APPENDIX F

Port operations and the effect of sedimentation

APPENDIX F

Port operations and the effect of sedimentation

SYNOPSIS

Independent technical specialist
Port Logistics Solutions Pty Ltd
30 April 2016

Hay Point sustainable sediment management assessment approach

AVOID OR REDUCE

- *Where do sediments come from?* *Appendix C*
- *Where do sediments accumulate in the port area?* *Appendix D, E*
- *What effect will this have on the port?* *Appendix F, G*
- *Can this be managed without dredging?* *Appendix H*

REUSE OR RECYCLE

- *What are the engineering qualities of the material?* *Appendix J*
- *Can the material be used beneficially?* *Appendix I*

ALTERNATIVES TO AT SEA

- *What are the environmental values to consider on land and at sea?* *Appendix L*
- *What are the details of onshore containment alternatives?* *Appendix K*
- *How do all the disposal alternatives compare?* *Appendix B*

Purpose of study:

Being a coal export Port, this report provides a narrative of the coal supply chain and describes how it relates specifically to the Port of Hay Point. The aim of the report is to communicate how unmanaged sediment accumulation in the ports navigational areas can affect the various elements of the supply chain.

Broad study approach:

This study was approached through consideration of five key elements inclusive of the following:

1. Examining the background and history of coal export in Australia and the global coal market. Specific detail of the local coal products that are exported through the Port of Hay Point is also provided.
2. Outlining how coal is moved from mine to ship, examining the supply chain and shipping demand. This section provides a description of vessel types, discusses operational constraints of bulk-carriers, the port's navigable depths and how vessel draft affects terminal loading operations.
3. Describing how contractual development has shaped supply chain and port operations over time.
4. Describing how the development of the Port of Hay Point has evolved over time in response to the coal market and nearby mines.
5. Examining sedimentation in berth pockets, aprons and departure paths as a cause of reduced under-keel clearance.

Key findings:

- Overall, the study demonstrates that the value of coal exports from central Queensland is of significant importance to the Queensland economy.
- The Port of Hay Point is the major export port for the central Bowen Basin mines due to its direct route from the mines, deep water access and access to rail.

- Demand of metallurgical coal is expected to increase from India, Brazil and China over time. Japan, South Korea and Taiwan are also expected to continue to be major buyers of Queensland coal to support steel production.
- The Port is visited by various classes of vessel, including:
  - Very Large Cape
  - Cape Size
  - Panamax and Japmax size
  - Handimax.
- Preservation of maximum sailing depth at the port is vital to support the flow of cargo moving through the terminals.
- Reduced water depth due to sediment accumulation in navigational areas may result in:
  - Suspended loading period during low tides
  - Increased demurrage costs
  - Reduced supply chain efficiency
  - Changed of fleet dynamics, with increased reliance on more smaller vessel visits
  - Reduced competitive advantage of the Port
  - Less revenue and state royalties due to supply chain inefficiencies.

Port of Hay Point

Sustainable Sediment Management Assessment for Navigation Maintenance (SSM Project)

Port Operation and the Effect of Sedimentation

April 2016

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Executive Summary

Australia is an Island continent with abundant raw materials which are in demand by other nations. To facilitate growth, Australia has developed an efficient network of bulk export ports and supply chains, driven by export demand. Australia's major bulk export ports are some of the largest and most efficient in the world and were largely funded with public money, constructed by State Governments.

Coal, like iron ore is found in abundance in Australia. Coal beds exist along the entire east coast of the continent and produce some of the best quality coal in the world. Queensland and NSW have large reserves of black coal which well exceed our domestic need. Other countries, both developed and developing, do not have either the reserves, or the quality of Australian coal which has laid the foundations for a prosperous mining industry.

The central Queensland coal fields produce some of the best coking coal in the world. Coking coal, unlike thermal coal, is used to produce steel and is economically available in just a few countries around the globe. Hence, Queensland's metallurgical coal is in high demand, which has resulted in the development of multiple mine sites throughout the Bowen Basin.

The Port of Hay Point was built to service the central Queensland coal fields and has expanded over time in line with metallurgical coal demand. In calendar year 2015, the Port of Hay Point exported 113,736,834 metric tonnes of coal, making it the second largest bulk export coal port in Australia and one of the largest bulk export coal ports in the world. The port comprises two modern coal export terminals with some of the most advanced bulk loading technology available. Investment in both terminals has been continuous with the combined asset value reported by the owner of the Hay Point Coal Terminal (BHPBilliton, 2015) and the Lessee of the Dalrymple Bay Coal Terminal (DBCT Management Pty Ltd, 2009), as exceeding A$5 billion.

The port offers deep water access which in turn, attracts vessels exceeding 200,000 deadweight tonnes. Employing large vessels to carry coal provides coal buyers with immense scope in planning their coal requirements. Coupled with an efficient supply chain and marine export terminals that can provide multiple different blending combinations, the Port of Hay Point offers unprecedented commercial benefit to steel makers.

Increasing export volumes through both coal terminals at Hay Point have reached record levels over the last 24 months with coal buyers favouring very large Capesize ships as their preferred vessels. As these vessels require deep water access, it is vital that the Port of Hay Point maintain the ability to service them. Due to the new Legislative requirements, the past practice of disposing capital dredging material at sea has been disallowed within the confines of the Great Barrier Reef Marine Park, in an effort to improve and prolong the health of the reef. Although sea disposal of maintenance dredging was not included in this action, pressure is mounting to find alternatives for all sediment management.

To address the issue and ensure the future viability of the port, North Queensland Bulk Ports (NQBP) has commenced a project to assess sustainable sediment management practices to ensure continued safe navigational access at Hay Point, while meeting the Government's commitment to protect the Great Barrier Reef. This report has been commissioned in support of the project by detailing the history of the port's development and its current operating methodology based on the way coal is sold to the end customers and those customer's use of vessels to transport the product. The purpose of the report is to educate the reader as to the way this port has developed, how it works and why it is in the interests of stakeholders to ensure the future of the port. The report has been structured into five sections with the following giving a brief overview of the sectional content.

- Section one of the report details the background and history of coal mining in Australia and outlines how increasing global demand for coal as a cheap energy source and as the carbon component required to produce steel, is driving overall Queensland black coal production. The focus of attention then concentrates on the Port of Hay Point as the export gateway for coal producers located in the port's hinterland. To this extent, the mines that are serviced by Hay Point are listed with the type of coal produced and their ownership. This section also considers the current coal market in terms of demand and supply in order to enlighten the reader as to the importance of the port.
- Section two considers how the product is moved from the mine to the ship by examining the port operation both in terms of the supply chain and shipping demand. The section provides an introduction to shipping and explains the responsibility for the shipping task as it relates to coal sales in Queensland and the impact of shipping market volatility on demand. Explanation is provided to differentiate bulk carriers from other ship types as the class of vessel used to carry bulk commodities. Descriptions of the types of vessels that utilise the port are given and demurrage, as a potential impact on profitability, is considered and explained. Operational constraints of bulk carriers are discussed and their impact on port operations and the supply chain. As a reflection of the importance of maintaining suitable depth, navigation is discussed and how draft dictates terminal loading operations. Both static and dynamic depth calculations are explained and the benefit of the dynamic under keel system is explained in terms of safe navigation and loading operations. While the deep dredged berth depths at DBCT and HPCT allow vessels to load to their maximum sailing draft, they still require the highest daily tide to sail. If delays result in the ship missing this tide, it may well have to delay its sailing until the next day's highest tide, which forces more delay into all the ships waiting to load.
- Section three considers how contractual development has shaped supply chain and port operations over time. As coal exports financially benefit more than just miners, this section reviews 3rd party beneficiaries which would suffer economic loss should port depth be restricted. To this extent, Government royalties are examined and a cause and effect model used to show how economic loss would be distributed in the event of reduced draft.
- Section four considers how the port has evolved and details the history of infrastructure development from the mines to the terminal and the supporting infrastructure (tug harbour). As demand has dictated the expansion of infrastructure, the development of the terminals, rail, mines and the tug harbour are examined in detail. The section concludes with an overview of the terminal operating methodology and why the logistics of coal supply are dictated by the size of storage at the port and the consequential impacts that the port operation has on the rest of the supply chain.
- Section five considers the question of sedimentation as a cause of reduced water depth. This is the critical issue in the future success of the port which has been clouded by demands from the green

movement for an end to sea disposal of dredged material. Without dredging sediments from berth pockets and the navigation channel, the siltation will adversely impact the port's future as its competitive advantage withers. To understand the current depth issues caused by sedimentation, the recent work by Royal Haskoning looking at the sedimentation issue in the berth pockets, aprons and the departure path has been reviewed with an overview of their findings. The section concludes with a review of how future port expansion would need to be planned considering the current legislation. Recent changes to support the protection of the Great Barrier Reef have listed Hay Point as one of only five priority Queensland ports where future development will be allowed. This is seen as a positive development for the central Queensland coal industry in that expansion opportunities are afforded through the priority ports.

The value of the port of Hay Point as an efficient export gateway for coal from the Bowen Basin cannot be understated. While the debate about global warming continues, the stark reality is that there is no substitute for coal in steel production. There is also no cheaper form of energy than coal fired power stations for developing nations, eager to improve quality of life for their populations. As such, the value of coal exports from central Queensland is of such importance that our bulk export ports must be protected and supported as the lifeline of an industry which remains critical to the prosperity of the Australian economy.

Section One – Coal Background

1.1 An Introduction to Coal

Coal has been used as a fuel source to support human civilization since the time of the caveman, largely due to the fact that it is the most abundant form of fossil fuel. World proven coal reserves in 2014 were sufficient to meet 110 years of global production, by far the largest reserve/production ratio for any fossil fuel (BP Statistical Review of World Energy, 2015). Coal is formed from the remnants of prehistoric forests which were overlaid and buried by sediment. Over the course of millions of years and through the heat produced by the rotting vegetation, peat swamps evolved into lignite or brown coal seams. With increasing pressure caused by continuous sediment overlays, lignite seams evolve into sub-bituminous, bituminous and anthracite coal seams or black coals. With increasing heat and pressure over time, water content decreases and carbon content increases. This process is called coalification, with the resulting types of coal classified by rank. Coal can be found across the globe and on every continent, however it is the degree of contaminants in the coal that holds the key to demand and use.

Coal was first found in Australia in 1797, in the cliffs south of Point Solander (Kurnell) and in the mouth of the Hunter River (NSW), which was the foundation for the development of Newcastle. Other discoveries soon followed with Victoria in 1825, Queensland in 1825 and South Australia in 1889 (Australian Year Book 1910, Australian Bureau of Statistics 2012).

Coal was discovered in the Bowen Basin in 1845, when Ludwig Leichhardt observed and journaled beds of coal indistinguishable from those on the Hunter at Newcastle near the current location of Blackwater. This was followed by an accidental discovery at a Blair Athol homestead in 1864, when a well-borer digging for water struck coal just 20 metres below the surface.

Coal seams of varying depths and quality run the entire east coast and across three quarters of the southern continent (Fig 1). Specifically, shallow seams have spawned the development of:

- the Latrobe Valley (Victoria);
- the Illawarra region west of Port Kembla/Wollongong (NSW);
- the Sydney, Gloucester and Gunnedah basins west and north west of Newcastle (NSW);
- the Ipswich and Southern Surat basins (Qld) west and north west of Brisbane;
- the Bowen Basin (Qld) west of Gladstone and Mackay; and
- the Galilee basin (Qld) west of Abbot Point.

Smaller developments are also to be found in West Australia and South Australia although, like Victoria, production from these mines is used to generate domestic electricity.

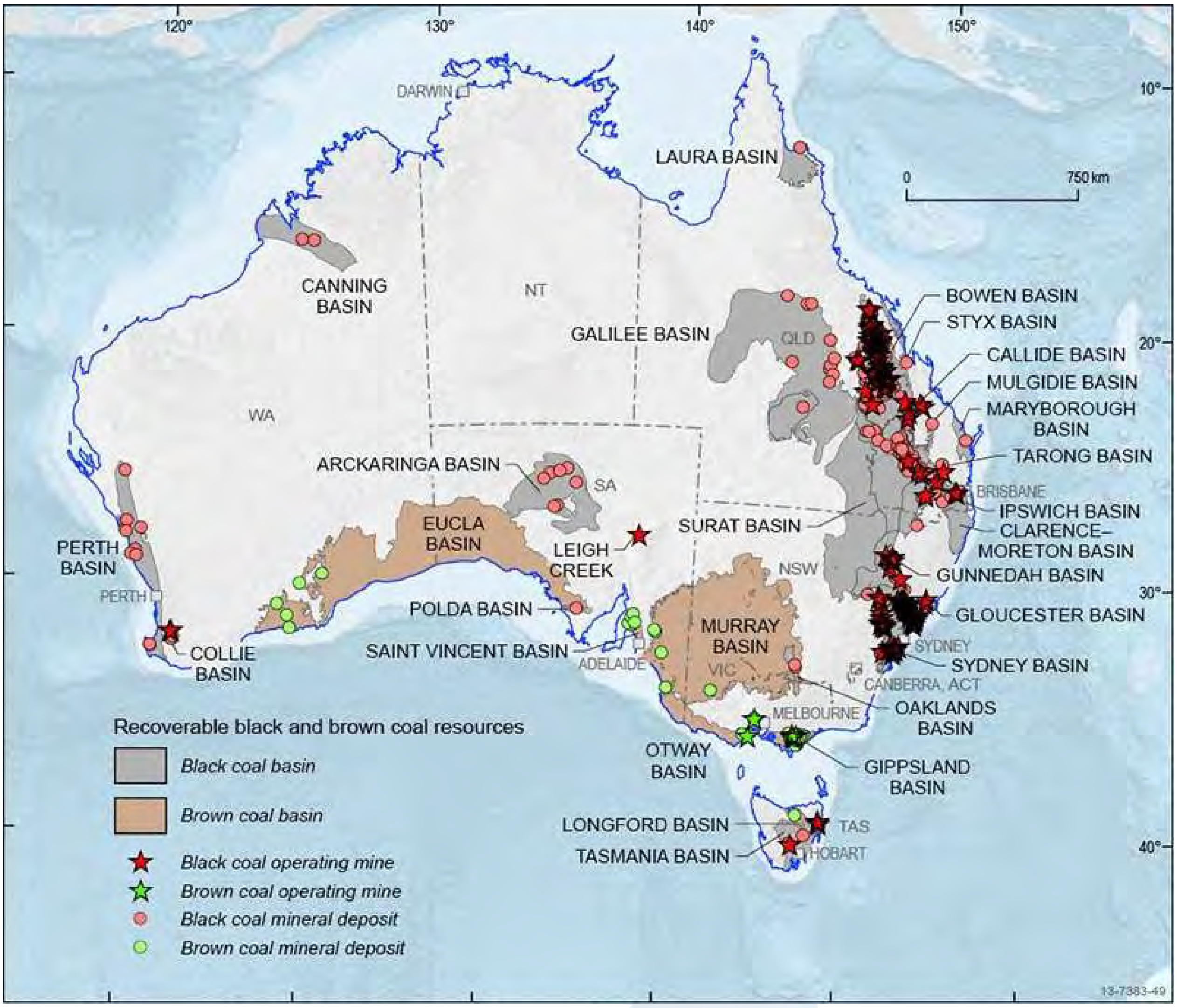

Fig 1. Map of coal seam deposits in Australia (Geoscience Australia 2012)

Australian coal production was first recorded on a commercial scale in 1881 (1,846,372 tons) in all states of Australia except South Australia. By 1908, production had grown to 10,193,635 tons valued at 3,762,914 Pounds (Australian Year Book 1910, Australian Bureau of Statistics 2012).

Australia has about 7% of the world's economically recoverable black coal and ranks fifth behind USA (31%), Russia (22%), China (14%) and India (8%) (BP Statistical Review of World Energy, 2015). While this may seem low, Australian black coals are high in quality and low in contaminants. Further, the seams are relatively close to the surface, reducing the amount of overburden required to expose the seam and therefore the total cost of production, which is responsible for Australia's strong position on the global cost curve. Due to the high quality and low production cost, Australia has continued to capture an increasing share of the world's seaborne coal trade. Specifically, NSW's thermal coal deposits are fuelling the developing world's need for electricity, while Queensland's hard coking coal is used to produce pig iron by the global steel making industry.

The central Bowen Basin has significant reserves of black coal, with almost three quarters of the deposits of Permian age (280 Million years) and about half of the coal seams shallow enough for open-cut mining. In particular, Bowen Basin hard coking coal is demanded by global steel makers because of its ability to meet the full spectrum of quality parameters for the production of quality steel. As a result of the historic demand, the industry has recorded impressive year-on-year growth since the early 1970's.

1.2 Usage of Coal

To understand the demand for coal, it is necessary to first understand the use for coal which is relative to coal "ranking" (Fig 2). Low ranked coals are lignite and sub-bituminous coals which are characterised by high moisture content and low carbon content. This is the coal predominately produced in South Africa, Indonesia, Colombia and much of the coal that is mined in China and India. In Australia, low ranked thermal coal is produced from the Hunter Valley in NSW, the Surat Basin and the Blackwater area of the Bowen Basin in Queensland. Coal reserves in Queensland's Galilee Basin are also low ranked thermal deposits. From the central Bowen Basin and relative to the Port of Hay Point is the Clermont thermal coal, which typically has an inherent moisture content >15%, which is considered high for coals shipped through Hay Point.

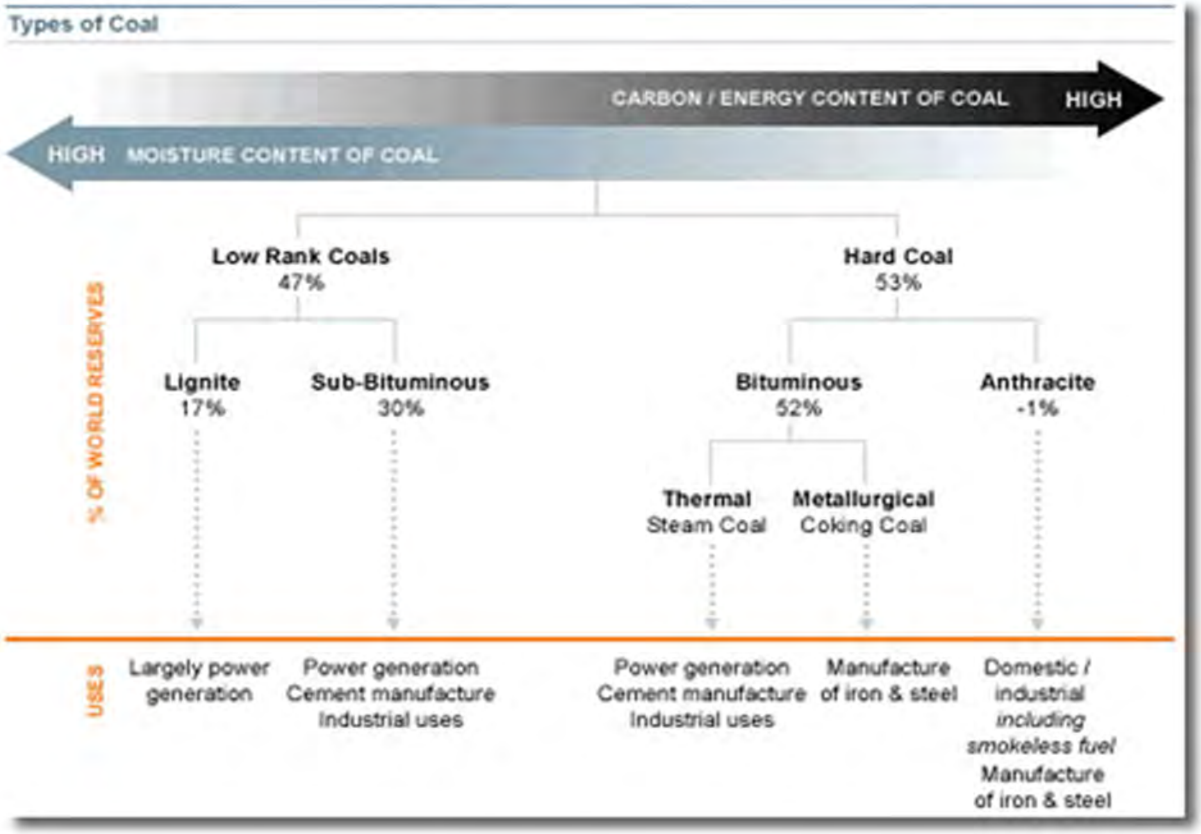

Fig 2. Types of Coal (World Coal Association 2016)

Low ranked coals are used as a fuel source to provide heat to boilers which in turn produces steam to drive turbines that produce electricity. Impurities in the coal cause an undesirable by-product called fly ash as well as generating greenhouse gases which attracted the attention of environmentalist across the globe.

However, with developing countries driven to provide electricity to their populations, the demand for thermal coal is forecast to continue.

High ranking coals such as metallurgical coals are harder and stronger than thermal coals and have lower inherent moisture content (7-8%), higher carbon content and higher energy. As such, they are demanded by global steel producers which are generally located in countries where domestic reserves of Hard Coking Coal (HCC) have been depleted or natural reserves are of low ranking thermal coals. The central Bowen Basin coals comprise the full spectrum of high ranking coking coals and together with the terminals' ability to blend various coal types into a ship, offer global steel producers a reliable and high quality product.

Metallurgical coal is blended to produce different types of pig iron. One of the advantages of the terminals at Hay Point is their ability to blend different types of coal from their stockyard into the ship's hold. Thus, metallurgical coals can be supplied in large quantities, but to boutique specifications, which is highly advantageous to the steel producer. Further, the central Bowen Basin not only supplies high grade coking coal but also Pulverised Coal Injection (PCI). PCI is a process that supplements coke in the blast furnace by injecting lower ranked pulverized coal into the base of the blast furnace to produce a source of heat and carbon. PCI does not replace coke, it just reduces the amount of coke required. It is made up of low volatility and ultra-low volatility, low ash coals which are also in limited supply. PCI coal tends to trade at a slight premium to semi-soft coking coal (SSCC), but still below HCC.

While HCC is found globally, it is in limited geographic locations and with differing qualities. HCC trades at a premium to other coals as it is the only coal type that can produce strong coke used in blast furnaces. SSCC, which is in abundant supply, is used as a filler in coke blends predominantly by Asian steel mills, but produces a lower quality coke with more impurities. There is scope for interchangeability between thermal coal and SSCC resulting in a stronger price correlation between thermal coals rather than HCC. Fig 3 shows the ranking relationship between coal types.

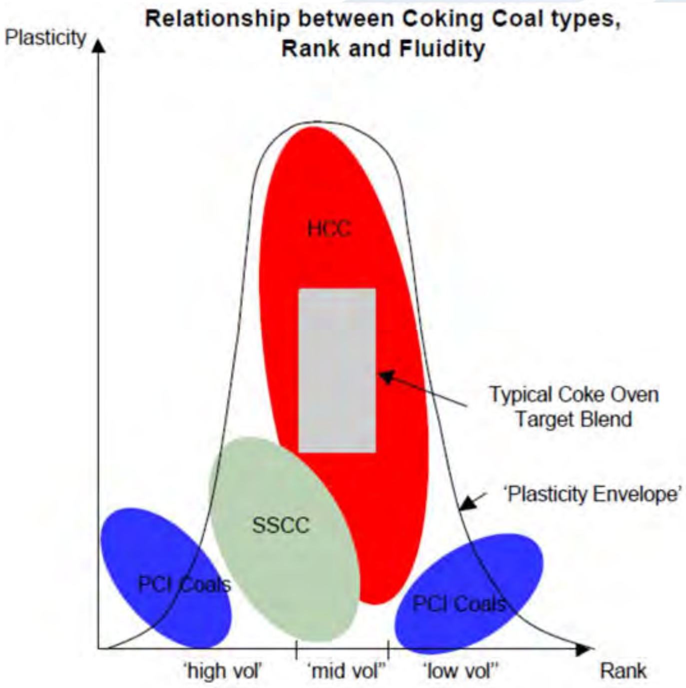

Fig 3. Classification of Coking Coal (BMA 2002)

Current forecasts show global steel production increasing by 536 million tonnes over the next 20 years or 1.3% CAGR (Wood Mackenzie, 2015). In September 2015 however, the OECD lowered its forecast for global growth to 3.6 percent citing the slowing Chinese economy and global financial market turbulence, which it sees as the key underlying risks to the forecasts. Wood Mackenzie has since (late October 2015) commented that, in its opinion, Chinese and Indian coking coal growth is still assured and that reductions in the seaborne market to China may be temporary on the basis that Chinese domestic metallurgical coal production may have plateaued. Further, Indian dependency will grow in line with its steel industry with annual demand increasing from 40 million tonnes to 60 million tonnes.

1.3 Demand for Thermal and Metallurgical Coal from Queensland's Bowen Basin

While data shows an increasing demand for thermal coal, little is produced from Queensland's central Bowen Basin as most of the coal mined and exported through the Port of Hay Point is metallurgical coal, which comprises the high ranking coals. In fact, the only thermal coal shipped through the Port of Hay Point in large volume comes primarily from the Clermont mine Joint Venture which was a topic for media attention when Rio Tinto Coal sold its 51% share in the JV to Glencore and Sumitomo in June, 2014. Clermont coal is sold largely to its Japanese Joint Venture partners ensuring a dedicated off-take supporting full production. It is not uncommon for the mine to export up to 12 million tonnes through DBCT per annum (i.e. its full contracted port capacity).

The only other thermal coal mine in the central Bowen Basin shipping through Hay Point is Moorvale, which was purchased (with the Coppabella mine) by Peabody Australia from MacArthur in October 2011. Moorvale production is generally blended with Coppabella's higher ranked coal to form a Pulverised Coal Injection (PCI) metallurgical coal. In terms of coal type and as a point of reference for Hay Point exports, the below chart (Fig 4) details the mines, their owners and the type of coal that they produce.

Mine	Owner	Coal type
Hail Creek	Rio Tinto Coal Australia	Hard coking
Clermont	Glencore	Thermal
Oaky Creek	Glencore	Hard coking
Moranbah North	Anglo Coal	Hard coking
German Creek/Foxleigh	Anglo Coal	Hard coking/PCI
Riverside, South Walker Creek	BMC	Hard coking/PCI
Peak Downs, Gregory, Saraji	BMA	Hard coking
North Goonyella	Peabody	Hard coking
Burton	Peabody	Thermal*, PCI, hard coking
Millennium	Peabody	Thermal*, PCI, coking
Coppabella	Peabody	Thermal*, PCI, coking
Moorvale	Peabody	PCI, thermal
Isaac Plains	Stanmore Coal	Thermal*, PCI, coking
Carborough Downs	Vale Australia Holdings	Thermal*, PCI, coking

*Thermal production is a byproduct of the mine's main metallurgical coal resource

Fig 4. Hay Point hinterland mines and coal type (PALS 2016)

Because of the small amount of thermal coal produced from the central Bowen Basin, there are little to no expansionary drivers with thermal exports comprising less than 10% of all coal exported through the Port. Further, supply competition is fierce amongst the larger southern producers with mines in Blackwater (Gladstone) and the Hunter Valley (Newcastle) competing with Kalimantan (Indonesia) and South Africa to win market share. As Japanese electricity companies are taking almost all of the thermal product exported through Hay Point, Clermont is reasonably protected from this competition which tend to sell more into China, India and Europe, all of which have domestic reserves of thermal coals (although of lower quality).

Because the majority of coal exported through Hay Point is metallurgical coal, drivers for expansion have been directed by metallurgical coal consumption. Throughput growth in the metallurgical coal market is directly linked to global steel production which in turn is linked to industrialisation and urbanization.

Steel Demand vs Capacity (year 2000 = 100 on the x axis)

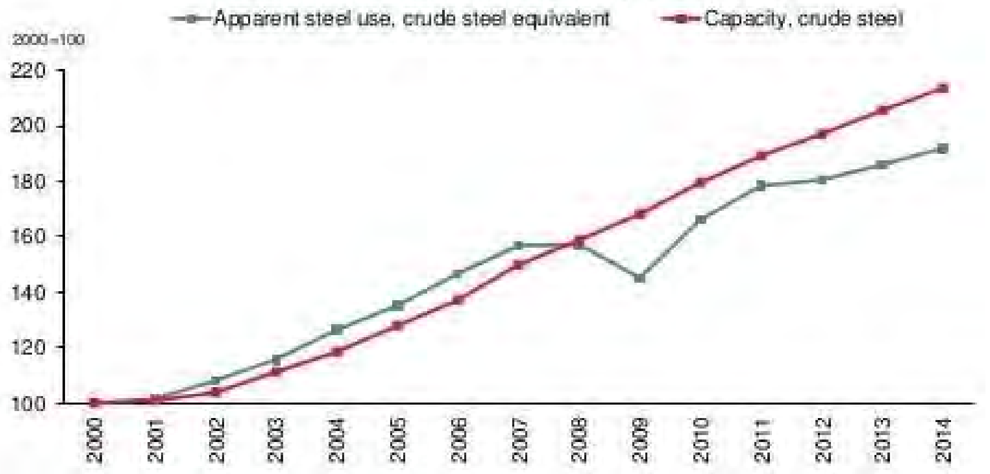

Fig 5. Steel demand versus capacity (World Steel 2013)

As 70% of steel used today consumes metallurgical coal, the driver for past port expansions can be co-related to steel production. Figure 5 shows the relationship between steel consumption and production capacity. The impact of the Global Financial Crisis (GFC) is clearly visible as is the ensuing gap between production capacity and actual consumption thereafter. This has led to an over-supply of raw steel as blast furnaces, particularly in China, continue to overproduce (Grigg & Murray, Australian Financial Review, April 2016). While the carry-on effect for metallurgical coal has seen strong growth, global demand has become volatile in FY 2015/16, due to a combination of differing national economic priorities, varying economic performance in the countries of consumption and general over-production by mining companies. Metallurgical coal in particular has been in a state of over-supply which has caused turmoil with many producers caught between high production costs and high supply chain delivery costs, all against a falling coal price.

To illustrate this point, in 2015, American coal producers Alpha Natural Resources Inc., Walter Energy Corp. and Patriot Coal Corp all filed for bankruptcy protection. In 2016, Peabody and Arch Coal Corp also filed for protection as a result of continuing difficult operating conditions. The Canadian coal producers are in a slightly stronger position, although many are working through drastic restructures. Teck, one of the largest Canadian coal producers with very low production costs, has delayed all expansion projects and released 2000 employees in 2015 alone (Financial Post November 2015).

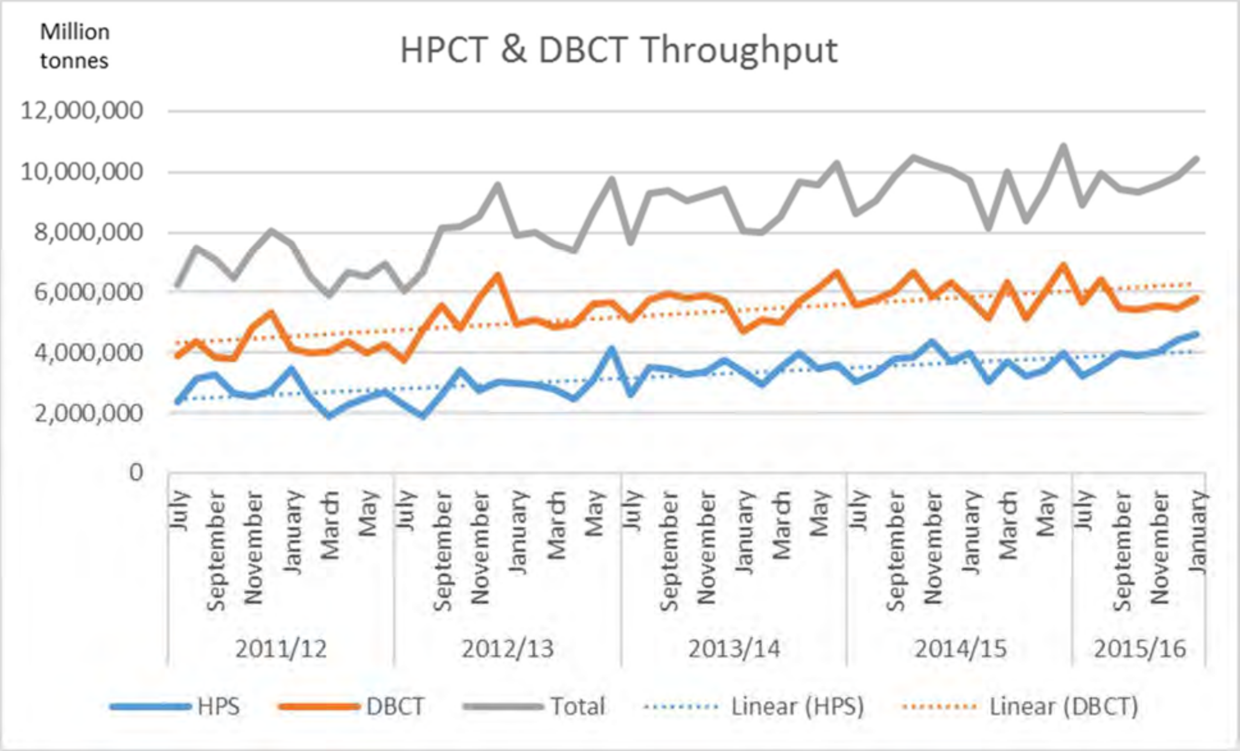

Fig 6. Port of Hay Point growth over time (PALS 2016)

Despite the global coal production over-supply issue, the failures in the North American market have tended to reinforce Australia's supply position, which is evidenced by the continued growth of coal exports through the Port of Hay Point (Fig 6) . The supply of metallurgical coal into the seaborne market is now dominated by Australia with a commanding share of 64% (Wood Mackenzie 2016).

The timing and extent of future growth however, could depend on the industry's ability to maintain productivity improvements and prevent erosion in global market share. In its June 2015 State of the Sector, the Queensland Resources Council (QRC) stated, "Queensland production of commodities is continuing to expand incrementally despite the environment of lower prices. The widespread fall in commodity prices through 2014 and early 2015 have led producers to shift focus from step-change production expansion to managing costs and productivity. As a result exploration expenditure, employment and capital spending are all down in Queensland, and more broadly in Australia. In the short term, market conditions are likely to be challenging for many producers. However, in the longer term the continued rise of highly populated emerging economies will continue to drive growth in consumption of both mineral and energy resources."

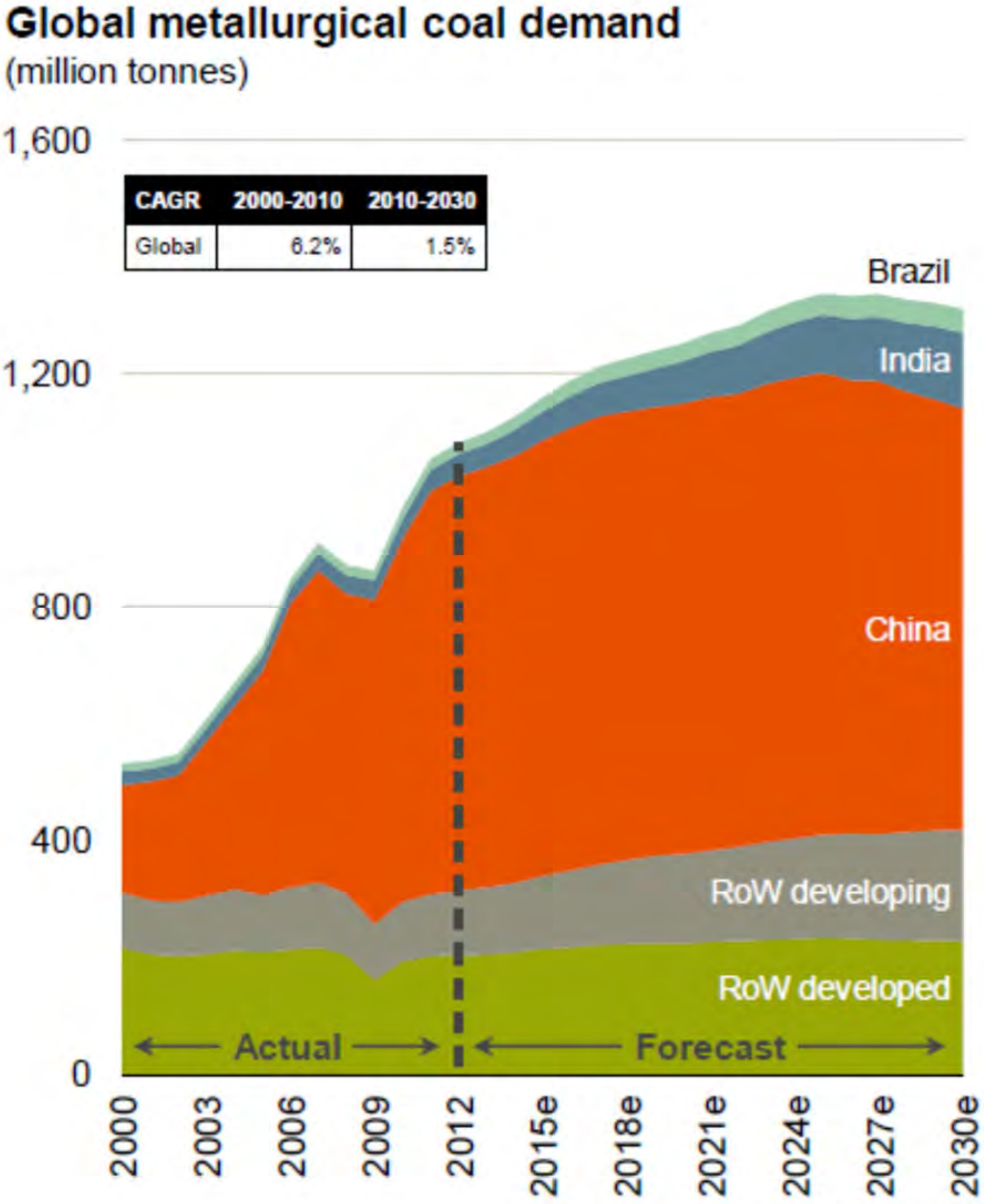

Fig 7. Anticipated metallurgical coal demand till 2030 (BHP Billiton 2012)

This positive outlook is also supported by a variety of analysts (e.g. Wood Mackenzie, BREE) and Producers, as can be seen from BHP’s forecasts in 2012 (Fig 7) with future metallurgical coal demand underpinned by steel production. Further, as competition from North America wanes and based on the significant reserves reported by Australian miners, Australia’s dominant supply position will remain in the context of seaborne metallurgical coal.

With this demand strength, the Hay Point terminals continue to close the gap between full capacity and throughput. To achieve high throughput, independent analysis by the Integrated Logistics Company (ILC) has shown the criticality of maintaining high and uninterrupted velocity of the coal moving from the mines to the ship. Any delay within the supply chain will not only delay the loading of that particular ship, but will force consequential delays into the ships waiting to load. Ship loading delays are a major threat to the velocity of coal and with recent increases in ship size to maximise cargo uplift, preservation of maximum water depth at the port is vital to support the smooth flow of cargo moving through the terminals.

1.4 Associated Mine Development and Geographical Distribution

The prospects for metallurgical coal production in the central Bowen Basin are directly linked to steel production. Since a structural realignment driven by the 2009 Global Financial Crisis (GFC), the steel industry has seen production shift to developing economies which should see demand from India, Brazil and China increase over time (Wood Mackenzie 2013). However, Japan, South Korea and Taiwan will continue to be major buyers of Queensland's metallurgical coal to support their own steel production industry (Bree 2014).

Until 2009, the metallurgical coal market had been driven by strong economic performance of steel making countries, which surged demand. This coincided with a major brownfield infrastructure expansion (i.e. expanding infrastructure while still maintaining operations) of one of the two Hay Point bulk coal export terminals, DBCT. The result of this expansion limited available throughput at the terminal from 2005 until its completion in June 2009. Extreme rain events in 2008 and 2010/11 limited coal production due to mine flooding, restricting supply even further. The resulting surge in coal prices created a new mining boom with mature mining operations looking to new expansions and new entrants fighting to purchase exploration licenses. On the demand side, China's industrial growth created spectacular demand post the GFC.

Tropical cyclones in Queensland in 2010 and 2011 caused mine flooding that again reduced Queensland's metallurgical coal supply which, together with the earlier production restrictions, forced buyers to seek alternative supply. North America benefited from Australia's issues which allowed global competitors to gain a selling advantage over Australian producers. In an effort to regain market share against a background of rising prices, producers expended whatever was necessary to increase production, forcing up production costs.

By mid-2011, a downward adjustment in the price of coal occurred driven by both over-production of steel and coal oversupply plus the cooling of China's growth. This quickly reduced profitability in the Australian metallurgical coal mining industry. While this has negatively impacted the entire industry, Queensland miners were able to react quickly to reduce their overheated costs while their North American competitors however, struggled to limit their cost exposure.

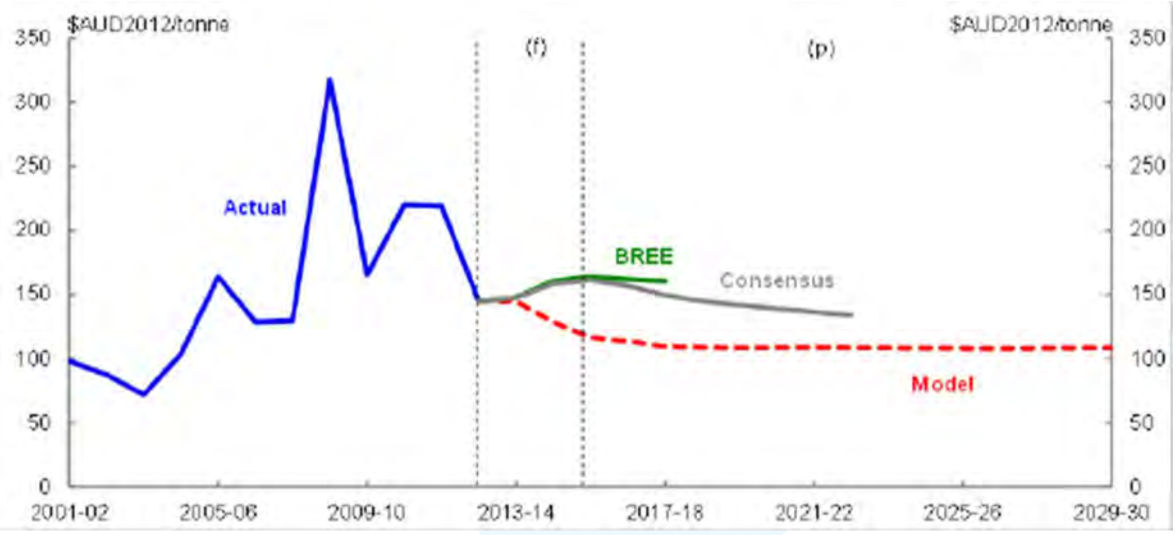

Fig 8. Forecast contract price for Hard Coking Coal (Australian Treasury sensitivity analysis 2014

While the price surge was predictable considering the supply crisis following the 2010 flooding, the extent of the subsequent price collapse has been far more difficult to predict. The above graph (Fig 8) was produced by the Commonwealth Government Treasury office in 2014, showing modelling results for metallurgical coal bottoming at just over US$100/mt. However as Fig 9 shows, the Q1 2016 HCC contract settlement was US$81/mt with the spot price in the high US$70's, well below the Governments forecast.

Fig 9. Historic quarterly contract price for Hard Coking Coal (Pals 2016)

What has since come to pass though, has been an increase in production from the existing miners rather than production moderation. After a prolonged period of cost reduction, miners are now battling each other to sell as much coal as they can produce in order to drive down their unit costs further. To this extent, the trend predicted by the Commonwealth Treasury (Fig 10) has so far proved correct. There has since been a slight reduction in demand at DBCT in the last quarter of 2015, although it is too early to say if this is a permanent new trend.

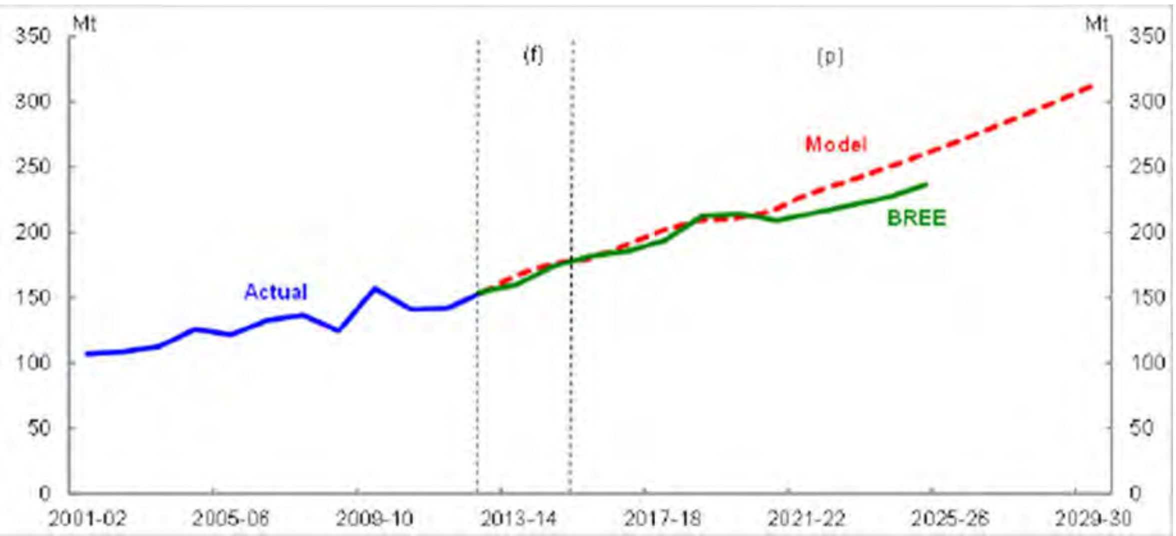

Fig 10. Forecast growth (Australian Treasury sensitivity analysis 2014)

In terms of the over-production issue, new mines that commenced operations in the Bowen Basin in 2015 were Daunia (BHP), Cavel Ridge (BHP) and Grosvenor (Anglo) with the new BHP mines responsible for the HPCT expansion (HPX3). As a result, Hat Point port capacity has increased to 140 Mtpa, making the Port of Hay Point one of the largest bulk coal export ports in the world. The following table (Fig 11) details the mines now serviced by the Port of Hay Point.

Mine	**Commenced**	**Type**	**Ownership**	**Estimated Production**	**Estimated reserves (Proven)**
Goonyella	1971	Open cut	BMC	12	321
Saraji	1972	Open cut	BMA	10	386
Peak Downs	1972	Open cut	BMA	13	492
North Goonyella	1994	Open cut and underground	Peabody	2	88
South Walker Creek	1995	Open cut	BMC	5	68
Norwich Park	1979	Open cut	BMA	C & M	154
German Creek	1981	Open cut and underground	Capcoal & Mitsui	6	100
Riverside	1982	Open cut	BMC	See Goonyella	See Goonyella
Oaky Creek	1982	Underground	Glencore	6.8	78
Blair Athol	1984	Open cut	Linc Energy	C & M	Unknown
Burton	1996	Open cut	Peabody	2	9
Moranbah North	1998	Underground	Anglo	5.5	78
Coppabella	1998	Open cut	Peabody, CITIC, Maurubeni, Sojiltz and Nippon Steel	4	62
Foxleigh	2000	Open cut	Anglo, POSCO, Nippon Steel	3	0.5
Moorvale	2002	Open cut	Peabody	2	20
Hail Creek	2003	Open cut	Rio Tinto JV	5.5	107
Millennium	2006	Open cut	Peabody	3.5	42
Carborough Downs	2006	Underground	Vale	2.2	21
Poitrel	2006	Open cut	BMC	3.4	34
Clermont	2010	Open cut	Glencore	12	140
Isaac Plains	2011	Open cut	Stanmore Coal	1.2	12
Daunia	2013	Open cut	BMA	4	88
Cavel Ridge	2014	Open cut	BMA	2.5	See Peak Downs
Grosvenor	2015	Open cut	Anglo	3.5	29

Fig 11. Mine commencement, type, ownership and estimated production (PALS 2016)

The geographical distribution of these mines in the port's hinterland are shown on the following map (Fig 12).

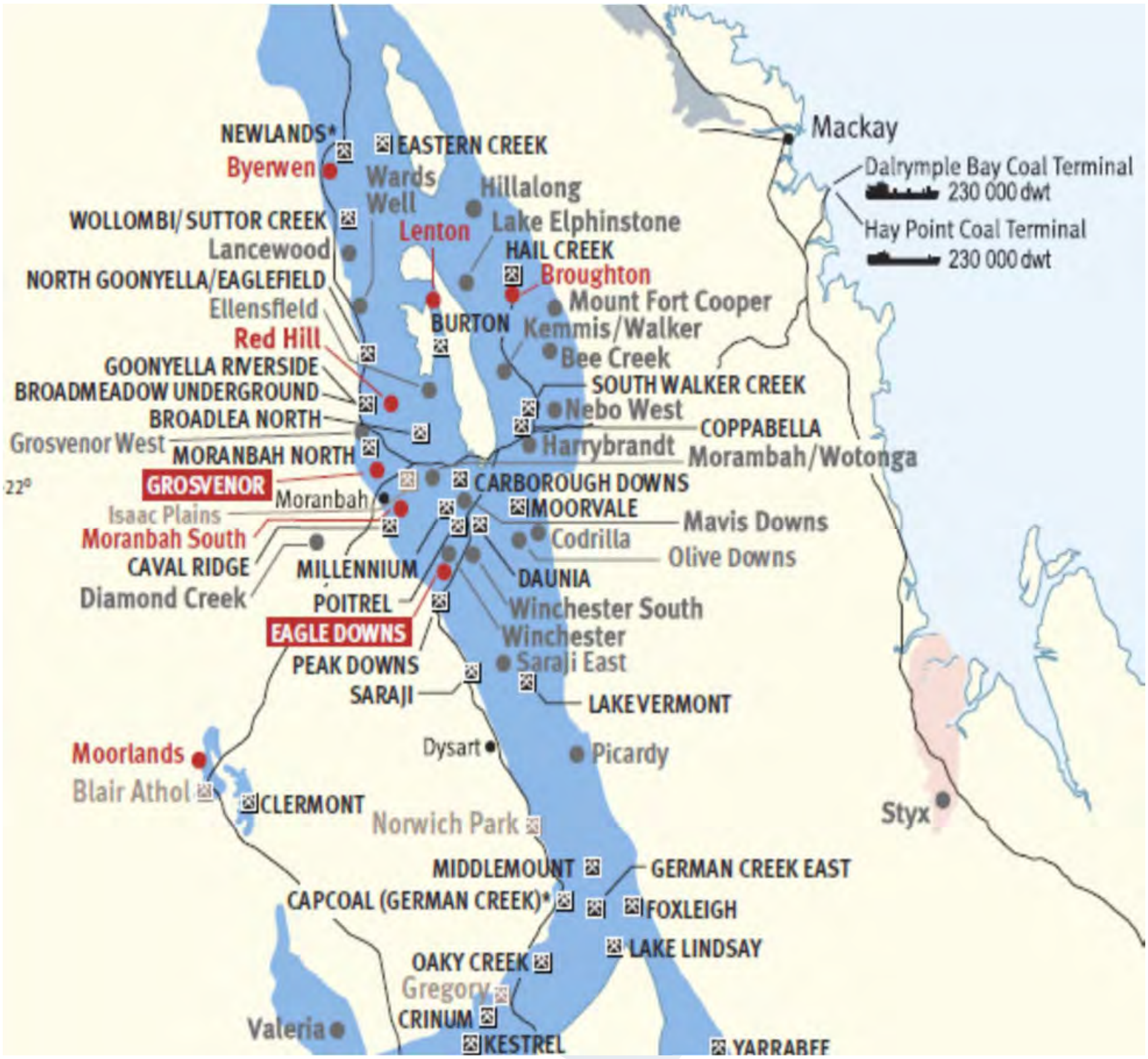

Fig 12. Geographical distribution of Central Bowen Basin mines relative to Hay Point (Dept. of Natural Resources and Mines 2015)

Section Two - Supply Chain and Shipping

2.1 An Introduction to Shipping

Bulk carriers are the work horses of the oceans. A bulk carrier is defined as any vessel designed and constructed to load, carry and discharge homogeneous cargoes in bulk. Dry bulk carriers carry non-fluid bulk commodities such as coal, iron ore and grains etc. Note that fluidized bulk cargoes are carried by oil or product tankers although some vessels can alternate between carrying both e.g. Ore/Bulk/Oil carrier or "OBO".

A dry bulk carrier has a series of segregated box like holds which give the vessel strength and stop the cargo from mixing and shifting, which would impact the vessels stability. Each hold has a hatch allowing access on deck so that the cargo can be loaded or unloaded. Hatches are generally small in comparison to other vessel types (e.g. container ships) to add strength to the ship structure. As bulk raw commodities such as iron ore and coal tend to be shipped in ever increasing quantities, this has resulted in an evolution in size of dry bulk carriers. To this extent, the size of the ship is usually determined by the limitations of either the loading port or the discharge port, or both, and the deepening of ports has also driven the increase of larger vessels.

The deadweight (dwt) of a vessel is the measurement of how much cargo the vessel can safely carry, including allowances for the crew, stores, fuel and fresh water, but excluding the weight of the ship (lightweight). All vessels have limitations on how much the ship can be immersed and this can be easily evidenced by the ship's marks or Plimsoll line, which is a circle found midship on the ships' hull (see photo below) indicating the maximum depth the vessel can be loaded to in differing conditions. At the Port of Hay Point, vessels can load to their summer load line ("S" in the photo) between 1 December and 31 March and to their tropical load line ("T" in the photo) from 1 April to 30 November (MSQ 2016) due to the differing water density that impacts the vessels buoyancy.

As a result of Hay Point's deep access, the port attracts four classes of bulk carriers:

- **Very Large Cape (VLC)**, which have a deadweight range from 140,000 to 220,000 tonnes and can be identified by 9 cargo holds and hatches. These vessels are gearless (i.e. no cranes);


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- **Cape size (Cape)**, which have a deadweight range from 100,000 to 140,000 tonnes and also have 9 cargo holds and hatches. These vessels are also gearless;


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- **Panamax and Japmax size**, which have a deadweight range from 65,000 to 100,000 tonnes and have 7 cargo holds and hatches. These vessels occasionally are fitted with cranes although it is rare; and


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- **Handimax**, which have a deadweight range from 50,000 to 65,000 tonnes and have 5 cargo holds or hatches and are predominately geared (i.e. fitted with cranes between the hatches).

(Photos sourced from Marine Traffic 2016)

2.2 Demurrage

Demurrage is a penalty imposed on the shipper (in this case, the miner) for taking longer to load the ship than the sales contract allows. The method for calculating the use of the loading time allowed under the sales contract commences on the ships arrival, provided the ship is ready in all respects to load the cargo. Should the ship have to wait to load due to a queue of other ships that have arrived before her, then the time allowed for the actual loading can be consumed in just waiting to berth. Not only can the vessel fall into demurrage while waiting to load, but the demurrage will continue unabated until such time that the ship actually loads and sails from the terminal. The loss is also consequential in that any delay not only affects the loading vessel but also every vessel waiting to load as their allowed load time is also being consumed.

Demurrage rates are usually linked to the market rate of the vessel so that the penalty for taking longer to load reflects the extra cost to charter the ship. Obviously, the stronger the shipping market, the higher the demurrage and so the length of the delay can have a very considerable impact on the total demurrage bill, reducing the profitability of the sale to the mine and other 3rd parties.

2.3 Shipping Dynamics and the Impact of Port Operations

Most Australian coal sales are based on “Free of Board” (FOB) terms, meaning that the responsibility for arranging the sea transportation rests with the buyer of the coal. The obligation on the miner is then to prepare the coal to the standard required by the sale contract terms and transport the product to the ship’s hold. The coal seller (miner) is therefore known as the shipper, for the purposes of the sale.

This form of selling coal gives vessel scheduling control to the coal buyer. As most steel mills have adopted “just in time” inventory practices, the ability to control the timing of when the coal reaches the mill, reduces the size of the inventory and as a consequence, the land area required for stockpiling bulk raw materials. The buyer can also transport different types of coal in a single vessel and avoid the capital expense associated with blending equipment and the extra land required for storage. The advantage for the shipper is that it removes the risk associated with the volatility of the shipping market.

The alternative form of sale sees the cost of the freight included in the sale price (Cost & Freight - C&F) or, the sale can also include insurance for the peril of the voyage (Cost, Insurance, Freight - CIF). This alternative requires the miner to not only arrange for the cargo to be loaded on the ship, but to also arrange and pay for the hire of the carrying vessel. The miner's responsibility ends as the cargo is discharged from the vessel at the discharge port, therefore it takes the shipping price volatility risk. The miner will obviously try to price the shipping risk into the sale price, although this is difficult in situations where the coal is sold in volume over a length of time (contract pricing), exposing the miner to any short term shipping volatility. In a low demand shipping market, miners have been known to charter vessels for a long period of time (1 to 2 years or longer) against a long term contract to supply coal (Contract of Affreightment or "COA"). This way they can lock in the shipping cost against the coal price. As the current coal sales market is moving to monthly pricing, it would seem miners would be unprepared to take on the long term shipping risk.

Bulk carriers tend to trade in two ways, one is to hire (or "let") the ship for a period of time, known as a period charter. The other is to "tramp" the vessel around the world's oceans looking for single voyages. Depending on the loading area and type of cargo, tramping can be quite lucrative as global loading ports are subject to the supply and demand placed on shipping. If cargoes are moving and there is a shortage of carrying vessels in that area, then the market price of the ship will rise. In the event of a surplus of ships waiting for a cargo to materialise, then the competition to employ the vessel will manifest in rate pressure, creating a falling market. The party responsible for supplying the sea freight is therefore economically exposed to this global shipping movement and the associated volatility.

Shipping requirements tend to follow the global economy. In strong economic environments where there is high demand for raw materials, ship owners will try to position their vessels to take advantage of the strongest freight market. This can result in vessels sailing empty from their last discharge port to the next load port (ballasting). If demand for the ship is strong enough, the party paying for the ship will also pay the costs to position the ship. In a weak market, the cost will fall on the ship owner to reposition the ship to the load port. Where there is poor demand, owners will tend to congregate their vessels in locations that offer equal opportunity to different loading areas. Singapore, the US Gulf and the Mediterranean are all example of where bulk carriers can be found waiting for cargo opportunities. In the case of Singapore, the ship can ballast to Australia (West or East coast), Asia or South Africa to load.

The global shipping market has been quite depressed due to an over-zealous building programme, particularly in the Panamax and VLC classes. This was driven as a reaction to historic high charter rates which occurred in 2007/8 which were driven by the overheated raw material markets and port congestion. Figure 13 shows the Baltic Dry Index (BDI) which is a measure of daily time charter hire rates for different classes of dry bulk carriers over different routes. The BDI gives an overall economic evaluation of the bulk shipping market on a daily basis and shows the accelerated levels of 2007/8 which prompted the large scale ship investment. As daily charter rates soared, ship owners and investors flocked to ship building yards to order new ships, seemingly oblivious to the 2-3 year delivery time and the sheer number of new orders.

Fig 13. Recent history of the BDI (The Economist 2015)

The result has seen a crippling oversupply of mid to large size bulk carriers which has negatively influenced the charter market. Coupled with the economic downturn in the steel industry over the last 18 months, the Cape and Panamax charter markets are at historic low levels (The Economist 2015).

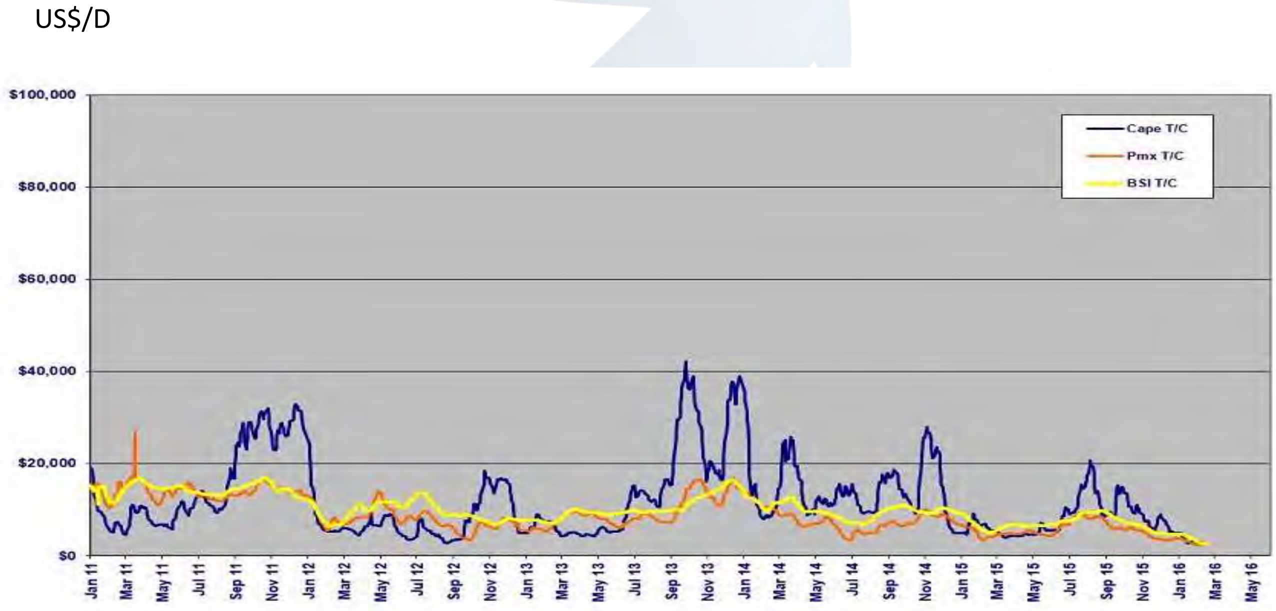


Fig 14. Historic charter hire rates for Cape and Panamax (DryShips In. 2016)

The low charter rates (Fig 14) are a stimulus for coal buyers as the freight costs for sea transportation are much more affordable. When large ships (Capes and VLCs) are cheaper to hire than mid-size ships (Panamax), coal buyers will charter larger vessels that increase the product diversity through loading different types of coal in the larger vessels. Conversely, when the market switches and Panamax become a cheaper option, the number of Cape arrivals give way to the smaller ships.

This dynamic has a major impact on the port mainly as a consequence of the trend since 2007 to build larger ships. Today's 175,000 – 200,000 dwt vessels that are favoured by coal buyers also draw between 17.5 and 18.2m draft when fully loaded. Accordingly, the port must be in a position to accommodate these vessels at their fully loaded draft or suffer the consequences of reducing the maximum cargo lift per ship or alternatively, delay the vessel's final loading to take advantage of the highest tide of the day to sail. Naturally, any non-productive time during the vessel's loading sequence not only affects that particular vessel, but also has a consequential impact on other vessels waiting to berth. This impacts the coal buyer by extending the vessel's charter hire (increasing the cost of the sea freight), as well as the Miner, by increases the demurrage exposure (taking longer to load than the sales contract allows).

In an FOB sales paradigm, the arrival of the vessel at the port dictates its order for loading. It is not possible to rearrange the berthing order unless the particular type of coal is unavailable. Accordingly, holding back a large vessel from its natural berthing sequence to take advantage of future favorable tidal windows is contrary to the terminal rules and port practice. HPCT may have more latitude to relax this practice than DBCT, especially if BMA or BMC have sold the cargo on CIF terms, because they then control the sea voyage. However, this still comes at a cost as it prolongs the voyage and the total hire costs.

There are also port issues associated with the use of smaller vessels. Because the port is located in the tropics and subject to extreme weather events, Maritime Safety Queensland require all vessels to berth in a ballasted state to enable the vessel's propeller to be immersed at all time during the loading operation. To meet this requirement, sea water is pumped into the ship's ballast tanks to immerse the vessel and facilitate safe navigation. However, to avoid overstressing the ship whilst loading, the vessel must pump out the sea water ballast while loading the cargo so that the forces of gravity are balanced against the forces of buoyancy.

To protect Australian waters from the invasion of detrimental sea creatures contained in ballast water taken in overseas ports, the Commonwealth Government introduced mandatory ballast water management requirements from 1 July 2001. The requirements are consistent with the International Maritime Organisation (IMO) Ballast Water Convention that aims to minimise the translocation of harmful aquatic species in ships' ballast water and ballast tank sediments. This means that the discharge of "high-risk" ballast water in Australian Ports or waters is prohibited. All vessel in transit to Australia must undertake a sea water ballast exchange and provide a Quarantine pre-arrive report to Quarantine officials prior to entering Australian waters. As such, water ballast discharged at the terminal's wharves is not 'high-risk" and does not pose any threat to Australia's unique Flora and Fauna. Full details of the Australian Ballast Water Management Requirements (V5 – Nov 2011) can be found at: http://www.agriculture.gov.au/biosecurity/avm/vessels/quarantine-concerns/ballast/australian-ballast-water-management-requirements#ballast-water-reporting

Large ships like Capes, have enormous ballasting and de-ballasting capacity through the use of large pumps that can move ballast water around the ship (to adjust the ship’s trim in the water), as well as pumping sea water in or out of the ship. This capacity is not replicated in smaller ships however, who have a smaller ballasting capability. As both terminals can load coal at rates between 7-8,500/tonnes per hour, the smaller ships often cannot pump out ballast fast enough to keep up with the loading. Consequently, the terminal loading operation stops until the ship’s de-ballasting programme catches up so as to avoid over-stressing the ship. This delays the vessel’s time alongside the berth and with a vessel queue, forces consequential delays back on the waiting ships, thus increasing the demurrage exposure and lengthening of the voyage.

2.4 Roles and Responsibilities Within the Coal Supply Chain

The following flow chart details the roles and responsibilities of key stakeholders in the provision of day-to-day operations of the supply chain and the port. This process generalises the interactions for convenience as there is a far greater interaction between the various stakeholders, depending on the difficulty of the particular task.

Coal Buyer and Miner agree annual contract volume. The price is then negotiated quarterly

↓

Coal Buyer nominates a vessel to perform a voyage under the sales contract and nominates the required cargo quantity, plus or minus 10%

↓

Miner checks nomination against the mine production. For DBCT, the Miner then nominates ship to Terminal Operator

↓

Terminal Operator vets the ship’s age, condition and past performance history. If clean, the ship nomination is accepted

↓

Miner then accepts cargo/ship nomination with the Coal Buyer

↓

Coal Buyer confirms the vessel charter and the ship starts to advise ETA notices to Vessel Tracking Service (VTS) and the terminal Operator

↓

Vessel sails to Hay Point continuing to advise the Terminal, Shipping Agent and VTS of ETA

↓

Terminal plans the stockyard and advises a cargo assembly delivery window to Miner and Rail Haulage provider

↓

Vessel arrives and anchors waiting its berth turn and submits Notice of Readiness (NOR) to the terminal Operator. The Master advises the Terminal of cargo uplift and deballasting schedule

↓

Trains are scheduled by the rail network provider to meet the Terminals' cargo build window

↓

Product is railed from the mine site to Terminals' rail inloaders, then stacked into the stockyard in pre-planned stockpile areas

↓

Once the last train has arrived or is proceeding to terminal, the Shipping Agent books a Pilot and Tugs, based on the VTS berthing schedule

↓

A Pilot boards the vessel by helicopter and the vessel berths. Border Control and Quarantine clear the vessel with loading commencing soon after. The Shipping Agent attends to any Ship business (crew exchange, provisioning)

↓

Terminal loads the vessel from the allocated stockpiles in the stockyard

↓

Shipping Agent communicates with terminal on loading progress, then books a Pilot and Tugs for the sailing

↓

Draft surveyor performs draft checks and confirms quantity of cargo loaded

↓

Terminal Operator produces the Bill of Lading and Manifest

↓

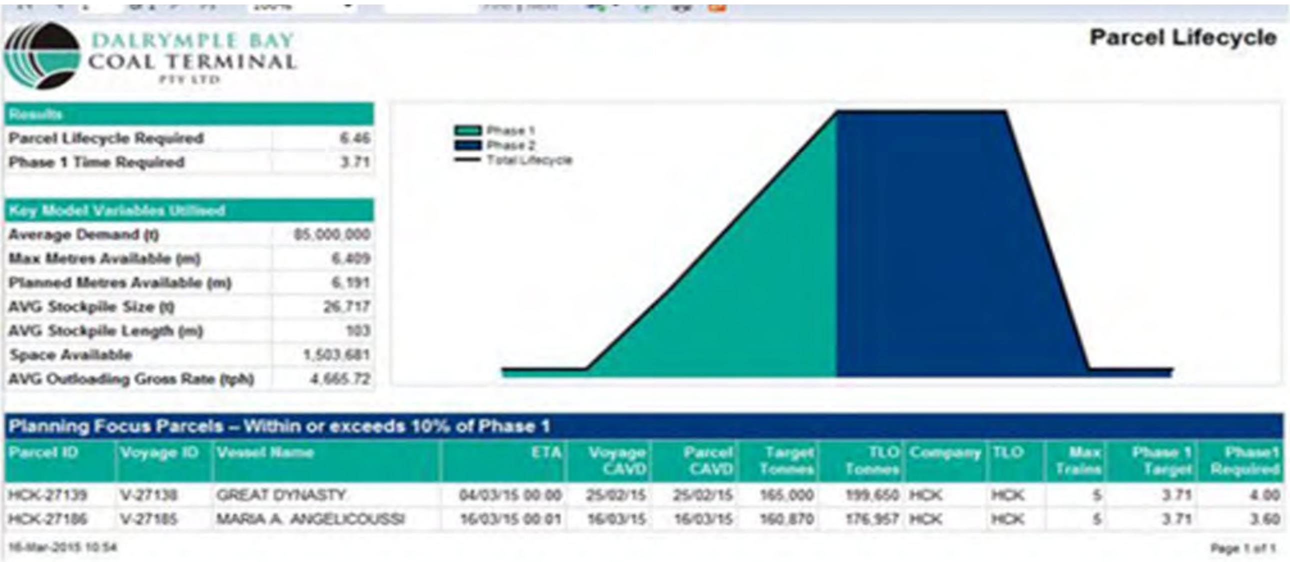
Ship sails from the port for the next discharge port and the pilot disembarks by helicopter

2.5 Supply Chain Methodology (Responding to Export Terminal Operations)

As a demand pull system, the terminal Operators need a variety of vessels at their disposal in order to maximise berth utilisation, according to what coal is available. For example, should a mine be unable to produce coal for the next ship in the queue, the Operator can select another vessel with coal parcels partially built in the stockyard, rather than lose capacity to an unoccupied berth or an idle outloading system.

While a demand pull system is more complex than dedicated stockpiling system, it is much less capital intensive, requiring lower capital expenditure and less land area in the port which, from a coal chain perspective, usually carries the highest capital expansion costs. However, there are costs in terms of upstream demands. Mine load outs are required to have high train loading rates and rail haulage providers are required to have sufficient rolling stock to back the terminal's incoming restocking requirements. As such, more rail infrastructure is required to ensure trains have adequate capability to meet cargo build requirements. As coal velocity passing through the system is directly correlated to throughput, it is essential that all the supply chain service providers agree to the same system operating requirements and fund capital solutions to meet that demand.

The Integrated Logistics Company (ILC) were tasked with developing a system based operating paradigm which would allow the supply chain partners to better integrate their operating systems. The result has seen the introduction of limited dedicated stockpiling (hybrids) for large volume Producers and a change from the terminal producing a daily rail order to the terminal providing rail operators with cargo build windows, based on velocity calculations.



Results	
Parcel Lifecycle Required	6.46
Phase 1 Time Required	3.71

Key Model Variables Utilised	
Average Demand (t)	85,000,000
Max Metres Available (m)	6,409
Planned Metres Available (m)	6,191
AVG Stockpile Size (t)	26,717
AVG Stockpile Length (m)	103
Space Available	1,503,681
AVG Outloading Gross Rate (tph)	4,665.72

Planning Focus Parcels – Within or exceeds 10% of Phase 1

Parcel ID	Voyage ID	Vessel Name	ETA	Voyage CAVD	Parcel CAVD	Target Tonnes	TLO Tonnes	Company	TLO	Max Trains	Phase 1 Target	Phase1 Required
HCK-27139	V-27138	GREAT DYNASTY	04/03/15 00:00	25/02/15	25/02/15	165,000	199,650	HCK	HCK	5	3.71	4.00
HCK-27186	V-27185	MARIA A. ANGELICOUSSI	16/03/15 00:01	16/03/15	16/03/15	160,870	176,957	HCK	HCK	5	3.71	3.60

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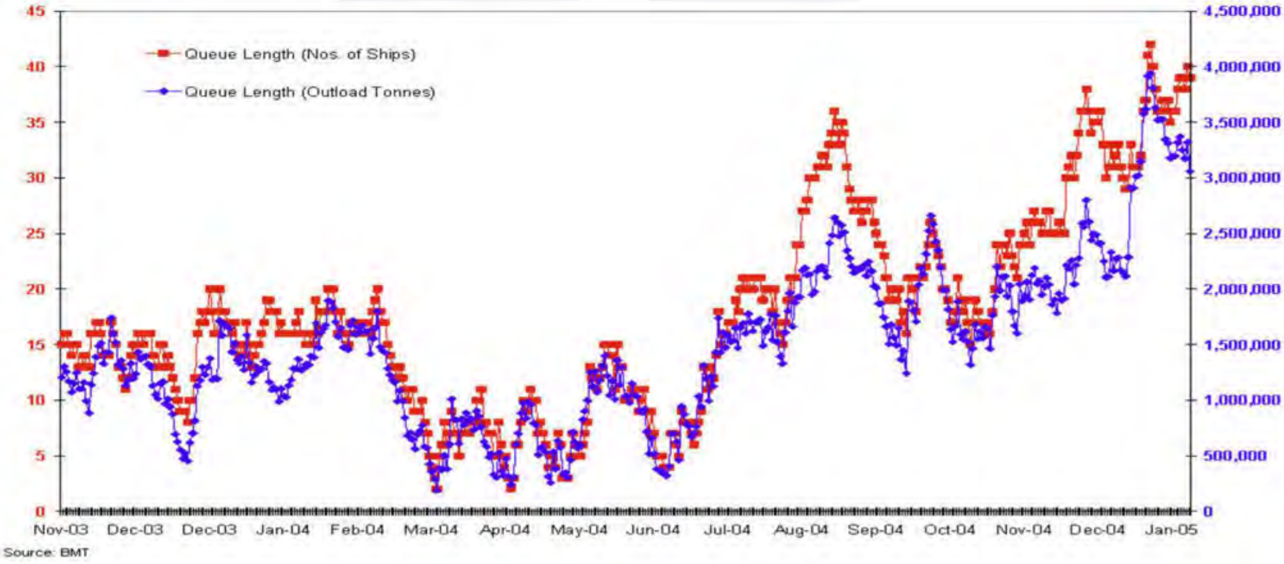
Fig 15. DBCT parcel lifecycle diagram (DBCT Pty Ltd 2015)

To illustrate the process Fig 15 shows the designed average cargo build time of 2.56 days as nominated by the terminal. This allows the rail operators to schedule trains so as to deliver the cargo to the terminal in the allocated time frame (from first train arrival to last train discharge). Should the cargo not be capable of delivery to the terminal in that time, the receiving ship is then moved back in the ship queue so that the delay is quarantined only to the impacted vessel, rather than the whole system. This is different to the old system that involved the terminal Operator producing a weekly train order which was often redundant the day it was released, due to different operating and commercial interests upstream of the terminal. While this paradigm is in its early stages of implementation, the basic principles are sound and fair and have to date, attracted support from the various supply chain stakeholders.

2.6 Issue Identification and the Role of the Integrated Logistics Company (ILC)

The basic composition of the Goonyella coal chain sees miners competing with each other for coal sales, rail operators competing with each other for rail network access and two terminals competing with each other to maximise their operation. It is therefore unsurprising that consensus and agreement have been difficult to achieve. Various attempts had been made since 2001 to identify and challenge supply chain issues albeit with limited success. However, no major operational efficiencies were achieved and with throughput severely impacted by the collapse of a reclaimer (RL1) at DBCT in February 2004, leading into the brownfields expansion of DBCT, coal buyers panicked and demand soared.

By February 2005, a significant queue of ships (Fig 16) had developed at the port of Hay Point waiting to berth and load coal. Demurrage at that time was estimated at approximately US$5 per tonne causing considerable grief among Miners. Compounding the port issues were supply chain misalignment issues and daily operational failures.



Source: BMT

Fig 16. DBCT vessel queue 2005 (DBCT Management Master Plan 2006)

However, the commercial desire to control demurrage costs remained secondary to the need to sell coal whilst prices were high. This seemed viable at the time as the demurrage risk was contractually capped and the high coal price far exceeded demurrage losses. Over time though, the increasing vessel queue caused a shortage of shipping which forced the hire rates to escalate. Vessel demurrage rates are a reflection of the daily market hire of the vessel so, as the daily hire rates escalated, so did the demurrage exposure. Eventually, the Miner's complaints to the State Government forced a report on the causes of vessel queuing at Hay Point, particularly DBCT.

In 2007, an independent review of the Goonyella Coal System was commissioned by the Queensland State Government. The report, known as the O'Donnell Review, recommended the establishment of an independent body controlled by a Board comprised of coal chain participants and the appointment of a Central Coordinator to oversee and coordinate supply chain alignment activities.

By 2008, a Memorandum of Understanding had been signed by the coal producers and the supply chain service providers to appoint a Central Coordinator, identify improvement initiatives, develop an integrated service delivery plan for the entire supply chain and monitor/report performance. The formation of the Integrated Logistics Company (ILC) followed in 2010. The ILC's first function was to "map" the Goonyella supply chain as a system, rather than as a series of individual silos. Due to past misalignment of infrastructure development, a System Master Plan was developed to suggest and align future supply chain infrastructure expansions.

The first System Wide Master Plan for the Northern Bowen Basin covered a 10 year planning horizon which encompassed:

- the development of a common set of assumptions for the determination of system capacity;
- the development and maintenance of a system wide simulation model, which has been used as a tool to assess system capacity and evaluate future capacity requirements;
- to align and assess alternative expansion options; and
- to develop an agreed coal chain operating mode which sets the service delivery level.

Fundamental to any attempt to provide a systemic approach to planning is the need to agree on just how the system will operate in the daily task of moving coal from mine to ship's holds. This was done by developing a common set of system capacity assumptions agreed by all stakeholders which will in turn, set the level of deliverable system capacity (being the lowest capacity of any one part of the system).

Should these principles be adhered too, service providers can contract capacity according to an agreed maximum system capacity, determined by the System Master Planning model which delivers certainty to the Miner. As such, all supply chain participants have to work with the ILC and each other to ensure alignment of operational capability (Fig 17).

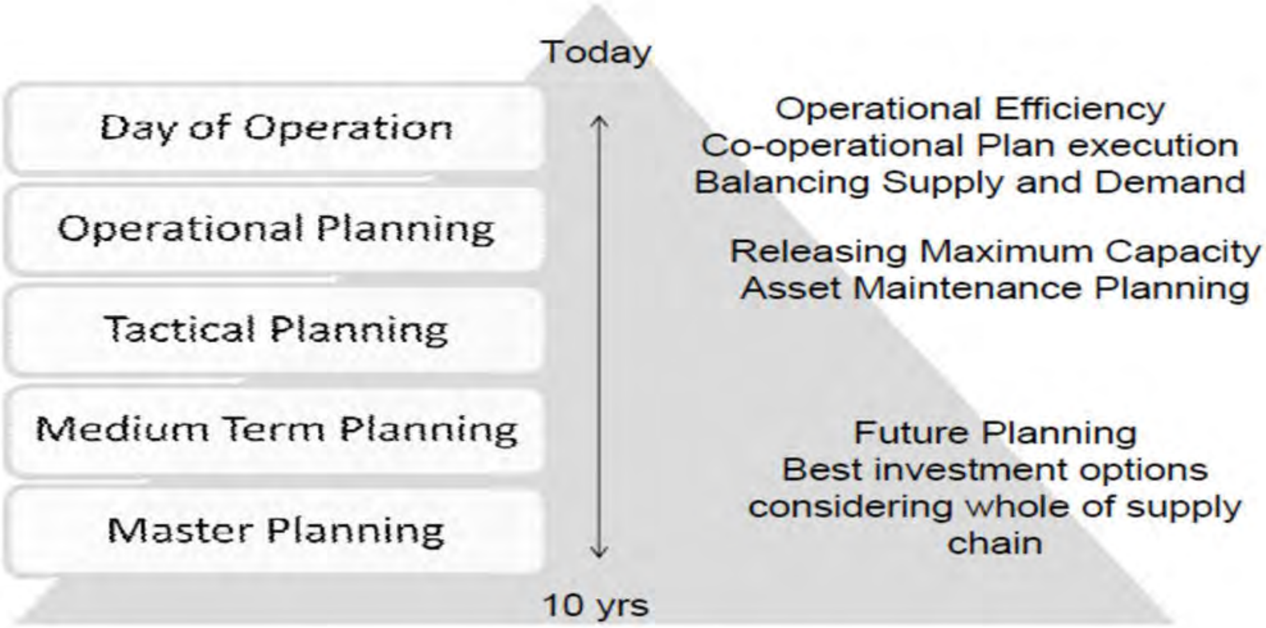


Fig 17. ILC Planning horizon (ILC 2008)

Progress has slowed in the last few years despite the validation of its success in the increased throughput of the system. With the current low coal price and the fierce competition within the industry, the ILC is under pressure to justify its continued existence as it is the Producers who pay most of the ILC's costs. However, in consideration of the past success of the independent body in developing efficiency programs and the likelihood of increasing operational dysfunction caused by competition between the Producers if demand wanes, there is considerable scope for further success in reducing export logistic costs, including demurrage risk mitigation, which will benefit the Producers.

2.7 Cargo Demands

As discussed in the opening chapters, the central Bowen Basin provides a variety of different coal types. Accordingly, a variety of different coal types are being stockpiled in the terminals. The end use of the different coal types dictates any requirement for separation to avoid contamination. Thermal coal, which is used only as a source of heat for power station boilers, has a greater tolerance for accidental mixing. PCI coals are a little more intolerant as the carbon content as well as the heating properties are important to the blast furnace mix. Hard coking coals however, are intolerant to any form of cross contamination by lesser quality coals. The requirement to separate different coals then places certain planning complications on the terminal stockyards as scarce stockyard space is lost to clear separation zones. Stockyard complications can also arise if the full volume of a coal type is not completely loaded on the carrying vessel, as any stockyard remnant must be left until the same type of coal can be overloaded for the next shipment. This impacts the velocity of product moving through the supply chain which inherently reduces the capacity of the system.

There are other issues associated with cargo demands. Both terminals at the Port of Hay Point have the ability to produce multiple different types of cargo blends to the receiving vessel. This is acknowledged by coal buyers as a preferred value-add service capability and beneficial to their “just in time” inventory control. Miners also acknowledge the commercial advantage that port blends provide over their competition in selling coal. However, cargo blending through terminals which have constrained stockyards, does come at a cost to terminal capacity.

Because the Hay Point terminals can use a combination of reclaimers to service any ship loader, miners do not have to mix different coals in their site stockyards, which minimizes their machinery (bulldozers) use thus decreasing their capital and opex costs. However, this means that trains are only loaded with single product in wagons. Because trains are allocated specific time slots at mines, there is only sufficient time to load single product trains, which means that cargo parcels will arrive at the port terminal in approximately 9,800 mts sizes. It is therefore impracticable to overlay the product from each train when assembling the stockpile in the terminal as the reclaiming operation will not blend the different overlaid products effectively.

The only way to achieve a true mix of different coal products into the ship is to reclaim from two (or more) separate coal stockpiles. Each stockpile takes up yard space that could be used to build cargo for another vessel and by doing so, slows down the velocity of the terminal. Further, most blends require a strict but unbalanced ratio between the products which requires one reclaimer to operate below its rated capacity, again slowing performance. Finally, should one reclaimer experience a breakdown, the other reclaimer often has to stop and wait for the repair to meet the integrity of the blend ratio. Again this is introducing inefficiency into the terminal operations which is manifested by a lower capacity.

A larger stockyard would allow more cargoes to be built but comes at increased capital cost which therefore increases the cost to ship coal. As mentioned previously, the miner is responsible for the delivery of the cargo to the ship in either and FOB or a CIF system, so it is a cost of operation to the miner which is not allowed as a deduction in the royalty calculation. Further, the terminals are at the end of the export supply chain meaning their coastal land is much more expensive than cheaper inland supply (e.g. mine sites).

After multiple discussions with both the terminal customers and the coal buyers, the blending ability provided by the terminals is considered too commercially important not to provide and the reduced terminal capacity is accepted as a necessary operational constraint. What has not been investigated is the impact on larger vessel loading with blended cargoes. While the deep dredged berth depths at DBCT and HPCT berth 3 allow vessels to load to their maximum sailing draft, they still require the highest daily tide to sail. If blending delays result in the ship missing this tide, it may well have to delay its sailing until the next day’s highest tide, which forces delay into all the ships waiting to load. In the case of HPCTs berth 1 and 2, the vessel must sail on the high tide as it would otherwise touch the bottom on the falling tide if it stayed. While this will not result in a delay, it can reduce the maximum cargo uplift on the vessel, which becomes an economic loss to the Miner (reduced revenue) and the coal buyer, as the vessel has not maximised its cargo carry capability.

Another issue associated with the many different types of coal available resulted in some buyers loading as many different products as possible on the one ship to maximise the variety of coals delivered to the steel mill. As the cargo holds of a ship are segregated for strength and safety, each hold can be used as a natural segregation between coal types. The more holds in the vessel presented more coal types that could be loaded. Because of stress factors, a ship cannot load an entire hold in one pour. In fact, the pour size in each hold is varied to meet allowable stress on the ship, as well as meeting trim requirements.

As a change of product requires the last product to be run through the entire loading system, including cleaning the sampling plant, considerable time can be lost changing products. To mitigate some of the loading losses, DBCT instigated a policy of reducing the maximum number of cargoes that can be loaded on any one ship.

While discussing cargo demands, it must be remembered that coal is a fossil fuel subject to spontaneous combustion and the longer the coal stays on the ground, the more susceptible it is to ignition. While this has not been a major problem for the terminal, there has been an instance when a coal product on a train did ignite as the train was waiting to unload at the terminal. Early discovery meant that the train was removed to a safe location to extinguish the fire although, if it had not been discovered and the train commenced unloading, the ignited coal may have caused severe damage to the terminal infrastructure (conveyor belts and transfer towers) that would have taken considerable time and cost to repair.

2.8 Shipping Trends and Impacts

Historically, the Port of Hay Point's shipping mix has largely been dictated by draft limitations in the discharge port. However, since the early 90's, many of these ports have deepened their harbours, channels and discharging berths to receive larger vessels. This allows the importer to take advantage of economies of scale with their ship selection (another advantage to coal buyers of FOB sales). While the following graph (Fig 28) is particular to DBCT, the trend is relevant to the Port of Hay Point in that the steel mills are moving to larger vessels sizes to increase the diversity of coal products and the amount of cargo that can be loaded when charter hire economies favour the larger vessels.

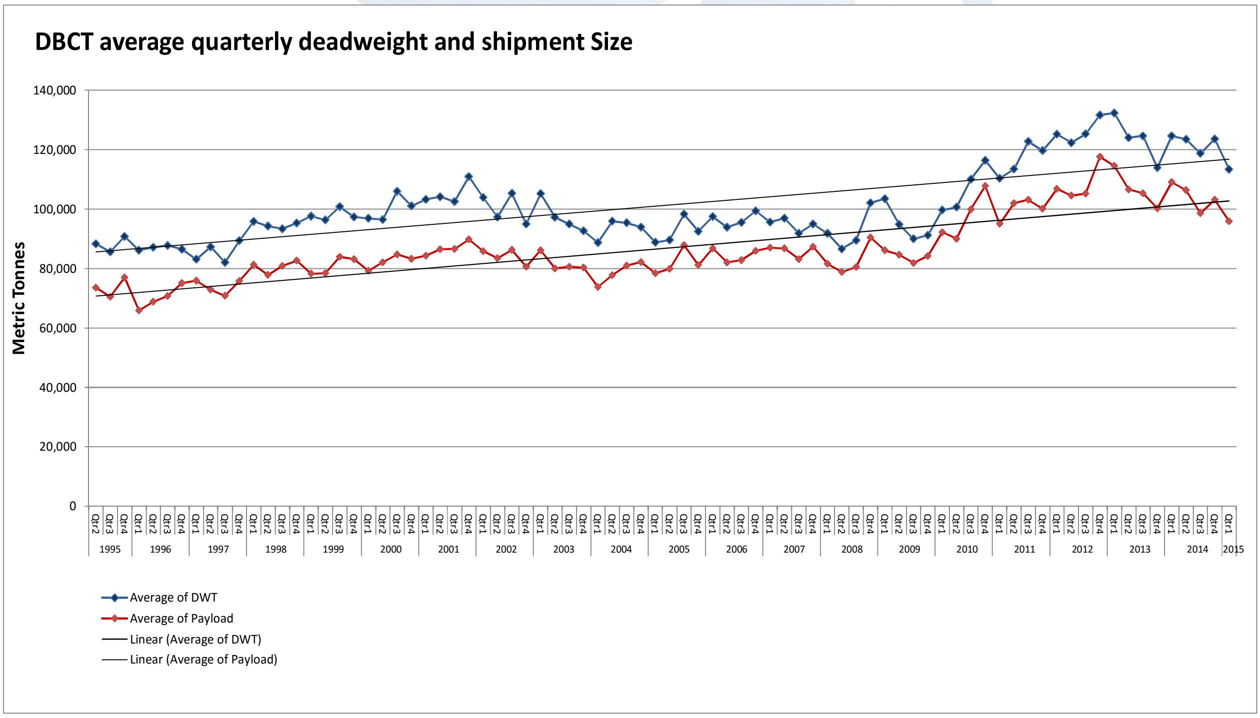


Fig 18. DBCT shipment and ship size development (DBCT Management 2015)

To focus on recent shipping trends, data was collected from the Queensland Department of Transport records for all ships loading at Hay Point from 30 December 2014 to 28 February 2016. Ships that did not load coal at Hay Point were excluded from the analysis. In that period, 1285 vessels loaded coal at either HPCT or DBCT. The data was then filtered by deadweight to represent the four classes of bulk carriers that are known to carry bulk coal resulting in the following observed vessel calls for each class of ship:

- VLC - 548 ships or 42.65% of the total Hay Point ship calls
- Cape - 46 ships or 3.58% of the total Hay Point ship calls
- Panamax - 619 ships or 48.17% of the total Hay Point ship calls
- Handimax - 72 ships or 5.6% of the total Hay Point ship calls

To develop some specific conclusions, further analysis was performed using the sailing draft of all vessels loading at the port in the period. As noted from the above analysis, 90.82% of all vessel arrivals were in two classes - VLCs (42.65%) and Panamax (48.17%) meaning coal buyers used two particular vessel classes for the shipping task. As can be seen from Fig 19, analysis of these vessels shows two predominate sailing draft ranges.

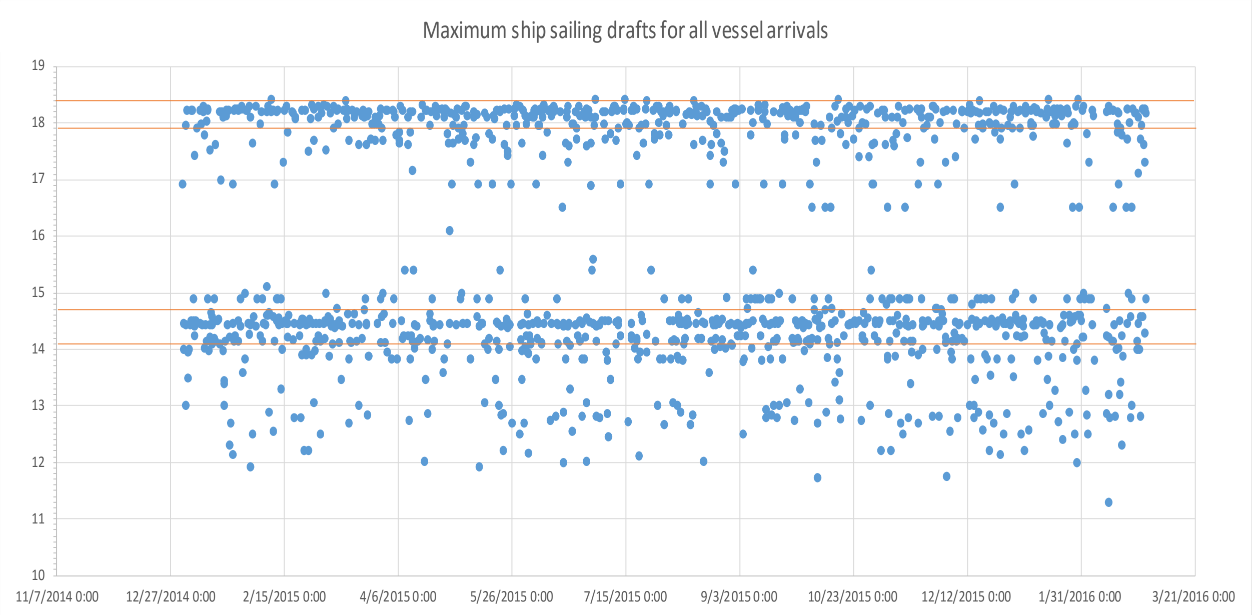


Fig 19. Maximum sailing drafts for vessel arrivals at Hay Point 2015 (PALS 2016)

The higher draft range (i.e. > 17.9m) in Fig 19 (32% of all ships) corresponds to vessels having a deadweight of approximately 170,000 – 185,000 tonnes, which aligns with the Dunkerque-max Cape size class of ship and the 200,000 dwt of the Newcastle-max class vessels (Fig 20).

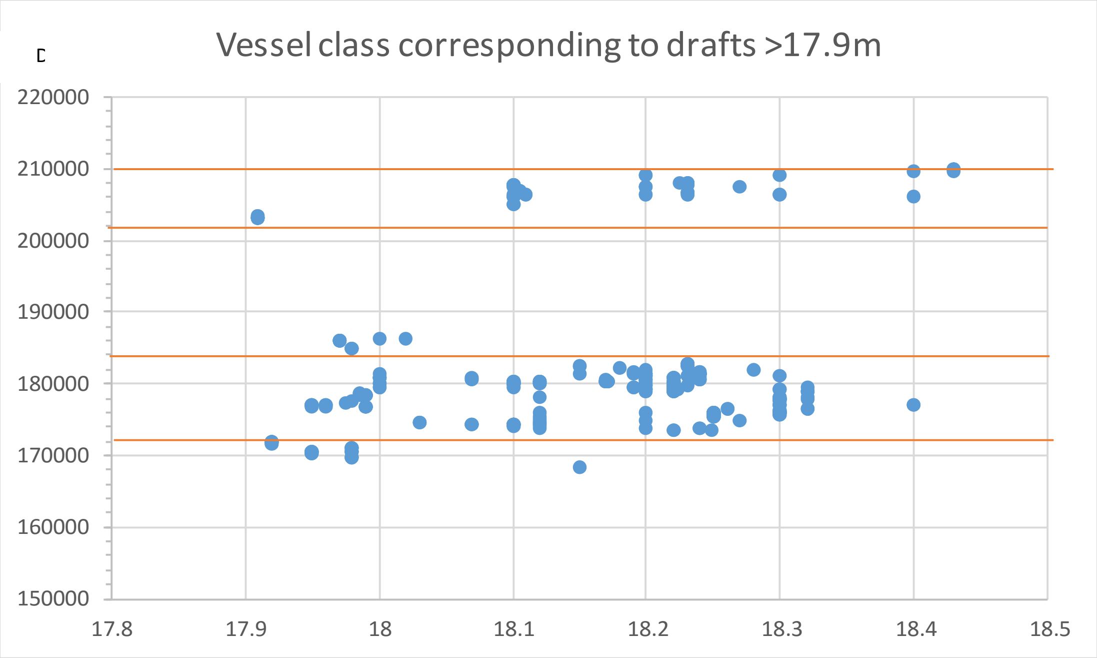


Fig 20. Vessel deadweight corresponding to specific draft (PALS 2016)

The lower draft range (i.e. >13.9 but <14.7m) in Fig 19 (36% of all ships) corresponds to vessels having a deadweight of approximately 72,000 – 84,000 tonnes (Fig 21), which is aligned with the Panamax class vessels. Further analysis of the discharge port range for these vessel arrivals shows a concentration of Chinese, Indian, Indonesian, Swedish and some Japanese discharge ports, most of which are draft restricted.

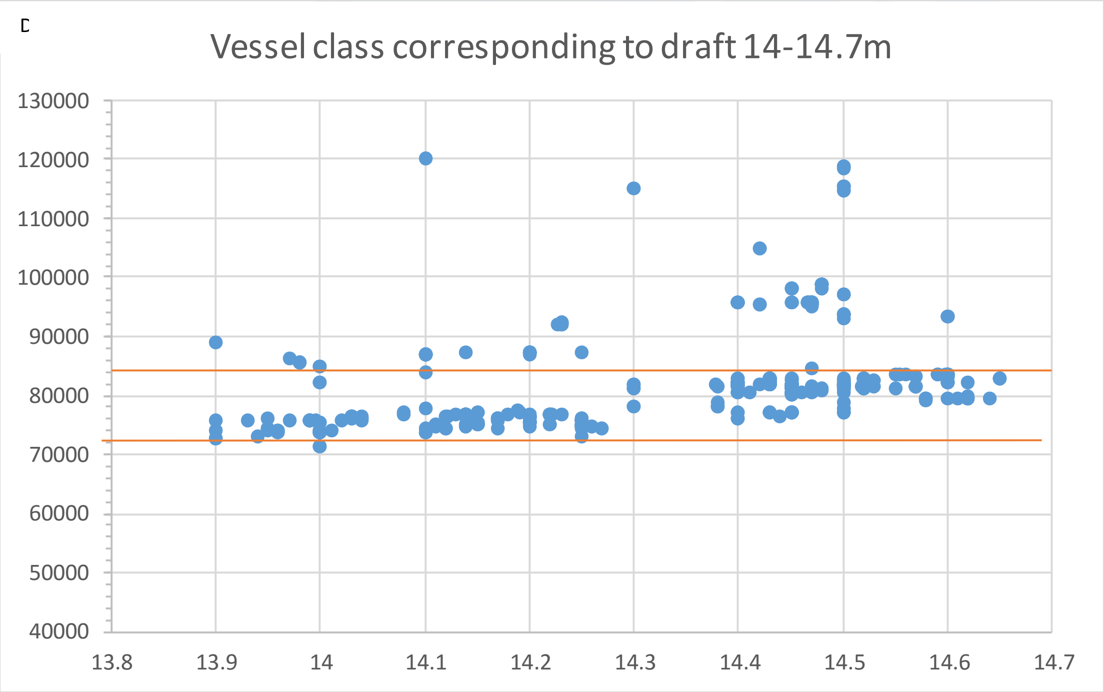


Fig 21. Vessel deadweight corresponding to specific draft (PALS 2016)

Other discharge ports in this range are deeper than the summer sailing drafts suggesting that the cheaper hire rates of this class when compared to Capes, may have been a contributing factor in the choice as shown in Fig 22. For example, the number of Panamax vessel arrivals at the port increased from August 2015, which corresponds with the increasing disparity between Cape and Panamax charter rates.

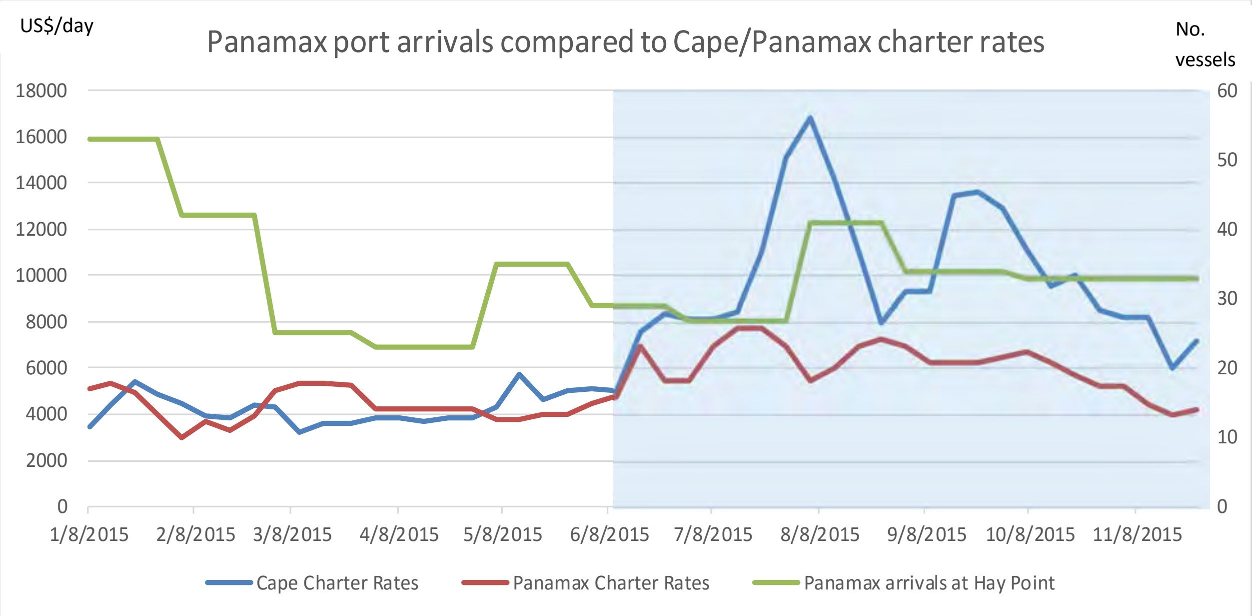


Fig 22. Comparison of Panamax and Cape charter rates against Panamax port arrivals (PALS 2016)

It is clear from Fig 18 above (increasing vessel size over time) that there is a continuing trend for coal buyers to use the largest vessel that the discharge port can accommodate when it is economically feasible to do so and that this trend will continue in order to maximise economies of scale for just in time delivery. The larger Cape class vessels require >17.9 meters sailing draft, meaning that any siltation of the existing berths at the Hay Point terminals will cause loading delays pushing consequential delays to all ships queued to load, regardless of that vessel's draft. Based on the data, any reductions in port depth will impact on the coal buyers choice of vessel imposing greater sea freight costs on the landed price of the coal and reducing the commercial appeal of the port. Accordingly, this will have a derogatory impact on the competitiveness of the port.

2.9 Navigational Safety UKC and DUKC

Navigational safety and good seamanship mean that the vessel is never placed in a compromising situation that may jeopardise the safety of the ship, its crew and cargo or the environment in which it operates. A port is the interface between the ship and the cargo operation, whether that be unloading or loading. However, as ports are attached to the land, the interface between the ship and the port will be at a place where the ocean depths are generally receding. Great care must be taken to ensure that ports have suitable navigation channels and berth pockets to allow the ship to; anchor in safety when waiting for a vacant berth; and navigate on to or away from the berth safely. This requires the provision of navigation assistance with well-marked entrances and channels, well trained and experienced pilots and towage services that allow the ship to connect and disconnect to and from the berths.

A vessel's Plimsoll Line will indicate how far the vessel can be immersed to sail safely in the ocean, however, any navigation in a draft restricted waterway requires an extra tolerance between the shallowest part of the channel and the deepest part of the immersed ship. This is known as "Underkeel Clearance" (UKC) and must include tidal movement across the length of the channel as well as wave conditions that may affect the position of the deepest part of the vessel, relative to the sea bed.

The Queensland Government (MSQ) is responsible for navigation within the State's coastal limits, which are defined as being 3 nautical miles seaward of the territorial sea baseline (considered as the lowest shore tidal mark for simplicity). MSQ and the relevant Port Authority are then charged with authority over the confines of any Port limits within this zone (*Transport Operations (Marine Safety) Regulation 2004*).

Authority for the port is vested in the Regional Harbour Master (RHM) with mandatory sections of the Port Procedures subject to the RHM directions under section 86 of the *Transport Operations (Marine Safety) Act 1994*. The RHM uses the Hay Point Vessel Tracking Service (VTS) at the Hay Point Port Control Centre to convey his actions. The VTS facilitates the safe, efficient and environmentally responsible movement of shipping within the Pilotage area.

For the Port of Hay Point, Pilotage is compulsory within the pilotage area for all commercial vessels >50m in length. Management of the pilot service rests with NQBP who is also the Statutory Port Authority for the Port of Hay Point. Harbour pilots access vessels using a helicopter service at the Port which reduces the pilots' transit time. During the pilotage operation, the Master of the ship still holds full responsibility for safe navigation. The Pilot has responsibilities for compliance with the provisions of the associated Act and Regulation, however the Pilot is only providing advice and does not relieve the Master and the owner of the vessel of their responsibility.

Once the vessel arrives at the port limits and if the berth is unavailable, the ship will be ordered to either the northern anchorage (if loading for DBCT) or the southern anchorage, if loading at HPCT (Fig 23). If these anchorages are full, there is another anchorage further seaward. Pilotage to the anchorage area for an arriving vessel is not compulsory.

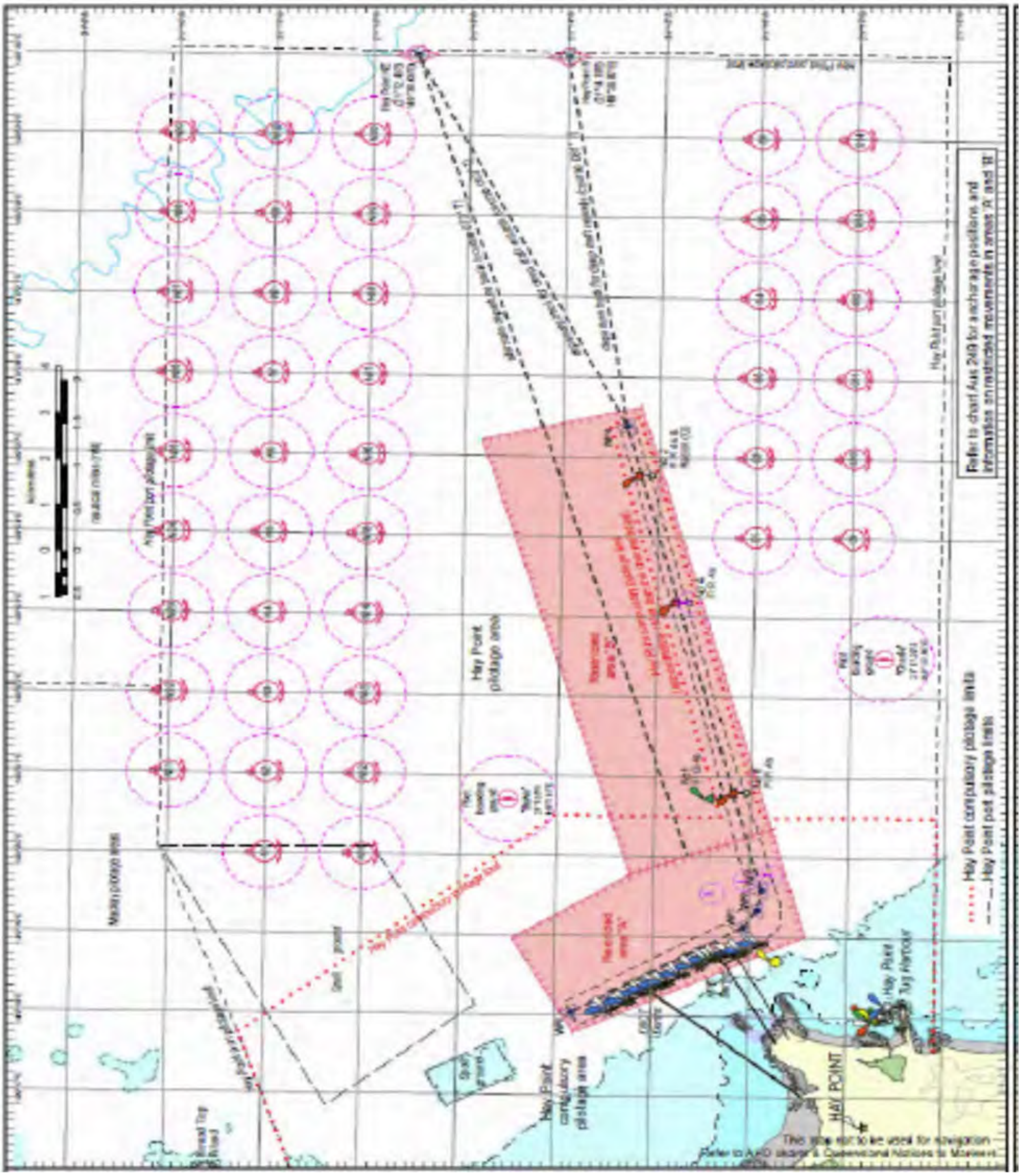
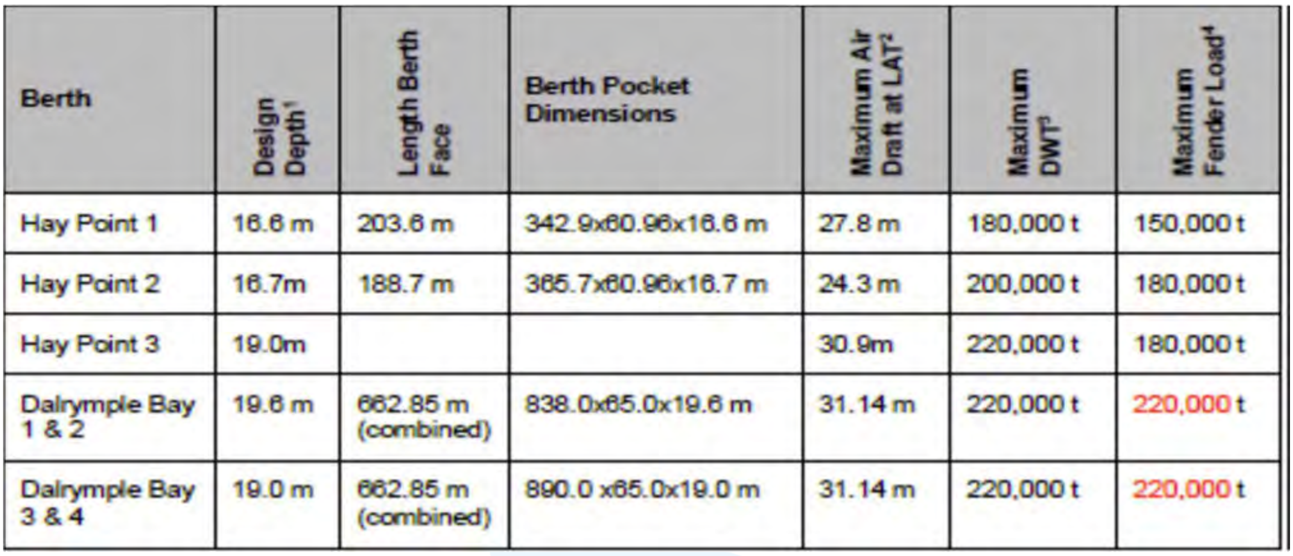


Fig 23. Hay Point Anchorages and Departure Path (MSQ 2016)

Designed berth depths alongside the terminals are illustrated below with maximum air drafts (Fig 24).



Berth	Design Depth[1]	Length Berth Face	Berth Pocket Dimensions	Maximum Air Draft at LAT[2]	Maximum DWT[3]	Maximum Fender Load[4]
Hay Point 1	16.6 m	203.6 m	342.9x60.96x16.6 m	27.8 m	180,000 t	150,000 t
Hay Point 2	16.7m	188.7 m	365.7x60.96x16.7 m	24.3 m	200,000 t	180,000 t
Hay Point 3	19.0m			30.9m	220,000 t	180,000 t
Dalrymple Bay 1 & 2	19.6 m	662.85 m (combined)	838.0x65.0x19.6 m	31.14 m	220,000 t	220,000 t
Dalrymple Bay 3 & 4	19.0 m	662.85 m (combined)	890.0 x65.0x19.0 m	31.14 m	220,000 t	220,000 t

Fig 24. Maximum Hay Point berth pocket dimensions (MSQ 2016)

While the Port is within the confines of the Great Barrier Reef, it is also susceptible to tropical lows which can produce violent storms reaching cyclonic strength. As a precaution and to aid safe navigation at all times, all vessels are required to be ballasted on arrival and load so as to keep the propeller fully immersed in the event the vessel needs to vacate the berth with short notice. Because of the movement of the ship alongside the berths in stronger winds and rising seas, it is not unusual for loading operations to be suspended when the wind strength exceeds 25 knots and in extreme situations, vessels may be ordered by the RHM from the berths to avoid damage to berth fenders and/or the vessel. Smaller vessels (< 60,000 dwt) are usually impacted first, with the effect on larger vessels depended on the stage of loading and the vessels' immersion.

In order to ensure safe navigation and to minimize grounding risks, the port requires an Under Keel Clearance (UKC) system to be used by all vessels. The UKC is a static measurement of the minimum distance from the lowest point of the vessel to the highest point of the seabed on the maneuvering route. The MSQ Port Procedures require minimum Clearances (UKC) for all aspects of vessel maneuvers within the Port Limits.

Because this is a guideline only, it tends to be conservative as it must take into consideration a variety of circumstances and vessels. Unsurprisingly, it can be overruled by the RHM depending on conditions, tide or special circumstances. The conservatism of the original safety allowance used in the UKC calculation (known as Stage I) has been revised as more confidence was developed around the actual safety risk, based on acquiring knowledge of the depth and profile of the seabed. The port has since progressed to Stage II UKC which reduced the safety tolerance to a 5% margin of the maximum sailing draft over and above the 1m static allowance i.e. the calculation to determine the applicable UKC is 1m + 5% of the maximum sailing draft. For reference, the full guidelines are:

- On arrival the UKC must be a minimum of 1.5m for two hours from the commencement of the maneuvered.
- When alongside the berth a vessel must maintain a minimum of 1.5m UKC

- On sailing, there are two calculation options – one calculates a maximum sailing draft when the minimum port depth and tide are known while the other calculates the minimum UKC when the maximum draft is known.

Because of the conservative nature of the UKC calculation (Fig 25), a more precise system was invented by OMC International Pty. Ltd. that considers relevant real time and predicted conditions to better define the navigation risk. The Dynamic Under Keel Clearance (DUKC) System can not only provide the maximum achievable draft for the conditions, but more importantly, it provides a departure window that can be used to maximise loading. The system uses accurate vessel information and hydrodynamic modelling to predict the movement of the ship. By matching that against the latest bathymetry and sea conditions data measured by sensors in the marine environment (tide, current, wind and wave) a much more accurate UKC can be determined. The DUKC development has been strongly supported by NQBP with Hay Point being the first port where the system was used in 1993.

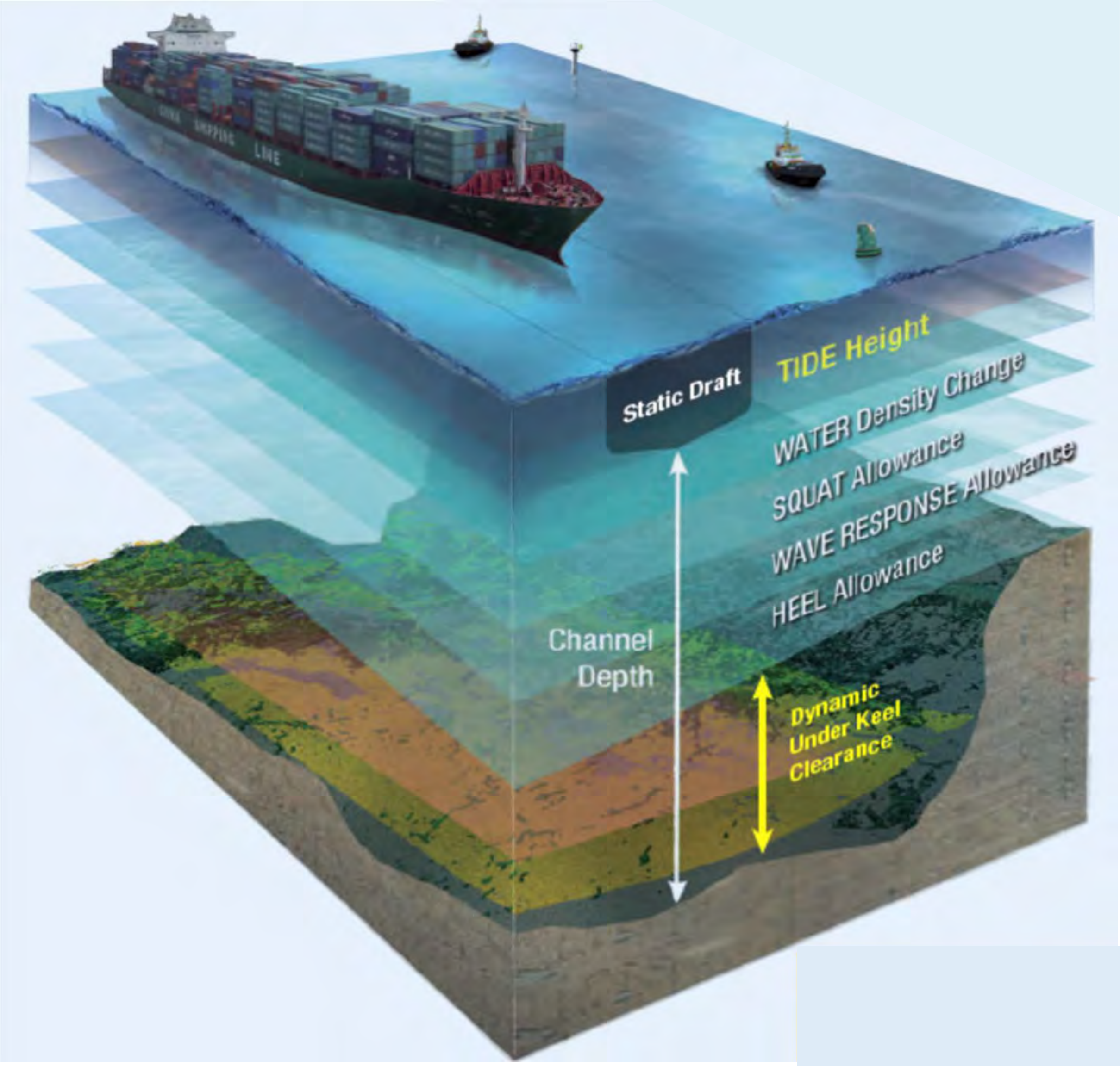


Fig 25. Explanation of water depth (OMC International 2015)

The use of DUKC at the Port of Hay Point has provided a system to maximise cargo loading and minimise unproductive berth time. This benefits the customer (increased cargo), the Miner (more revenue), the Government (increased royalties) and the terminal/supply chain operations (maintaining velocity of throughput), without compromising the safety of ship or the port.

Section Three – Contractual Arrangements and Royalties

3.1 Contractual Development as a Driver of Port Operations

HPCT operates a functional supply chain by controlling the delivery of BMA/BMC coal product through the terminal and in to the ship. The mines are owned by BMA/BMC, the rail contract is managed by HPCT and the terminal operated by BMA thus providing pit to ship control. The DBCT supply chain however, has a complexity of contracts which can cause dysfunction in the daily operations as there is no single supply chain contract which binds all service providers to an integrated coal service delivery from the pit to port. Instead, there are separate contractual silos for:

- Rail network services, which sees rail pathing contracts between the above rail Operators and the rail network provider;
- Above rail haulage contracts between the rail haulage providers and the miners;
- In the case of DBCT terminal services, a regulated Standard Access Agreement between the terminal lessee and the miners which sees the terminal Operator nominated as the miners rail agent;
- Separate rail haulage contracts between BHP and the rail haulage providers; and
- Rail network service contracts between BHP rail and the network rail provider.

This mix of contracts sees the rail network provide rail paths for the train journeys to and from the mines on a regular scheduled rail service basis (i.e. even scheduled rail journeys or railings), while the port campaigns rail deliveries to mines whose cargoes are being built for the next ship in the berthing queue, based on when the ship arrived. Rail haulage providers have no contractual obligation to the DBCT terminal, despite the terminal ordering the trains on behalf of the miner. Further, there is no contractual interface between the rail system and the terminal to control how the supply chain should operate, despite both being regulated service providers. The rail network is supplying common infrastructure to all mines and two bulk export sea terminals against a backdrop of mining customers openly competing against each other in the sale of their product to the global steel making industry.

3.2 Value and Royalty Structure

As HPCT is a dedicated export facility for the BMA and BMC mines, the actual cost of the service provision is not divulged. However, from past presentations the terminal's costs were shown in the lowest quartile of bulk terminal operating costs prior to the last expansion (HPX3). Further, HPCT controls all logistic and quality functions from the mine to the ships' hold, which gives their customers unlimited blending opportunities. The terminal delivers 17 primary products and in excess of 22 blends and in 2013, the BMA Asset President referred to HPCT as providing a significant competitive advantage because of this blending ability. However, the terminal's total service provision cost (capital and opex) has increased significantly after the commissioning of HPX3, largely due to the inflated construction costs. The total asset value was quoted at $3 billion in the official HPX3 opening statement issued by BHP Billiton (16 December 2015) which will have inflated the cost per tonne to provide the terminal service.

DBCT is a regulated asset and so the terminal value and service charges are transparent. Like HPCT, considerable value to both the customers and the owners reside in the asset. For the customers, it is a competitive advantage to be able to create almost any coal blend required by a steel mill which in turn increases the attraction of the terminal. For the owners, this attraction is evidenced by the length of the service contracts – the longer the contract, the more certainty for the return to the owners. Further, with the current throughput, the supply chain has shown a capability to service whatever the mines can produce. This value is of course based on the ability of both terminals to meet shipping demand. Should port draft be unable to be maintained in the future, it would jeopardise the viability of the industry during a pricing depression and possibly give off-shore suppliers a competitive advantage that the Queensland industry has strived to recover.

For the terminal owners, any inefficiency that reduces the terminals' attraction could cost volume. In the case of HPCT, this will be a bottom line impact on their P&L. For DBCT, the Lessee is somewhat protected by regulation in the form of take or pay commitments from the customer base. However, with a large percentage of the customer contracts due for renewal over the next 2-3 years, any inability of the terminal to service the needs of deep drafted vessels could cause decreasing coal sales, which in turn could see miners allowing their port contracts to expire thus jeopardising investment in the terminal.

Reduced shipping demand would result in economic loss to:

- The Port Authority (NQBP) through reduced harbour dues revenue (the levy paid by miners on every tonne of coal exported).
- Other Government agencies and private businesses responsible for the provision of maritime services
- Queensland Government through reduced royalties.

In a statement from the Queensland Resource Council (QRC) in Feb 2016, the State Government was reported as having received $2.4 billion in royalties which accounted for approximately 13% Treasury revenue. Any reduction in throughput would have a drastic impact on the State's budget and threaten social infrastructure projects, which are reliant on subsidized funding from other revenue streams. Unemployment is already a major issue in the current mining downturn with over 20,000 industry jobs lost in the past two years alone (Queensland Resource Council 2016).

3.2.1 Royalties

Royalty payments are calculated according to Schedule 3 of the Mineral Resources Regulation (2013). Royalties are a liability arising from the sale of certain minerals. The value of the royalty is calculated by the gross value of the sale after deducting certain permitted expenses. For example, in the case of coal and after the price upturn of 2012, the State Government introduced three levels of coal royalties:

- Up to and including $100/mt = 7% of the value of the sale;
- Over $100 and up to $150 = first $100 is 7% of value, then 12.5% for the balance; and
- More than $150 = first $100 is 7% of value, then for the next $50 it is 12.5%, then finally 15% for the balance

The sale value must also include:

- any exchange rate losses or gains between the time of the sale and receipt of the proceeds;
- any contractual despatch paid at the load port because of early loading;
- any reimbursement for royalties paid by the buyer of the coal; and
- the value of the mineral, even if the product has been traded for no monetary consideration.

Permitted deductions from the value include:

- demurrage incurred at a loading port due to late contractual loading; and
- Ocean freight and insurance (generally this will not be applicable to Australian coal sales which are made on FOB terms, where the coal buyer arranges and pays for the ocean freight and insurance).

It should be noted that supply chain delivery costs (often take or pay) are not considered to be a permitted deduction.

However, the greatest potential loss comes from demurrage exposure. Any reduction in water depth will cause “stop loading” delays to deep drafted vessels due to the port regulation to maintain a static distance between the bottom of the ship and the seabed. As the tide falls during the loading operation, the terminal will be forced to stop the loading and wait for the rising tide to ensure preservation of the minimum under keel clearance. This delay has a variety of possible impacts from extending the loading time (increasing demurrage) to short-loading the ship to meet the tide, thus reducing sales revenue and royalties. The following diagram (Fig 26) depicts the full effect of reduced depth).

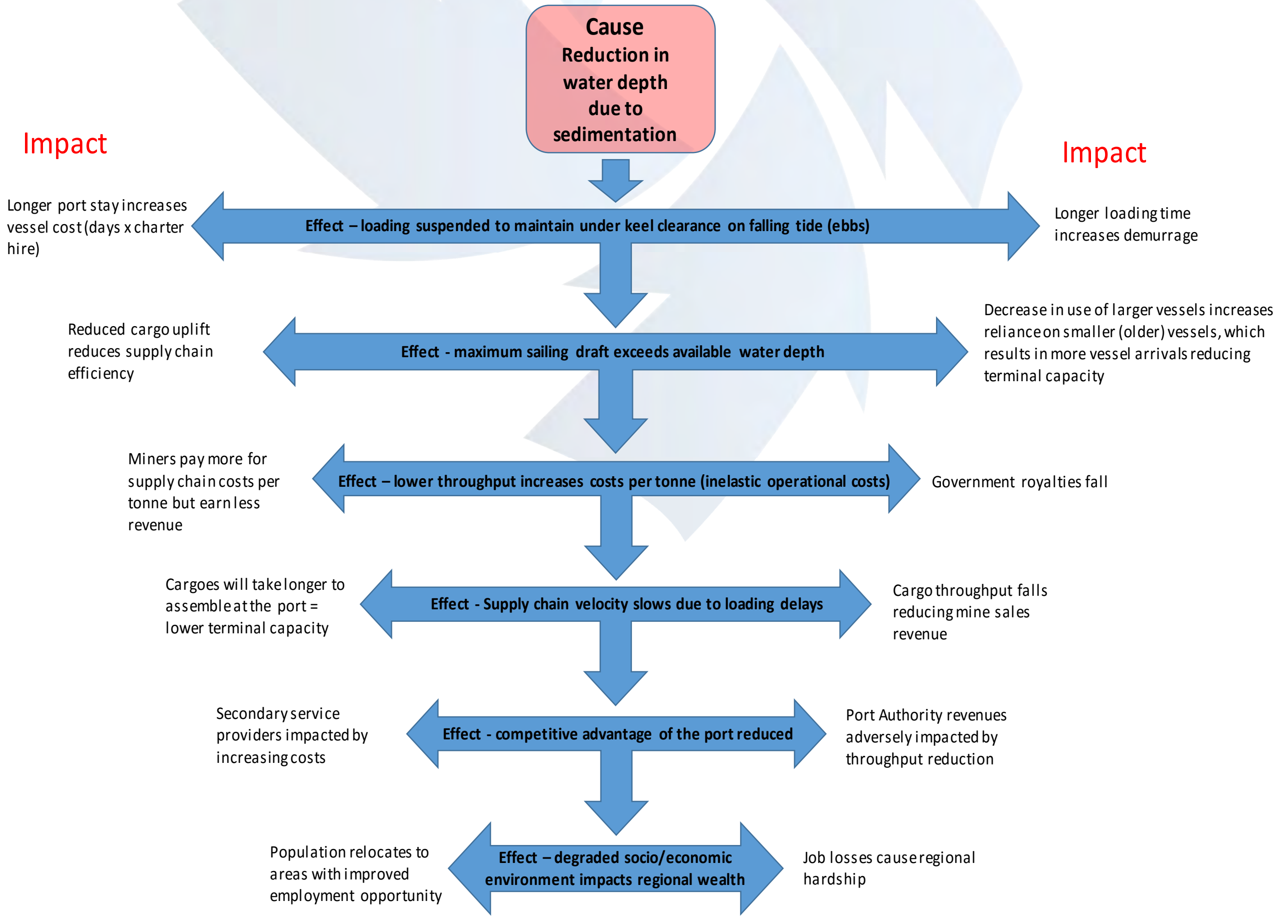


Figure 26 – Cause and Effect model depicting loss and impact from water depth reduction (PALS)

Section Four – Hay Point as a Port

4.1 History of the Port of Hay Point

The Utah Construction and Mining Company foresaw increasing Asian demand for coal and in the late 1950s started mineral exploration in the central Bowen Basin region of Queensland. In 1964, Utah established a joint venture with Mitsubishi in order to facilitate the emerging coal trade with Japanese steel mills. A ten-year agreement with the Japanese steel industry followed in 1965 which underpinned the granting of mining rights and the construction of the Goonyella railway by the Queensland Government for an estimated 2000 million tonnes of coal over an 84-year period (Molloy, Australian Mining 2008).

The Central Queensland Coal Association (CQCA) was then formed in 1966 and by 1967, open cut mining operations were well underway (Molloy, Australian Mining 2008) governed by the Central Queensland Coal Associates Agreement Act (1968). By early 1970, Utah were planning the commencement of the Goonyella and Peak Downs mining operations and the development of Saraji and Norwich Park in the central Bowen Basin. These mines required a new export facility resulting in the construction of the Hay Point Coal Terminal (HPCT) on freehold land at Hay Point, approximately 38 kms south of Mackay by CQCA. The Port of Hay Point was defined around the new terminal which commissioned on 5 November, 1971. To accommodate ship handling, the Government constructed the Half Tide tug harbor which was originally dredged to RL - 9.6m and provided shelter from the prevailing weather for tugs and line boats. The Tug Harbour construction was funded jointly by CQCA and DBCT (the DBCT Operator and its then Users) and opened in October 1987 (DBCT P/L).

In 1984, BHP paid a reported $2.42 billion (Molloy, Australian Mining 2008) to purchase UTAH International from General Electric making BHP a global mining company (BHP Billiton Chronology 2001). The purchase not only secured the Queensland coal assets but added mining operations in the United States, Brazil, Canada and Chile.

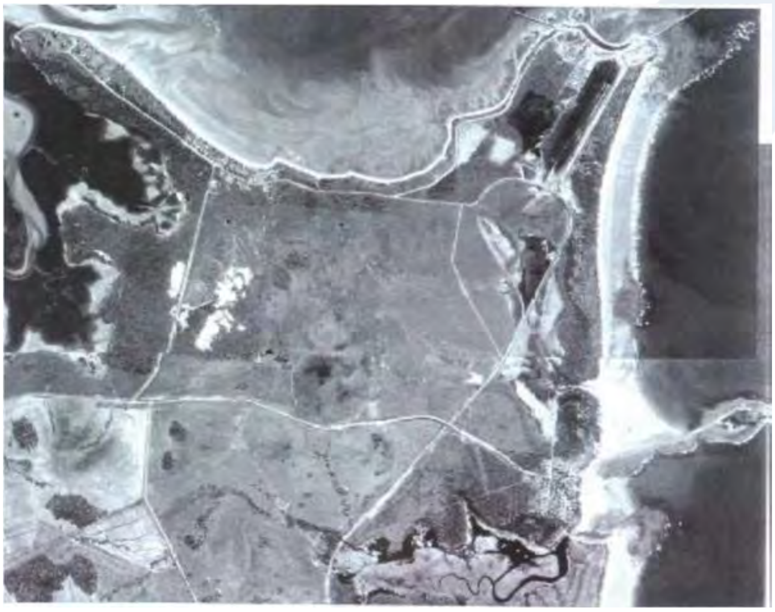


Fig 27. Early development of Hay Point Coal Terminal circa 1972 (Introspec Consulting 2012)

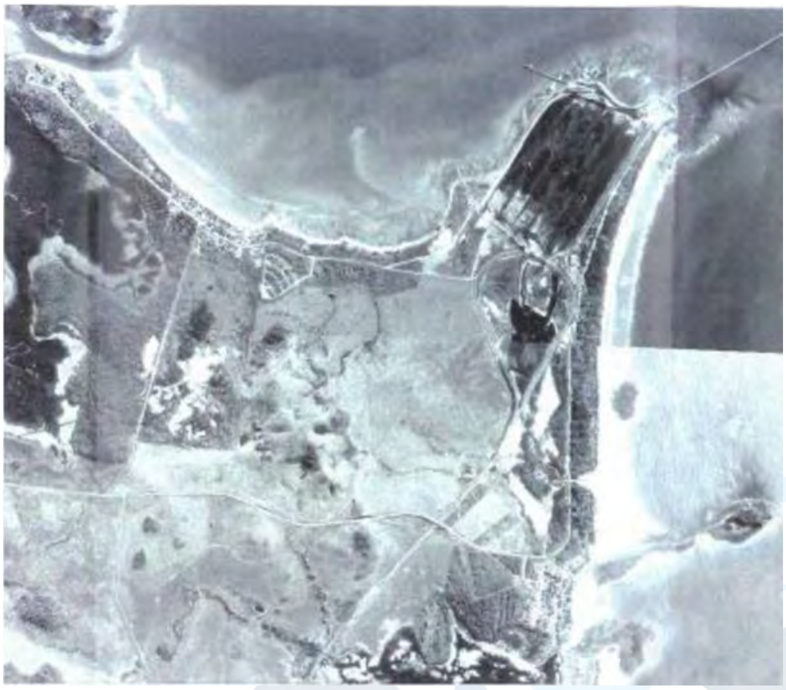


Fig 28. Hay Point Coal Terminal circa 1976 (Introspec Consulting 2012)

The success of Utah triggered interest in the region with more miners securing coal exploration and mining rights in the central Bowen Basin. By the late 1970s, a number of new coal mine developments not associated with Utah, were being planned but were unable to access CQCA port facilities at Hay Point as these were for the exclusive use of CQCA mines. These miners were Pacific Coal's Blair Athol mine, BHP/Mitsui's Riverside mine, the Shell Petroleum Company's German Creek mine and Mount Isa Mines (MIM) Oaky Creek mine. Pressed by these companies to develop an alternative export terminal to HPCT, the Queensland Government committed to the construction of a new common-user coal export facility immediately adjacent to the existing HPCT facility, to service the new mines. The new terminal facility, Dalrymple Bay Coal Terminal (DBCT), started construction in 1981 by the then Harbours Corporation of Queensland on behalf of the Queensland Government and commissioned in 1983. At this time, the Government also constructed electric rail facilities linking the new mines to the existing Goonyella to Hay Point rail line with the first train delivering coal to DBCT in October 1983, and the first ship (mv "Horyu Maru") loading/sailing in November 1983 (Rae, DBCT P/L 2015) with Blair Athol coal.

The significance of the location of Hay Point as the major export port for the central Bowen Basin mines should not be underrated. In addition to the economic requirement to locate the export port on the most direct and shortest route from the mines as geographically possible, shipping required the best deep water port. Accordingly, the terminal had to be located in an area accessible by rail and deep drafted ships, yet as close as possible to the mine sites.

The Central Queensland coast has one of the largest tidal movements in Australia (next to the Derby coast in North Western Australia), so it was important to ensure that the water depth around the export wharves was sufficient to accommodate the sailing draft of the expected shipping. To this extent, the Mackay region has deep water access reasonably close to the shore line from Prudhoe Island, south of Mackay to Scawfell

Island to the north of Mackay. With the best rail route down the great dividing range a short distance south of the Hay Point area (Black Mountain), the decision was made to locate the coal terminal on Hay Point. However, the off-shore wharves of HPCT still had to be located approximately 1.9 kms from the shore line in order to reach deep water and for DBCT, the distance is 3.9 kms, as the shore line recedes north of Hay Point.

The two terminals, together with the Tug Harbour, comprise the Port of Hay Point and service the mines of the central Bowen Basin (see Fig 29) which extends about 600km from the area around the town of Collinsville in the north, through the regions near Moranbah, Dysart, Emerald and Blackwater, down to Moura and Theodore at the southern end of the Basin traversing nine local government areas. Major coastal towns nearby include Bowen, Mackay, Rockhampton and Gladstone.

Fig 29. Bowen Basin coal fields and associated rail/port supply chains (Queensland Historical Atlas 2012)

4.2 Infrastructure Development to Accommodate Demand

While the two export terminals at the Port of Hay Point service different customers, the basis of port infrastructure development has been the same. HPCT has been financed, developed and expanded to meet the throughput requirements of the BMA and BMC mines. Alternatively, DBCT has been developed to meet the demand of the miners who could not access HPCT. As both terminals service the needs of the central Bowen Basin coal industry, it is not surprising to see a mirrored development path driven by export demand. The following graph (Fig 30) illustrates the development history of the two terminals over time.

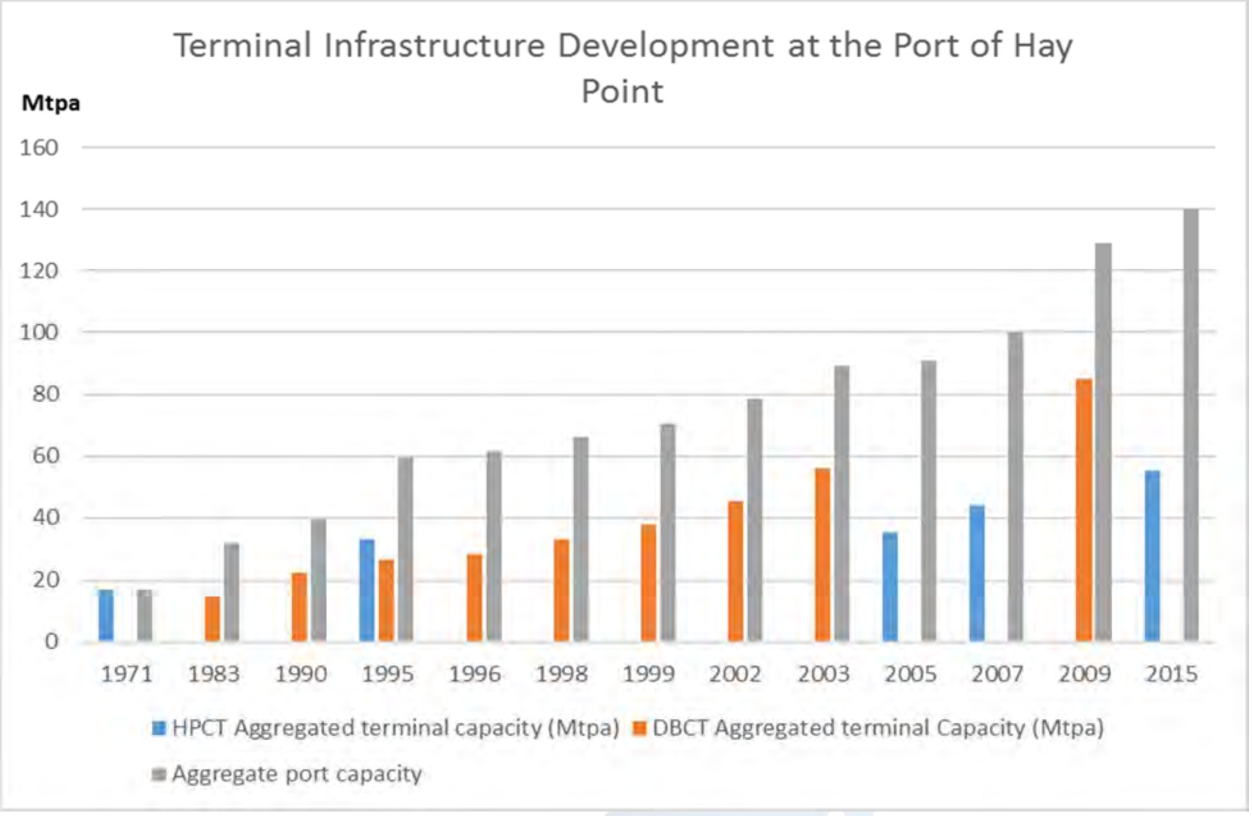


Fig 30. Hay Point coal terminal infrastructure development charting each terminals' expansion contribution to total capacity (PALS 2016) Note: HPCT expansions occurred in 1995, 2005, 2007 and 2015. DBCT expansions occurred in 1990, 1995, 1996, 1998, 1999, 2002, 2003 and 2009

4.2.1 Hay Point Coal Terminal

The terminal was developed by Utah Development Company and is now owned by BMA. The original layout consisting of 2 inloading rail tippler stations (now both bottom dump), a stockyard consisting of 6 rows, 3 stacker/reclaimers, 1 stacker and one berth with a design depth of 16.5m, which could load vessels up to 175,000 dwt. The original berth alignment caused issues with the prevailing current and with increasing demand, a second berth was added in 1975, but on a different alignment more compatible with the prevailing currents. After the construction of the second berth, the terminal capacity was rated at approximately 33 Mtpa.

Berth 2 was constructed to the north of berth 1 using a caisson design which makes further capital deepening of the berth impossible, as it will undermine the caisson foundation. This requires the loading operation to complete loading deep drafted vessels on the high tide using tidal assistance to achieve the sailing draft. Berth 2 has a design depth of 16.7m and can accommodate ships greater than 200,000 dwt, but still must complete loading on the rising tide. Tidal variation at the Port of Hay Point is between 5.5 - 6.5 meters.

In 2007, HPCT was expanded (HPCT expansion are prefixed with “HPX” meaning Hay Point Expansion) with the combined HPX 1 and 2 construction. HPX1 upgraded the inloading conveyor rate to 6,000 mts/hr, extended two of the stockpile rows (the two most western) adding 2 and 3 stockpiles respectively and added a new machinery bund with a new stacker/reclaimer (SR5). The new stockyard was linked to both inloading and outloading with the expansion adding an additional 7 Mtpa capacity.

HPX 2 relocated the stacker to the east of the first row and added a new stacker/reclaimer (SR4) in its place. The new stacker/reclaimer machine was connected to both outloading strings which provided an additional 3 Mtpa capacity.

In late 2015, HPX 3 was commissioned, which added a new berth (berth 3) dredged to 19m and a new shiploader. The old trestle which proved to be vulnerable to tropical cyclone activity (Fig 31) was also replaced. The new trestle was constructed to the west of the old trestle and required a new transfer system off-shore to be able to feed all the shiploaders. The outloading systems from the yard then had to be redirected from the old to the new trestle, via new surge bins. The yard machine configuration was also changed to 5 stacker/reclaimers.

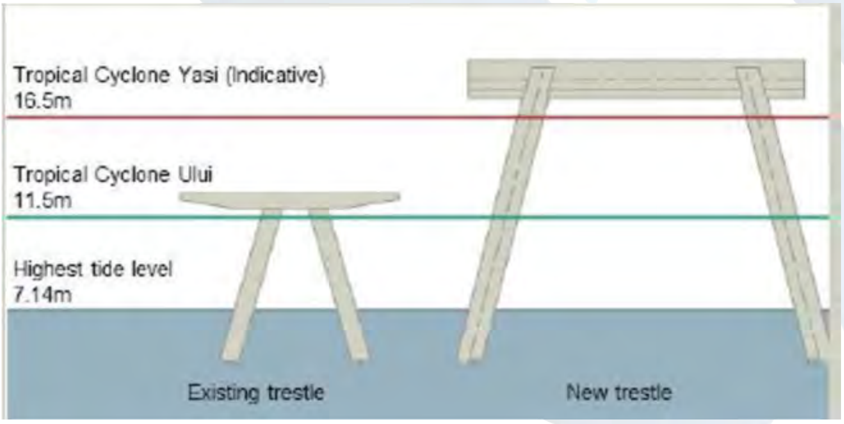


Fig 31. HPCT new trestle development for HPX3 (BHP Billiton 2014)

The current HPX terminal has a rated capacity of 55 million tonnes with a stockyard capacity of 1.45 million tonnes when stockpiles are dry season stacked to 4 benches (a bench equals the diameter of the reclaiming bucket wheel). In the wet season, the height is reduced to 3 benches which also reduces the stockyard capacity to 1 million tonnes. The terminal reduces the height of the stockpiles to avoid slumping in extreme rain events. Berth 1 is serviced by a luffing boom gantry with telescopic chute and is rated at 4,500 tph. Berth 2 has a rail mounted shuttle boom with telescopic boom and is rated at 6,000 tph and berth 3 has a rail mounted shiploader with luffing boom and is rated at 8,000 tph.

4.2.2 Dalrymple Bay Coal Terminal

From its conception in 1983 (Fig 32) until 2001, DBCT was owned and developed by the Harbours Corporation of Queensland which became Ports Corporation Queensland (PCQ) and then North Queensland Bulk Ports (NQBP). In 2001, the Queensland Government awarded a long-term lease over DBCT (50-year term with a 49-year renewal option) to a consortium collectively known as Coal Logistics–North Queensland (CL-NQ). After an Initial Public Offering (IPO) in June 2002, the group became Prime Infrastructure. Following a further name change in 2005, the group became Babcock & Brown Infrastructure (BBI). BBI's interest in DBCT was then purchased by Brookfield Infrastructure Partners (BIP) with DBCT Management (DBCTM) continuing to take management responsibility for the DBCT asset as the Secondary Lessee.

Fig 32. The Port of Hay Point 1982 - HPCT in full operation, DBCT terminal under construction (Introspec Consulting 2012)

DBCT is a bulk export coal terminal which is owned independently of miners and coal companies and as such, aims to achieve the optimum balance of meeting terminal Producer's sometimes conflicting needs for receiving, stockpiling and processing coal, within the context of its commercial obligations. The terminal is run by a 3rd party operator (DBCT Pty Ltd), owned by 5 of the 6 mining customers (Anglo, BMC, Glencore, Peabody and Rio Tinto). The Operator's responsibilities and obligations are contained in an Operating and Maintenance Contract (OMC) that was originally inherited with the terminal Lease. Basically, the DBCT Operator is responsible for operating, maintaining and caring for the terminal on a daily basis without interference of the Lessee. The Lessee's obligations and responsibilities are contained in the Ports Services Agreement (PSA) which is the leasing agreement between the Government Holding Company (DBCT Holdings) and the Lessee. While the PSA holds the Lessee responsible for expanding, operating and maintaining the terminal for the life of the lease, the operating and maintenance obligation is delegated through the OMC to the Operator, making the Lessee only responsible for capital expansion and maintenance capital (referred to as Non-expanding Capital or NECAP).

DBCT's expansion history is as follows (Fig 33):

Stage	Capacity	Construction	Construction	Cost
	Mtpa	Start	Completion	$ million
1	15	1980	1983	250
1A	22.5	1988	1990	4
2	26.5	1991	1995	140
2A	28.5	1995	1996	4
3	33	Oct-96	Dec-98	185
4	37.5	Jun-98	Oct-99	25
5	45.5	Apr-01	Feb-02	45*
6	56	Apr-02	Jun-03	88*
Short Gain	59	Jul-04	Aug-06	31.1*
7x Phase 1	68	Sep-04	Mar-08	561.7*
7x Phase 2/3 Step A	72	Oct-04	Dec-08	746*
7X Phase 2/3	85		Jun-09	

* Excludes finance costs

Fig 33. DBCT terminal expansion history (DBCT Management 2009)

DBCT's current basic configuration is described as: 3 bottom dump rail receiving stations; a stockyard (static capacity is 2.4 million tonnes) consisting of 7 and a half stockyard rows (each full row is 1,100 metres) separated by 8 machinery bunds supporting 4 stackers, 3 reclaimers and 5 stacker/reclaimers. There are 4 off-shore wharves which are all connected by a series of conveyor systems (Fig 34) with dredged berth pockets ranging in design depth from 19 to 19.6m . The site stretches for more than 2.38 kms from the rail inloading stations to the shore side jetty head with the wharves a further 3.8 kms off-shore along a jetty trestle. The total rated terminal capacity is 85 Mtpa, making it Queensland's largest export coal terminal.

Fig 34. DBCT Schematic post 7X Project completion (DBCT Management 2009)

A distinguishing feature of DBCT is the use of two reclaimers to feed each outloading conveyor/shiploader. This feature enables DBCT to blend cargoes out of the stockpiles which, with other service provision, is acknowledged by terminal Producers as enhancing their commercial position in global markets. Figure 35 show both terminals.

Fig 35. Port of Hay Point (DBCT Management 2013)

4.2.3 Rail

The Goonyella Rail System is a narrow gauge electrified bulk haulage rail network that has a bi-directional duplicated track from the Port of Hay Point to Wotonga (approximately 174 kms west of the port). The track splits before Coppabella to service Hail Creek and South Walker Creek. A single line (with passing loops) splits south at Coppabella servicing the mines of Moorvale, Millennium, Peak Downs, Saraji, Norwich Park, Lake Vermont (shipping through Abbot Point), Middlemount (shipping through Abbot Point), German Creek and Oaky Creek. A single line connection from Oaky Creek to Gregory then links the Goonyella System with the Blackwater coal system. There are balloon loops running off the main duplicated track to service Coppabella, Carborough Downs, Burton and Isaac Plains. A single track (with passing loops) proceeds west from Wotonga to Blair Athol with an extension to Clermont. The track also splits north from Wotonga to service the mines of Moranbah North/Grosvenor, Goonyella, Riverside and North Goonyella (Fig 36).

The maximum operating train speed on the network is 80 km/hr. Train sets are made up of 3 locomotives and 120 to 124 wagons of 110 mts each. Train lengths are generally about 2000m which is limited by the grade down the Great Dividing Range (Black Mountain) and the length of the systems' passing loops. There are three major train servicing facilities at Sarina (Aurizon), Coppabella (Aurizon) and Nebo (Pacific National - PN).

Fig 36. Goonyella rail system (Aurizon Network – Goonyella Information Pack 2016)

The three competitive rail operators running services on the regulated network from the mines to the port in a total of 41 trains sets are Pacific National (20 trains), Aurizon National (17 trains) with BHP running 4 dedicated train sets between their own mines and HPCT. The rail Operators can vary the number of trains by moving trains between the rail systems according to their commercial and operational requirements.

4.2.4 Mine Loadout Facilities

The performance of individual mine outloading infrastructure also contributes to the overall system capacity. As such, the capability of the mine loadout infrastructure must be able to support the connecting supply chain operation. If not, the total system capacity will be de-rated as delays in each of the under-performing mine load-outs impacts delivery of coal at the terminal, as well as contributing to consequential losses when the train returns late to perform their next haulage task or misses the connection completely.

Mine loadouts however, have been designed and constructed to meet the production capabilities of the mining operation, not the requirements of the supply chain. Due to the age of some of the mines in the Goonyella system, many mine loadouts cannot match the performance of the hauling train in terms of load rates. Trains tend to take longer to load, which in turn creates losses in the total train operation. As the system velocity slows to accommodate the mine loadout, the performance across the entire chain will degrade. The current Dalrymple Bay Coal Chain (DBCC) system modelling shows any discrepancy in mine load-out infrastructure shortfalls, however there is no mechanism to force the owner of the infrastructure to upgrade its facilities to match the demand requirements of the system.

4.2.5 NQBP

The construction of a departure path channel and associate aprons between the berths and the channel was commissioned by NQBP in 2006, to facilitate the sailing of deep drafted vessels. This departure path has a minimum design depth of 14.7m above the Lowest Astronomical Tide (LAT) and extends seaward from the quay line for approximately 6.2 nautical miles. Approximately 9 million cubic metres of sea bed had to be removed to create the departure channel and apron which added an extra 1 Mtpa capacity to each terminal through the reduction of shipping delays associated with tidal delays. This capacity estimate is conservative and based on the shipping trends of the day, which have seen a significant increase in number and size of vessels. This, combined with the ongoing improvement of the DUKC system, is more than likely responsible for increased ship loading capacity at both terminals.

The Tug harbour (Fig 37) was constructed as part of the Queensland Government's commitment to the development of the HPCT. The tug harbor currently provides shelter for 5 tugs and 2 line boats which are used to service both terminals. The design depth of the swing basin is 5.6m and the tug berths 6.1m. However, the harbor is subject to siltation and requires regular maintenance dredging to preserve operational capacity. Failure to provide this maintenance will jeopardise the towage service. As each berth movement requires two attending tugs, any reduction in service will have consequential impacts on vessel movements which in turn will adversely impact the velocity of coal moving through the port.

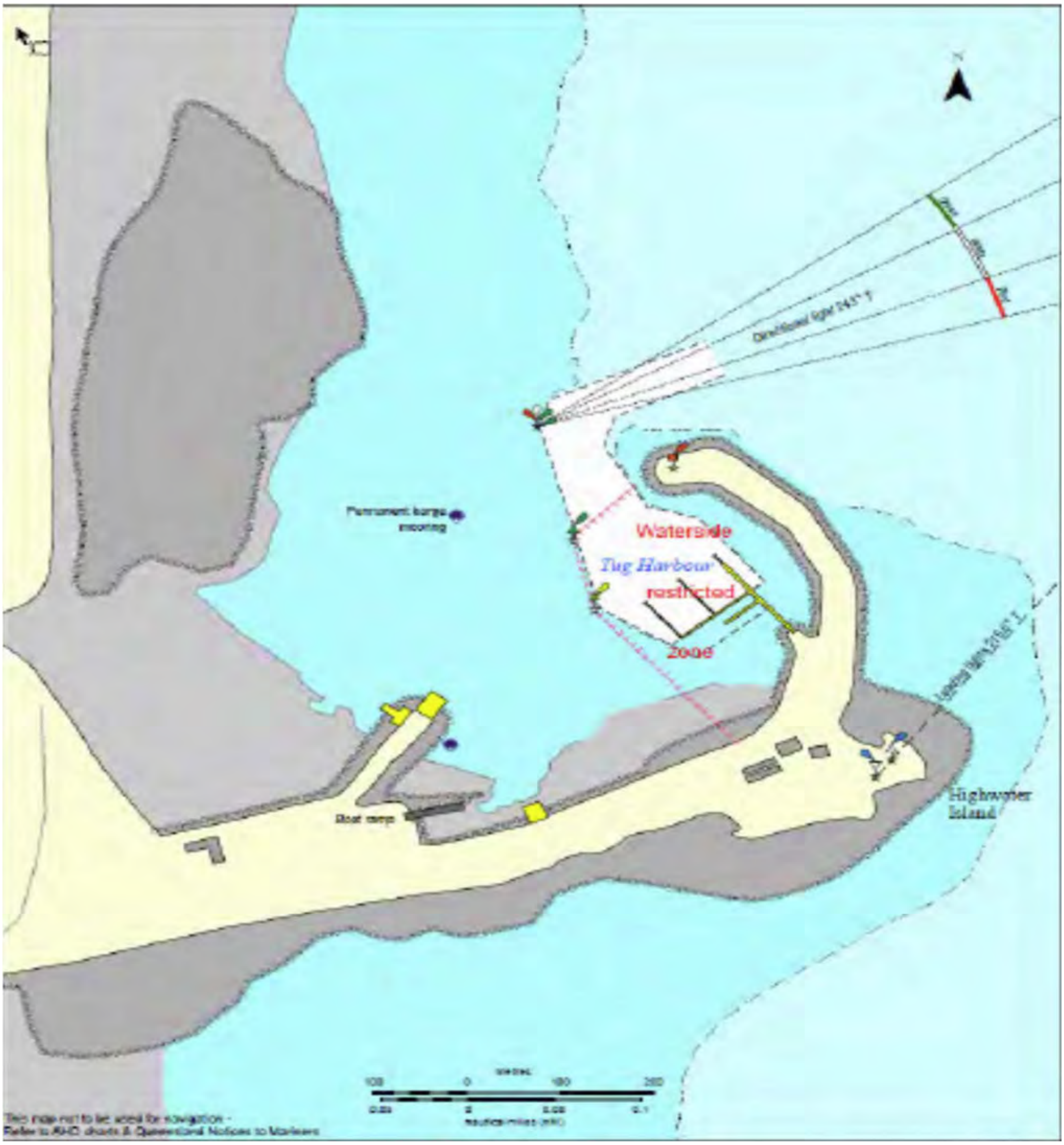


Fig 37. Half Tide Tug Harbour (MSQ 2016)

4.3 Export Terminal Operating Platforms

The two terminals at the Port of Hay Point share a similar operating methodology although for different reasons. HPCT serves only BMA and BMC mines and as such, shares both FOB and CIF shipping. To maximise their competitive advantage, the terminal controls all quality in terms of coal delivered into the ship’s hold. Because of this, the HPCT terminal Operator has a degree of options when it comes to which vessel to load first and the way that it moves coal from its mine sites into the terminal stockyard. Stockpiles are arranged to meet capacity of mine production, the volume of sales and the customer's requirements with high volume product placed in dedicated stockpiles and slower moving product called down from the supplying mine when required.

DBCT on the other hand provides its service to multiple different miners who compete to sell coal to the same buyers. While some steel mills will favour particular types of coal depending on their quality requirements, the choice of others is price related. Because the Bowen Basin has such a wide variety of metallurgical coals, the terminals have evolved discrete blending options. The issue is similar for both terminals although more so for DBCT due to the multi-user environment.

As both terminals serve a multitude of different mine customers selling so many products, the respective stockyards are simply not large enough to allow every product to have its own dedicated stockpile. DBCT currently ships up to 33 different products and has 90 registered blends that can be loaded while HPCT is on record as processing 17 main products and 22 blends (BMA 2006). Coals that move in large volumes from mines with large production capability can be stockpiled in dedicated areas at the terminal because of their constant high velocity in moving to the ship. However, as soon as that demand reduces, the stockpile size is reduced to make more room for other products.

Because of Producer product diversification catering for specific steel making blends, multi-user terminals are required to meet varying service requirements. This creates specialised demands within the terminal operation as different coal types present different handling characteristics which require a variety of handling strategies to preserve product identity. Any reduction of normal equipment rates to cater for these requirements will impact terminal capacity. Because different handling requirements impact the terminal's performance (e.g. sticky coal, blending, loading small ships), some coal types and product blends consume more terminal capacity than others.

Terminal capacity is calculated considering historical service provision and shipping mix (i.e. the capacity model accounts for the capacity impact of differing service requirements). However, if future service requirements evolve beyond the current demands, the rated terminal capacity could be adversely impacted. Any detrimental impact of terminal service demands can also impact the upstream coal chain, causing consequential bottlenecks which in turn limit the delivery of coal to the terminal's rail receival pits. The terminal Producers have recognised that service provision does cause capacity erosion although development of processes to allocate accountability for errant capacity consumption are still under discussion.

Bulk supply chains usually operate in one of two major forms i.e. dedicated stockpiling in the export terminal or cargo assembly, although hybrids do exist. The basic philosophy of the operation revolves around the capital investment decisions and the number of products to be accommodated versus the availability of land for the port stockyard. Regardless of the type of supply chain operating system chosen, it is fundamental that both the rail and port are using and contracting to the same operating system.

A dedicated stockpile allows the terminal Producers to push product to the port's stockyard which is then drawn down by arriving shipping. This terminal stockyard methodology actually supports mine production and the rail system by allowing the product to rail evenly (i.e. a scheduled service) from the mine to the export terminal. Accordingly, track infrastructure and mine stockyards are tailored to suit the exact number of trains required to match a mine's production. When the shipping arrivals become uneven, the terminal stockyard buffer can be exceeded causing operational planning issues. The Blackwater rail system, coupled to the RG Tanna and WICET Coal Terminals in Gladstone, is a good example of a push system, with both terminals having large stockyards to support even railing train arrivals.

Historically, these systems have evolved from the days when shipping was controlled by the miner under the sales contract (CIF). Shipping arrivals were scheduled to match stockyard inventory and mine production, which gave some control over the size of the terminal stockyard. However, the development towards coal buyer controlled shipping (FOB) introduced irregularity in the shipping arrivals, as coal buyers sought to use the shipping voyage as buffer capacity for their "just in time" inventory control. This in turn forced stockyard expansions at the export ports to meet the storage demands of continuous mine production.

The alternative operation is a cargo assembly port which builds individual cargoes to suit the uneven arrival of the shipping demand i.e. cargo is pulled into the port's stockyard only as a result of the carrying ship's arrival. Because the cargo is pulled into the stockyard, the intensity of trains to deliver product is higher at differing times and differing parts of the rail network. This requires more track infrastructure so as not to cause excessive train queuing within the system.

Both of the coal export terminals at Hay Point design and calculate their terminal capacity on the basis of a "mine to ship" railing regime, supporting cargo assembly terminal operations. As explained above, this methodology enables the coal to be pulled to the carrying vessel, once that vessel's berthing program has been developed. This regime requires careful scheduling to slot the right cargo into a pre-planned stockyard area in order to avoid stockyard congestion. The operating paradigm has evolved over time at the port to help quarantine capital expenditure associated with stockyard expansions and to overcome the issue of the scarcity of land available at the port.

The size of the terminal stockyard therefore has a significant influence on throughput as it provides the footprint necessary to receive, store and reclaim coal. It should be noted that both of the Hay Point terminal stockyards have reached the maximum capacity for the available land, so any further expansion will need to consider land for additional stockyard capacity outside of the current terminal footprints. Such land is available as strategic port land or can be sourced to accommodate any future expansion and the Port of Hay Point Land Use Strategy should be consulted for detail pertaining to any future port developments. However, additional land will increase expansion costs and must be included in Master Planning required by the Queensland Sustainable Ports Act (2015).

Terminal throughput in a cargo assembly operation is a function of how quickly the coal can be presented to the terminal and how quickly the shipment can be loaded and the ship sailed. At DBCT for example, the Terminal Regulations require that a shipment must be largely assembled in the terminal stockyard prior to the carrying ship berthing. The 85 Mtpa rated terminal's three outloading systems and 4 berth configuration requires sufficient yard space for a minimum of 3 fully assembled shipments (on average 240,000 tonnes) with six further shipments under construction (similarly 240,000 tonnes). Therefore, cargo build time is contingent on the ability of the upstream logistics chain to present the coal in the right quantity and right sequence, when required by the terminal Operator. This also provides insight as to why these type of cargo operations depend on a queue of available ships, as anything that upsets the velocity of the cargo build will delay a ship's berthing. With a queue of waiting vessels, an alternative ship can advance to take the berth and maintain throughput.

The Goonyella coal supply chain is a good example of a demand pull system showing both the advantages and disadvantages of the methodology. Because the terminals have evolved to adopt cargo assembly, albeit in differing models, the causal relationships are basically the same i.e. to cater for the increasing number of products and terminal clients which sell their cargoes on a Free on Board (FOB) basis. This means that neither the supplier nor the terminal have any great control over when a ship will be nominated for loading. Because of this vagueness in the loading pattern of any particular product and the limitations in the size of the stockyard, it is impossible to keep dedicated stockpiles for all products moved through the terminal in the available stockyard space.

This system uses two cargo assembly stockpiles allocated to each Parcel in the dynamic stockyard zones comprising ideally of 90-95% of the maximum cargo requested by the Vessel. The balance, plus any surplus remaining in the last train consignment relevant to the Parcel, will be loaded in the Access Holder's remnant management area.

For example, if the Access Holder has suitable coal in their remnant area, the amount of coal railed should ideally be less than the required parcel, with the balance of the parcel being topped up from the existing Access Holder's remnant area. If there is insufficient coal in the remnant area, the remainder of the coal in the last Train Consignment relevant to the Parcel, after completing the Cargo Assembly stockpiles, will be stacked into the Access Holder's remnant area.

Each Access Holder will be responsible for managing the quantity and quality of remnant coal in its dedicated area, including separation requirements pertaining to different Products. With the objective of maximising cargo velocity through the Cargo Assembly stockyard and in the event of there being any residual stockpile in the Cargo Assembly area after loading of a vessel, the Operator has total discretion in determining the next cargo to be allocated to that area, subject to contamination with unsuitable coals and endeavouring, as practicable, to maintain the same grades/products of coal. If however, in the opinion of the Operator, it is impractical to maintain the grade of coal between cargo assembly stockpile builds and immediately upon identification of a residual cargo assembly stockpile, the Operator must consult with the Access Holder to whom the residual belongs as to the next cargo to overlay that residual, in order to facilitate coal remnant trading.

To explain some of the limitations of a dedicated stockpiling methodology in the Hay Point environment, it has to be recognised that there are currently multiple different mines producing different base coal and exporting through two separate coal terminals with limited land availability all operating on the one rail network. However, because the HPCT is a closed system for BMA/BMC coal only, just the DBCT terminal has been used for comparison purposes.

Using a benchmark of 8.5% of Annual Contract Tonnage, which is considered by some producers to be the maximum requirement for dedicated stockpiling (at any point in time), the DBCT terminal would need to accommodate approximately 7.2 million tonnes of coal (this number excludes space between each pile). To illustrate the amount of land required to accommodate this much static stockpiled coal, the DBCT Lessee commissioned Connell Hatch to review the terminal's operating methodology. The resulting drawing (Fig

38) illustrates just how big the terminal stockyard would need to be (relative to the surrounding land area) to meet the benchmark. The increased stockyard requirements would also have a corresponding impact on the terminal’s supporting inloading infrastructure, requiring a total of 5 inloading stations and rail balloons plus additional yard machines, just to replicate the current capacity (85 Mtpa).

Fig 38. Estimation of the size of DBCT stockyard to accommodate dedicated stockpiling (DBCT Management Master Plan 2009)

Clearly, this is not a viable option for a number reasons:

1. The land required for stockyard expansion to support dedicated stockpiling would consume all current expansion options for DBCT
2. The additional stockyard area required would encroach on a protected mangrove environment in Louisa Creek and require resumption of all of the current Louisa Creek Community
3. The capital cost of such additional stockyard will have to include new bunds and additional machines as well as at least two new inloading rail receival pits and rail balloon loops
4. There is no capacity benefit associated with this addition, yet the additional capital costs would result in additional service charges to Miners

At DBCT, the cargo assembly model uses a zonal stockyard methodology where each zone incorporates two yard rows which are assigned to an outloading system. To achieve optimum yard utilization and at the discretion of the Operator, an area of the Terminal stockyard has been dedicated to managing remnant coal while the rest of the stockyard operates in full cargo assembly/hybrid mode.

Section Five – Sedimentation and Impacts on Port Operations

5.1 Sedimentation Analysis and Relationship to Export Throughput

Before the construction of the departure path, the Port of Hay Point had been limited by the declared depth of RL - 13.1m. Accordingly, vessels with deep drafts were required to adjust their cargo intake in order to sail on the first available high tide after completion of loading. A Sandwell Engineering (2003) report commissioned by the new DBCT lessee, Prime Infrastructure found that the draft restriction of RL - 13.1m was causing:

- Delays in ship departures of an average 1.2 hours per ship;
- The necessity for ships to sail on the next available high tide rather than the highest high tide, to avoid unproductive berth time and subsequent terminal capacity impact;
- Short loading of vessels by approximately 4% on average and by up to 25,000 tonnes on larger vessels;
- Higher freight costs for shippers;
- Potential Demurrage ramifications; and
- Some loss of "incremental coal sales" through short loading of the vessels.

Through simulation modelling of the terminal operation, Sandwell indicated that a depth of 14.9m would provide a significant reduction in delays to shipping, quoting a saving of approximately 300 hours for HPCT and approximately 440 hours for DBCT, plus a reduction in short loading for all terminals. Sandwell's conclusions were largely based on a review of a Connell Wagner study commissioned by the Port Authority in September 2000. The objective of this study was to:

- Define the location and extent of capital dredging need to support the DBCT Stage 6 and 7 expansions including evaluations of a departure path or channel; and
- Assess the cost/benefit of increasing the declared depth for DBCT and recommend the most efficient berth pocket depth.

A further review of the reports associated with the departure channel project have revealed relatively modest historic siltation rates in the port, requiring infrequent maintenance dredging (GHD 2005). Berth siltation volumes that were calculated from surveys showed an accretion of 500 mm in total over a 14 year period, which was back-engineered to give a range of 36 - 44 mm/annum across the berth pockets, approximately 25 mm/annum across the proposed apron area and approximately 60 mm/annum in the inshore area of the proposed channel.

By 2014, berth depths had degraded by a factor far greater than estimated by the earlier reports. The degradation was far worse in the northern berths (berth 3 & 4) of DBCT than in HPCT which was mainly due to HPCT's regular use of drag bar operations to sweep the berth pockets clear of sedimentation. Analysis by Great Barrier Reef Marine Park Authority (GBRMPA) shows that a large influx of siltation and fine sediments was released from Queensland rivers between the years of 2007 and 2012. This period also corresponds to siltation in the DBCT berths and was associated with extreme rain events in the Central

Bowen Basin, particularly in 2008, 2009 and 2011. The following chart tracks the water and sediment discharge from the Pioneer river in Mackay from 2000 till 2012 (Fig 39) and is sourced from this report:

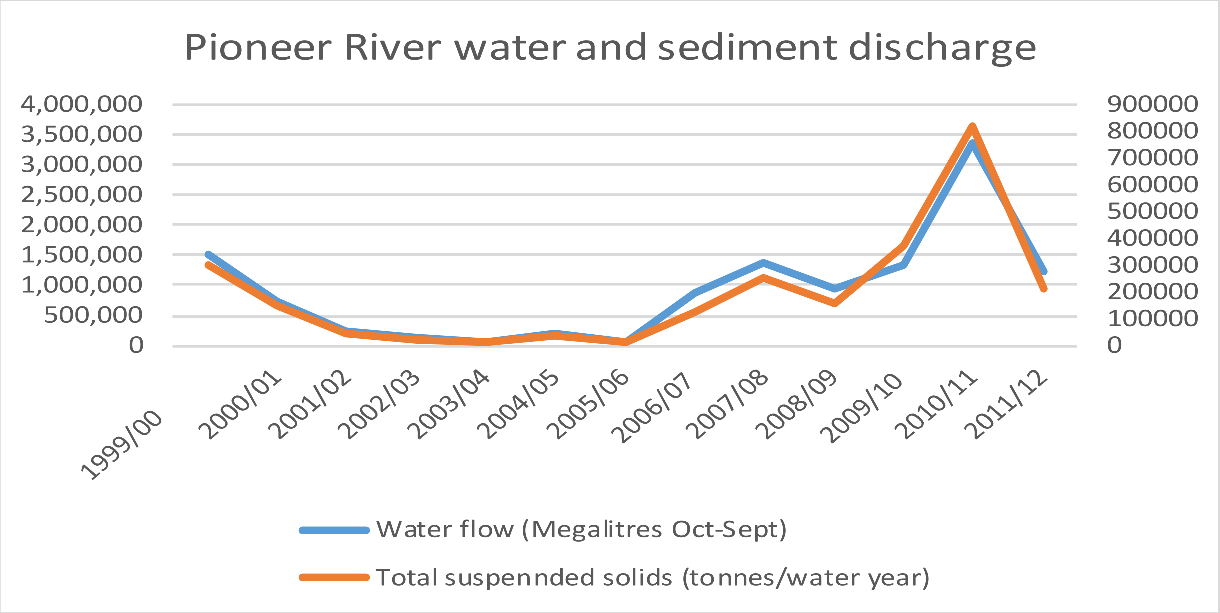


Fig 39. Sediment deposition rates from Pioneer River 2000/2012 (GBRMPA 2015)

The graph shows increased suspended solids release from the Pioneer River peaking in FY 2011/12, which coincides with TC Yasi. However, the Pioneer River discharges into the Coral Sea approximately 38 kms north of the port, so it is questionable whether these suspended solids were capable of mobilising in currents to cause DBCT's berth pocket siltation. Further, if this was the cause, then what effect would that sediment mobilisation have on the Hay Point departure path and apron?

Increasing allegations had been made by the Green movement as to potential coral reef damage from port dredging activities leading to the Federal Government banning the sea disposal of capital dredging material within the confines of the Great Barrier Reef Marine Park (GBRMP). The Queensland Government also restricted future Queensland port development, including capital dredging, to 5 priority ports (Abbot Point, Mackay/Hay Point, Gladstone and Townsville). This included increasing the sea disposal ban (of dredged material) to include the World Heritage Area as opposed to the GBRMP, taking the ban to the high water mark on shore. This effectively means that only shore based disposal of dredged sediment from capital works would be legal where there is beneficial reuse (Sustainable Ports Development Act 2015). The priority Ports must also develop a management plan for the sustainable disposal of maintenance dredging material. Faced with this issue, questions were raised as to the exact maintenance dredging requirements for the Port of Hay Point in terms of the volume of dredge sediment and the placement of the dredged sediment.

A legal challenge to the GBRMPA issued maintenance dredging permits for the port in 2013, coupled with the Queensland Government's strategic ports review and the Commonwealth Government's "Reef 2050" strategy, directed a more scientific approach to marine port sedimentation disposal, which had historically been released in port spoil grounds located at sea but within the Port Limits.

The maintenance dredging approval submissions were withdrawn by the Port Authority in 2014, to avoid the legal challenge. It was at this time that the Port Authority and the two Hay Point coal export terminals, formed an alliance to investigate port sedimentation and, where required, develop a strategy for maintenance dredging and the sustainable disposal of marine sediment from port related navigation channels and berth pockets.

As part of this work, NQBP commissioned Royal Haskoning DHV to investigate historic siltation rates at Hay Point (2016) so as to understand port sedimentation and as a consequence, to develop a strategy for future maintenance dredging requirements in the port. The findings of this study would also feed in to the larger investigation by NQBP focusing on sustainable sediment management.

The conclusions from the Royal Haskoning work (Royal Haskoning DHV, 2016) are:

- that the sea bed elevations in the Port are relatively stable, meaning that there is little net erosion or deposition occurring in the area;
- water quality data indicates that there is a thin mobile sea bed layer which is regularly re-suspended into the water column by wave action associated with tropical storms. Currents then transport this re-suspended material until it deposits back on the sea bed;
- siltation in the apron and departure channel is minimised by propeller wash associated with deep drafted shipping movements;
- both siltation and erosion has occurred in the apron and departure path which is associated with tropical storms;
- higher siltation rates in the DBCT berths are attributed to the dredging of the berth pockets to a level well below the surrounding seabed, causing a sediment trap;
- HPCT has shallower berth pockets which are regularly swept by a tug dragging a large steel beam. As such, HPCT does not experience the same level of siltation as DBCT;
- While extreme rain events coincided with cyclonic activity and could result in more mobile sediments entering the water column, it is more severe wave action which causes the resuspension of sediments; and
- A predictive sedimentation model will be developed to better forecast sedimentation rates leading to great accuracy and sequencing of dredging requirements.

The annual maintenance dredging of the departure channel was originally estimated to be in the vicinity of 200,000 m3/annum although, the Royal Haskoning analysis has clarified this to be only 59,300m3 (approximately) at this current time. Together with the DBCT and HPCT berth pockets, the total maintenance requirement (October 2015) is 205,800m3 although, as the dredge material is likely to re-suspend in the water column during the dredging operation, the process could be relatively time consuming.

The Port of Brisbane Corporation own a small (3,000m3) twin trailing arm suction dredge (“Brisbane”) which has performed the port maintenance dredging on a contract basis in the past and is still available for these commercial programmes. The maintenance dredging schedule however, is subject to periodic sea disposal permits to which the Port Authority, acting for the two terminals, takes responsibility for obtaining.

Delays in obtaining new maintenance dredging approvals have occurred since the Great Barrier Reef Marine Park Authority (GBRMPA) were challenged by the Australian Maritime Conservation Society for approving of NQBP's Hay Point maintenance dredging sea disposal permit 2013. Apart from drag bar operations which move rather than remove sediment, there has been no major maintenance dredging programme in the Port of Hay Point since 2010 when 216,000m3 was removed from the Departure Channel, Aprons and berth pockets.

The Royal Haskoning Report indicates that in times of excessive wave action around the port, berth pocket siltation rates can be expected to be higher than historic rates. Accordingly, it must be appreciated that without the ability to perform regular and at times, emergency maintenance dredging, the inflow of siltation in to the berths and possibly areas of the departure channel will result in a general degradation of water depth which will impact terminal operations. As the navigable water depth is measured from the highest seabed point, there will be a corresponding minimum draft applied to the whole navigable area. To illustrate, a highpoint in a berth pocket (regardless of the extent of coverage or the precise location), will decrease the navigable depth of the whole berth (i.e. lowest common denominator).

On 14 July 2014, the berth pockets depths for the Port of Hay Point were shown as per Fig 40 (DBCT Pty Ltd 2014). The effects of heavy siltation are evident in the DBCT berths:

Berth Pocket	Design Depth (m)	Actual Depth (m)	Lost depth (m)
HPCT Berth 1	16.6	16.4	0.2
HPCT Berth 2	16.7	16.8	0
HPCT Berth 3	Under construction	Under construction	NA
DBCT Berth 1	19.6	17.8	1.8
DBCT Berth 2	19.6	17.8	1.8
DBCT Berth 3	19	17.5	1.5
DBCT Berth 4	19	17.4	1.6

Fig 40. Hay Point berth pocket depths 2014 (DBCT Pty Ltd 2014)

5.2 Ramifications of Draft Constraints on Export Volumes

DBCT has calculated that on the basis of the current berth drafts, any vessel with a deadweight exceeding 110,000 tonnes would be at risk of incurring loading delays at the terminal. In calendar year 2015, this equated to approximately 45% of all vessels that called at DBCT. As shown in the Shipping Trends section above (Fig 30), ships with a deadweight greater than 180,000 dwt are becoming more popular with steel makers as global discharge ports undergo dredging projects and deepen. Further, the Shipping Dynamics section showed the continuing depressed trend in the Capesize charter market, which results in large ships becoming more competitive for bulk haulage (i.e. more affordable). Provided the Port of Hay Point maintains its capability to load these ships to their full deadweight, it is reasonable to assume that the trend should continue and more of these very large Capes will arrive at the Port. However, what would be the ramifications to the port if water depth continued to decrease due to siltation and a lack of a regular maintenance dredging programme?

It has been shown that DBCT has the more critical siltation issue, so this terminal has been used for the purposes of illustrating operational throughput impacts. However, any depth loss in the Departure Channel will have a corresponding impact on vessel loading at both terminals, as the ship will only be able to load to the maximum draft available in the Departure Channel.

To illustrate, a Capesize vessel of 180,000 dwt will have an immersion factor of approximately 120 tonnes per centimeter (TPC) and a maximum summer sailing draft of 18.2 meters. If, through siltation, the Departure Channel draft was reduced to 14 meters and the next high tide was 5 metres, then using the UKC formula, the ship’s maximum sailing draft to safely meet the draft restriction would be:

$$\frac{14 - 1 + 5}{1.05}$$

Which would equate to a maximum sailing draft of 17.142 metres. As the vessel’s maximum summer sailing draft is 18.2m, the draft restriction would cost the ship 1.058 metres of carry capacity. The TPC being 120, the actual lost cargo uplift would be 105.8 x 120 = 12,696 mts of coal. So despite the berth pocket at HPCT 1 or 2 having sufficient water (with a rising tide) to complete and sail the vessel on its maxim sailing draft, the Departure Path restriction results in the vessel short loading its maximum uplift.

If the second high tide of the day was the higher of the two, loading could be suspended at a point where the vessel could maintain the alongside UKC (1.5m) requirement on the low tide. However, this would depend on how much product would be left to load on the next rising tide, in terms of the terminal’s loading capability. In any event, the depth restriction will result in either a short-loading of the maximum possible cargo or a tidal delay to loading, which will extend the loading operation affecting every other ship waiting.

The other loss which is relevant would be to terminal throughput due to berth pocket depth. Due to the reduced depth at DBCT, an estimated 812,270 tonnes was lost in financial year 13/14 throughput when 44 vessels incurred low water stop delays for an average of 4.1 hours each. Should the siltation problem continue unabated, the DBCT capacity loss for every 0.5m increment thereafter based on the demand equaling the terminal capacity (85 Mtpa) would be (DBCT Pty Ltd 2014):

Average 17.7 depth = 226 lost hours or 1,028,752 mt

Average 17 depth = 437 lost hours or 1,989,224 mts

Average 16.5 m depth = 618 hours or 2,813,136 mts

Average 16m depth = 790 hours or 3,596,080 mts

5.3 Terminal Expansion Impacts

In July 2011, the UNESCO World Heritage Committee requested the Australian Government undertake a comprehensive strategic assessment of the Great Barrier Reef World Heritage Area (GBRWHA) and to develop a long-term plan for sustainable development that will protect the region’s outstanding universal values. This assessment has been completed by the Federal and Queensland Government and resulted in the development of the “Reef 2050 Long Term Sustainability Plan”.

The Queensland Government has responsibility for protection of the State waters and therefore, is committed to a number of Reef 2050 initiatives relating to port development. The *Queensland Sustainable Ports Development Act (2015)* has since been legislated to provide protection of the GBRWHA through managed port-related development in and adjacent to the World Heritage area. The legislation recognises that Queensland's major bulk ports are vital for job creation and economic prosperity, but that new developments need to be properly managed in order to protect the Great Barrier Reef's outstanding universal value. The Sustainable Ports Bill:

- prohibits particular development in the GBRWHA;
- restricts and concentrates port development, including capital dredging, to existing "priority port" port limits;
- requires the Minister for State Development to develop long-term Master Plans for these nominated priority ports and their supply chains that provide a strategic and coordinated approach to managing economic, environmental, cultural and social values (Fig 41);
- requires allowed priority port development to meet the regulations and zoning plans of the Great Barrier Reef Marine Park Act 1975 and the Queensland Marine Parks Act 2004;
- efficiently use port and supply chain infrastructure;
- prohibits sea based disposal of capital dredging material into the GBRWHA and mandate the beneficial re-use of port related capital dredged material where it is environmentally safe to do so;
- proposes to establish a maintenance dredging framework;
- expands port and supply chain capacity in a staged and incremental way that meets the emerging demand; and
- identifies and protect land and infrastructure critical to the effective operation of the port networks.

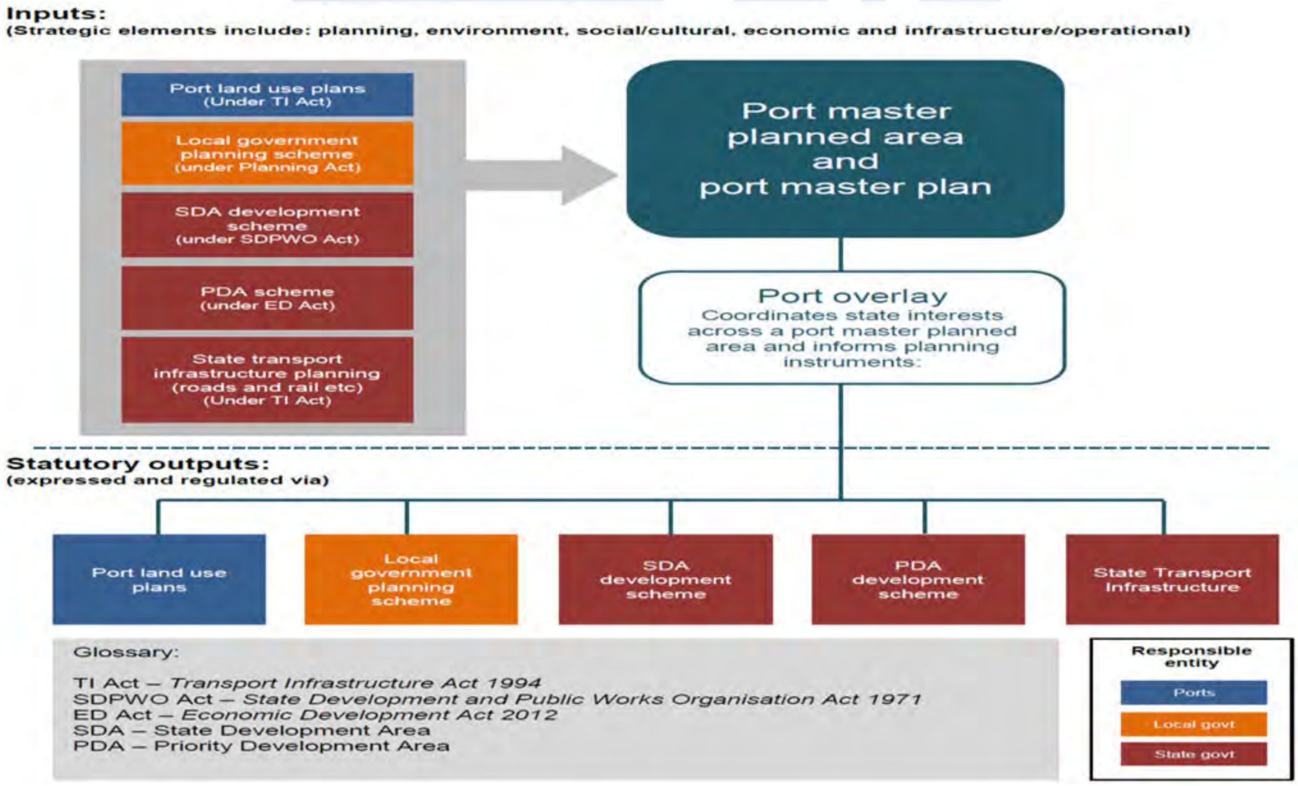


Fig 41. Port Master Planning Overlay diagram Qld Dept of State Development (2015)

5.4 Proposals for Land Use and Site Development

As a requirement of the Transport Infrastructure Act 1994 (TIA), a Port Authority is required to develop and review a Land Use Plan for the appropriate and sustainable development of strategic port land. NQBP is the Statutory Port Authority for the Port of Hay Point and as such, under the Sustainable Planning Act 2009, NQBP is the Assessment Manager for all assessable development on Strategic Port Land in the port.

The current NQBP Land Use Plan was approved in April 2010 and provides an overall framework for the appropriate regulation and management of the development of strategic port land. This will ensure that any future growth of the Port is "ecologically sustainable and meets the demand for world class port facilities to support and grow the region's economy" (NQBP Land Use Plan - Port of Hay Point, 2010). The Land Use Plan sets out NQBP's planning and development obligations according to the provisions of the Sustainable Planning Act 2009 (SPA) via the Integrated Development Assessment System (IDAS). The Land Use Plan is NQBP's Strategic Port Land assessment tool for assessing development including all premises, roads and waterways and overrides the Local Government Planning Scheme.

Operating in conjunction with the Land Use Plan is a separate "Development Guidelines" document which includes the standards against which NQBP will assess strategic port land developments. These Guidelines have been developed in accordance with "Desired Environmental Outcomes" or key objectives which provide the Port Authority's overarching vision and direction in relation to ecological processes and sustainability, economic development and community wellbeing. As a point of reference, Fig 42 show the current off-shore and on-shore areas defined as Strategic Port Land at the Port of Hay Point.

Any terminal expansion, be it a brownfield expansion of one of the existing terminals or a new greenfield development, will require dredging for the new berth pockets. While the responsibility and cost will reside with the developer, the Port Authority will use the above process to assess the development. The new Sustainable Ports Legislation does allow capital dredging at priority ports, however the dredged material must be disposed of on land. The cost of the sediment placement will have a direct bearing on a project's viability, depending on the need for the expansion.

While the need to maintain the current port depths is linked to the wellbeing of both the central Queensland coal industry and the Queensland Government, the availability of strategic port land for new development at the Port of Hay Point is the key to opening up new trading opportunities. However, any new development will require a comprehensive marine sediment disposal strategy that is conducive to further developing the State's economy. Because of the correlation between ship size and discharge port improvements, new port facilities will need to accommodate deep drafted vessels if they are to be successful in attracting new export projects. Further, harbour operation support services such as towage, require safe and sheltered areas with sufficient depth to offer unhindered 24 hour services to shipping frequenting the port. In consideration of the new Legislation, the port will need to develop a sustainable sediment management process that is acceptable to the stakeholders and allows the port to continue to flourish.

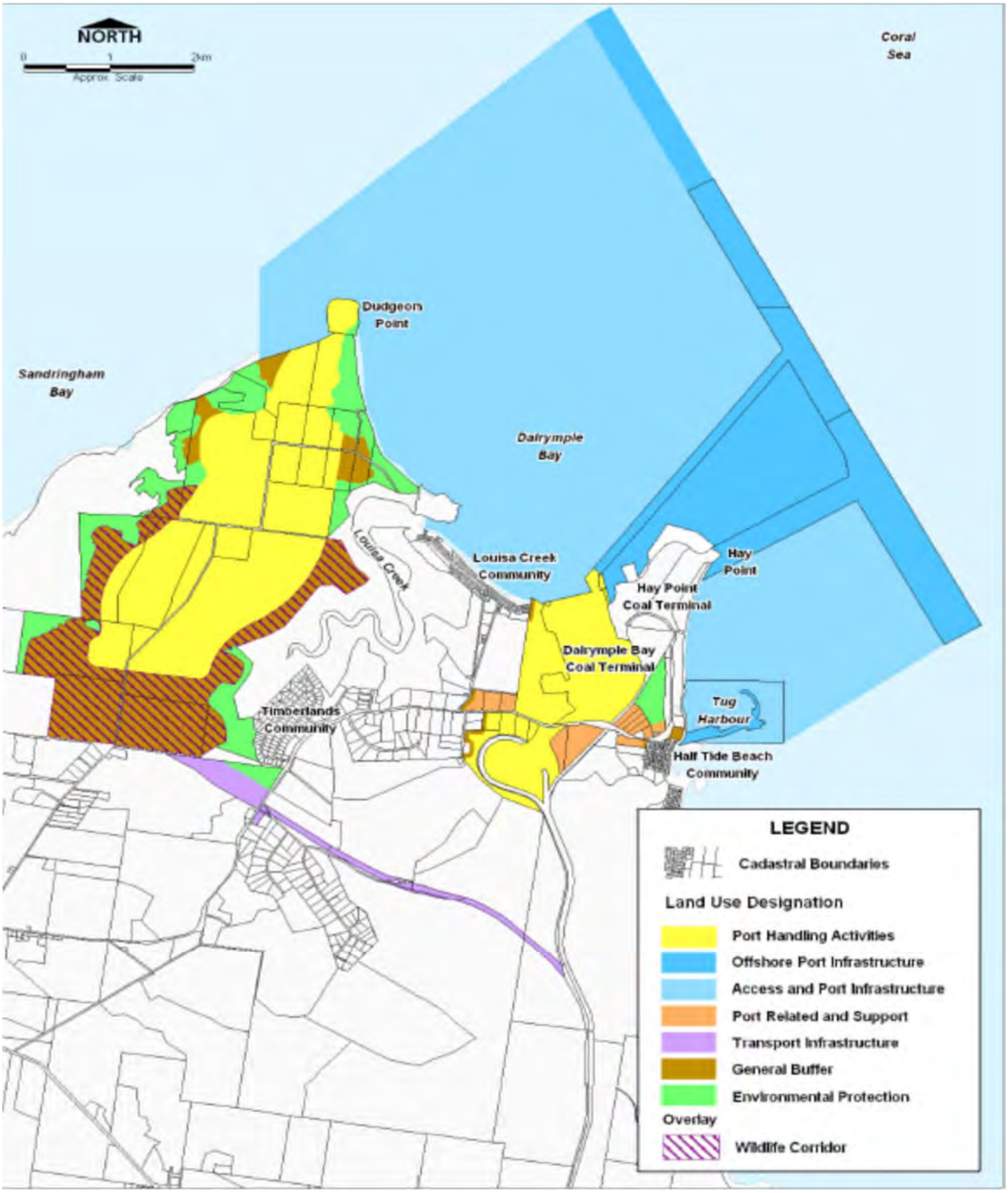


Fig 42. NQBP Strategic Port Land and Offshore Port Infrastructure Hay Point (NQBP 2010)

Abbreviations

BBI	Babcock Brown Infrastructure
BHP	BHP Billiton
BIP	Brookfield Infrastructure Partners
BMA	BHP Billiton Mitsubishi Alliance
BMC	BHP Billiton Mitsui Coal
CAGR	Compounded Annual Growth Rate
C&F	Cost and Freight
CIF	Cost Insurance Freight
COA	Contract of Affreightment
CQCA	Central Queensland Coal Association
DBCC	Dalrymple Bay Coal Chain
DBCT	Dalrymple Bay Coal Terminal
DBCTM	Dalrymple Bay Coal Terminal Management
DUKC	Dynamic Under Keel Clearance
DWT	Deadweight
FOB	Free on Board
FY	Financial Year
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
GFC	Global Financial Crisis
HCC	Hard Coking Coal
HPCT	Hay Point Coal Terminal
HPS	Hay Point Services
HPX 1	First expansion of HPCT
HPX 2	Second expansion of HPCT
HPX 3	Third expansion of HPCT
IDAS	Integrated Development Assessment System
ILC	Integrated Logistics Company
IMF	International Monetary Fund
IMO	International Marine Organisation
IPO	Initial Public Offering
LAT	Lowest Astronomical Tide
MIM	Mount Isa Mines
MSQ	Maritime Safety Queensland
Mts	Metric Tonnes
Mtpa	Million tonnes per annum
NECAP	Non-expanding Capital (Maintenance Capital)
NQBP	North Queensland Bulk Ports (formally PCQ)
OECD	Organisation for Economic Cooperation
O&MC	Operations and Maintenance Contract
OMC	OMC International Pty Ltd
P&L	Profit & Loss

PCI	Pulverised Coal Injection
PCQ	Ports Corporation of Queensland
PN	Pacific National
PSA	Port Services Agreement
QCA	Queensland Competition Authority
QRC	Queensland Resources Council
RHM	Regional Harbour Master
RL	Reclaimer
SAA	Standard Access Agreement
SPA	Sustainable Planning Act
SR	Stacker/Reclaimer
SSCC	Semi Soft Coking Coal
ST	Stacker
TIA	Transport Infrastructure Act
tph	tonnes per hour
TPC	Tonnes per Centimeter
UKC	Under Keel Clearance
UNESCO	United Nations Education, Scientific and Cultural Organisation
VLC	Very Large Cape
VTS	Vessel Tracking Service
WICET	Wiggins Island Coal Export Terminal
UDC	Utah Development Company

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