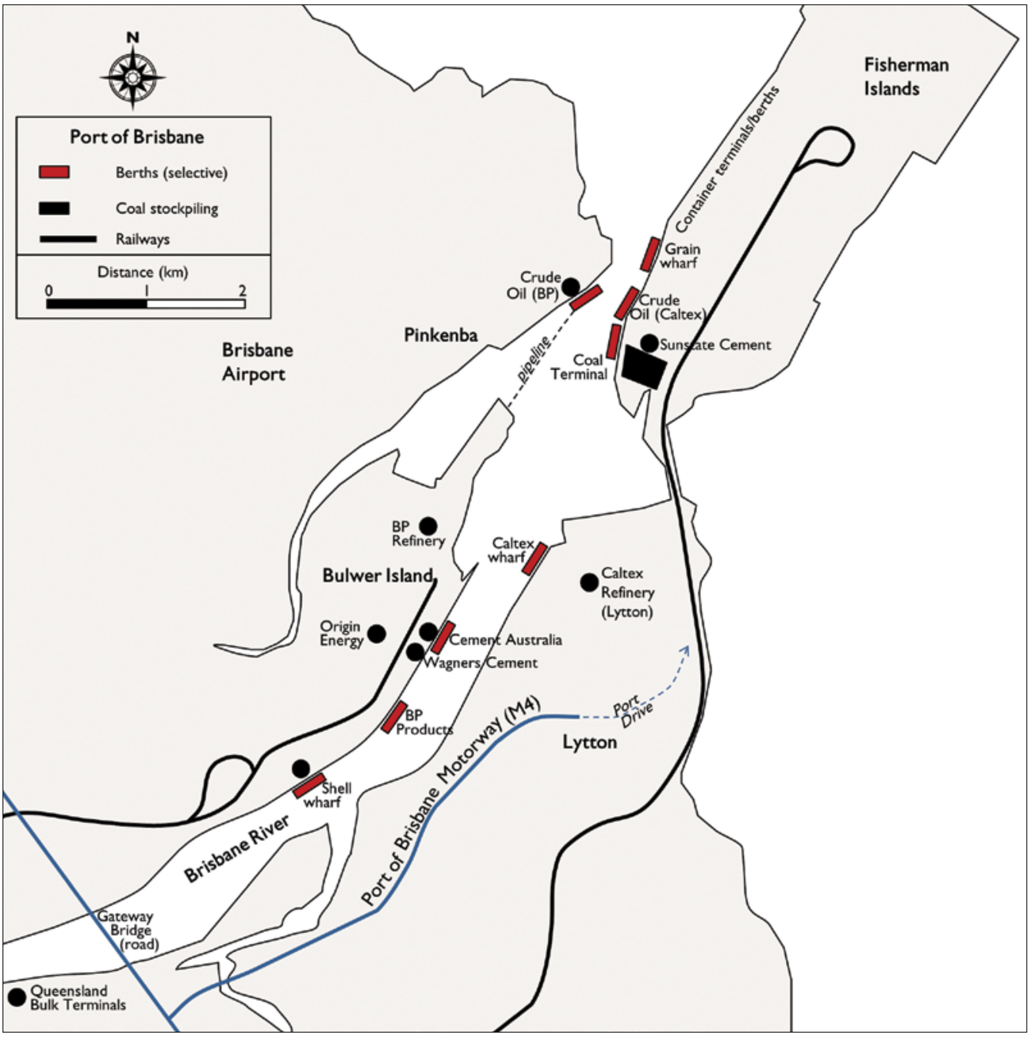
The principal bulk commodities handled by the port are imports of crude and refined oil and cement and exports of thermal coal, refined oil and grains.

Harbour and landside facilities

The principal maritime and associated landside infrastructure facilities at the Port of Brisbane are shown in Figure 51, highlighting major bulk wharves. Relevant freight railways are shown. Within the port precinct, there are 16 berths that are primarily or exclusively used for bulk cargo.

80 The consortium consists of Abu Dhabi Investment Authority, Global Infrastructure Partners, Industry Funds Management and Queensland Investment Corporation [a Queensland Government-owned corporation].

Figure 51 Port of Brisbane: principal wharves and landside bulk activities



Major bulk commodities that pass through the port undergo processing in the vicinity of the port, with subsequent dispersal of processed commodities. This changes the logistics required relative to other ports. Crude oil is landed (at the BP and Caltex wharves), processed (at the Bulwer Island, and Lytton, refineries, respectively) and the resulting refined oil being distributed to retailers or shipped to other ports. Similarly, landed refined oil (at the Shell wharf) is distributed to retailers.

The predominant dry bulk activity at the port is the export of thermal coal, with the common-user Queensland Bulk Handling coal terminal (with single berth) on Fisherman Islands. Agricultural produce (grains, meat, sugar and cotton) are brought by road and rail to the port.[81]

81 Trains operate from south-west Queensland and along the far north (Cairns) line, the latter being marketed under the (Aurizon) Seafreighter brand. Services are provided by Aurizon and Asciano (Pacific National). Those lines are not shown on Figure 52

Inputs for cement production are landed at the port (notably, clinker from overseas and Gladstone) and then used at three plants (Cement Australia [Pinkenba], Sunstate Cement [Fisherman Islands], Wagners Cement [Pinkenba]) around the port. The Cement Australia production plant supplies 10 per cent of the country's cement.

Proposed and committed capacity expansions

The issue of bulk capacity expansion at the port is particularly relevant where significant growth in throughput has occurred, that is, with exports of thermal coal. Any major expansion of coal exports through the port would require a number of landside and port terminal enhancements. Coal throughput at the terminal was 8.9 million in 2011–12, against a nameplate terminal capacity in excess of 10 million[82]. To expand coal throughput further would require complementary expansion of capacity at the terminal and on the railway network from the mines, and along the passenger-train-dominated Brisbane urban railways.

Landside logistics

The coal export logistics chain is the Western coal system (serving the West Moreton coal fields), using Queensland Rail's freight and passenger infrastructure along which diesel-electric locomotives (operated by Aurizon) haul wagons to the multi-user Queensland Bulk Handling facility on Fisherman Islands.[83]

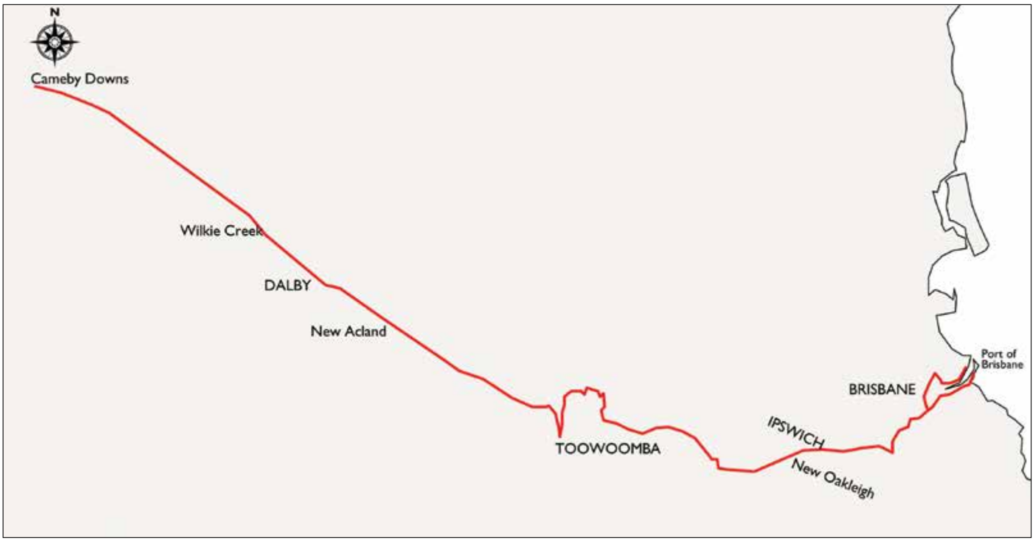
Figure 52 shows the railway route that conveys coal to the Port of Brisbane at Fisherman Islands (through Brisbane); the line to Pinkenba (for some other bulk goods) is also shown. Several branch railways from this route (such as the line through Warwick and the line to Glenmorgan) are used to convey grain to the port.[84] The railways are built to narrow gauge (1 067 mm); the interstate (standard-gauge) railway also serves the Port, at Fisherman Islands.

82 QR Network Pty Limited 2009, pp. 83, cites 2009 nameplate capacity of 10 million, while expansion of the stockpile area from late 2009 would have expanded the nameplate capacity.

83 The terms and conditions of access to the network are set out in Queensland Rail's Access Undertaking, as approved by the regulator, the Queensland Competition Authority—see <www.qca.org.au/rail/>

84 The Western Coal System is described in QR Network Pty Limited (2009), pp. 82–88.

Figure 52 Railway route conveying coal to the Port of Brisbane (Western coal system)



Haulage distances from the four coal mines to Fisherman Islands are between 82 kilometres and 380 kilometres. The Western coal system is the smallest (in tonnages) of the five Queensland coal systems. Track axle loads and train payloads are relatively modest, with 15.75 tonnes per axle and 1 925 tonnes (on average) per train.[85] These restrictions reflect the underlying railway gradients arising from the Toowoomba–Brisbane track alignment passing across the Great Dividing Range.

Crude oil is imported by sea to supply the Caltex (Lytton) and BP (Bulwer Island) oil refineries; similarly, refined oil is imported to a Shell depot (Pinkenba) and Neumann Petroleum Terminals (Eagle Farm). Some of the oil that is refined in Brisbane is shipped out of the port as is LPG that is produced at both oil refineries.[86]

Port utilisation

Figure 53 presents the bulk throughput for the port, including volumes of the principal commodities. The growth in coal exports, evident at other ports, is also apparent at Brisbane. Oil movements represent around one-half of the bulk tonnage throughput. A considerable proportion of the activity is crude oil imports, destined for the Caltex and BP refineries, additional already-refined oil imports destined for the Shell depot, and refined oil loaded at the port. (In 2010–11, 89 per cent of the loaded refined oil was destined for locations elsewhere in Australia; just under 6 per cent of the unloaded crude oil came from other Australian locations.)

85 This compares with axle loads and average train payloads on the other systems, of: 20 tonnes/axle and 5 000 tonnes payload on the Newlands system; 26.5 tonnes/axle and 8 350 tonnes payload on the Moura system; 26.5 tonnes/axle and 8 350 tonnes payload on the Blackwater system; and 26.5 tonnes/axle and 10 000 tonnes on the Goonyella system. (QR Network 2009, p. 25) (Note that Aurizon (2011a) cites a Moura axle load limit of 20 tonnes.)

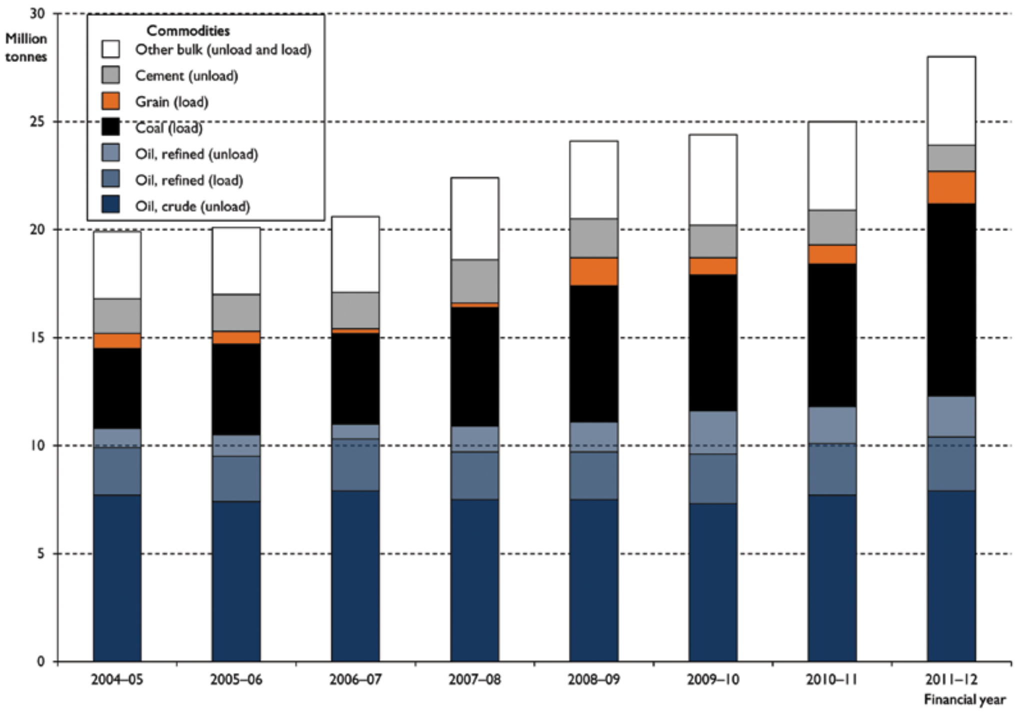
86 A review of the Australian oil refinery industry was undertaken by the House of Representatives Standing Committee on Economics (2013). That review, and submissions by BP (2012), Shell Australia Limited (2012), Mobil Oil (2012) and Caltex (2012), provides further material on crude and refined oil logisitcs and production.

There is a very diverse range of other bulk commodities moved through the port, including imports of motor vehicles, gypsum/limestone (for cement production at the port) and chemicals/fertiliser.

The port's grain throughputs are strongly influenced by growing conditions, with export levels in this period being influenced by the El Niño climatic cycle. GrainCorp, operator of the grain facility on Fisherman Islands, provides monthly export tonnage data and a range of key performance indicators for the facility (and grain facilities at other ports). GrainCorp also provides indicators on projected grain storage capacity at the facility (GrainCorp, n.d.).

By contrast with most other bulk ports reviewed here, Brisbane has substantial major non-bulk port activities with 2011–12 non-bulk (container) tonnage representing 24 per cent (8.5 million tonnes) of the total port tonnage throughput (36.5 million tonnes).

Figure 53 Brisbane bulk throughput, by commodity



Source: Port of Brisbane, n.d.

Port activities

Table 7 presents a split of the principal bulk vessel visits to the port. (Note that, if container vessels were included within this table, the bulk vessels would represent around two-thirds of all the commercial vessel visits to the port.)

In essence, the breakdown of vessel types reflects the volumes of tonnage handled at the port. An important exception is LPG flows. As noted in the introduction, using tonnage to measure task can understate the activities of "light" commodities such as LPG and LNG. This is the case of Brisbane's port. The number of gas vessel movements is high relative to the recorded tonnages; this reflects the low weight/high gaseous volumes of the vessels, calling at Shell and BP facilities[87].

Table 7 Vessel visits to the Port of Brisbane, by vessel type (number)

	2008–09	2009–10	2010–11	2011–12
Bulk carrier	259	214	239	307
Tankers				
chemical/oil products	138	148	213	263
crude oil	141	109	137	119
oil products	121	108	78	82
LPG	102	110	106	111
Chemical	48	70	67	38
Other bulk	756	793	843	846
Total vessel visits	1 565	1 552	1 683	1 766

Source: Port of Brisbane, n.d.

Box 14 Data sources, Brisbane

- Port of Brisbane Pty Ltd, *Trade statistics* <www.portbris.com.au/TradeLogistics/TradeStatistics> Tonnage of import and export commodities; ship visits by type of vessel, monthly
- Port of Brisbane Pty Ltd, *Yearly trade archive*, <www.portbris.com.au/TradeLogistics/TradeStatistics/YearlyTradeArchive> Annual tonnage of imports and exports by commodity and origin/destination country
- Port of Brisbane Pty Ltd, *Shipping handbook 2012/2013*, <www.portbris.com.au/LinkClick.aspx?fileticket=jZO2fXJ9Wnk%3D&tabid=481>, Totals of imports and exports; profile of wharf usage by commodity and wharf customers.

Fremantle (Kwinana)

Port overview

The port of Fremantle commenced operations with the settlement of the European colony at Perth in 1829, albeit in a location fronting the open sea. Although the port is called Fremantle, it is located at two distinct locations, Fremantle (at the entrance to the Swan River) and Kwinana (facing the Indian Ocean).

Kwinana snapshot

- Loaded alumina, grain, coal, iron ore, refined petroleum
- Unloaded crude and refined oil, caustic soda, cement clinker
- Landside unloaded grain, iron ore, coal, by rail
- Portside production of refined oil, alumina

87 Put another way, gas carriers have a low DWT (Deadweight Tonnage) relative to their Gross Registered Tonnage (which is a measure of the enclosed volume of the vessel): the ships have large dimensions, carrying large amounts of compressed gas with relatively little weight

In 1897 a sheltered port location at Fremantle, inside the mouth of the Swan River — the Inner Harbour — was completed. Twenty kilometres south, in Cockburn Sound, the Outer Harbour at Kwinana was completed in 1955. The activities of Fremantle's Inner Harbour are based around container and break-bulk trade while Kwinana's Outer Harbour provides sheltered deep waters for bulk port activities.

The principal bulk commodities are petroleum products, alumina, iron ore and coal.

The port is managed by Fremantle Ports, a trading enterprise of the Western Australian Government. Fremantle Ports operates the Bulk Jetty and the Bulk Terminal[88] at Kwinana, through which a range of bulk commodities pass. Other key bulk maritime facilities are operated by Alcoa (aluminium refinery, with alumina exported), BP (oil refinery, with crude oil imported and two-way trade in refined petroleum) and CBH (grain export terminal).

Harbour and landside facilities

Projecting into the sea, Fremantle's Outer Harbour vessel facilities consist of jetties, rather than the wharves found in a number of the other major bulk ports. The principal Outer Harbour facilities are:

- Alumina refinery jetty (Alcoa). Caustic soda (for the refinery) is unloaded on the south side of the jetty. Alumina is loaded on the north side of the jetty. Bauxite is supplied by rail from the world's largest mine at Huntly in the Darling Range.
- Bulk Terminal jetty (Berths 1 and 2). It is used for loading iron ore for Mineral Resources Ltd (from Carina mine in Yilgarn Shire); for loading coal[89] (for Lanco Infratech — Griffin Coal, from coal mines in the Collie Basin); and for loading and unloading a range of other commodities, including cement clinker, gypsum, LPG, mineral and silica sands. The other jetty, with Berth 1, is not in use.
- Oil refinery jetty (BP). This facility has one jetty with three berths. The facility unloads crude and refined petroleum and loads refined petroleum.
- Bulk jetty (Berths 3 and 4). This single jetty has two berths, is used for unloading bulk commodities such as sulphur, fertiliser and petroleum cargoes, and loading nickel.
- Grain jetty (CBH). This facility, with one berth, is for loading grain for export.

Proposed and committed capacity expansions

The export of Mineral Resources' Carina iron ore,[90] from the Yilgarn province north of Koolyanobbing, was a recent expansion at Kwinana. The infrastructure work included extensive landside upgrading, restoration of the standard-gauge track into the Bulk Terminal and installation of vessel loading facilities. The iron ore trade commenced in November 2011. Two trains are operated between Darrine (east of Koolyanobbing) and Kwinana and, with the Bulk Terminal facilities, will enable 4.4 million tonnes per annum throughput. (See also Brookfield Rail, n.d.)

88 The Bulk Terminal is on the site of the BHP steelworks; Fremantle Ports purchased the site in 2002.

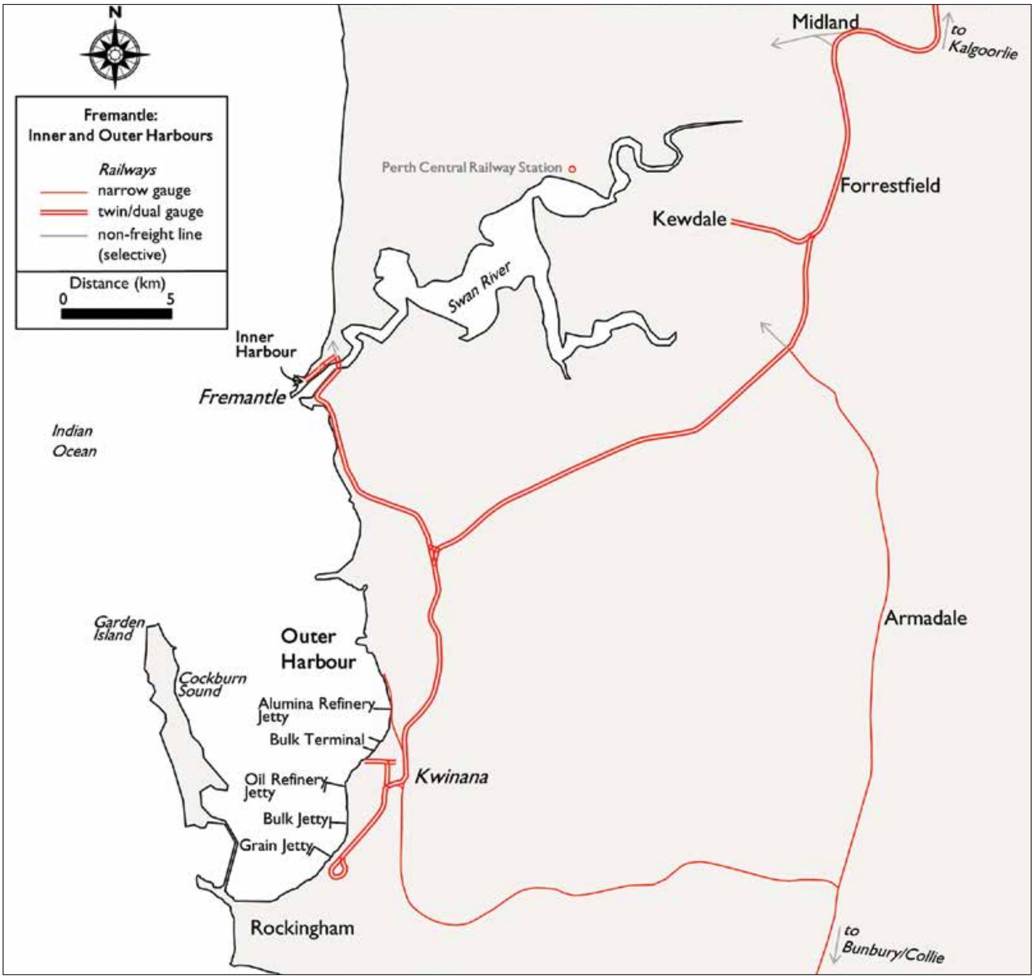
89 The loading of coal at the Bulk Terminal is a temporary arrangement; after contruction of coal facilities at Bunbury, the coal will be loaded at that port.

90 The operation is undertaken by Polaris Metals, a subsidiary of Mineral Resources.

Landside logistics

Figure 54 shows the location of the Inner Harbour (Fremantle) and Outer Harbour (Kwinana), showing railway lines (most of which are owned by Brookfield Rail). The prevailing network railway gauge in the south-west of Western Australia is narrow (1 067 mm) gauge, but Perth and the port facilities are also connected to the national railway network's standard (1 435 mm) gauge[91]. A range of bulk commodities, such as grain, nickel, iron ore and coal[92], are brought to the Outer Harbour by rail on (freight-only) Brookfield Rail tracks[93]; some commodities are processed within plant at Kwinana while other commodities are transferred directly from rail to vessels.

Figure 54 The port of Fremantle, showing railway access routes



91 The standard gauge provision is either by a separate standard gauge track (running parallel to the narrow gauge track) or by a dual-gauge track (with a narrow gauge track but with an additional rail set to standard gauge).

92 Grain comes from the south-west agricultural districts; nickel comes from Hampton (south of Kalgoorlie); iron ore comes from near Koolyanobbing; and coal comes from the Collie coal fields.

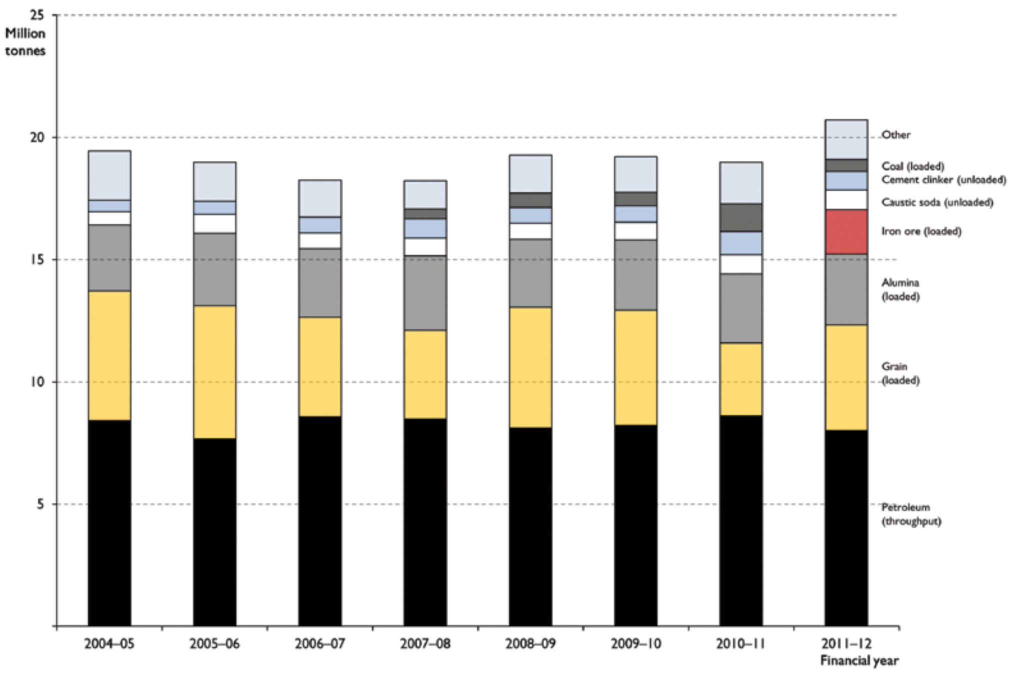
93 See BITRE 2012, pp. 80–81, for further discussion on the Inner Harbour freight lines.

Port utilisation

Fremantle is a major port for containers (at the Fremantle Inner Harbour) and a significant port for bulk commodities (at the Outer Harbour at Kwinana). The bulk trade is split almost evenly between loaded and unloaded commodities. In the same year, the largest commodity handled was petroleum; most of this was crude petroleum, destined for refining at the BP refinery at Kwinana.

Figure 55 shows the Outer Harbour throughput for recent years. Relatively stable throughput of some mainstay port commodities — cement, alumina, petroleum — reflects the underlying production facilities (Cockburn Cement, Alcoa's alumina refinery, BP Refinery) adjacent to the port at Kwinana. Variations in grain loading are seasonal. Apart from these, then, the variations arise from the introduction or demise of other facilities or trades, with the demise of HIron™, Kwinana's temporary coal trade (which will shift to Bunbury in due course) and the commencement of the iron ore exports from Carina.

Figure 55 Fremantle Outer Harbour (Kwinana) throughput, by commodity



Source: Fremantle Ports, various years, *Annual report.*

Port activities

Table 8 presents a summary of relevant available Kwinana activity indicators; there are no data for performance at the Alcoa, BP and CBH jetties. In each case, the level of activity and performance is strongly influenced by the trade throughput. For instance, in 2010–11, the growth in coal throughput at the Bulk Terminal affected the performance, with vessels having to wait to get access to the single operational berth at that facility. The other reported facility, the Bulk Jetty, has two berths. Similarly, the relatively strong years of loading grain, 2008–09 and 2009–10, led to substantially more grain vessel visits in those years.

Table 8 Fremantle Ports — Kwinana — activity parameters, by year

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Vessel visits (number)								
Liquid bulk — tankers	na	274	270	267	265	256	266	260
Dry bulk — grain	na	160	118	85	145	154	81	114
Dry bulk — other	na	190	200	216	227	217	220	263
Total	697	707	691	681	785	780	891	1 060
Unavailability of berths (percentage of all vessels affected)								
Kwinana Bulk Terminal	na	na	19	44	37	32	61	47
Kwinana Bulk Jetty	na	na	16	18	28	17	18	23
Berthing delays due to unavailability of services [including pilotage, towage and mooring] (percentage of total vessels affected)								
Kwinana Bulk Terminal	0	na	0	0	0	0	1.4	0
Kwinana Bulk Jetty	0	na	0	0	0	0	0	0

Source: Fremantle Ports, various years, Annual report.

Box 15 Data sources, Fremantle–Kwinana

- Fremantle Ports Corporation, *Shipping movements,* <www3.fremantleports.com.au/VTMIS/Public/PublicMovements.aspx> Scheduled vessel arrivals and departures by port of origin or destination, vessel type

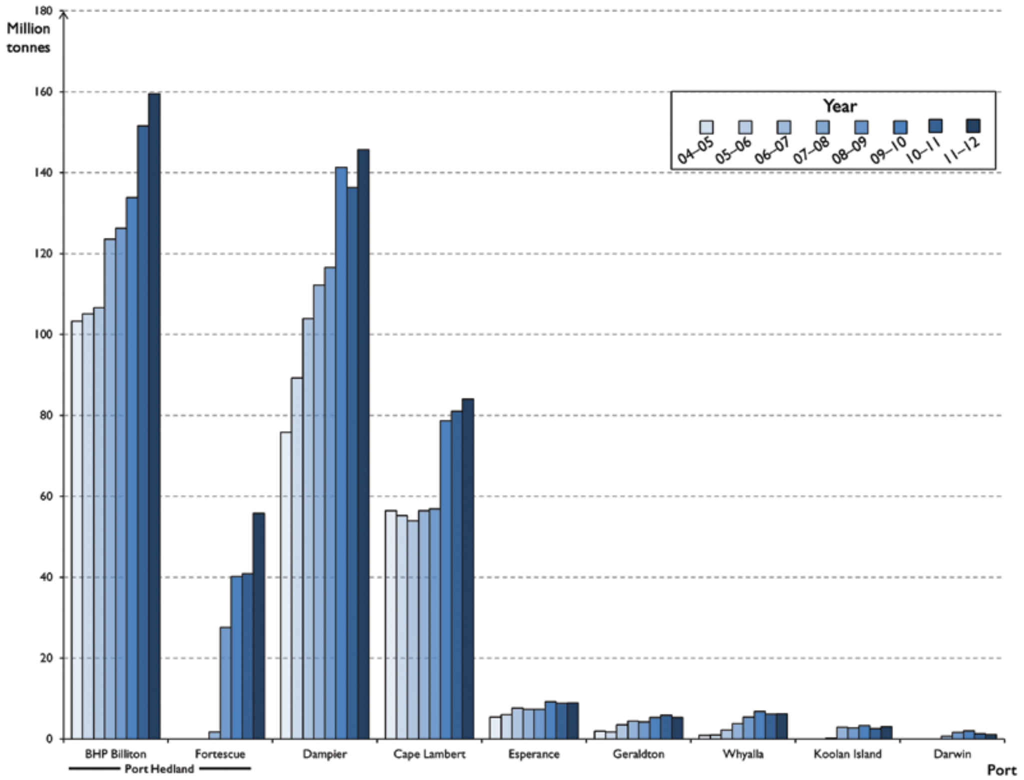
CHAPTER 4
Commodities profile

This section presents a cross-section review of major bulk terminals and ports as seen from the commodities they handle.

Iron ore ports

Figure 56 presents iron ore exports by operator and port since 2004–05. As with coal port throughput, iron ore exports have strongly expanded in recent years; Chinese demand has grown rapidly in recent years and Australia has large reserves of top-quality, cost-competitive ore.

Figure 56 Iron ore exports, by port/operation, 2004–05 to 2011–12



Sources: Port Hedland Port Authority, various years; Dampier Port Authority, various years; Esperance Port Authority, various years; Geraldton Port Authority, various years; Darwin Port Corporation, various years; Government of South Australia, various years; Arrium, n.d.; Arrium 2012; Mount Gibson Iron, various dates; Pilbara Infrastructure Pty Ltd 2008, OneSteel 2010; DnB Nor 2010.

The volume growth in iron ore exports has been concentrated on Pilbara operations at Port Hedland, Dampier and Cape Lambert (Port Walcott). Exports from Port Hedland grew rapidly, with Fortescue's new facilities bolstering the already-strong growth of BHP Billiton's facilities. Against a background of strong demand for iron ore, the opening of the Utah berth (a common-user facility) in late 2010, the BHP Billiton facilities at Harriet Point and expansion of berths in South West Creek, should enable continued expansion of activity at the port. Following a review of capacity issues in the Inner Harbour, BHP Billiton has concluded that additional capacity can be extracted; Fortescue also believes that there is substantial additional capacity within the current harbour.

Rio Tinto's iron ore exports through Dampier (the second-largest iron ore-exporting port) almost doubled in the five years from 2004–05. Despite a substantial capacity expansion, Dampier was operating at its then-rated capacity in 2009–10; there have been relatively small increments in capacity since then. Rio Tinto's Cape Lambert (Port Walcott) was also operating at its then-rated capacity in 2009–10. The company's iron ore export expansion is being focused on Cape Lambert, with substantial investment in additional landside (railway capacity), terminal (car dumpers, stockpiles, reclaimers and shiploaders) and port facilities (jetty and berths).

The predominant iron ore mining developments have been in the Pilbara region but there are plans for expanded mining in other regions. The committed developments at these ports will not change the predominance of the Pilbara region but there will be increased prominence of the task performed by these second-tier iron-ore exporting ports.

The next largest iron ore ports are at Esperance, Geraldton and Whyalla (Figure 56), each of which would be the beneficiary of substantial increases in mining in their hinterland should the proposed developments come to fruition. The developments are set out briefly here.

Esperance

Iron ore is exported through Esperance from the Koolyanobbing mining operations (in the Yilgarn Region) of Cliffs Asia Pacific Iron Ore. Current iron ore exports through the port (forming around three-quarters of the port's throughput in 2011–12) are around 9 million tonnes per annum (Figure 56). It is intended to increase mining to an annual rate of 11.5 million tonnes per annum.[94] This expansion will be largely achieved within existing logistics and port infrastructure. Iron ore is conveyed to the port by railway, via the Koolyanobbing–Kalgoorlie (interstate/Eastern Goldfields) and Kalgoorlie–Esperance railways. Track renewals and additional passing loops have been undertaken. Trains have been lengthened from 126 wagons to 159 wagons; some rail infrastructure work has been undertaken around Esperance.[95]

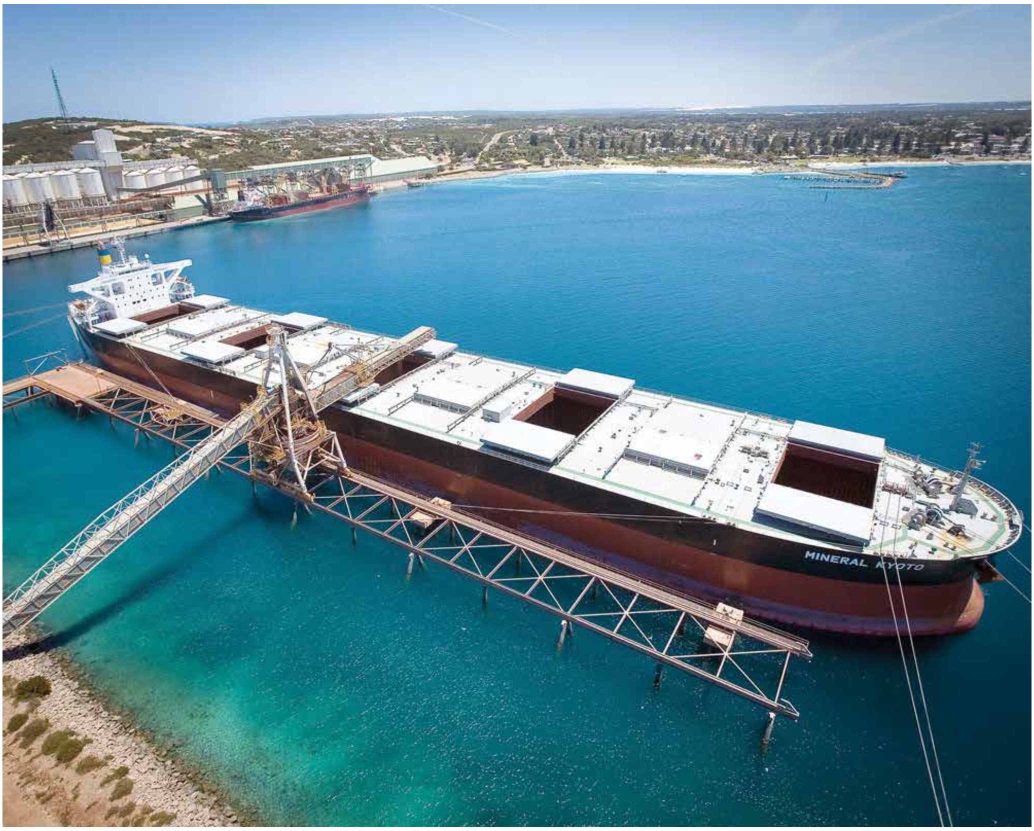
To foster ore trade (especially based on ore reserves in the Yilgarn Region[96]), the WA Government has decided to develop a Multi-user Iron Ore Facility at Esperance (Esperance Ports Sea & Land 2012, p. 3). The Government is looking to develop facilities that would enable iron ore throughput of up to 30 million tonnes per annum (Ibid., p. 4).

94 Esperance Ports Sea & Land 2010, p. 1.

95 Brookfield Rail, n.d.

96 See Yilgarn Iron Producers Association for further information, <www.yipa.com.au/>

Figure 57 Iron ore loading, Esperance Port



Source: Courtesy of Eperance Ports Sea & Land.

Geraldton

In recent years, relatively modest levels of iron ore (around 5 million tonnes per annum) have been exported through the Port of Geraldton—see Figure 56. The ore is mined in the Geraldton/Midwest region and exported through Geraldton.

However, the rate of exporting increased in September 2012, when iron ore from a mine at Karara commenced; the Karara Iron Ore Project is a joint venture between Gindalbie Metals and Ansteel. A new port terminal (rated at 16 million tonnes per annum) was built at Geraldton to accommodate the export traffic.

The Karara project has involved constructing a 85-kilometre railway between Brookfield Rail's existing rail network at Morawa and the mine site at Karara. That project underpinned Brookfield Rail's upgrading of its Midwest Railway between Morawa and the port. The sleepers on the re-laid narrow-gauge track were provided with the capability to add a third rail to enable operation with standard-gauge track. The renewal/upgrade/re-alignments and re-signalling have increased annual capacity on the railway from 3 million tonnes, to 25 million tonnes, with the potential for more than 75 million tonnes. (See Brookfield Rail 2012 for details of the track renewal and upgrade.)

The principle for the port's planning is that the hinterland is rich with resources, particularly iron ore, and that strong demand for such resources and robust prices will lead to the need to develop landside logistics and port facilities to support new mining ventures.[97]

Despite the expanded capacity at the Port of Geraldton, it has been assessed that there will be insufficient capacity should the resources of the Midwest region be fully exploited. To that end, a new deep-water port facility has been proposed at Oakajee, 24 kilometres to the north of the existing port. The facility would be supported by additional landside infrastructure, including new railways that would link to new mines. The infrastructure would be open access facilities. The intended initial capacity of Oakajee Port would be 45 million tonnes per annum.[98]

The Oakajee facility would be linked by new standard-gauge railways; these new lines would be compatible with, and linked to, the existing Brookfield Rail tracks into the Port of Geraldton that have been re-built with provision for a third rail for standard gauge.

Whyalla

Whyalla Port is owned by the iron-ore producer and steel-maker, Arrium Mining and Materials (formerly OneSteel). In recent years it has loaded iron ore up to the port's capacity of around 6 million tonnes per annum. This ore has been sourced from mining in the Middleback Ranges, to the west and south-west of the port. Since 2005, the company's steel works have used magnetite iron ore; the mined haematite iron ore has been freed for export.[99] The Acquisition of WPG Resources in 2011 has enabled the company to also draw on ores from new mines in the Peculiar Knob Region, to the south of Coober Pedy. This enhances the options for increasing the range of blended ores.

The port capacity has been expanded to handle the additional throughput (mostly for export), enabling up to 12 million tonnes of ore to be loaded. Until 2012, smaller vessels loading ore would berth in the port's Outer Harbour. For larger vessels, the ore would be conveyed by barge offshore from the Outer Harbour to a transhipment point either 9 kilometres (Panamax vessels), or 14 kilometres (Capesize vessels) from the port. The port expansion enables ores to be shipped through the port's Inner Harbour while an additional transhipment vessel increases the offshore loading rate. The Inner Harbour facility is rated at 6 million tonnes per annum, serving both smaller vessels and transhipment barges. The Outer Harbour also serves the offshore transhipment and is rated at 6 million tonnes per annum. New facilities have expanded the capability for blending ores. See OneSteel 2012 for further details of the port expansion.

Historically, the port has sourced its ores only from the Middleback Ranges; ores have been conveyed to the port via the company's narrow-gauge railway network, operated on the company's behalf by Genesee & Wyoming Australia (GWA). The recent drawing of ores from the Peculiar Knob Region has introduced a new logistics chain, using GWA's standard-gauge Tarcoola–Darwin railway and the ARTC track between Tarcoola and Whyalla. The narrow-gauge and standard-gauge networks converge on the Inner Harbour port facility (allowing

97 The Geraldton Iron Ore Alliance represents major mining interests in the region and their perspective on the region's prospects can be found at <www.gioa.com.au/>.

98 See the WA Government's web site at <www.transport.wa.gov.au/imarine/20065.asp> and the private-sector project proponent, Oakajee Port and Rail Pty Ltd, at <www.opandr.com/about_us/ownership/structure.phtml>. The latter company is wholly owned by Mitsubishi Development Pty Ltd.

99 See Arrium Mining and Minerals, n.d., web site, <www.arrium.com/about-us/history>

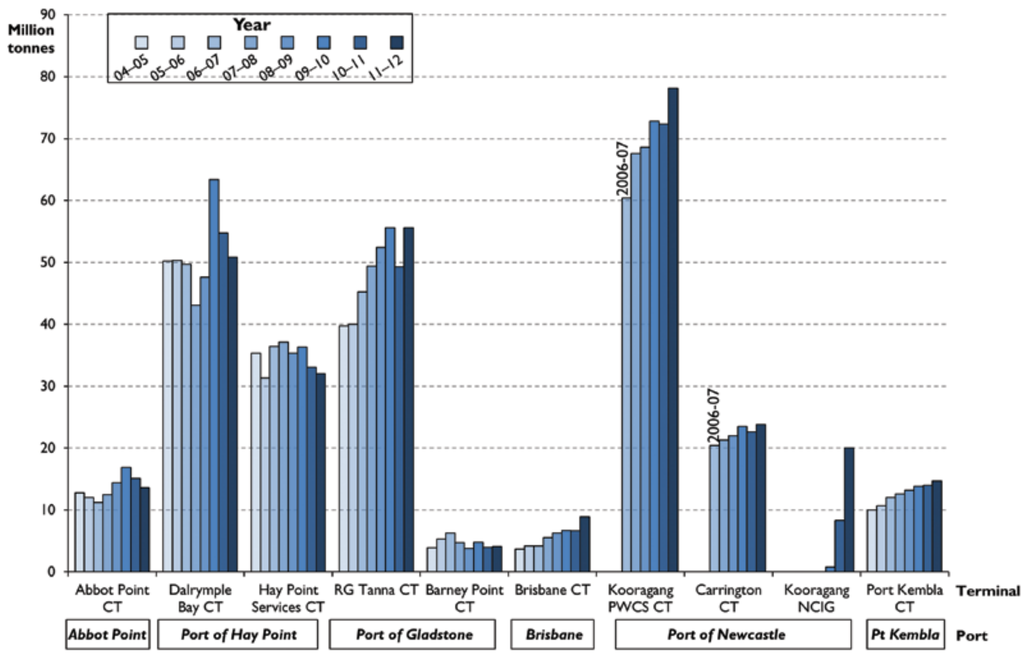
blending of Middleback and Peculiar Knob ores) while the narrow-gauge network additionally serves the Outer Harbour (for blending of different Middleback ores and for transhipment barging).[100]

Coal ports

Figure 58 presents the terminal throughput between 2004–05 and 2011–12 for the principal coal terminals at Abbot Point, Dalrymple Bay, Gladstone, Brisbane, Newcastle and Port Kembla. It is evident from the data that there has been a strong growth in coal terminal throughput in this period.

The largest coal terminal is the Kooragang PWCS[101] Coal Terminal, in the Port of Newcastle, followed by Dalrymple Bay Coal Terminal, in the Port of Hay Point. The Kooragang NCIG[102] coal terminal was opened in the later part of the 2009–10 financial year; modest throughput was recorded relative to the Stage 1 capacity of 30 million tonnes per annum. Stage 2 opened in 2012, with capacity being increased up to 53 million tonnes. Stage 3, for completion in 2013, will bring capacity up to 66 million tonnes per annum.

Figure 58 Principal Australian coal terminal throughput, 2004–05 to 2011–12



Source: Department of Transport and Main Roads (Queensland); Prime Infrastructure, n.d.; Port Waratah Coal Services, n.d.; Port Kembla Port Corporation, n.d.; QR Network Pty Ltd 2009, North Queensland Bulk Ports Corporation 2010; Queensland Government, 2008.

100 The logistics chain is illustrated in OneSteel 2012 (page 32).
101 PWCS: Port Waratah Coal Services.
102 NCIG: Newcastle Coal Infrastructure Group.

As noted in the port reviews in Chapter 3, there are numerous schemes for expanding mining activity in the Queensland and NSW coal fields. Additional terminals are planned or under construction at Newcastle (the T4 project), at Hay Point (Terminal A and Terminal B at the Dudgeon Point site), at Gladstone (the Wiggins Island Coal Export Terminal) and at Abbot Point (the 0, 2, 3 and AP-X Terminals). This requires expansion of landside logistics, so schemes are planned or underway for expanding railway capacity through to the port. This includes new railways, such as the proposed 500 kilometre railway between the Galilee Coal Basin (around Alpha) and the proposed new port facilities at Abbot Point.[103]

Grain ports

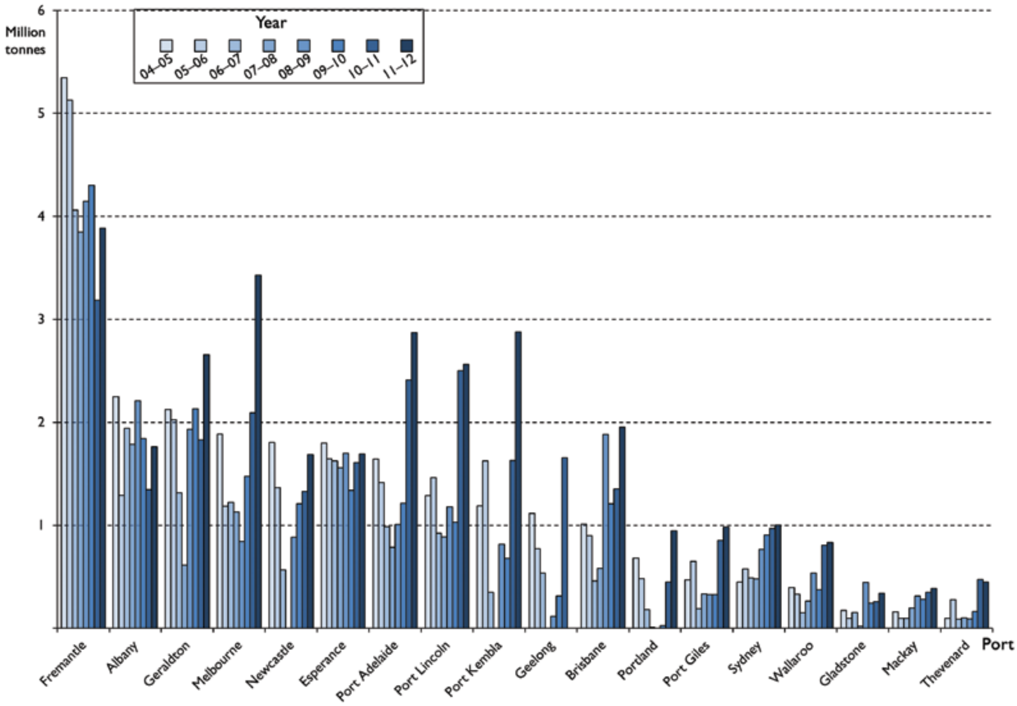
There are eighteen major ports that regularly export grain—see Figure 59. Most of these ports have railway lines providing the primary form of transport from the hinterland to grain storage areas provided at the port. Grain is handled predominantly in bulk, using bulk carriers. Grain through Sydney (Port Botany) is undertaken using containers rather than silos or terminal receival centres.

While terminal capacity or berth availability provide key constraints to throughput at coal and iron ore ports, respectively, constraints on grain port operations include the vessel size that can be accommodated at the port (such as with channel or berth depth restrictions); and the grain loading rate. Where the potential grain throughput is modest, investment in enhancing low capacity ports to expand handling capabilities is unlikely to be warranted.

For grain ports, the volume of farm production available for export is the prevailing parameter that sets the level of throughput at the port. This contrasts with coal and iron ore, where the volume of throughput tends to be determined by the volume of system capacity (be it train, track or terminal).

103 There are a few proposals for new railways linking with Abbot Point, including the joint Aurizon/GVK Hancock-owned 500 kilometre railway; and the Alpha West–Abbot Point 453 kilometre standard-gauge railway that has been proposed by Waratah Coal/China First.

Figure 59 Grain exports, by principal ports, 2004–05 to 2011–12



Source: Ports Australia, n.d.

Bauxite/alumina/aluminium ports

Some of Australia's extensive bauxite deposits are being mined, notably in the Darling Range (Western Australia, south-east of Perth), western Cape York (Weipa) and Gove (Northern Territory). Associated bulk ports that handle bauxite and the alumina and aluminium are at Gove, Weipa, Gladstone, Newcastle, Bell Bay, Geelong, Portland and Kwinana (Fremantle). Typically, the bauxite is recovered through strip mining, so the bauxite may be transported over a wide area to a central collection point.

Operations are based around three major companies (with wholly- or partly-owned subsidiaries):

- Rio Tinto,[104] with bauxite mines at Gove and Weipa; alumina refineries at Gove and two at Gladstone (Queensland Alumina Limited,[105] Yarwun Alumina Refinery[106]); and smelters at Bell Bay (Bell Bay Aluminium, Tasmania), Gladstone (Boyne Smelters) and Tomago (Tomago Aluminium, near Newcastle). A process of divestment of some of these assets

104 In 2007, Rio Tinto Canada Holding Inc merged with Alcan [of Canada], forming Rio Tinto Alcan Inc. Former Alcan facilities include the bauxite mines at Gove and Weipa, the Gove Alumina refinery, the Yarwun Alumina refinery (Gladstone) and the aluminium smelters at Boyne (Gladstone), Bell Bay and Tomago (Newcastle).

105 Rio Tinto has an 80 per cent share, with Rusal [of Russia] with a 20 per cent share.

106 A $2.5 billion investment to expand this refinery was completed in late 2012.

has commenced, with the Gove bauxite/alumina operations and the smelters at Bell Bay, Gladstone and Tomago being vested in Pacific Aluminium, a unit within Rio Tinto.

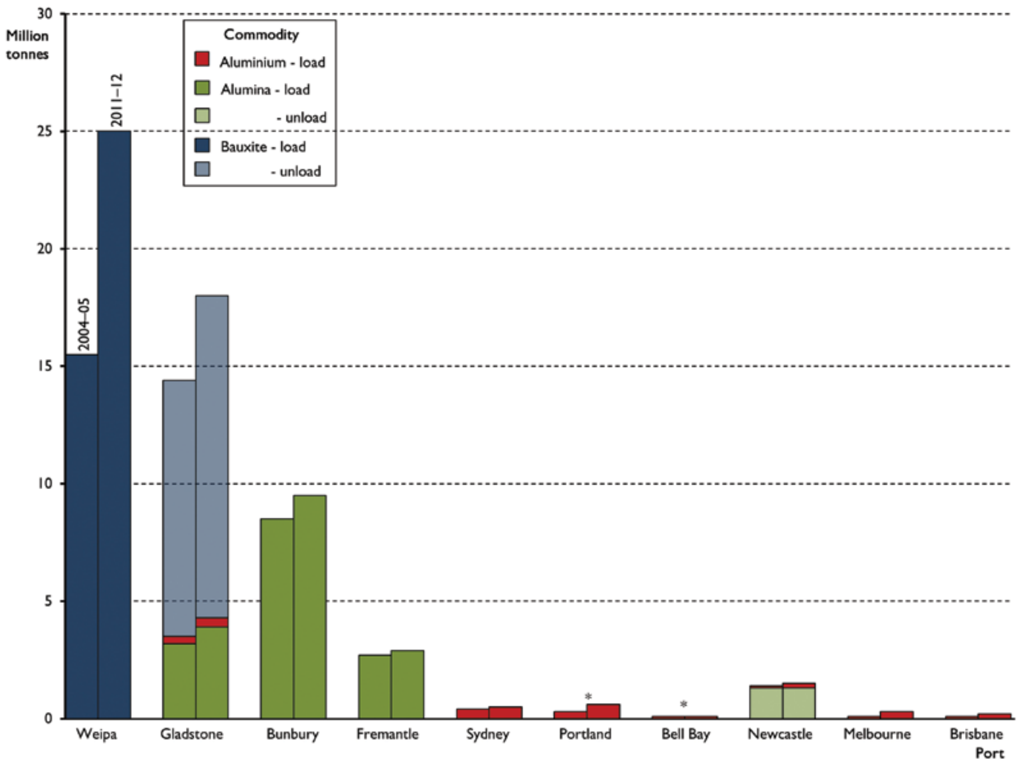
- BHP Billiton, with a bauxite mine at Boddington and an alumina refinery near Worsley (Worsley Alumina), connected by a 51 kilometre conveyor belt. Smelting of the alumina is undertaken in overseas facilities.
- Alcoa of Australia, with bauxite mines at Huntly and Willowdale (both in Western Australia's Darling Range); alumina refineries at nearby Pinjarra, Wagerup and Kwinana; aluminium smelters at Port Henry (near Geelong) and Portland.

Transport logistics links the stages of bauxite processing, as it is converted to alumina and aluminium. The logistics process involved at each processing stage involves progressively less product: between 4 and 5 tonnes of bauxite are used to produce 2 tonnes of alumina, from which 1 tonne of aluminium is produced.

Conversion of bauxite to alumina takes place in alumina refineries. Some of Gove's bauxite is converted to alumina at Gove's refinery and the remainder is shipped overseas; its alumina is mostly shipped overseas, with some going to Newcastle. In most cases, the domestic refineries are located near to the bauxite deposits. The principal exception are the Gladstone refineries; these facilities—the Yarwun and Q.A.L. refineries—receive their bauxite from Weipa, a shipping distance of around 2 200 kilometres. (As noted in Figure 46, a proportion of the Weipa bauxite is exported.)

Smelters convert alumina to aluminium. Some of Gladstone's alumina is processed at Australia's largest aluminium smelter at Boyne Island, nearby. Alumina from the two Gladstone refineries is also shipped to Bell Bay, Brisbane and Newcastle (Tomago smelter) (Bell Bay Aluminium). The volumes involved in the bauxite–alumina–aluminium logistics chain can be partly inferred from Figure 60, noting that some smaller flows (such as Bunbury to Portland alumina; alumina to Bell Bay) are not shown.

Figure 60 Bauxite/alumina/aluminium throughput, by port, 2004–05 and 2011–12*



Source: Ports Australia, n.d.; Newcastle Port Corporation, n.d.; Gladstone Ports Corporation, various issues.

Note: * It has not been possible to identify the levels of some relatively minor inbound alumina flows, for Portland and Bell Bay.

Bauxite that is mined in Western Australian may be shipped, unprocessed, overseas, or converted to alumina at one of the four refineries in the State, at Worsley, Kwinana, Wagerup, Pinjarra. Alumina from the latter 3 (Alcoa) refineries is shipped from Bunbury to smelters at Portland (Victoria) and Point Henry (near Geelong, Victoria) using two Alcoa Steamship Inc. vessels. Some of the Bunbury alumina is exported, to a range of destinations. Point Henry's aluminium is exported or used at the nearby Alcoa Australia Rolled Products factory. Portland Aluminium's output is exported (mostly via Portland and some via Melbourne).

Alumina from Worsley goes from Kwinana (Fremantle) to Newcastle.

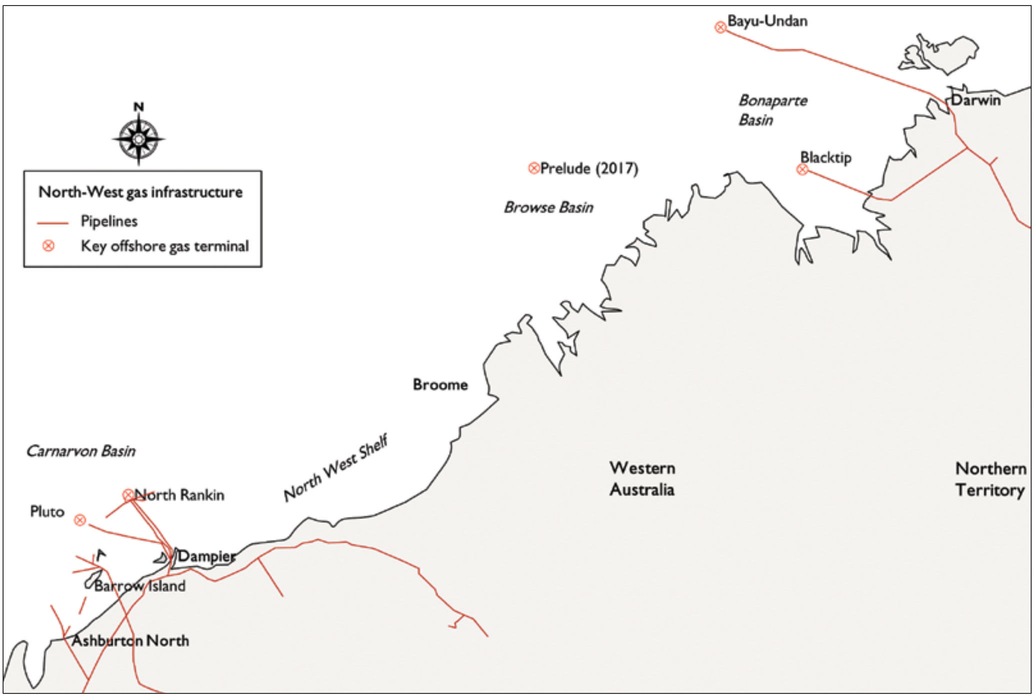
Liquefied Natural Gas (LNG)

Liquefied Natural Gas is natural gas that has been cooled to around -161 degrees Celsius. At this temperature, the gas converts to liquid form that is around one-six-hundredth of the volume that is used by the methane gas. Using up relatively little volume, the liquefied gas is then easier to transport to overseas markets. Demand for LNG, and extraction of natural gas, has grown very strongly in recent years. The International Energy Agency has noted that natural gas is the fastest-growing fossil fuel being consumed (International Energy Agency 2012, p. 126).

Three gas reserve areas account for the existing, or planned, export of the gas from Australia: the (offshore) North West Shelf, the (offshore) Bayu-Undan fields in the Timor Sea, and the (coal seam) onshore gas fields in the Surat and Bowen Basins of Queensland. The respective principal onshore ports for exporting the processed liquefied gases are Dampier and Darwin; current coal-seam projects will feed into gas plants in Gladstone, where liquefied gases will be exported.

Figure 61 presents a broad outline of the principal offshore gas infrastructure in north-west Australia. The figure does not show individual gas-producing fields. Key gas pipelines are shown.

Figure 61 North-West gas infrastructure



There are three existing plants that convert the gas to liquefied form: Karratha (opened in 1984) and Pluto (opened in 2012) — both on the Burrup Peninsula at Dampier, and a plant in Darwin (opened in 2006). A further seven LNG plants are at various advanced stages of development:

- Australia Pacific, Gladstone, and Queensland Curtis Island: these three plants would be sited on Curtis Island, adjacent to Gladstone (where the LNG would be exported).
- Gorgon: this plant would be on Barrow Island, off the Pilbara coast.
- Ichthys: this plant would be built in Darwin, with some infrastructure currently being constructed.
- Prelude: this is a floating LNG plant that is currently (2013) under construction; it will be sited in the Ichthys gas field of the Browse Basin in the Timor Sea. See Figure 61.
- Wheatstone: this plant will process gas from the southern end of the Carnarvon Basin (south of Thevenard Island). It is being built near the port at Ashburton North.

As noted in Box 1, gas logistics are very different from other bulk commodities. Even when compressed, the gas has a large cubic volume but relatively low weight. Until processed at the LNG plant, the gas is usually transported (domestically) by pipeline; once it has become LNG, then its logistics characteristics (that is, shipping) becomes similar to other bulk commodities. Compression makes it feasible to transport large quantities.

In addition, the LNG logistics can also be dramatically different from other bulk commodity logistics in terms of the production process. As noted in the previous chapter, it is common for the port environs to be used for the processing of bulk commodities (and this is typical in iron ore blending, coal blending, bauxite/alumina refining and smelting, and crude oil refining). The LNG industry is changing the role of the bulk port, however, by shifting the gas processing and the port itself to the vicinity of the point of the extraction of the commodity. This has been illustrated by the development of a Floating Production Storage and Offloading (FPSO) vessel on the North West Shelf, first using the Cossack Pioneer vessel and its replacement, the Okha FPSO.

More importantly, Shell Global's Prelude Liquefied Floating Natural Gas (FLNG) vessel, currently under construction, will shift the port and the production process to the commodity reserves rather than shifting the commodity from the reserves to the port and adjacent production plant. (The gas field is 200 kilometres offshore.) The FLNG will obviate the need for shifting the gas to a landside location for processing and (when exported) for dockside loading. The plant is expected to begin operation in 2017. (International Energy Agency 2012, p. 150)

CHAPTER 5
Conclusions

Australia's bulk ports have witnessed extraordinary growth: bulk throughput (tonnes) rose by over 75 per cent between 2001–02 and 2011–12. Mining exports account for most of this growth.

Six ports dominate this export task. These are the iron ore ports of Port Hedland (the world's largest bulk export port), Dampier and Cape Lambert; and the coal ports of Newcastle (the world's largest coal export port), Hay Point and Gladstone. These ports draw resources from the large iron ore reserves of the Pilbara, and the Hunter Valley and Queensland coal fields, respectively. Further development of these, and other, reserves is propelling the expansion plans at terminals at other ports such as Brisbane, Abbot Point, Esperance and Geraldton; and several proposed ports. LNG is a rapidly-growing liquid-bulk export task, drawn from the North West Shelf, the Timor Sea and, soon, from coal-seam gas in the Queensland coal fields.

Bulk ports are also central to Australia's domestic activity, such as for importing petroleum products (crude and refined oil) into, and around, the country. The ports undertake similar import and domestic distribution tasks with cement constituents and shifting bauxite-based commodities between mining areas, refineries and smelters.

The expansion in activity has been achieved by expanding infrastructure capacity along the logistics chain, such as at the ports themselves. For example, at Port Hedland the iron ore-handling capacity has expanded five-fold in the last decade and iron ore capacity has more than doubled at Dampier and at Cape Lambert. At Newcastle, coal-handling capacity has more than doubled between 2004–05 and 2012–13, with further capacity expansion underway.

Port-terminal infrastructure capacity expansion includes additional berths and shiploader equipment, as well as in production-based equipment for commodity blending. Increases in volumes—often by increasing the number of mines from which the commodity is sourced—requires:

- increases in upstream infrastructure capacity, and
- improvements in day-to-day logistics co-ordination.

The need for additional upstream capacity (notably, equipment at mines and the railway capacity for moving the commodity to port) complements the expanded port–terminal capacity.

Additional throughput also heightens the logistics challenges. In particular, increasing the number of mines, commodity products/blends and terminal users will escalate the challenges for the day-to-day operating, and long-term infrastructure planning, co-ordination. At one end of this co-ordination issue spectrum are the Pilbara iron ore operations, with mining companies operating their own railways and terminals from a relatively limited number of mines; the challenging tasks of co-ordinating logistics operations and infrastructure provision are predominantly in-house tasks. Nevertheless, port capacity is typically shared between different mining companies—the port capacity can be a major constraining factor, especially when it is a sheltered harbour rather than a jetty; this is particularly relevant for Port Hedland, for the allocation of berthing capacity and capacity between the Inner Harbour and the open sea.

At the other end of the co-ordination spectrum are some of the east coast coal operations where coal comes from a wide range of mines, from a wide range of mining companies, to multiple-user terminals. Also, the coal is usually conveyed to the port using contracted train operators operating over another company's tracks. The use of the port coal terminals may be shared between joint-miner owners of the terminals but, in two notable cases (Dalrymple Bay Coal Terminal and PWCS Kooragang) the terminals also operate as common-user facilities (with in-principle access to the terminal by any mining entity).

Where logistics facilities are extensively provided or shared by multiple entities, formal systems for planning and managing the logistics chain have been increasingly adopted. This is exemplified by the development of the Hunter Valley Coal Chain Co-ordinator.

The formal planning and management of logistics chains has increased the monitoring of different tasks and stages along the chain. This report has presented a range of such statistics. However, the logistics chain cannot be described by a single "magic bullet" measure of activity because of the diversity of logistics and production tasks. The picture of the bulk port activity is therefore achieved by using a range of complementary indicators that report on different aspects of the upstream, port and downstream activities. Data that illustrate ways in which logistics chains have changed in recent years include:

- measures of landside capacity. Additional railway capacity has been provided (such as through additional, longer, passing loops or double track and signalling that permits more trains), complemented by longer trains with more payload per wagon. For example, Fortescue's new railway has trains with payloads that are almost four times the weight of payloads on trains using the BHP Billiton railway from Yarrie to Port Hedland. Fortescue's wagons have the heaviest axle loads in the world.
- measures of vessel size. Data for Port Hedland illustrate the marked rise in vessel size, with increased average cargo tonnage per vessel. Similarly, in an interval of 6 years, the large Cape vessels have shifted from 30 per cent, to 47 per cent, of vessels.

Measuring the activities of logistics chains is also challenging because there is no standard form of logistics chain. For example, dry bulk handling is very different from liquid bulk. Dry bulk exports are predominantly undertaken by rail whereas liquid bulk exports (including gas) is shifted through pipelines. Dry bulk requires a relatively high degree of ongoing co-ordination whereas, once pipelines are installed, the liquid bulk logistics are relatively straightforward.

At high levels of throughput, the most operationally cost-effective landside mode is usually rail transport. That said, road transport may be used, even with relatively high volumes, due to the significant investment levels required to build a railway. For example, Atlas Iron shipped around 5.6 million tonnes of iron ore in 2011–12 from its then-two operating mines around 100 kilometres from Port Hedland; the ore was shifted entirely by road. Similarly, some coal and coke from dispersed sites around Port Kembla is shifted by road; and grain from dispersed receival centres is often moved to port by road.

An important task for dry bulk commodities is the production element. After extraction, this involves:

- crushing and screening the commodity; and
- blending different types of the raw commodity.

Coal and iron ore can be crushed, screened and blended at the port. Each overseas customer has a requirement for a given standard of the mineral or ore. With the commodity being assembled at the port from a range of mines, the specified commodity standard is achieved by blending output from those mines.

For other commodities, the production element at the port involves processing the commodity. Bauxite may be refined (to produce alumina), alumina is smelted (to produce aluminium), crude oil becomes a range of refined oil products, and natural gas is cleaned and compressed and super-chilled to form LNG.

The bulk port, then, is often anything but a simple conduit that links the hinterland and vessels plying goods to foreign destinations; it is part of the production process and this complicates the wider logistics process.

Australia's resources boom has magnified attention on bulk ports; this heightens the importance of appreciating the inter-linkages between the port and the wider upstream and downstream logistics chain. The bulk port is essential to the chain but its performance is inseparable from those other links.

APPENDIX A
Overview of bulk port logistics data

As noted in Chapter 3, a range of data are presented that describe logistics tasks to, and through, the ports. In this Appendix, we review the principles behind the range of upstream and port activity measures, including production processes. (summarised in Table 9, at the end of the Appendix)

Principles of logistics monitoring

Port and terminal operators usually report activity within their direct control; for bulk activity, however, logistics-chain co-ordination is a crucial driver for monitoring activity. This pertains, especially, where organisations have established formal co-ordination of logistics chain activities; the collation of such data can result in its publication. Thus port logistics measures now include upstream and downstream indices such as rail wagon availability, train punctuality, vessel schedule punctuality (Olivier 2008, p. 7), landside tonnage delivered (Prime Infrastructure, n.d.) and tonnage of vessel arrivals (Port Waratah Coal Services, n.d.).

Understanding the logistics task, rather than the port activity in isolation, is also needed for purposes of identifying and timing infrastructure needs. As Bichou and Gray note, landside efficiency "also needs to be addressed when ways are sought to expand port capacity" (Bichou & Gray, 2004, p. 49).

Bulk commodity logistics chains make the landside and portside tasks interdependent. Even when the chain is controlled by a single entity, the chain manager does not have control over all the factors that influence activity. In particular, activity is affected by factors that are external to the logistics chain, notably weather extremes.

As outlined in Table 9, bulk logistics monitoring can be broadly grouped into five areas:

- port utilisation (throughput);
- dockside rates of handling commodities;
- upstream and downstream logistics;
- indirect logistics measures; and
- port production.

The measures can be presented at different locations (landside, port, maritime) and at different levels of activity (port, terminal, wharf, berth). The measures can be reported by type of task (commodity handled) and volume handled (tonnage transferred) and characteristics of landside transport or shipping sizes. Often, bulk activities along the logistics chain involve producing a derived product at the port—the blending of different grades of the commodity. In such instances, understanding the bulk task requires, at the least, that such activity be identified.

Because of logistics inter-linkages, individual indicators often show that something has changed but do not in themselves explain why that change has occurred. It is not appropriate to use just one measurement if we are to understand bulk port (or terminal) activity adequately. A number of measurements are needed.

In the case of export-based mineral and ores flows, for instance, these logistics activities include:

- mining output and loading rates to transport the commodity to the terminal;
- operational performance of transport (notably, train) from mine to the terminal;
- operational performance of infrastructure (railway, road, pipeline or conveyor belt) linking mine and terminal;
- terminal stockyard characteristics (including cargo-assembly systems and closed- or common-user priorities—see stockyard issues discussed in Box 3);
- commodity characteristics, notably when it involves product blending; and
- vessel characteristics, such as ship size and the number of parcels (cargo brands) loaded.

As discussed earlier, gas logistics are very different from dry bulk operations. This, in turn, means that measures of gas-loading activity will also be very different. For instance, loading vessels for the transport of LNG and LPG is defined in cubic-volume term rather than tonnage: a rate of cubic metres of gas per hour rather than tonnes per hour.

In the following section we discuss the five principal types of activity.

1. Traffic throughput and facility utilisation

The principal form of describing bulk port activity is to report the tonnage volume throughput. This throughput could be measured by cubic-volume or by the value of the commodity but arguably these do not adequately reflect the logistics task. That said, as noted in the Introduction, cubic-volume measurement is a better measure of the substantial logistics task in LPG/LNG bulk movements.

A complementary task measure that describes port activity is the utilisation rate of the facility. A utilisation indicator may provide a signal for additional capacity. Where there is highly-variable throughput (especially with seasonal variations with grain haulage), then utilisation rates can be highly variable.

Measures of utilisation also need to be interpreted with care. Berth utilisation may be measured as time the berth is used relative to either total hours in the year or relative to hours that the berth is available in the year (for example, by excluding maintenance time). It would be incorrect to assume, however, that the berth could ever operate at 100 per cent utilisation. Some Port Hedland berths have been used at up to 87 per cent of available time. This level of utilisation might be regarded as effectively "fully-utilised" because factors such as manoeuvring to and from berth, and tidal issues, will inevitably mean that there is not always a ship at berth, even if there is a queue of ships to load at the berth. In addition, if there is any clustering of vessel arrivals, it may lead to some periods when there are no vessels to be loaded. Upstream logistics issues can constrain that utilisation. More generally, less-than-full utilisation of port capacity should not necessarily mean that actions at the port are responsible for throughput not being realised; other parts of the logistics chain may retard utilisation—upstream incidents, capacity constraints or port production (such as ore blending performance).

2. *Dockside activity rates*

Berth utilisation rates (the proportion of time that a facility is occupied) does not signal the effectiveness of the facility's occupation. Applying an activity rate is arguably superior. One such measure is "Tonnage throughput per linear metre of wharf face", which shows the rate of storage onto (or off) the vessel. Improving loading rates can be achieved by factors such as more efficient vessel handling procedures, higher capacity/rated ore loaders, and larger vessels (with commensurately less downtime for tasks such as vessel positioning). This indicator should be used with other parts of the broader logistics chain. A similar measure of dockside activity is the vessel loading (or unloading) rate.

3. *Upstream/downstream (supply chain) indicators*

Activity upstream or downstream from the port or terminal is a third broad category of the logistics chain[107]. One indicator of this activity is the number of dry bulk vessel visits to a port or terminal and this is commonly reported in port annual reports.

Assessing ports in terms of their downstream activity rather than their at-dock activity can change perceptions of the port. For instance, Figure 6 shows that, in 2009–10, Port Hedland and Dampier were the largest ports, when measured by volume of throughput. In terms of the number of vessels, however, Newcastle and Gladstone were the busiest bulk ports. Different vessel sizes explain the apparent contradiction[108]. While Capesize vessels represented just over 1 per cent of Newcastle dry bulk vessels and 2 per cent of Gladstone dry bulk vessels, they were around 18 per cent of Port Hedland's dry bulk ships. Between 2004–05 and 2009–10, the number of dry bulk vessels calling at Port Hedland rose from 807 to 1 152 (that is, by around 43 per cent), with the proportion of Capesize vessels rising from 16 per cent to around 18 per cent of visiting dry bulk vessels. This trend to larger bulk vessels has been apparent at other ports.

Upstream activity may also be reported, particularly when the supply chain is co-ordinated (such as with the Hunter Valley coal chain) and when port facilities are regulated. Average train tonnage arriving at the terminal is a common measure. It might be expected that low average tonnage arrivals could result in lower ship loading rates at the terminal if there is insufficient coal reserved to load on the vessels. However, in itself, the train tonnage deliveries show what has happened, not why it has happened. For instance, the tonnage could have been constrained by mining difficulties, by adverse weather, by the level of spare storage capacity at the port or by the extent of coal blending undertaken.

107 In the following discussion, "upstream" implies backwards towards the mine, while "downstream" implies out to sea; it is recognised, however, that the commodities can be moving in the opposite direction, that is, from the sea, to the inland.

108 The definitions of vessel size used in this report are provided in the Glossary.

4. *Indirect (ancillary) measures*

A further form of logistics measurement is to look at the logistics chain in terms of observed traffic flows, such as vessel delays or train punctuality. The presumption of smooth flows might be that vessel loading rates are acceptable unless there is evidence of a "long" shipping queue or long vessel turnaround times. The presence of a long queue should not be used to attribute blame, however: a long vessel queue but rapid vessel turnaround times would imply an efficient logistics operation. For instance, a bunching of vessel arrivals at the port will tend to generate longer queuing, even when there are no apparent problems upstream in the logistics chain.

When terminals are processing a range of different brands or blends of a commodity, a degree of vessel queuing can be beneficial when a given blend can be made up for multiple vessels at a time. That is, the product can be more efficiently processed in "bulk", with the various coal types being acquired from multiple mines and the then blended in a large operation for distribution across multiple vessels.

To the extent that the queue is unintended or excessive, a queue indicator can highlight that there is an issue somewhere in the logistics chain. However, by itself the queue indicator cannot be used to attribute where the problem in the chain lies.

There is merit in reporting both the queue and turnaround statistics, along with other logistics chain measures. Mining companies attract demurrage charges for vessels waiting so the length of the queue is a proxy for the terminal's aggregate level of costs incurred in vessel waiting. Nonetheless, arguably a better measure of logistics chain performance is the time at anchor or turnaround time—the queue may be long but vessels may not be waiting appreciably longer than when the queue is short. Thus, in viewing the logistics chain's performance (of which the terminal is part), both the queue length and the turnaround time should be considered.

Box 16 provides a background to a queuing issue that arose at Dalrymple Bay in 2007. The example provides a good insight into the intricacies and inter-linkages in the parts of the logistics chain.

Box 16 Vessel queuing at Dalrymple Bay Coal Terminal, 2007

Vessel queuing can be the result of a number of factors within the logistics chain, to do with the vessel arrival pattern and vessel characteristics, the nature of the commodity being loaded (blending) and external factors (such as the weather). This range of factors is evident in the documentation of the relatively long queues seeking to access Dalrymple Bay Coal Terminal in 2007.

The level of vessel queuing to load coal at Dalrymple Bay Coal Terminal was at relatively high levels in the first half of 2007. The Terminal operators identified four primary reasons for the queue, which are paraphrased as:

1. Contractual misalignment between rail haulage services and Terminal services.
2. Logistics chain capacity shortages, especially in rail capacity.
3. Increased global demand for coal.
4. The increased demand for coal led to more vessels coming to the terminal, exacerbated as a sudden surge in vessels arrivals.

Despite the operation of a Queuing Management System to manage these competing demands and factors, there were external events that exacerbated the situation:

- Industrial action by the rail provider, in February 2007;
- Issues with locomotive reliability, in December 2006, January–March 2007, June;
- Train crewing issues, December 2006–March 2007;
- Trains operating at less than maximum planned length, January–August;
- Train power supply disruption, March;
- Weather disruptions, such as "excessive" rain and high winds;
- Disruption from activities associated with terminal expansion work, July–August;
- Loading disruption caused by fire on conveyor belt, June;
- "Poor performing vessels", with "excessive ballast stops", June–July;
- Stockyard constraints due to high stock levels, August;
- Slow unloading, due to sticky coal, January–August.

Source: Dalrymple Bay Coal Terminal Pty Limited, 2007.

5. *Port production*

Bulk freight logistics through the port often include an element of production, when product blending occurs. In particular, coal, iron ore and grain are not homogenous products; they have varying grades and standards. At the port, in particular, specialised stockpiling of each grade may be undertaken. This leads to differentiated stock assembly or blending, specialised vessel loading with blending during loading, and loading into compartmentalised storage on the vessel. This process impacts on the overall management and operation of the broader logistics chain.

By way of example, Dalrymple Bay Coal Terminal (at the Port of Hay Point) handles 33 separate types/blends of coal; systems are required to isolate, assemble and load those different products onto ships. After each coal product is loaded, resources are applied to clearing/cleaning the conveyor belts that are used to transfer coal from onshore stockpiles to vessels. The task also extends to the storage on the vessel, where capacity needs to be reconfigured to take those different coal types or blends—"parcels" of goods, as they are known. This influences the vessel loading operation. Similar issues arise with iron ore, involving the terminal task of blending of ores.

Terminal production processes—discrete commodity-grade stockpiles and blending—has a bearing on the logistics chain and, therefore, on rates of loading, which will therefore vary across terminals and ports in reflection of the different levels of production. Presenting indicators of such tasks is a useful acknowledgement that such activities are being undertaken and therefore helping to explain variations.

Vessel loading rates and, thus, perceived terminal activity rates, can therefore be influenced by the extent to which commodities are blended at the terminal and loaded as separate "parcels" on the vessel. Such tasks are sometimes reported. Dalrymple Bay Coal Terminal publishes statistics for the average number of "parcels" per vessel size. Each "parcel" placed in the vessel is a unique blend of coal. Other things being equal, the more parcels that have to be assembled and loaded, the lower the throughput rate as the conveyors are stopped to change blends. Even a single-parcel vessel can involve coal blending to achieve the coal customer's preferred coal specification[109]. In principle, the number of different parcels can be increased up to the maximum number of cargo holds on the vessel; in the case of Panamax vessels, for instance, there are usually seven cargo holds.

Reporting vessel sizes can provide insights into handling rates to the extent that terminal task performed varies with vessel size. On one hand, other things being equal, a very large vessel requires longer loading times than smaller vessels; on the other hand, the large vessel achieves both vessel- and terminal-economies of density. For example, berthing a Capesize vessel might take twice the time that it takes for a Handysize vessel but it might load four times as much ore.

109 For example, at Dalrymple Bay Coal Terminal, the coal is shifted from the stockpile to a "surge bin"; the bin provides a buffer between the stockyard and the conveyor-belt system that feeds the shiploaders. The same surge bins are used to mix the different types of coal to a given coal blend specification. Similarly, at R G Tanna Coal Terminal, coal is shifted from multiple stockpiles; control gates at stockpile dischargers are used to adjust feed rates for coal from each stockpile, to ensure that the resulting coal blend rate from the different stockpiles is achieved. These blending examples are a form of "on-the-belt" blending, by contrast with "Windrow" "bed" blending. Windrow is a form of layering coals in a chevron formation to form a stockpile of blended coal is achieved by layering of the different coals; it requires a complementary form of reclaiming of the coal to ensure that the layered coals are suitably blended when conveyed to the vessel. At Hay Point Services Coal Terminal both "belt" and "bed" blending are undertaken. It may also be possible for the blending to be undertaken before leaving the mine.

Table 9 A framework for reporting bulk port logistics

	Subject to (control factor)	Supplementary parameters	Comment
1. Task indicators/utilisation			
• commodity tonnage throughput at port/terminal (total tonnes)		split port activity by loading/unloading report main commodities (terminal) report as time trends (terminal)	Measures gross level of activity
• berth/capacity utilisation rates (percentage of time that facility is used)	Vessel size	utilisation rates of conveyor/loading facilities (percentage)	Measures dockside asset utilisation. Reporting by vessel size can identify (dis)economies achieved with larger vessels
• capacity of facilities (actual and projected) (tonnes per annum)			Measures the current and projected nameplate capacity
• vessel calls at port/terminal (number)	Vessel size	also number of vessel calls by vessel size	Measures maritime activity
• tonnage throughput at port/terminal, split by vessel size (tonnes/vessel type)	Vessel size		Measures uptake of port capacity used by vessels utilising economies of density
• average cargo tonnes lifted per vessel (tonnes)			Illustrates provision/uptake of port provision for larger vessels; rate is not directly influenced by dock so is not a performance measure
2. Dockside handling rates			
• vessel turnaround time at berth (hours)	Vessel size		Measures pace of vessel turnaround, with vessel size classification as a (blunt) control factor
• commodity loading rate ("outloading" rate to vessel, tonnes/hour)		Conveyor rates	Measures equipment throughput rating and reliability
• wharf turnover (tonnage throughput per linear metre of wharf face, tonnes/m)			Complements vessel size and loading rate characteristics and reliability of equipment
3. Upstream/downstream (supply chain) measures			
• train tonnage delivery levels/rates (e.g., tonnage delivery per month)		"Scheduled" and "actual" delivery (tonnes) average train unloading time (hours)	Insights from upstream activities (mine, track and train)
• vessel arrival rate (vessels defined in "vessel tonnage" or "number of vessels")			Insights from downstream activity (rate of vessel arrivals) in assessing dockside outloading rate and downstream vessel queuing
4. Logistics chain performance			
• vessel queuing (average number of vessels at anchor across given time period)		Should be used with anchor-time and other supply chain indicators	May provide signal of possible dockside, upstream and/or downstream perturbations, although does not indicate the source of the perturbation
• vessel time at anchor (hours or days)		Should be used with anchor-time and other supply chain indicators	May provide signal of possible dockside, upstream and/or downstream perturbations. Arguably is a superior ancillary performance measure than vessel queuing
5. Commodity production and vessel handling measures			
• product blending (number of parcels)			Provides fuller description of dockside activities
• vessel parcel rates (number of parcels per vessel)	Vessel size		Provides fuller description of dockside activities
• terminal/dock stockholdings (tonnes)			Variation in level of stocks provides fuller description of dockside activities
• vessel size (distribution of sizes or aggregate vessel tonnage)			Level of dockside activities is influenced by vessel size

Glossary of port and vessel definitions

Term	Definition
Baltic Dry Index	This Index is a measure of price of shipping dry bulk commodities. The price is drawn from freight costs for a (weighted) basket of Capesize, Panamax, Supramax and Handysize dry bulk vessels. The costs of conveying the dry bulk commodities are measured for a specified set of shipping routes. The Index is calculated daily.
Beam	This is the maximum breadth of the vessel.
Berth	The berth is the water-side equivalent of the (land-side) wharf/quay. The berth is the location where the ship loads or discharges its cargo. A "lay-by berth" is a temporary location where the ship waits to access the loading/unloading berth.
Capesize	Vessels larger than Panamax size are loosely called "Capesize", albeit that there are sub-categories of this larger vessel, such as Japsize vessels (for coal). There is a range of definitions of Capesize, defined in tonnes deadweight. Lloyd's Register defines them as ranging from 100 000 tonnes deadweight, to 180 000 tonnes deadweight, with an approximate draught of 17 metres. For the purposes of this report the Capesize dry bulk vessels are assumed not to have an upper dwt limit.
Deadweight (dwt)	This is the total weight of the vessel that the ship can carry when immersed to a particular load line. The deadweight carrying capacity is the weight of cargo (in tonnes) that the ship can carry when immersed to the same load line.
Demurrage	Demurrage is a penalty charge that is normally paid by the customer to the vessel owner. The charge relates to the number of excess days (beyond an agreed number of days) that a vessel takes to load or unload.
Draught (draft)	The draught (or "draft") is the depth to which a ship is immersed in the water. This measure can then be compared with the maximum draught for the channel or berth for a given port, to determine whether the vessel can access the port/terminal/berth and the extent to which the vessel can be loaded. That is, the "laden draught" should not exceed the depth of water at the facility or in the channel leading to the facility.
Dry bulk	Dry bulk commodities include bulk movements of coal, iron ore, gypsum, grains and bauxite. The "dry" is a particular contrast with liquid bulk commodities, which include oil and liquid natural gas.

Gas carrier	Gas carriers, also known as gas tankers, are used to transport LNG and LPG. The vessels may also be known by the gas carried, such as LNG carriers. Modern carriers incorporate refrigerated tanks to carry the gas in liquefied form. Vessel sizes are defined in cubic metre capacity rather than a deadweight tonnage. A LNG carrier may have a size between 140 000 and 260 000 cubic metres.
Handymax	These vessels are bulk carriers with around 35 000–50 000 tonnes deadweight (using the Lloyd's Register definition).
Handysize	These bulk-carrier vessels are up to 50 000 tonnes deadweight (using the Lloyd's Register definition).
LNG	Liquefied Natural Gas. This is natural gas (itself being a methane- and ethane-based energy gas) that has been super-chilled to around -161 Celsius so that it turns to liquid. In this state it uses around one six-hundredth of the space required for the same amount of the gas in its gaseous state. This lower space usage can make the gas cost-effective for transporting over long distances (avoiding cost-prohibitive pumping and construction costs of pipelines).
LPG	Liquefied Petroleum Gas. Like LNG, the LPG is a liquefied form of a hydrocarbon gas, in this case being varying proportions of propane and butane gases. Large volumes of the gas are transported under pressure; it liquefies under pressure at which point it absorbs around one-two hundred and fiftieth of the space of the uncompressed gaseous form.
Panamax	These are vessels that have a breadth of 32.2 metres, which is the widest that the ship can be and still be possible to transit through the Panama Canal. In that same context, their maximum permitted length is 275 metres. The bulk carriers normally have seven cargo holds and deadweight tonnage of (typically) between 65 000 and 80 000 tonnes, with around 52 500 dwt when passing through the Panama Canal. (This definition is based on that used by Lloyd's Register.)
ULCC	These are Ultra Large Crude Carriers, for crude oil, with deadweight of 300 000 to 550 000 tonnes.
VLCC	These are Very Large Crude Carriers, for crude oil. They have a deadweight of 200 000 to 299 999.

Source: Derived from material contained in Brodie, 2006; Lloyd's Register, n.d.

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