

## **Appendix B**

### **Ship Anchorage Management in the Great Barrier Reef World Heritage Area**

**July 2013**

### **Cost Benefit Analysis**



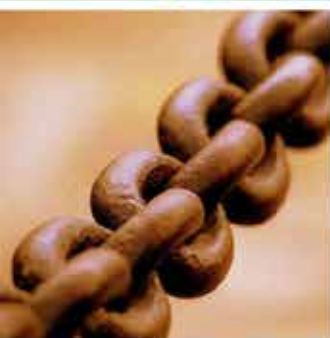
# Great Barrier Reef Marine Park Authority

Identification of Impacts and Proposed Management  
Strategies associated with Ship Anchorages in the  
Great Barrier Reef World Heritage Area

## Cost Benefit Analysis

July 2013

FINAL



**CONTENTS**

- EXECUTIVE SUMMARY ..... VII**
- ACKNOWLEDGEMENTS .....XIV**
- ACRONYMS/GLOSSARY .....XV**
- 1. INTRODUCTION.....1**
  - 1.1 Relationship of this project to the comprehensive Strategic Assessment ..... 1
  - 1.2 Background to this project ..... 1
  - 1.3 This project .....2
  - 1.4 Study area .....4
  - 1.5 The structure of this report.....7
- 2. METHODOLOGY.....8**
  - 2.1 Social Economic Appraisal using a Triple-bottom-line approach .....8
    - 2.1.1 Cost Benefit Analysis framework .....8
    - 2.1.2 Economic Appraisal assumptions .....9
  - 2.2 Stakeholder engagement..... 10
    - 2.2.1 Background..... 10
    - 2.2.2 One-on-one interviews with relevant stakeholders..... 12
    - 2.2.3 Workshop with relevant stakeholders ..... 12
- 3. STAKEHOLDER CONSULTATIONS ..... 14**
  - 3.1 Background ..... 14
    - 3.1.1 Data sources..... 14
  - 3.2 General findings on social issues associated with ship anchorages..... 14
    - 3.2.1 Altered aesthetic value..... 15
    - 3.2.2 Interference with access to resources..... 15
  - 3.3 Port specific social issues ..... 16
    - 3.3.1 Social issues for the Port of Cairns ..... 17
    - 3.3.2 Social issues for the Port of Townsville..... 18
    - 3.3.3 Social issues for the Port of Abbot Point.....20
    - 3.3.4 Social issues for the Port of Hay Point.....21
    - 3.3.5 Social issues for the Port of Gladstone .....22
  - 3.4 Overall conclusions on social aspects of ship anchorages .....24
- 4. DEMAND FOR SHIP ANCHORAGES AND THEIR OPERATION .....27**
  - 4.1 Background .....27

4.1.1	Data sources.....	27
4.2	How ships use anchorages and the drivers of demand for anchorages.....	28
4.3	Other users of ship anchorage areas.....	30
4.4	Overall demand for and use of ship anchorages along the study port range.....	30
4.4.1	Current total ship visits to the five main ports and the share of ships using anchorages.....	30
4.4.2	Expected future total ship calls to the five main ports.....	31
4.4.3	Expected future total demand for ship anchorages covering the five main ports.....	33
4.5	Demand for and use of ship anchorages at the Port of Cairns.....	35
4.5.1	Current profile of ship anchorages at the Port of Cairns.....	35
4.5.2	Current demand for ship anchorages at the Port of Cairns.....	37
4.5.3	Future demand for ship anchorages at the Port of Cairns.....	38
4.6	Demand for and use of ship anchorages at the Port of Townsville.....	39
4.6.1	Current profile of ship anchorages at the Port of Townsville.....	39
4.6.2	Current demand for ship anchorages at the Port of Townsville.....	42
4.6.3	Future demand for ship anchorages at the Port of Townsville.....	43
4.7	Demand for and use of ship anchorages at the Port of Abbot Point.....	44
4.7.1	Current profile of ship anchorages at the Port of Abbot Point.....	44
4.7.2	Current demand for ship anchorages at the Port of Abbot Point.....	47
4.7.3	Future demand for ship anchorages at the Port of Abbot Point.....	47
4.8	Demand for and use of ship anchorages at the Port of Hay Point (including Dalrymple Bay).....	48
4.8.1	Current profile of ship anchorages at the Port of Hay Point.....	48
4.8.2	Current demand for ship anchorages at the Port of Hay Point.....	51
4.8.3	Future demand for ship anchorages at the Port of Hay Point.....	52
4.9	Demand for and use of ship anchorages at the Port of Gladstone.....	53

4.9.1	Current profile of ship anchorages at the Port of Gladstone.....	53
4.9.2	Current demand for ship anchorages at the Port of Gladstone.....	56
4.9.3	Future demand for ship anchorages at the Port of Gladstone.....	57
4.10	Use of anchorages during severe cyclone events .....	58
4.11	Ability to control ship anchoring demand and use.....	58
<b>5.</b>	<b>RANGE OF OPTIONS FOR ANCHORAGE MANAGEMENT .....</b>	<b>59</b>
5.1	Background and potential management options.....	59
5.1.1	Overview of an identified set of port ship anchorage management options.....	59
5.1.2	Business-as-usual option .....	60
5.1.3	Improved option .....	60
5.1.4	All-at-port option.....	61
5.1.5	All-in-port limits option.....	61
5.1.6	Fixed-moored option .....	61
5.1.7	All-at-sea option .....	61
5.1.8	Scheduled arrivals without anchorage option.....	62
5.1.9	Scheduled arrivals with anchorage option.....	62
5.1.10	Demand management option .....	62
5.1.11	Port consolidation strategy option .....	63
5.1.12	Other options .....	63
5.2	Results of examining the potential relevance of identified ship anchorage management options for the five main ports .....	63
5.3	Relevance of identified ship anchorage management options for each of the five ports under study.....	66
5.3.1	Relevant ship anchorage management options for the Port of Cairns .....	66
5.3.2	Relevant ship anchorage management options for the Port of Townsville.....	69
5.3.3	Relevant ship anchorage management options for the Port of Abbot Point.....	72
5.3.4	Relevant ship anchorage management options for the Port of Hay Point.....	75
5.3.5	Relevant ship anchorage management options for the Port of Gladstone .....	78
<b>6.</b>	<b>OVERVIEW OF AN EXISTING VESSEL ARRIVAL MANAGEMENT SYSTEM .....</b>	<b>82</b>
6.1	Background .....	82
6.1.1	Overseas.....	82

6.1.2	Australia .....	83
6.2	Port of Newcastle’s Vessel Arrival System (VAS).....	83
6.2.1	History of the VAS at Newcastle .....	83
6.2.2	Operation of the VAS at Newcastle.....	84
6.2.3	Potential opportunities and issues for Queensland coal ports .....	85
<b>7.</b>	<b>ECONOMIC APPRAISAL.....</b>	<b>86</b>
7.1	Background .....	86
7.2	Description of the CBA model.....	86
7.3	Economic appraisal for the Port of Cairns .....	88
7.4	Economic appraisal for the Port of Townsville .....	89
7.5	Economic appraisal for the Port of Abbot Point .....	90
7.6	Economic appraisal for the Port of Hay Point .....	90
7.7	Economic appraisal for the Port of Gladstone .....	91
<b>8.</b>	<b>CONCLUSIONS.....</b>	<b>93</b>
8.1	Ship anchorage management options for the five main ports.....	93
8.2	Implications of the Economic Appraisal results for future environmental management strategies at the five main ports.....	94
<b>9.</b>	<b>REFERENCES.....</b>	<b>95</b>
 <b>APPENDIX</b>		
	Appendix A.....	96
 <b>TABLE INDEX</b>		
	Table 1-1: Great Barrier Reef Region vs Marine Park vs World Heritage Area .....	4
	Table 1-2: Bounds (latitude and longitude) and area (in ha) of the anchorage areas at each of the five major ports (Latitudes and longitudes are provided by point number. Point 1 is top left corner, Point 2 is top right corner, Point 3 is bottom left corner and Point 4 is bottom right corner of a bounded area).....	7
	Table 2-1: Overview of stakeholders identified for consultation and consulted for the CBA (* Feedback provided via Shipping Australia Limited) .....	11
	Table 3-1: Summary of social issues identified for the Port of Cairns from consultation under this Project.....	17
	Table 3-2: Summary of social issues identified for the Port of Townsville from consultation under this Project.....	18

Table 3-3: Summary of social issues identified for the Port of Abbot Point from consultation under this Project.....	20
Table 3-4: Summary of social issues identified for the Port of Hay Point from consultation under this Project.....	21
Table 3-5: Summary of social issues identified for the Port of Gladstone from consultation under this Project.....	23
Table 3-6: Summary of overall conclusions of social aspects of ship anchorages from consultation under this Project .....	24
Table 4-1: Overview of Great Barrier Reef ports and their key commodity trades, 2012 (Source: Data courtesy of Great Barrier Reef Marine Park Authority) .....	28
Table 4-2: Total ship visits to five main ports and share using ship anchorages, 2009-2012 (* Excludes Port of Townsville in 2009 due to no data available on split of vessels direct to berth and direct to anchor. Hence, 2009 is the total for four ports. Source: MSQ data / GHD analysis.).....	31
Table 4-3: Overview of current and future anchorage demand for the Reef's five main ports (* as at year 2032) .....	34
Table 4-4: Total ship visits to the Port of Cairns and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis).....	37
Table 4-5: Total ship visits to the Port of Townsville and share using ship anchorages, 2009-2012 (* No data available for 2009 at the Port of Townsville. Source: MSQ data/GHD analysis.).....	42
Table 4-6: Total ship visits to the Port of Abbot Point and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis).....	47
Table 4-7: Total ship visits to the Port of Hay Point and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis).....	51
Table 4-8: Total ship visits to the Port of Gladstone and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis).....	56
Table 5-1: Overview of potential ship anchorage management options.....	59
Table 5-2: Overview of ship anchorage management options and relevance for Port of Cairns .....	67
Table 5-3: Overview of ship anchorage management options and relevance for Port of Townsville .....	70
Table 5-4: Overview of ship anchorage management options and relevance for Port of Abbot Point .....	73
Table 5-5: Overview of ship anchorage management options and relevance for Port of Hay Point .....	76
Table 5-6: Overview of ship anchorage management options and relevance for Port of Gladstone .....	80

**FIGURE INDEX**

Figure 1-1: Overview of ports in the Great Barrier Reef Marine Park and World Heritage Area.....5

Figure 4-1: Queensland Government forecast ship call number scenarios for the Reef ports (2012-2022) as extracted from DSDIP 2012.....32

Figure 4-2: PGM Environment forecast ship call numbers “probable case” for the Reef ports (2012-2032) as extracted from PGM Environment 2012.....32

Figure 4-3: Map of the current anchorage area of the Port of Cairns.....36

Figure 4-4: Forecast ship call numbers “probable case” for Port of Cairns (2012-2032) as extracted from PGM Environment 2012.....38

Figure 4-5: Map of the current anchorage area of the Port of Townsville.....41

Figure 4-6: Forecast ship call numbers “probable case” for Port of Townsville (2012-2032) as extracted from PGM Environment 2012.....44

Figure 4-7: Map of the current anchorage area of the Port of Abbot Point.....46

Figure 4-8: Forecast ship call numbers “probable case” for Port of Abbot Point (2012-2032) as extracted from PGM Environment 2012.....48

Figure 4-9: Map of the current anchorage area of the Port of Hay Point.....50

Figure 4-10: Forecast ship call numbers “probable case” for Port of Hay Point (2012-2032) as extracted from PGM Environment 2012.....52

Figure 4-11: Map of the current anchorage area of the Port of Gladstone.....55

Figure 4-12: Forecast ship call numbers “probable case” for Port of Gladstone (2012-2032) as extracted from PGM Environment 2012.....57



# EXECUTIVE SUMMARY

## Background to the project

The current project seeks to develop understanding of the environmental impacts, risks, costs and benefits of ship anchorages adjacent to main ports operating in the Great Barrier Reef (Reef). The project synthesises relevant information and identifies effective strategies for managing anchorage areas under future demand requirements. Findings from this project will provide information to support best practice environmental management of ship anchoring in the Reef and inform future policy and planning outcomes, including the Strategic Assessment, Regional Sustainability Planning and the North East Shipping Management Plan.

This report covers phase two of works being completed under this project. This work considers the socio-economic costs and benefits associated with different anchorage management options for the five main ports in the Great Barrier Reef World Heritage Area: Cairns, Townsville, Abbot Point, Hay Point, and Gladstone.

## Project approach

This phase of work evaluated current and estimated future anchorage demand, the identification and examination of potential ship anchorage management options, stakeholder views regarding issues and potential impacts, and completed an economic appraisal of relevant anchorage management options using a developed Cost Benefit Analysis (CBA) model. This model considered environmental, commercial and social costs and benefits associated with anchorage demand and management under current and future development scenarios out to 2032.

The model used an iterative approach. Where modelling identified that future anchorage demand requirements were greater than available capacity, the model used comparative analysis to identify management options appropriate to ameliorate impacts and avoid future expansion.

## Stakeholder consultations

Consultation achieved within the scope of this study obtained information from targeted stakeholders regarding impacts to non-shipping users of anchorage areas and relevance of different anchorage management options to industry.

Consultation was achieved through one-on-one meetings and a workshop. Due to time constraints of the project, stakeholder consultation was targeted only. It is recognised that this study did not obtain information about the cultural values and issues of importance to Traditional Owners. Consultation data informed model parameters and selection of potential anchorage management options for application in the CBA model.

Consultation findings revealed that some management options, such as a scheduled arrival system, have emerging concerns regarding safe shipping management. These risks, and potential amelioration measures, would require further investigation prior to implementation of any scheduled arrivals system. They were not seen to be fatal flaws, however, and this management tool was built into the CBA modelling.

## Potential anchorage management options

Ten potential ship management anchorage options were identified by desktop review and consultation. Consideration of the applicability of these options to the five ports of interest refined the potential options to four that were considered relevant. These four potential options were used in the subsequent CBA modelling and are summarised below:

- All-at-port – Ships proceed direct to available berths in port

The “All-at-port” option provides for future demand for ship anchorages by constructing an adequate number of ship-waiting berths (quays or jetties) as part of the port infrastructure within current port limits. These ship-waiting berths would then prevent the need to expand current anchorage areas to meet the future demand for ship anchorages.

- Fixed-moored – Ships moored to fixed structures in anchorage areas

The “Fixed-moored” option is a possible approach to managing future demand for ship anchorages at the five main ports by installing fixed mooring structures (buoy or single-point moorings) in an appropriate anchorage expansion area. The size of the fixed-mooring structures would depend on the depth of water, sea conditions and type of vessel to be moored (e.g. large, un-laden, Cape-size coal ships).

- Scheduled arrivals – Vessels are scheduled with a port arrival management system

The “Scheduled arrivals” option is a possible approach to managing future demand for ship anchorages at the five main ports by deciding not to have any anchorages at all with all vessels proceeding direct from sea to a berth in the port based on scheduled ship arrivals. This approach can be considered to be less feasible than the others as it would require a change in long-accepted practice of port and shipping operations.

Schedule arrivals can also be used to manage future demand for ship anchorages by deciding not to expand current anchorages and to implement a scheduled ship arrival system which uses the sea voyage to the port to ensure ships proceed efficiently (do not speed-up) and anchor at the port for minimum periods of time. This approach still allows for the future growth in ship calls, but avoids the expansion of anchorage areas (wherever possible). The time at anchor is then solely linked to the flexibility required by the terminal operators at the port to ensure efficient loading of cargoes and use of the berths.

A scheduled arrivals system currently operates at the Port of Newcastle and a case study regarding this operation completed for this project provided evidence (for modelling) of some of the costs and benefits of using this management option.

- Demand management anchorage pricing – Restriction on the level of ship arrivals using pricing disincentives

The “Demand management anchorage pricing” option is a possible approach to managing future demand for ship anchorages by limiting the length of time at anchor using pricing disincentives (penalties).

Demand management practices can be implemented through pricing regimes on the use of anchorages.

## **Project findings**

Data which informed the project included recently released forecasts of shipping within Queensland prepared by PGM Environmental (PGM 2012) to estimate future anchorage demand requirements (out to 2032). Maritime Safety Queensland anchor movement records from 2009 to 2012 were also used to inform existing patterns of ship movements' average anchor waiting times for each of the ports. To inform the analysis, use of anchorage areas was rated according to a scale that ranged from negligible (<3 per day) to significant (>20 vessels per day).

Findings for each of the five ports of interest from review of all available data are:

- Ship call numbers are forecast to increase slowly at the Port of Cairns. Despite this, it is likely that the future demand for ship anchorages over this period will decrease if the planned accommodation of large cruise-ships via channel access upgrades occurs.

The future scale of the use of ship anchorages at the Port of Cairns over the forecast period can be summarised as possibly becoming negligible from an already minor position. If planned port access does not eventuate, then the future scale will likely continue to be minor.

It is anticipated that the very limited future growth in anchorage demand for Cairns can be accommodated by the existing anchorages. As this location has existing designated anchorages improved management options were not considered to be required.

- Ship call numbers are forecast to increase slowly at the Port of Townsville. It is likely that the future demand for ship anchorages over the forecast period will increase at a rate similar to the increase forecast in ship call numbers. In addition, as port infrastructure is upgraded and expanded, it is likely that certain types of ships will not have to wait at anchor for a berth (i.e. container ships, vehicle carriers and some general cargo ships). This will have the effect of a lower growth rate in the demand for anchorage over the study period.

The future scale of the use of ship anchorages at the Port of Townsville can be summarised as possibly remaining minor with demand possibly increasing by approximately one third between now and 2032. This equates to less than two ship calls per day requiring the use of anchorage by 2032.

Townsville does not currently have a designated anchorage area. A conservative area of anchorage was assessed (in consultation with the Regional Harbour Master) within this report. It is anticipated that the limited future growth in anchorage demand for Townsville can be accommodated in the existing anchorage area (assessed herein), particularly if more designated anchorages and/or more densely organised anchorages are used. The improvement of implementing organised designated areas is likely to produce the least cost for the desired net environmental outcome over the next 30 years at this site.

- Forecast ship call numbers are predicted to increase significantly at the Port of Abbot Point. It is likely that the future demand for ship anchorages will increase at a rate similar to the increase in ship call numbers. Given the historical fluctuations of usage, it is difficult to predict whether in future the number of ships proceeding direct to anchor will change. Some coal producers at Abbot Point will control coal exports from mine to overseas port. This means that they are more able to control the scheduling of their shipping which will facilitate management of anchorage use.

The future scale of the use of ship anchorages at the port can be summarised as becoming more significant. Demand could possibly increase by around nine times between now and 2032. This equates to around 2.5 ship calls per day requiring the use of anchorage. Abbot Point does not currently have a designated anchorage area. A conservative area of anchorage was assessed (in consultation with the Regional Harbour Master) within this report and that area is expected to be able to accommodate all future anchorage demands, particularly if designated anchorages and/or densely organised anchorages are used.

Port of Abbot Point does not contain specific designated anchorages; therefore, the existing area used for anchorage was defined in consultation with the port's Regional Harbour Master. If a reduced area of anchorage (to that assessed herein) was desired for Abbot Point consideration could be given to applying a scheduled arrival system to improve management of anchorage demand within this single commodity port.

- Forecast ship call numbers are predicted to increase significantly at the Port of Hay Point. It is likely that the future demand for ship anchorages over the forecast period will increase at a similar rate such that demand may treble between now and 2032 (i.e. around 6.5 ship calls per day requiring the use of anchorage). There is a possibility that coal producers using the planned new terminal at Dudgeon Point will control shipping. This provides better potential to schedule ships to call at a berth direct from sea and improve management of anchorage areas.

This future growth in anchorage demand at Hay Point is predicted to outstrip the current capacity of the designated ship anchorages unless the average ship time at anchor is reduced. Modelling identifies that implementation of a scheduled arrivals system could provide the greatest net social welfare gain for management of this anchorage area over the next 30 years. This is principally driven by estimated savings in ship fuel costs.

Implementation of a scheduled arrivals system for both the ports of Hay Point and Abbot Point may have beneficial flow on affects not tested by this project given the commonalities in management governing each location.

- Forecast ship call numbers are increasing moderately at the Port of Gladstone. It is likely that the future demand for ship anchorages will continue to increase over the forecast period, however at a reduced rate. Dedicated shipping and berthing operations of LNG exports will be able to schedule vessels to call at an LNG berth direct from sea. This would be facilitated by planned channel duplication, which is yet to be assessed.

Even with improved management, the future scale of the use of ship anchorages at the Port of Gladstone can be summarised as becoming more significant. It is forecast that demand could possibly increase by around 1.8 times between now and 2032. This equates to approximately six ship calls per day requiring the use of anchorage. Based on preliminary observations, this future growth in anchorage demand should be able to be met by the current capacity of the designated ship anchorages assuming that average ship time at anchor does not increase significantly beyond current levels.

Results, therefore, suggest that the current practice of anchorage management at the Port of Gladstone is likely to produce the least economic cost for the desired net environmental outcome over the next 30 years. However, this finding is sensitive to the assumed (i.e. current) average waiting times of ships at anchor. If average waiting times increase in future then opportunities to improve anchorage management would need to be considered. Expansion of the existing designated anchorages would not be considered an environmentally beneficial solution to increased demand management. Consideration could be given to designating specific anchorages for coal vessels and adopting a VAS for only those anchorages.

The results of the CBA modelling suggested that physical expansions of anchorages at the Ports of Cairns, Townsville, Abbot Point and Gladstone would not be required over the period 2012-2032 based on PGM Environment's "probable" forecasts for each of the five ports. This implies that current anchorage practices (with some improvements for the Ports of Townsville and Abbot Point) remain appropriate to the management of environmental, social and economic risks under increased shipping forecasts. The data used to support modelling is, however, sensitive to future changes in average ship waiting times and has used a conservative anchorage area at each location for assessment. Adopting improved management strategies at the Ports of Townsville and Abbot Point, including designation of anchorage areas and considering use of a scheduled arrivals system at Abbot Point, may provide beneficial outcomes in environmental performance of those anchorages beyond that assessed by the economic appraisal completed here.

Unlike the other locations modelled, the anchorage at the Port of Hay Point is predicted to require expansion by around 30 per cent by 2032 unless more efficient use is made of current anchorages. Expansion of the existing anchorage would result in environmental and socio-economic impacts. Therefore alternative anchorage management options to avoid expanding the anchorage area were considered through iterative modelling.

Use of a scheduled arrivals management strategy in conjunction with organised anchorages is predicted, for Hay Point, to provide the greatest net societal gain. However, this result should be set in the context of emerging concerns relating to some potential flow-on impacts of scheduled arrivals that would require further evaluation prior to implementation of a VAS.

A summary for each of the five ports is included in table E-1.

**Table E-1:** Overview of anchorages for the Reef’s five main ports (\* source: GHD 2013 as at year 2032.)

Ports:	Cairns		Townsville		Abbot Point		Hay Point		Gladstone	
	Current	Future*	Current	Future*	Current	Future*	Current	Future*	Current	Future*
Ship calls per year	476	501	726	1161	179	1640	796	2380	1510	3029
Average per cent direct to berth	85%	>85%	44%	Uncertain	20%	Uncertain	1%	1%	20%	Uncertain
Average per cent direct to anchor	15%	<15%	56%	Uncertain	80%	Uncertain	99%	99%	80%	Uncertain
Number of anchor locations (if designated)	8	Possibly not > current	-	Possibly not > current	-	Possibly not > current	102	Possibly 129	32	Possibly not > current
Average waiting days	0.5	Uncertain	3	Uncertain	3	Uncertain	19 (sample)	Uncertain	4	Uncertain

## **Conclusions and next steps**

This report provides findings of the CBA phase of this study. This is the second phase of work. The third and final phase of work which will be completed in early 2013 will use information developed within this phase of work and from the impact assessment phase of work to develop potential management strategies for the anchorages at the five main ports.

The economic appraisal work reported here has provided some direction for the development of environmental management strategies for the five main ports. Key findings of importance in developing up relevant management strategies across the ports are that:

- The key port requiring future management intervention to avoid any physical expansions of anchorages will be the Port of Hay Point.
- Use of scheduled ship arrivals combined with designated anchorages is a cost effective management strategy for future demand requirements at the Port of Hay Point. Use of scheduled ship arrivals may also benefit management of anchorages at the Ports of Abbot Point and Gladstone.
- Adoption of any VAS would require further investigation on some emerging concerns regarding transfer of risk. It would also require investigation into the key requirements for successful adoption of such an approach, including with regard to legislative and management jurisdictional requirements, for implementation at any of the ports.
- Use of designated anchorages at Townsville and Abbot Point will avoid potential increase in environmental risk under increasing shipping forecasts.

## **ACKNOWLEDGEMENTS**

We would like to acknowledge the contributions made by stakeholders who agreed to be interviewed, participated in workshops/meetings, and provided data, to inform the social and economic analyses of ship anchorage management in the Great Barrier Reef World Heritage Area.



## ACRONYMS/GLOSSARY

<b>Acronym/Term</b>	<b>Meaning</b>
AMSA	Australian Maritime Safety Association
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
DAFF	Department of Agriculture, Fisheries and Forestry
DBCT	Dalrymple Bay Coal Terminal
DSA	Designated Shipping Area
DSDIP	Department of State Development, Infrastructure and Planning
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
Environmental	the ecosystems and their constituent parts, natural and physical resources; and the qualities and characteristics of locations, places and areas, that contribute to their biodiversity and ecological integrity
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
GBRMPA	Great Barrier Reef Marine Park Authority
GPCL	Gladstone Ports Corporation Limited
GPS	Global Positioning System
Fisheries Queensland	Department of Agriculture, Fisheries and Forestry
ha	hectares
HPCT	Hay Point Coal Terminal
HVCSC	Hunter Valley Coal Supply Chain
IMO	International Maritime Organisation
km	kilometres
km <sup>2</sup>	square kilometres
LAT	lowest astronomical tide

<b>Acronym/Term</b>	<b>Meaning</b>
LNG	liquefied natural gas
LWM	low water mark
m	metres
MNES	Matters of National Environmental Significance
MSQ	Maritime Safety Queensland
NPC	Newcastle Port Corporation
NPV	Net Present Value
OUV	Outstanding Universal Value
POTL	Port of Townsville Limited
PSSA	Particularly Sensitive Sea Area
NQBP	North Queensland Bulk Ports
RHM	Regional Harbour Master
the Marine Park	the Great Barrier Reef Marine Park
the Reef	the Great Barrier Reef
VAS	Vessel Arrival System
World Heritage Area	Great Barrier Reef World Heritage Area

# 1. INTRODUCTION

## 1.1 Relationship of this project to the comprehensive Strategic Assessment

The Great Barrier Reef Marine Park Authority (GBRMPA) is the principal advisor to the Commonwealth Government on the conservation, care and utilisation of the Great Barrier Reef Marine Park (the Marine Park). The Marine Park is a multiple-use marine park that supports a range of activities, industries, communities and businesses. The GBRMPA's goal is to provide for the long-term protection, ecologically sustainable use, understanding and enjoyment of the Great Barrier Reef (the Reef) for all Australians and the international community through the care and development of the Marine Park.

The Australian and Queensland Governments are working together on a comprehensive Strategic Assessment of the Great Barrier Reef World Heritage Area (World Heritage Area) and the nearby coastal zone. The Strategic Assessment is an overall assessment of the effectiveness of management arrangements to protect the environmental values of the World Heritage Area. The goal is to ensure the World Heritage values of the Reef are protected while creating a long-term plan for sustainable development in the region.

The Strategic Assessment will identify planned and potential future development that could impact on the World Heritage Area's Outstanding Universal Value (OUV) and inform long-term planning for sustainable development. The Strategic Assessment will examine the pressures, including the cumulative impacts of actions, such as shipping, on the World Heritage Area, other relevant Matters of National Environmental Significance (MNES), and the management arrangements to deal with such impacts.

The Strategic Assessment comprises two elements: The Great Barrier Reef Coastal Zone Strategic Assessment to be undertaken by the Queensland Government; and The Great Barrier Reef Marine Strategic Assessment to be undertaken by the GBRMPA.

The marine assessment will examine the uses of the Marine Park and the impacts of these uses as well as examining the controls on those uses and policies and assessing the effectiveness of those controls. Of the activities in the Marine Park, ports and shipping is one area where concern about impacts has been expressed. This project supports the marine assessment by completing works to achieve the *"identification of impacts and proposed management strategies associated with ship anchorages in the Great Barrier Reef World Heritage Area"*. Findings from the project will inform the comprehensive strategic assessment of the Reef and associated regional sustainability planning.

## 1.2 Background to this project

There is a predicted increase in shipping traffic within the Marine Park and World Heritage Area over the next 10 years, primarily driven by bulk commodity exports. This increase is focused around existing and future port expansions at Queensland ports between Cairns and Gladstone. The proposed port expansions

may have far reaching and long-lasting implications for the health of the Marine Park and in particular the in-shore biodiversity of the Great Barrier Reef Region.

The International Maritime Organisation (IMO) designated the Reef as a Particularly Sensitive Sea Area (PSSA) in 1990. This confirms that the Reef was considered particularly vulnerable to the impacts of international shipping. With this declaration, the Australian Government was able to implement a number of measures to protect the Reef, including ship routing, traffic management, shore based monitoring, emergency response arrangements and pilotage.

The *Great Barrier Reef Marine Park Zoning Plan 2003* designates where ships may navigate; which is only within the Designated Shipping Areas (DSA) and the General Use Zone. The definition of navigate includes moor, or anchor, in the course of navigation. This indicates that ships are allowed to navigate (including anchor) in the DSA and the General Use Zone in the Marine Park.

The projected increase in shipping has the potential to increase both the number and size of anchorage areas adjacent to ports with potential environmental impacts (such as turbidity plumes and seabed damage caused by anchor drops and chain dragging, disturbance to fauna from noise and light impacts, and increase risk of pest species introductions) and potential impacts to other users (for example fishing, tourism and recreational). Potential impacts caused by ship anchorages are explored in the Environmental Impact Assessment Report (EIA) delivered as phase one of this project (GHD, 2012a). Existing arrangements for anchorage placement in the Great Barrier Reef Region are undertaken through a process where the Queensland Department of Transport and Main Roads, through Maritime Safety Queensland (MSQ), provide guidance to mariners to ensure orderly management of shipping in areas adjacent to ports, with the focus on safety and navigation. Environmental and multiple-use considerations for those areas are not formally considered as part of the process.

### 1.3 This project

The current project will develop understanding of the environmental impacts, risks, costs and benefits of ship anchorages adjacent to major ports operating in the Reef and synthesise relevant strategies for managing these anchorages to reduce potential impacts. The project will provide information to support best practice environmental management of ship anchoring in the Reef and inform future policy and planning outcomes, including the Strategic Assessment, Regional Sustainability Planning and the North East Shipping Management Plan.

This project is being delivered across three phases of work:

1. Identification of the environmental impacts of anchoring associated with the five major ports in the World Heritage Area: Cairns, Townsville, Abbot Point, Hay Point, and Gladstone.
2. Socio-economic costs and benefits associated with different anchorage strategies.
3. Anchorage management strategies that could be used to avoid, mitigate, offset or adaptively manage identified impacts.

This project will directly inform the following Strategic Assessment deliverables, as set out under the Terms of Reference for the Great Barrier Reef Region Strategic Assessment:

- Item 3.1 Assessment of actual and potential impacts including direct, indirect, consequential and cumulative impacts
- Item 4.1.1 (c) Consider environmental, social, cultural and economic issues
- Item 4.1.1 (d) Avoid, mitigate, offset and adaptively manage impacts
- Item 4.1.1 (e) Address uncertainty and risk
- Item 4.1.1 (f) Provide certainty regarding where uses may occur etc.
- Item 4.2 Relevant Demonstration Cases
- Item 5 Describe projected condition of relevant Matters of National Environmental Significance
- Item 6 Recommendations for changes to the Program

Key benefits of the project are identified to be:

1. Assist the GBRMPA and the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) in providing high level scientific and environmental advice and strategies for improved ship anchorage management for the Great Barrier Reef Region.
2. Assist with addressing potential environmental issues related to anchoring, including cumulative impacts, due to increases in ports and shipping activities in the Great Barrier Reef Region (i.e. port expansions and associated increases in shipping volumes).
3. Assist in the identification of improved management and protective measures to protect values that underpin Matters of National Environmental Significance (MNES) (such as the Marine Park) and those values identified in the GBRMPA Outlook Report (GBRMPA 2009), which include biodiversity, ecosystem health, heritage values, human use and aesthetics.
4. Improved guidance for ports and mariners concerning anchoring arrangements and selection of future anchoring areas that support the orderly management of shipping through safety, navigation, environmental and multiple-use considerations.
5. Likely administrative reductions for the GBRMPA, other regulatory agencies and ports due to improved guidance and through the development of policies that streamline environmental assessment processes.
6. The project's expected outputs have potential to support the interests of other commercial and non-commercial users of the Marine Park by reducing the risk of user conflict.

The project, in its entirety, will complement other projects being delivered in support of the Strategic Assessment, including development of improved information upon which to base decisions in relation to dredge spoil management. This report prescriptively pertains to the Cost Benefit Analysis (CBA) phase of the project. Additional reports relating to the remainder of the project will be developed over the course of the project and provided at a later date.

## 1.4 Study area

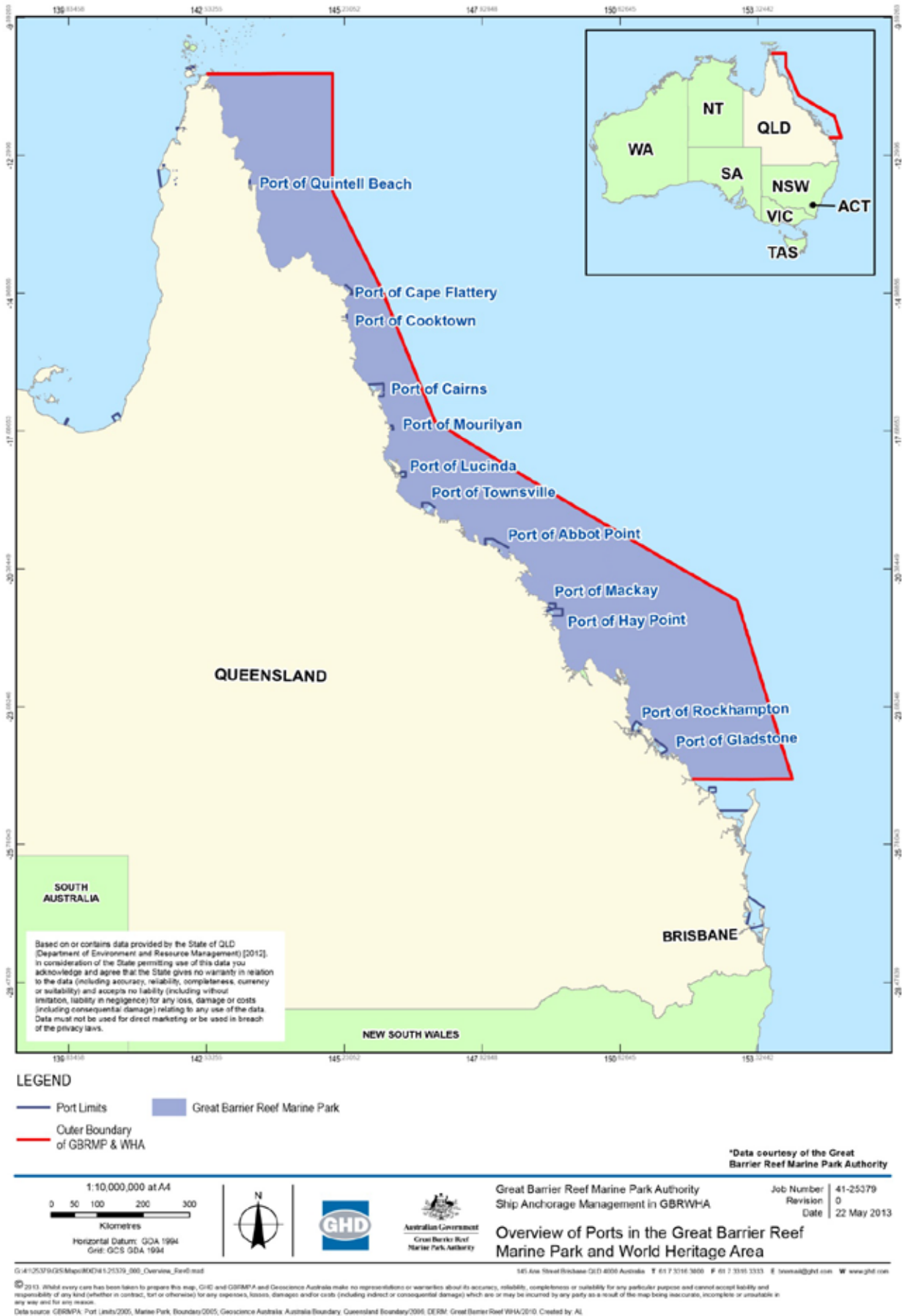
In 1975 the Great Barrier Reef Region was established and today provides for the long-term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef. Australia's Reef is the largest coral reef ecosystem on earth. The Great Barrier Reef Region extends more than 2300 kilometres (km) along the Queensland coastline and covers an area of 346,000 square kilometres (km<sup>2</sup>).

In 1981 the area was listed as a World Heritage property for its OUV and in 2007 it was listed as a National Heritage property. The property was the first coral reef ecosystem in the world to be nominated on the basis of all four natural criteria. The Great Barrier Reef Region and World Heritage Area have the same outer boundary. However, the Great Barrier Reef Region does not include internal waters of Queensland or Queensland islands, which are included in the World Heritage Area.

The Marine Park was declared in sections (between 1979 and 2001) and today covers the majority (99.5 per cent) of the Great Barrier Reef Region (or just under 99 per cent of the World Heritage Area). As sections of the Marine Park were declared, various ports and harbours were not included. Today 12 ports are located in the World Heritage Area (figure 1-1, table 1-1).

**Table 1-1:** Great Barrier Reef Region vs Marine Park vs World Heritage Area

<b>Great Barrier Reef Region</b>	<b>Marine Park</b>	<b>World Heritage Area</b>
Proclaimed 1975	Declared in sections between 1979 and 2001; made into one amalgamated section in 2004	Inscribed 1981
346,000 km <sup>2</sup>	344,400 km <sup>2</sup>	348,000 km <sup>2</sup>
Great Barrier Reef Region does not include: <ul style="list-style-type: none"> <li>• Internal waters of Queensland</li> <li>• 980 Queensland islands</li> </ul>	Marine Park does include 70 Commonwealth owned islands Marine Park does not include: <ul style="list-style-type: none"> <li>• Internal waters of Queensland</li> <li>• 980 Queensland islands</li> <li>• 10 ports</li> </ul>	Does include: <ul style="list-style-type: none"> <li>• All islands within outer boundary (1050)</li> <li>• All waters seaward of low water mark (LWM) of coast (including internal waters of Queensland and port waters)</li> <li>• 2 ports</li> </ul>



**Figure 1-1: Overview of ports in the Great Barrier Reef Marine Park and World Heritage Area**

As noted under section 1.2, the predicted increase in shipping traffic within the Marine Park and World Heritage Area in coming years is driven primarily by bulk commodity exports with contribution from other trade developments from ports located between (and including) Cairns and Gladstone. These other trade developments concern increased demand for imported commodities (driven by increasing population in Queensland) and increasing agricultural exports. Accordingly, to inform the GBRMPA Strategic Assessment, this project is considering the risks from trading vessel anchorages associated with the five major Queensland ports of:

- Port of Cairns
- Port of Townsville
- Port of Abbot Point
- Port of Hay Point
- Port of Gladstone.

Anchorage areas are designated on navigational charts for only three of these locations; Cairns, Hay Point and Gladstone. Vessels may also anchor outside of designated areas at the discretion of the ship's Master as long as they are compliant with relevant zoning and legislative protection measures for the World Heritage Area. Management and direction for anchorage within the vicinity of each of the ports is provided to bulk cargo and other trading vessels by the Regional Harbour Master (RHM).

This project involves investigation of impacts associated with anchorages of the five major ports. A key step, therefore, has been to define the existing areas being used for anchorage by trading vessels working to each of the nominated ports. This was achieved through consultation with each port's RHM to confirm designated areas and, for locations without charted anchorages (i.e. Townsville and Abbot Point), to define an area within which vessels are known or directed to anchor. Where specific designated anchorages are mapped (i.e. Cairns, Hay Point and Gladstone) a conservative approach of considering the entire area across which anchor drop may occur has been used to define the anchorage area of a port. This has provided an area of seabed adjacent to each of the five ports within which anchorage currently occurs (refer the maps presented in section 4). This approach enables the project to take into account direct impacts from anchor drop in addition to indirect impacts that can be experienced by designating a network of drop points, such as habitat fragmentation or impact to habitat continuity/integrity.

The bounds of the ship anchorage areas (global positioning system (GPS) coordinates) at each of the ports and the total area (in hectares (ha)) of each ship anchorage are provided for reference (table 1-2) and for the purposes of informing the Economic Appraisal work.

It should be noted that these spatial areas defined above and in table 1-2 provide the footprint of investigation adjacent to each port addressed by both the associated preceding EIA (GHD 2012a) and this social economic study.



**Table 1-2:** Bounds (latitude and longitude) and area (in ha) of the anchorage areas at each of the five major ports (Latitudes and longitudes are provided by point number. Point 1 is top left corner, Point 2 is top right corner, Point 3 is bottom left corner and Point 4 is bottom right corner of a bounded area)

Port	Point 1	Point 2	Point 3	Point 4	Area (ha)
Cairns	-16.809302	-16.75466	-16.97995	-16.95247	24,118
	145.77560	145.86635	145.96195	146.01798	
Townsville	-19.01963	-19.02737	-19.13087	-19.13266	23,762
	146.80780	147.03623	146.90595	147.06002	
Abbot Point	-19.65923	-19.67425	-19.81606	19.87983	58,818
	147.98337	148.28264	147.98092	148.22934	
Hay Point	-21.17225	-20.97303	-21.29850	-21.29862	157,284
	149.31492	149.81436	149.31236	149.95951	
Gladstone inner anchorage	-23.83373	-23.82218	-23.87902	-23.86798	1403
	151.29568	151.31167	151.35518	151.36551	
Gladstone outer anchorage	-23.83195	-23.76377	-23.94741	-23.87346	22,722
	151.42357	151.49485	151.59231	151.66395	

## 1.5 The structure of this report

The structure of this report comprises sections on:

- Methodology – Describes the approaches used for the economic and social analyses and the environmental inputs to the Economic Appraisal.
- Demand for ship anchorages and their operation – Describes the current and expected future demand for each of the five main ports to frame the scope of and parameters for the cases used in the Economic Appraisal.
- Range of options for anchorage management – Identifies and assesses a full range of options for each of the five main ports and considers which options are relevant to each port.
- Overview of an existing vessel arrival management system – Describes an example of a current vessel arrival management system in Australia at the Port of Newcastle for coal ships.
- Stakeholder consultations – Presents the findings of stakeholder consultation (interviews with additional feedback from the CBA workshop) on possible and voiced concerns, issues and impacts associated with ship anchorages.
- Economic Appraisal – Presents the results of the CBA modelling of options.
- Conclusions – Discusses the possible implications of the Economic Appraisal results for further evaluation of ship anchorage management strategies.

## 2. METHODOLOGY

### 2.1 Social Economic Appraisal using a Triple-bottom-line approach

The methodology adopted for the social economic work is based on a “Triple-bottom-line” CBA framework, as suggested for use by Australian governments and agencies. This CBA draws together findings from the Environmental Impact Assessment Report delivered as phase one of this project (GHD 2012a), the forecasts of future anchorage demand, and the results of the assessment of the relevance of various ship anchorage management options, together with stakeholder consultation information on social issues for each of the five main ports in the study area.

Where benefits for different anchorage management strategies cannot be quantified (evidenced and monetised) then the Economic Appraisal takes the form of a Cost Effectiveness Analysis (CEA), which estimates the lowest cost for a desired outcome.

#### 2.1.1 Cost Benefit Analysis framework

The Triple-bottom-line CBA approach recognises and combines the potential direct social, economic and environmental impacts of changing an anchorage management strategy at a port. Each impact of changing a management strategy is identified as either a cost (with negative consequences) or a benefit (with positive consequences) in comparison with the current situation. Impacts must also be quantified (if possible) and be assigned a monetary value (‘monetisation’).

Some impacts are termed ‘externalities’. These are impacts that occur outside of the activity itself but as a direct consequence of the activity. These may include pollution/emissions (an environmental category) or deaths/accidents of people (a social/economic category).

Those costs or benefits which may occur but that cannot be quantified or monetised are treated as qualitative impacts for assessment. For example, the ‘aesthetics’ of a natural panorama being changed by the construction or enlargement of a ‘man-made’ object is difficult to financially quantify. The weighting of qualitative impacts depends on the goals of the project and/or the proponents of the project. For this study, the CBA needs to take account of the net environmental gain of a change option versus the current practice for ship anchorages. In this regard a positive result is considered to be one in which a change option produces both a net monetised benefit and a net environmental gain.

Direct social impacts are typically items such as changes to the conduct of leisure activities, changes to health via pollutant emissions, accidents and fatalities, increased light pollution and noise and changed aesthetics of a landscape. However, there can also be beneficial impacts with a positive change to a social amenity or leisure activity or a reduction in a negative impact.

Direct economic impacts are typically items such as the commercial operations of industries and businesses, both involved in the change activity and/or directly

affected by the change activity. These items can be both positive (gains in productivity and efficiency) and negative (increased cost of doing business).

Direct environmental impacts are typically items which relate to the surrounding ecology, flora and fauna and ecosystems of the activity, both land and marine-based (i.e. effects on items deemed to be of state, national or world environmental significance). Some of these environmental items can also be directly contributing to the economy (e.g. Reef tourism).

The steps for the Economic Appraisal comprised:

- The identification of relevant options for CBA modelling using a desktop review and workshop approach with targeted stakeholders and industry representatives.
- The identification of possible environmental, commercial and social impacts of each option in considering both benefits and costs. This process also used the CBA workshop and other stakeholder consultations as information sources.
- The quantification and monetisation of the benefits and costs of each option using currently available data.
- The development of forecast anchorage demand and supply over the next 20 years using currently available data.
- The development and running of a CBA model with output as Net Present Value (NPV) of the various modelled options.
- Summarising findings of the CBA model to identify anchorage management strategies that provide net benefits under forecast demand.

### **2.1.2 Economic Appraisal assumptions**

The CBA model (Economic Appraisal tool) was developed using a framework capturing environmental, commercial and social impacts, and populated with evidenced data. The model considered a 30 year future time-horizon (2012-2042 with 2012 as Year 0) where economic data was available for quantification of benefits and costs.

Future demand for each of the identified anchorage areas (identified in section 1.4) was based on PGM Environment's "probable" forecasts for each of the five ports. This demand value was adjusted for any assessed changes in direct ship calling to berths versus anchoring for the period 2012-2032. The ten years from 2032-2042 were maintained at the same levels as for year 2032 (PGM Environment 2012).

A discrete set of ship anchorage management options were modelled to identify appropriate anchorage management in locations where future shipping demands on port anchorage areas was predicted to require a physical expansion of the current anchorage area.

For the purposes of the model, the Base Case approach (i.e. current practice) to any future shortfall in current anchorage capacity caused by increased demand is to expand the current anchorage area. It is assumed that any expansion would be into an area resulting in the least environmental and socio-economic impact either

within existing port limits or within the Marine Park, taking into account safe operational and permitting requirements.

Any identified ship anchorage management option (strategy) which avoids the expansion of the current anchorage area or which reduces the current impacts is considered an Alternative Scenario for the CBA. The incremental benefits and costs and Net Social Welfare Gain (the NPV) of the Alternative Scenario is then compared against the Base Case. Any location for anchorage which offers net environmental gains over the current anchorage area is also considered an Alternative Scenario for the CBA. The evaluation, therefore, assessed the net benefit of each Alternative Scenario incremental to the Base Case.

## **2.2 Stakeholder engagement**

### **2.2.1 Background**

Stakeholders have valuable knowledge regarding the use, management and operation of anchorages associated with the ports within the World Heritage Area. However, as is often the case, there is limited documented research in the public domain which sheds light on the views of, and effects to, the wider community regarding ship anchorages at the five subject ports.

For the purpose of informing the CBA, selected targeted stakeholders were consulted with the aim to understand the social implications, costs and benefits of various ship anchorage management strategies. Consultation undertaken included a project specific CBA workshop and one-on-one interviews as described in the following sections.

Consultation achieved within the scope of this study obtained information from targeted stakeholders regarding impacts to non-shipping users of anchorage areas and relevance of different anchorage management options to industry. Consultation was achieved through one-on-one meetings and a workshop. Due to time constraints of the project, stakeholder consultation was targeted only. It is recognised that this study did not obtain information about the cultural values and issues of importance to Traditional Owners. This knowledge gap is acknowledged. Consultation data informed model parameters and selection of potential anchorage management options for application in the CBA model. The targeted stakeholders who participated in the interviews and/or the workshop are listed in table 2-1.

Information obtained during the one-on-one consultations was used to qualify those elements of the CBA that cannot be costed. The CBA workshop was also used to inform appropriate anchorage management options/strategies and re-confirm earlier information supplied. Results and findings from the consultations have been used throughout this report, however, the details of individuals have been withheld due to confidentiality agreements.

**Table 2-1:** Overview of stakeholders identified for consultation and consulted for the CBA (\* Feedback provided via Shipping Australia Limited)

Stakeholders identified and invited	Consultation activities	
	One-on-one consultations	CBA workshop
Association of Marine Park Tourism Operators	✓	✓
Australian Maritime Safety Association (AMSA)	-	✓
Cairns Regional Council	-	-
Dalrymple Bay Coal Terminal and Integrated Supply Logistics Chain	✓	-
Department of Agriculture, Fisheries and Forestry (Fisheries Queensland)	✓	✓
Department of Sustainability, Environment, Water Population and Communities (DSEWPaC)	-	✓
Department of Transport and Main Roads	-	✓
Great Barrier Reef Marine Park Authority (GBRMPA)	✓	✓
Gladstone Ports Corporation Limited (GPCL)	-	-
Gladstone Regional Council	✓	-
Mackay Regional Council	-	-
Maritime Safety Queensland (MSQ)	-	✓
Northern Queensland Bulk Ports (NQBP)	-	✓
Ports North	-	-
Port of Townsville	-	-
Queensland Sea Food Industry Association	✓	-
Shipping Australia Limited	✓	-
Sunfish Queensland	✓	-
Tourism Queensland	✓	-

Stakeholders identified and invited	Consultation activities	
	One-on-one consultations	CBA workshop
Tourism Queensland Far North	✓	-
Newcastle Port Corporation*	-	-
Townsville City Council	✓	-
Traditional Owners	-	-
Whitsunday Regional Council	✓	-

### 2.2.2 One-on-one interviews with relevant stakeholders

A total of 11 one-on-one interviews were held in early October 2012. Participants included representatives from: the Association of Marine Park Tourism Operators, Fisheries Queensland, GBRMPA, Gladstone Regional Council, Queensland SeaFood Industry Association, Sunfish Queensland, Tourism Queensland, Whitsunday Regional Council, Townsville City Council and Integrated Supply Logistics Chain who work closely with Dalrymple Bay Coal Terminal.

The interviews consisted of structured one-on-one telephone calls to identify if and how the current operation of ship anchorages associated with the five main ports were impacting the various users of the study area and the surrounding communities (as represented by local government authorities (councils)). The interviews extended to identify if and how any impacts for the stakeholders may occur as a result of expected increased ship numbers in the future.

In addition, one-on-one discussion was held with Shipping Australia in December 2012 which targeted specific information of relevance to the costs and benefits of management options, in particular the vessel management strategies applied by Newcastle Port Corporation.

### 2.2.3 Workshop with relevant stakeholders

A project specific CBA workshop was conducted in Brisbane at the GHD office on 16 October 2012. Targeted stakeholders were identified to be relevant to this phase of works in consultation with the GBRMPA and through suggestions of other stakeholder representatives. Participants who attended the workshop (n = 14) included representatives from the Association of Marine Park Tourism Operators, the Australian Maritime Safety Association, the Department of Agriculture, Fisheries and Forestry, the Department of Transport and Main Roads, DSEWPaC, GBRMPA, Maritime Safety Queensland, and North Queensland Bulk Ports. Invited organisations and those who participated are listed in table 2-1.

The purpose of the workshop was to

- Describe the proposed socio-economic CBA methodology for stakeholder input.
- Examine preliminary thinking on a range of possible ship anchorage management options.
- Review a draft set of possible concept management options/strategies for shipping anchorages, resulting in a set of proposed management options/strategies for economic analysis.
- Identify and confirm existing data sources required for the economic analysis (e.g. ship forecasts).
- Review/validate information obtained prior to the workshop from one-on-one stakeholder interviews.
- Identify option/strategy impacts which can be monetised and categorised as either benefits or costs.

Feedback from both one-on-one phone calls and the workshop were assimilated to inform the CBA.

### 3. **STAKEHOLDER CONSULTATIONS**

#### 3.1 **Background**

This section presents the findings of targeted stakeholder consultations conducted for the CBA and other associated processes. The findings from the stakeholders consulted inform the CBA modelling presented in later sections. In particular, the findings were used to establish whether, and to what degree, other users of the shipping anchorage areas are currently impacted by commercial shipping and how this would change with any expansions in ship anchorages in the future.

##### 3.1.1 **Data sources**

As highlighted in section 2.2, targeted stakeholder engagement was undertaken to inform the CBA consisting of 11 one-on-one interviews and a workshop with 14 participants held in October 2012. Representatives from a variety of stakeholder groups were invited to participate, however, participants were limited to those available to participate within the timeframes of the study. This study did not obtain information about the cultural values and issues of importance to Traditional Owners. Represented parties are noted in section 2.2.1.

In addition to the targeted consultation activities, social inputs to the CBA have been informed by the Environmental Impact Assessment Report (phase 1) and EIA Consultation Report (GHD 2012a) and ongoing liaison with GBRMPA. To support the phase 1 findings, an EIA workshop was held at GBRMPA's offices in Townsville on 25 September 2012 with representatives from GBRMPA, GPCL, MSQ, POTL, NQBP, Ports North and AMSA.

#### 3.2 **General findings on social issues associated with ship anchorages**

As part of the EIA workshop conducted in September 2012, participants identified 130 different potential impacts that could result from anchorage area use. Two categories of potential impacts accounted for nearly 40 per cent of all potential impacts identified. These were:

- Impacts to the benthic environment from anchoring and associated ship behaviour such as chain drag or release of wastes and other pollutants while at anchor.
- Impacts on the aesthetic value of the World Heritage Area (as viewed from land) as a result of vessels sitting at anchor or undertaking other supply chain activities.

Other potential impacts included:

- Ship safety
- Influence on other users of the Marine Park
- Marine pests
- Pollution other than that from wastes released at anchor



- Efficient and effective management of anchorages, port operations and the Marine Park.

This suggests that for stakeholders consulted within this project, environmental issues are a priority. Social impacts such as aesthetic values and sustainable use of the Marine Park by multiple users are also important issues to be considered with regard to ship anchorages in the Great Barrier Reef World Heritage Area. The social issues relevant to ship anchorages, as described by stakeholders consulted, are summarised below.

### **3.2.1 Altered aesthetic value**

The Environmental Impact Assessment Report prepared for phase 1 (GHD, 2012) identified that the anchorage areas are visible to residents and tourists from land during both day and night at all ports, with the exception of Abbot Point. Whether this creates an impact to the vista of the Reef is subjective. The presence of anchored vessels has potential to detract from the natural state of the vista from both the shoreline and moving vessels travelling to and from the Reef, however, in some instances, the ports are recognised as a tourism opportunity along the 'grey nomad' trail (refer to section 3.3.1).

A draft visual impact assessment undertaken for the Port of Hay Point and tabled at the CBA workshop (yet to be released) suggests that only the first row of ships within that anchorage area is visible from the shore at ground level. More ships are visible from elevated positions such as the port look-out. This suggests that any expansion of the ship anchorage areas towards the horizon may have little impact on vistas from the shoreline.

Given the importance of access to the Reef from a tourism perspective, the aesthetic values as visible from tourist vessels and aircraft in transit must also be considered.

There is, however, a lack of knowledge regarding how the presence of ships at anchor affects the aesthetics of the World Heritage Area and whether or not impacts are consistent across all of the five port anchorage areas. Due to this uncertainty, aesthetic impacts are considered to have a likelihood of affecting the environmental values of the Reef across all of the anchorage areas.

Consultations undertaken for this CBA have provided additional information to inform this issue in support for each of the ports as outlined in section 3.3.

### **3.2.2 Interference with access to resources**

A high density of vessels at anchor can interfere with another user's ability to effectively use that area. Anchorages are naturally positioned offshore of operational port environments and adjacent shipping channels for ease of port access. These areas also support residential and tourist centres that seek to access the Reef environment through use of the shipping channels and surrounding habitat. This offers potential opportunity for conflict of use of the marine environment, particularly with the marine tourism and fisheries sectors who may seek access to the same resources occupied by the ship anchorage areas.

Tourism provides a significant economic revenue base for Queensland's economy. Reef based tourism provides opportunity for international and domestic visitation to the World Heritage Area and plays an important role in facilitating appreciation of the Reef's values in support of their protection.

Consultation to date by this project indicates tourism vessels are not detrimentally affected in their passage to the Reef by vessels using the anchorages. These vessels navigate via the shipping channels past the anchorage areas to the offshore reef systems. However, tourists aboard these vessels may be influenced by the presence of vessels at anchor during their journey.

Fishing is an important commercial industry in Queensland. Recreational fishing and boating is also a popular pastime for residents of Cairns, Townsville, Mackay (near Hay Point) and Gladstone and demand is predicted to increase. All of the anchorage areas under assessment support some level of commercial and/or recreational fishery activity with targeted catch principally through trawl and line activities.

In comparison to the tourism sector, it is more likely that conflict of use could exist between the commercial and recreational fishing sector and commercial ship anchorages. Trawl or line fishers targeting prawns or mackerel schooling across anchorages could be required to navigate around vessels at anchor. If density of anchorage was high within a valued fishing ground this could restrict access to fisheries resources and potentially reduce economic opportunity. Safety is a concern on disturbed sites where vessels had previously anchored due to changes in bathymetry, which can compromise the safe and optimal operation of trawl equipment. Vessels at anchor may also affect the experience of recreational fishers. Although catch is reported from anchorage areas, the relative contribution of this catch to the overall fishery is unclear.

No dedicated study has been undertaken to establish the degree of impact on fisheries from anchoring alone. While the actual environmental impacts of ship anchorages on fisheries are unknown, historical accounts indicate a decline in fisheries productivity near the major ports. Therefore, it must be assumed that the decline in fisheries may be due to a variety of factors, which may include anchorages.

Based on the stakeholder consultation undertaken and data available at the time of this study, both the tourism and fishery sectors are currently operating without significant identifiable conflict from the existing anchorage areas and, as such, if any impacts are present, they do not appear to be substantially impairing these existing operations in the long-term. While it is almost certain that the presence of vessels at anchor alters the behaviour of other potential users of the Marine Park, the consequence of this is considered to be relatively minor. The preclusion of other users is, therefore, considered to have some likelihood which affects the values of which the anchorage areas are recognised.

### 3.3 **Port specific social issues**

This section details the social issues as relevant to each of the five major ports in the World Heritage Area, drawing upon the Environmental Impact Assessment Report and the stakeholder consultations undertaken by this project for this CBA.

It should be noted that the stakeholder consultations were not exhaustive and comprise a sample only. Hence, the social issues identified are those captured for the sample of stakeholders consulted and may not necessarily reflect all social issues and/or the relative importance of the identified social issues. Issues identified are bound by the consultation achieved in the timeframes of this project.

**3.3.1 Social issues for the Port of Cairns**

The social issues identified during the Project’s consultation for the Port of Cairns are summarised in table 3-1 below.

**Table 3-1:** Summary of social issues identified for the Port of Cairns from consultation under this Project

Social issues	Comments with respect to Port of Cairns
Altered aesthetic values during day time and night time (light issues)	<p>Large anchored vessels or cruise ships are not believed to be an aesthetic issue at Cairns as they are transitory and not permanent features.</p> <p>The majority of anchorage traffic in Cairns comprises of cruise ships, which come closer to the shore for anchoring. Because of their transitory nature and intriguing structures they can become more of an attraction than a visual impediment.</p> <p>Large anchored vessels may be visible like dots on the horizon. At night time the lights from the vessels offer diversity in the dark scape and can benefit small boats fishing at night.</p>
Interference with commercial fishing activities	<p>Anchorage areas in Cairns are not currently known to interfere with commercial fishing activities. Fishing vessels are able to pass between anchored vessels to access resources.</p> <p>A conflict may arise if commercial fishing is excluded from anchorage areas as that would remove access to fisheries resources.</p>
Interference with recreational fishing and boating	<p>There are no noteworthy issues or conflicts between recreational fishing and boating users and anchorage of large vessels. Conflicts can, however, occur for vessels under steam versus at anchor.</p> <p>Those involved in recreational activities, such as fishing and boating may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef’s values.</p>
Interference with tourism activities	<p>There are no perceived conflicts or interactions between the tourism industry operating out of Cairns and the vessels using the anchorage areas.</p>

<b>Social issues</b>	<b>Comments with respect to Port of Cairns</b>
	<p>Often large vessels anchored at sea or cruise ships anchored close to shore can become a point of attraction or intrigue for locals and tourists.</p> <p>The tourism industry notes that the environmental issues associated with anchorage use, which have the potential to damage the Reef, are of greatest importance to them.</p> <p>Currently about 90 per cent of tourism to the Reef originates from Cairns. Tourists may encounter anchored vessels during their reef experience. Tourism stakeholders perceive that tourists are often curious about the anchored vessels.</p> <p>Tourists may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values.</p> <p>Comments included reflection on the need for improved education for tourists about the existing best practice measures and guidelines that are in place for ships operating in the Marine Park.</p>

### 3.3.2 Social issues for the Port of Townsville

The social issues identified during the Project's consultation for the Port of Townsville are summarised in table 3-2.

**Table 3-2:** Summary of social issues identified for the Port of Townsville from consultation under this Project

<b>Social issues</b>	<b>Comments with respect to Port of Townsville</b>
Altered aesthetic values during day time and night time	<p>Stakeholder opinions differ relating to the visibility of anchored vessels from the mainland.</p> <p>Some stakeholders note that large anchored vessels are not an aesthetic issue in Townsville as they are not visible from the town centre.</p> <p>Others suggest that large anchored vessels may be visible like dots on the horizon from the mainland. At night time the lights from the vessels offer diversity in the dark scape and can benefit small boats fishing at night.</p> <p>Large vessels, because of their transitory nature and intriguing structures, can become an attraction rather than a visual impediment.</p>
Interference with commercial fishing	<p>For some of those consulted, anchorage areas in Townsville are not currently perceived to interfere with commercial fishing activities. Fishing vessels can still access resources</p>

<b>Social issues</b>	<b>Comments with respect to Port of Townsville</b>
activities	<p>and traverse between anchored vessels.</p> <p>A conflict may arise if commercial fishing is excluded from anchorage areas.</p> <p>Safety is of concern when there is interaction between anchored vessels and commercial fishing activities, typically trawling because of the risk of collision and fishing gear becoming entangled with anchored vessels. Safety is also of concern in areas where vessels have previously anchored due to possible changes in bathymetry which can compromise the safe and optimal operation of trawl equipment.</p> <p>Safety can also be of concern for commercial maritime users where the perceived safe operating distance around anchored ships may be greater than the direct physical dimensions and the swing distance of an anchored ship. This can affect navigational paths.</p>
Interference with recreational fishing and boating	<p>For some of those consulted, no noteworthy issues or conflicts between recreational fishing and boating users and anchorage of large vessels were identified.</p> <p>Main recreational areas near Townsville are Magnetic Island and Orchard Rocks which are popular locations for day trips. They may have views of the large vessels, but due to the transitory nature of the vessels and the visitors to the Islands, it was perceived by some targeted stakeholders that the aesthetic values of these areas are not compromised.</p> <p>Safety can be of concern for maritime users where the perceived safe operating distance around anchored ships is greater than the direct physical dimensions and the swing distance of an anchored ship.</p> <p>Recreational maritime users may also avoid getting too close to anchored ships. Those involved in recreational activities, such as fishing and boating, may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values, including aesthetic values.</p>
Interference with tourism activities	<p>No conflicts or interactions between the tourism industry operating out of Townsville and the anchorage areas were identified by consulted parties.</p> <p>Often large vessels anchored at sea or cruise ships anchored close to shore can become a point of attraction or intrigue for the locals and tourists.</p> <p>Tourists may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk</p>

<b>Social issues</b>	<b>Comments with respect to Port of Townsville</b>
	to the Reef's values.

### 3.3.3 Social issues for the Port of Abbot Point

The social issues identified during the Project's consultation for the Port of Abbot Point are summarised in table 3-3.

**Table 3-3:** Summary of social issues identified for the Port of Abbot Point from consultation under this Project

<b>Social issues</b>	<b>Comments with respect to Port of Abbot Point</b>
Altered aesthetic values during day time and night time (light issues)	<p>The Port of Abbot Point is not visible from the major population centres around the port.</p> <p>The sea scape in the Whitsunday region is dominated by recreational boats and tourist vessels (such as reef tourism boats and charter fishing boats). Targeted stakeholders did not consider large commercial vessels to significantly alter the visual scape of the sea.</p>
Interference with commercial fishing activities	<p>For some of those consulted, anchorage areas at Abbot Point are not perceived to interfere with commercial fishing activities. Fishing vessels are able to access resources and traverse between anchored vessels.</p> <p>A conflict may arise if commercial fishing is excluded from anchorage areas.</p> <p>Safety is of concern when there is interaction between anchored vessels and commercial fishing activities, typically trawling because of the risk of collision and fishing gear becoming entangled with anchored vessels. Safety is also of concern in areas where vessels had previously anchored due to changes in bathymetry which can compromise the safe and optimal operation of trawl equipment.</p> <p>Safety can also be of concern for commercial maritime users where the perceived safe operating distance around anchored ships may be greater than the direct physical dimensions and the swing distance of an anchored ship. This can affect navigational paths.</p>
Interference with recreational fishing and boating	<p>The recreational fishing and boating areas are separate to the Port of Abbot Point, hence there is no perceived conflict between the recreational use of waters and the anchorage area.</p> <p>However, safety is a concern with the forecast increase in shipping activities and tourist boating activities, particularly for small boats. These principally relate to vessels under</p>

<b>Social issues</b>	<b>Comments with respect to Port of Abbot Point</b>
	<p>steam versus at anchor.</p> <p>Safety can be of concern for maritime users where the perceived safe operating distance around anchored ships is greater than the direct physical dimensions and the swing distance of an anchored ship.</p> <p>Recreational maritime users may also avoid getting too close to anchored ships.</p> <p>Those involved in recreational activities, such as fishing and boating may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values.</p>
Interference with tourism activities	<p>There are currently no identified conflicts or interactions between the tourism industry vessels operating out of Bowen, Airlie Beach and the Whitsunday Islands and the anchorage areas located some distance away to the south at Abbot Point.</p> <p>Anchored ships may be visible from tourism vessels travelling to and from the Reef. Tourism stakeholders perceive that tourists are often curious about the vessels.</p> <p>Reef tourism is not focused around Abbot Point.</p>

### 3.3.4 Social issues for the Port of Hay Point

The social issues identified during the Project's consultation for the Port of Hay Point (Mackay area) are summarised in table 3-4.

**Table 3-4:** Summary of social issues identified for the Port of Hay Point from consultation under this Project

<b>Social issues</b>	<b>Comments with respect to Port of Hay Point (Mackay)</b>
Altered aesthetic values during day time and night time (light issues)	There is recognition in Mackay that the port is important to the region's economic wellbeing. It was perceived that visual impacts may have less relative importance than economic benefits, including tourism benefits.
Interference with commercial fishing activities	<p>No comments were raised by parties consulted through workshops and one-on-one interviews.</p> <p>Safety is of concern when there is interaction between anchored vessels and commercial fishing activities, typically trawling because of the risk of collision and fishing gear becoming entangled with anchored vessels. Safety is also of concern in areas where vessels have previously anchored due to possible changes in bathymetry which can compromise the safe and optimal operation of trawl</p>

Social issues	Comments with respect to Port of Hay Point (Mackay)
Interference with recreational fishing and boating	<p>equipment.</p> <p>Safety can also be of concern for commercial maritime users where the perceived safe operating distance around anchored ships may be greater than the direct physical dimensions and the swing distance of an anchored ship. This can affect navigational paths.</p> <p>Some of those consulted did not identify any significant impacts.</p> <p>Safety can also be of concern for maritime users where the perceived safe operating distance around anchored ships is greater than the direct physical dimensions and the swing distance of an anchored ship.</p> <p>Recreational maritime users may also avoid getting too close to anchored ships. Those involved in recreational activities, such as fishing and boating may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values.</p>
Interference with tourism activities	<p>Consultation indicated there is limited Reef tourism based out of Mackay, hence it is considered that there are no or minor interactions between the tourism industry and the anchorage areas.</p> <p>Often large vessels anchored at sea can become a point of attraction or intrigue for locals and tourists.</p> <p>The large vessels anchored and lining up to get into the port are recently being acknowledged as a tourist phenomenon attracting the 'grey nomads' (retiree caravan tourists) who enjoy the views of vessels from a high point in the city.</p> <p>Tourists may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values.</p>

### 3.3.5 Social issues for the Port of Gladstone

The social issues identified during the Project's consultation for the Port of Gladstone are summarised in table 3-5.



**Table 3-5:** Summary of social issues identified for the Port of Gladstone from consultation under this Project

<b>Social issues</b>	<b>Comments with respect to Port of Gladstone</b>
Altered aesthetic values during day time and night time (light issues)	Those consulted noted that the anchorage areas are consistent with the nature of Gladstone as an industrial and port town and therefore do not impact the aesthetic value of the sea scape.
Interference with commercial fishing activities	<p>There is a potential conflict between commercial fishing and increased shipping activities in Gladstone, but correlation between decline in fishing and ship anchorage areas has not been established (or investigated).</p> <p>Safety is of concern when there is interaction between anchored vessels and commercial fishing activities, typically trawling because of the risk of collision and fishing gear becoming entangled with anchored vessels. Safety is also of concern in areas where vessels have previously anchored due to possible changes in bathymetry which can compromise the safe and optimal operation of trawl equipment.</p> <p>Safety can also be of concern for commercial maritime users where the perceived safe operating distance around anchored ships may be greater than the direct physical dimensions and the swing distance of an anchored ship. This can affect navigational paths.</p>
Interference with recreational fishing and boating	<p>Anecdotal evidence suggests that in recent years Gladstone has had the highest number of boat registrations in Queensland, marking an increase in recreational boating and fishing activities.</p> <p>Stakeholder consultations revealed it is not the anchorage areas per se that interfere with the recreational activities. Rather it is the overall increase in activities along the port and increased ship movements that are limiting access for recreational fishers.</p> <p>The increase in ship movements and port developments has meant increased safety risks; recreational users may have to alter their behaviour to become more aware of where they are and what they are doing to avoid larger vessels.</p> <p>Safety can be of concern for recreational maritime users where the perceived safe operating distance around anchored ships is greater than the direct physical dimensions and the swing distance of an anchored ship.</p> <p>Recreational maritime users may also avoid getting too close to anchored ships.</p>

<b>Social issues</b>	<b>Comments with respect to Port of Gladstone</b>
Interference with tourism activities	<p>There is limited Reef tourism based out of Gladstone, hence consulted parties reflected there are no perceived conflicts or interactions between the tourism industry and the anchorage areas.</p> <p>Often large vessels anchored at sea can become a point of attraction or intrigue for the locals and tourists.</p> <p>The large vessels anchored and lining up to get into the port have recently been acknowledged as a tourist phenomenon attracting the 'grey nomads' who enjoy the views of the vessels from a high point in the city.</p> <p>Tourists may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values.</p>

### 3.4 Overall conclusions on social aspects of ship anchorages

The overall conclusions on the social impacts of ships anchorages identified during the Project's consultation are summarised in table 3-6. These include a summary of those issued identified in the preceding sections, as well as those identified throughout the consultation that are applicable across the whole study area.

**Table 3-6:** Summary of overall conclusions of social aspects of ship anchorages from consultation under this Project

<b>Social issues</b>	<b>Overall comments</b>
Altered aesthetic values during day time and night time (light issues)	<p>Targeted consultation suggested that ship anchorage areas by themselves are not perceived to be a significant issue at most ports. Typically, the anchorages are considered to have limited visibility from the mainland or are considered an accepted element of the visual landscape. However, in some cases the presence of ships day or night may impact on the aesthetic values.</p> <p>In some circumstances, ships are considered more of a visual interest rather than an impediment as they are visible on the horizon at night time and visually intriguing.</p> <p>The overall cumulative effects of all shipping activities (vessel movements in addition to anchorage) that are altering the coastline are more of a concern from an aesthetic value perspective.</p>
Interference with commercial fishing	Commercial fishing is on a decline, however this impact is not identifiably due to increased use of

<b>Social issues</b>	<b>Overall comments</b>
activities	<p>anchorage areas. The decline has not been fully investigated but is perceived to be due to the cumulative changes occurring to the coastline in conjunction with market drivers.</p> <p>Safety is of concern when there is interaction between anchored vessels and commercial fishing activities, typically trawling, because of the risk of collision and fishing gear becoming entangled with anchored vessels. Safety is also of concern in areas where vessels have previously anchored due to possible changes in bathymetry which can compromise the safe and optimal operation of trawl equipment.</p> <p>Safety can also be of concern for commercial maritime users where the perceived safe operating distance around anchored ships may be greater than the direct physical dimensions and the swing distance of an anchored ship. This can affect navigational paths.</p>
Interference with recreational fishing and boating	<p>Anchorage areas in deeper, offshore, water are not usually frequented by recreational fishing and boating users.</p> <p>Recreational fishing and boating is part of lifestyle. It is about the experience not the catch in itself, hence visual and environmental issues matter.</p> <p>Those involved in recreational activities, such as fishing and boating may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values.</p> <p>Perception of potential environmental damage caused by anchored ships dumping wastes into the water is a major concern among recreational users. Regulation of this is not well understood.</p> <p>Stakeholder consultations revealed it is not the anchorage areas per se that interfere with the recreational activities but it is the overall increase in activities along the port and increased ship movements that limit access for recreational fishers.</p> <p>The increase in ship movements and port developments has meant increased safety risks. Recreational users may have to alter their behaviour to become more aware of where they are and what they are doing.</p> <p>Safety can be of concern for recreational maritime users where the perceived safe operating distance</p>

Social issues	Overall comments
Interference with tourism activities	<p>around anchored ships is greater than the direct physical dimensions and the swing distance of an anchored ship.</p> <p>Recreational maritime users may also avoid getting too close to anchored ships.</p> <p>Tourists accessing the Reef from Cairns or the Whitsundays region may witness anchored vessels during their Reef experience either in or within the vicinity of the Marine Park. Tourism stakeholders perceive that tourists are often curious about the vessels.</p> <p>Tourists may perceive the presence of large vessels in or within the vicinity of the Marine Park negatively and as a risk to the Reef's values.</p> <p>Comments included reflection on the need for improved education for tourists about the existing best practice measures and guidelines that are in place for ships operating in the Marine Park.</p>

## 4. DEMAND FOR SHIP ANCHORAGES AND THEIR OPERATION

### 4.1 Background

To achieve a sound social economic analysis it is necessary to understand and set a base-line in terms of the demand for, and operation of, current ship anchorages. It is also important to benchmark how this demand is forecast to develop over time assuming there are no changes to existing management measures. This enables analysis of how the current management, or “business-as-usual”, compares with other management strategies under future demand requirements. Through this process it is possible to identify whether a change in management strategy would realise benefits.

A necessary first step in the analysis is to describe the base-line of current ship anchorage operation. This section explains how ship anchorages are used and the drivers of their use. The current and expected future demand for the ship anchorages is then presented for each of the five ports considered in this project. As described in Section 1.4, the anchorage areas for the purpose of this study have been agreed through consultation with the each port's Regional Harbour Master. In section 5, a range of options for managing anchorage are described. The expected future demand for ship anchorages is then used by an Economic Appraisal (CBA) model in later sections. The model uses a step wise process which firstly evaluates the need for expansion of ship anchorage areas at the five main ports under future demand requirements. If expansion is triggered by the demand, the model quantifies the costs and benefits of relevant management options to mitigate the need for any expansions. In the case where demand does not trigger expansion then the model is not run, i.e. does not consider management options to mitigate the impact. To inform the analysis, use of anchorage areas was rated according to a scale that ranged from negligible (<3 per day) to significant (>20 vessels per day).

#### 4.1.1 Data sources

A number of sources of data were used to establish the demand for ship anchorages.

The current demand for ship anchorages was identified for the period 01 January 2009 to 30 September 2012 using Marine Safety Queensland actual (tracked) vessel movement data for commercially trading ships. Commercial trading ships being considered by this project are defined as those being greater than 50 metres (m) in length. This current demand data provided visibility on the current intensity of anchorage use of each of the five main ports, as well as the number of ship calls made at the five main ports in the study area.

As noted under section 2.1, the evaluation of estimated future anchorage demand from 2012-2032 was based on recent forecasts prepared by PGM Environmental for the Reef (PGM Environment 2012). This study, completed as part of the Cumulative Environmental Impact Assessment for Abbot Point (PGM Environment 2012), provided ship number forecasts at the upper-end based on a calculated 100 per cent use of each ports planned capacity expansions (i.e. the maximum

case situation for shipping demand). Data from this study was used as the basis of ship call forecasts and future anchorage demand in the CBA modelling work.

Future shipping, and resulting demand for ship anchorages over the long-term, was also supported by the Queensland Government’s “Great Barrier Reef Ports Strategy 2012-2022 – public consultation paper” (Department of State Development, Infrastructure and Planning (DSDIP) 2012). This study provided forecasts based on estimates of future production and resulting seaborne trade (cargo demand).

#### 4.2 **How ships use anchorages and the drivers of demand for anchorages**

Ship anchorages in the study area, and elsewhere around Australia, are effectively extensions of port infrastructure which serve the export and import trades of various commodities (see table 4-1).

**Table 4-1:** Overview of Great Barrier Reef ports and their key commodity trades, 2012 (Source: Data courtesy of Great Barrier Reef Marine Park Authority)

<b>Port</b>	<b>Commodity trades</b>
Quintell Beach	Imports general cargo
Cape Flattery	Exports silica sand
Cooktown	Non-trading cruise shipping
Cairns	Imports petroleum Exports sugar & molasses, general cargo Cruise shipping
Mourilyan	Exports sugar and molasses
Lucinda	Exports sugar
Townsville	Imports nickel, ore, general oil Exports sugar and molasses, fertiliser, zinc, lead, and copper Cruise shipping
Abbot Point	Exports coal
Mackay	Imports petroleum Exports sugar, grain Cruise shipping
Hay Point	Exports coal
Rockhampton	Imports and exports dangerous goods such as ammonium nitrate
Gladstone	Imports bauxite, industrial inputs Exports coal, alumina and aluminium

Ship anchorages, in the study area, are used in a number of ways by commercial cargo ships:

- Waiting upon arrival from sea after notification that a berth slot will be available with set movement hours, or date for mobilisation, from anchorage to port berth once it becomes available.
- Waiting upon arrival from sea based on speculation that a cargo could be booked for the ship – time at anchorage can be several days or weeks with the possibility that without cargo the vessel departs out to sea again.
- Waiting as part of a port removal from one berth to a subsequent berth (where a ship temporarily leaves the port to wait to move to a subsequent berth in the same port, sometimes back to the same berth) driven by the handling of different cargoes and the temporary lack of berth availability – time at anchorage typically hours or a few days.
- Waiting upon arrival from sea for the high tide to allow sufficient channel water depth for the vessel to enter the port – time at anchorage would be no more than 12 hours; this typically happens for cargo ships entering the Port of Cairns.
- Temporary mooring facility (using ship's own anchors) to accommodate a ship that may be either too large for the port or when the port does not have the required facilities or sufficient capacity to service all the ships calling. An example concerns the larger cruise-ships at the Port of Cairns which moor at a designated anchorage with passengers/crew tendered to/from shore. After anchoring for around 12-24 hours the ships depart the anchorage and travel out to sea.
- Minor ship maintenance by the crew can also occur when waiting times at anchorages are several days or weeks, as can the opportunistic supply of the ship with consumables for the crew.
- Safe area or temporary refuge for a stricken/damaged ship to be surveyed, repaired or salvaged in order to prevent or minimise the risk of further incidents to environmentally sensitive areas and/or to the safety of the crew – time at anchorage can be days or weeks.

It is important to note that not all ships arriving at a port go first to an anchorage. In many cases, where there are no queues for berths or where ships operate on a fixed calling schedule ships arriving from sea go directly to a berth in a port. This is the case for some container ships and some domestic vessels.

The drivers of the demand for anchorages are essentially the growth developments in the underlying cargo trades and the supply and operation of port capacity. Ship numbers for each port, therefore, reflect the growth and cyclical nature of imports and exports through that port. When port berth utilisations become high (e.g. in excess of 60 to 80 per cent depending on the commodity-mix handled) then ship queuing will occur and grow rapidly. Queuing requires the use of anchorages. Anchorage demand will also benefit (i.e. lessen) from increasing shipment and ship sizes as less ship calls are required to carry a given amount of cargo.

### 4.3 **Other users of ship anchorage areas**

Anchorage areas in the study area are not exclusively used by commercial cargo ships. There is the potential for both the undesignated and designated ship anchorage areas in the study area to be used by a number of other stakeholders, notably those engaged in:

- Commercial fishing (trawling)
- Recreational boating/fishing
- Reef tourism
- Traditional Owners' activities.

There may be some degree of overlap between stakeholders within anchorage areas which is relevant to the CBA in terms of the Base Case and changed impacts with different ship anchorage management options. The degree to which overlaps occur in practice is discussed further as required throughout the report.

### 4.4 **Overall demand for and use of ship anchorages along the study port range**

#### 4.4.1 **Current total ship visits to the five main ports and the share of ships using anchorages**

Based on MSQ historic vessel movements data for vessels over 50 m in length over the period 1 January 2009 to 30 September 2012, there are currently around a total of 4000 ship arrivals per year covering the ports of Cairns, Townsville, Abbot Point, Hay Point and Gladstone. This number includes a number of naval vessel arrivals as well as cruise-ships, which are not included in the scope of the CBA.

Significantly for this study, currently around 30 per cent of total ships arriving at the five subject ports proceed directly to berth at the port without requiring anchorage (table 4-2). This reflects the difference in the type of cargoes handled and berth availabilities or operations. An analysis of each of the five ports below shows that there are variations between the ports regarding the number of ships proceeding directly to a berth versus directly to anchor before entering the port. This is a reflection of the different types of trades serviced by the respective ports.

However, this analysis only presents the current ship call demand for anchorages. The current utilisation of the anchorage areas, their current maximum capacities (of having ships simultaneously anchored), and the current distribution of times spent at anchor, all define the parameters of the ship anchorages currently in operation. It may well be the case that some anchorage areas (particularly those not designated) are not efficiently used in terms of comparison with the maximum 'safe' density of anchored ships. These factors, some of which are more controllable than others, will influence the future requirements for anchorage areas including the size and management options.



**Table 4-2:** Total ship visits to five main ports and share using ship anchorages, 2009-2012 (\* Excludes Port of Townsville in 2009 due to no data available on split of vessels direct to berth and direct to anchor. Hence, 2009 is the total for four ports. Source: MSQ data / GHD analysis.)

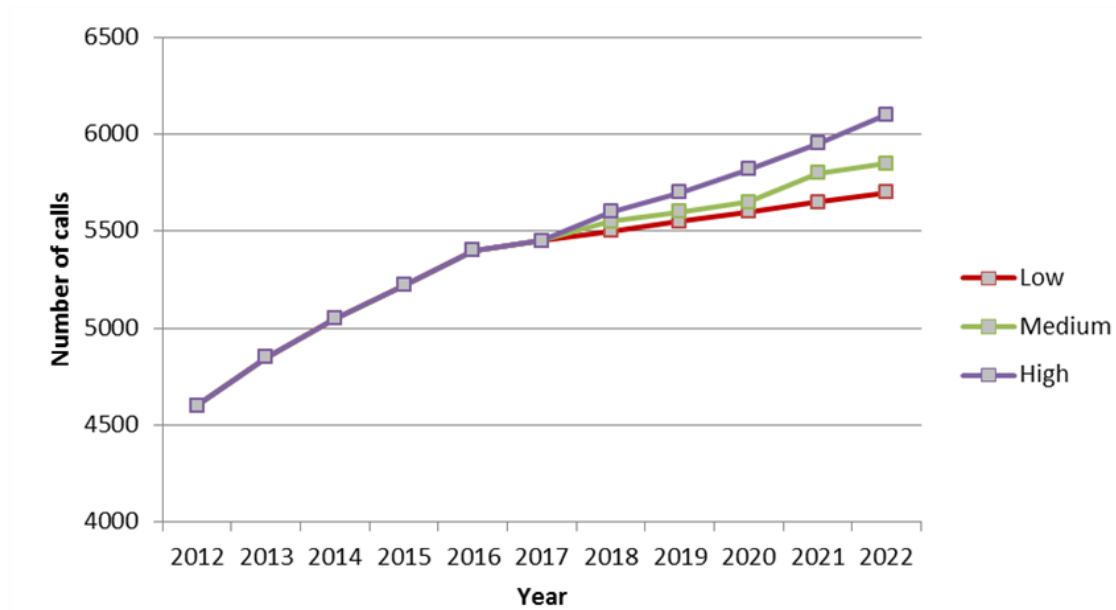
<b>Five main ports</b>	<b>2009*</b>	<b>2010</b>	<b>2011</b>	<b>2012 (nine months)</b>
Total ship arrivals	3399	4069	3687	2824
Total direct to berth	946	1253	1119	776
Total direct to anchor	2453	2816	2568	2048
Per cent direct to berth	28%	31%	30%	27%
Per cent direct to anchor	72%	69%	70%	73%

#### **4.4.2 Expected future total ship calls to the five main ports**

The total number of ship calls expected in the future for the five subject ports ranges from a low-end forecast scenario of around 5650 in 2022 to a high-end forecast scenario of around 7450 in 2020.

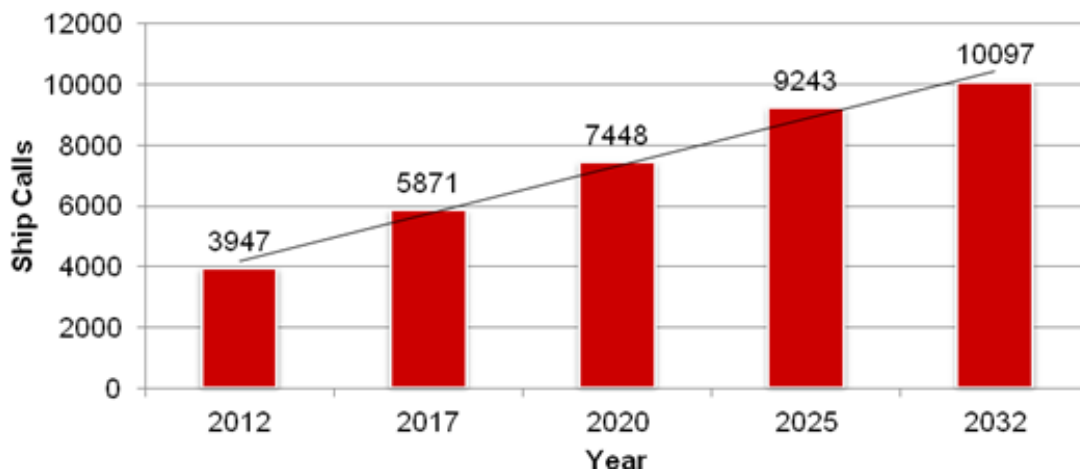
The low-end forecast (based on three per cent per year future growth in the number of ship calls – equivalent to the last ten years) is presented in the *Great Barrier Reef Ports Strategy 2012-2022* (DSDIP 2012) discussion document. Medium and high forecasts were also included of 5900 ship calls (based on four per cent per year growth in the number of ship calls) and 6100 ship calls for 2022. The low and medium forecasts of 5650 and 5900 ship calls are considered to be ‘more-likely’ scenarios by the Queensland Government (figure 4-1).

For the purpose of figure 4-1 and figure 4-2 “Reef ports” are defined as the 11 trading ports located within the Marine Park and the World Heritage Area, namely: Quintell Beach, Cape Flattery, Cairns, Mourilyan, Lucinda, Townsville, Abbot Point, Mackay, Hay Point, Rockhampton and Gladstone.



**Figure 4-1:** Queensland Government forecast ship call number scenarios for the Reef ports (2012-2022) as extracted from DSDIP 2012

The high-end forecast of around 7450 ship calls by 2020, increasing to around 10,100 ship calls by 2032, is presented as a “probable case” (based on four-five per cent per year growth in ship calls) in PGM Environment’s recent “Great Barrier Reef Shipping: Review of Environmental Implications - Abbot Point Cumulative Environmental Impact Assessment (PGM Environment 2012)” document (figure 4-2). It should be noted that the Queensland Government and PGM Environment analyses have each used different methodologies to arrive at the future forecasts, each approach valid for its respective purpose (see section 4.1 above).



**Figure 4-2:** PGM Environment forecast ship call numbers “probable case” for the Reef ports (2012-2032) as extracted from PGM Environment 2012

It is worth noting that according to PGM Environment's analysis, in 2012, 42 per cent of the total ship call numbers were coal vessels with this forecast to increase to 57 per cent by 2020 and 65 per cent by 2032.

For the purposes of this ship anchorage study, the Queensland Government and PGM Environmental analysis are assumed to frame and inform the expected future ship call numbers for the CBA. The PGM Environment forecasts at the individual port level are considered to be better suited to the CBA given the port level content and their ability to better understand the upper bounds of the risk of possible negative impacts and the ultimate level of required mitigations.

#### **4.4.3 Expected future total demand for ship anchorages covering the five main ports**

The expected future total demand for ship anchorages covering the five main ports in the Reef study area will be primarily driven by a combination of the forecast number of ship calls, the average percentage use of anchorages by the ships calling (including removals from port when transferring between berths or awaiting additional cargoes), and the average time required by ships to be at anchor.

For the purposes of this study, it is reasonable to assume that the average time required by ships to be at anchor will not change compared with present. However, the percentage of ship calls requiring anchoring in the future may change depending on the nature of any new trades emerging. For example, the emerging Liquefied Natural Gas (LNG) trade at Gladstone, given its dedicated berth infrastructure and controlled/dedicated shipping requirements, is likely to have ships proceeding directly to berth and generally not requiring anchorage. Also proposed new port infrastructure and/or deepened (all-tides access) shipping channels (as is planned but yet to be assessed) for the Port of Cairns to service cruise-ships, may cause more ships to proceed direct to berth as opposed to firstly anchoring.

The expected future demand for ship anchorages in the study area is quantified in the following sections for each of the five main ports, and an overview of the current and future anchorage demand for the Reef's five main ports is provided below in table 4-3.

**Table 4-3:** Overview of current and future anchorage demand for the Reef's five main ports (\* as at year 2032)

<b>Ports:</b>	<b>Cairns</b>		<b>Townsville</b>		<b>Abbot Point</b>		<b>Hay Point</b>		<b>Gladstone</b>	
	<b>Current</b>	<b>Future*</b>	<b>Current</b>	<b>Future*</b>	<b>Current</b>	<b>Future*</b>	<b>Current</b>	<b>Future*</b>	<b>Current</b>	<b>Future*</b>
Ship calls per year	476	501	726	1161	179	1640	796	2380	1510	3029
Average per cent direct to berth	85%	>85%	44%	Uncertain	20%	Uncertain	1%	1%	20%	Uncertain
Average per cent direct to anchor	15%	<15%	56%	Uncertain	80%	Uncertain	99%	99%	80%	Uncertain
Number of anchor locations (if designated)	8	Possibly not > current	-	Possibly not > current	-	Possibly not > current	102	Possibly 129	32	Possibly not > current
Average waiting days	0.5	Uncertain	3	Uncertain	3	Uncertain	19 (sample)	Uncertain	4	Uncertain

## 4.5 Demand for and use of ship anchorages at the Port of Cairns

### 4.5.1 Current profile of ship anchorages at the Port of Cairns

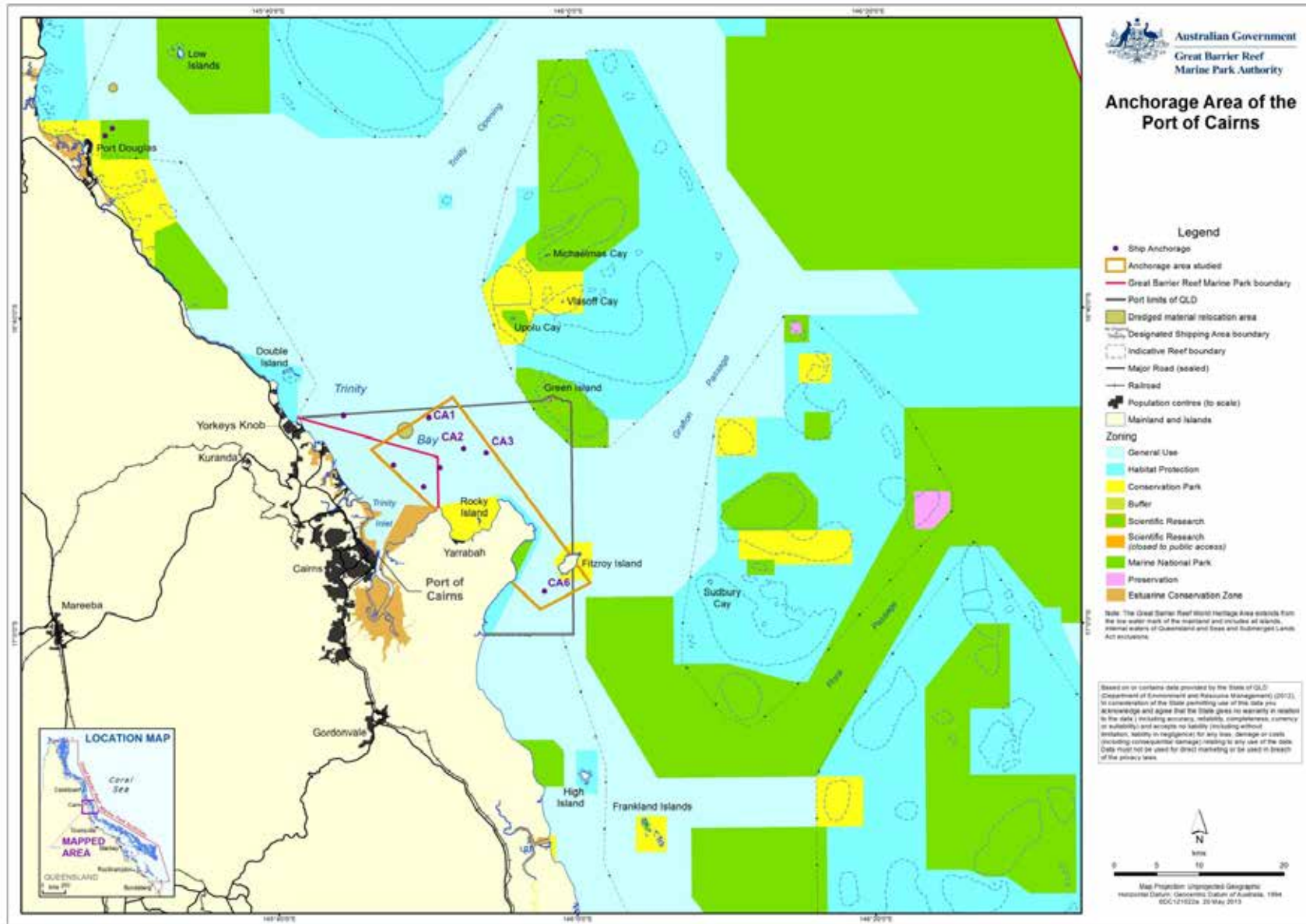
Anchorage points for ships servicing the Port of Cairns (see figure 4-3) are principally located at the mouth of Trinity Inlet, to the north-north-east of the port and the city of Cairns (essentially all within the port limits of Cairns). A single designated anchorage also occurs to the south of Cairns, approximately 3 km to the south-west of Fitzroy Island. The anchorage area is relatively large at 24,118 ha. However, the southern designated anchorage point is rarely used, which reduces the effective anchorage area to approximately half the size. The anchorage area for the Port of Cairns is located within sight of the city of Cairns and as such anchored ships may be visible to residents and visitors to the city and surrounding islands within the World Heritage Area.

Cairns Port anchorage area is located within a Marine Park General Use Zone. It is transited by commercial vessels accessing the port, but also by commercial and recreational fishing vessels accessing fishing areas and a high volume of tourism vessels accessing the Reef and islands within the World Heritage Area. Adjacent to the anchorage area are a number of management zones offering habitat protection. In the vicinity of the anchorage area, there is an Estuarine Conservation Zone located immediately south and a Conservation Park Zone approximately 5 km to the south-east. Scientific Research, Habitat Protection and further Conservation Park Zones are located 9 km to the east of the main anchorage area but are within 3 km of the southern anchorage. The Yarrabah Aboriginal community is located approximately 2 km to the south of the anchorages area.

The anchorage area at the Port of Cairns is located in deepwater habitat and characterised by *“open, relatively bare, bioturbated habitat. Sediments in the northern portion of the anchorage area are dominated by silts and clays”* (GHD 2012a). Some solitary corals and algae are sparsely distributed throughout the anchorage area, but it does not support any hard coral reefs or seagrass meadows. Mangroves and intertidal seagrass meadows are, however, present in high density along the mouth of Trinity Inlet and the Cairns foreshore, approximately 3 km away. Species present at the anchorage area, and of cultural and environmental value, include marine reptiles, dugong, dolphins and whales. EPBC listed migratory wetland and marine birds may also utilise the anchorage area. The anchorage provides habitat and/or resources for these protected marine fauna in addition to a range of pelagic fish targeted by commercial, charter and recreational fishers.

The Environmental Impact Assessment (EIA) (GHD 2012a) phase of this study, determined that:

*“the anchorage area is not considered to provide highly valued habitat or geomorphic features that are integral to the ongoing maintenance of ecosystem processes or core feeding or breeding habitat critical for the persistence of any protected species”.*



**Figure 4-3:** Map of the current anchorage area of the Port of Cairns

#### 4.5.2 Current demand for ship anchorages at the Port of Cairns

Based on MSQ historic vessel movements data for vessels over 50 m in length over the period 1 January 2009 to 30 September 2012, there are currently around a total of 500 ship arrivals per year at the Port of Cairns, of which around 15 per cent involve ships proceeding directly to anchor. This number includes a number of naval vessel arrivals as well as cruise-ships.

**Table 4-4:** Total ship visits to the Port of Cairns and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis)

Port of Cairns	2009	2010	2011	2012 (Nine months)
Total ship arrivals	499	466	476	351
Total direct to berth	445	401	403	290
Total direct to anchor	54	65	73	61
Per cent direct to berth	89%	86%	85%	83%
Per cent direct to anchor	11%	14%	15%	17%

However, of the ships that proceed directly to anchor, a number do not proceed on to berth at Cairns but depart out to sea again. These are typically (large) cruise-ships which anchor at the designated passenger ship anchorage at Yorkeys Knob and typically only remain at anchor for 9-10 hours. In 2011, 10 of the ship calls proceeding directly to anchor involved cruise-ships not proceeding into port (i.e. they departed again out to sea from anchoring at Yorkeys Knob).

In 2011, the designated anchorages used by ships were:

- Admiralty Anchorage
- Cairns Anchorages 1, 2, 3 and 6
- Cairns Passenger Ship Anchorages 1 (Yorkeys Knob) and 2 (Cairns).

Of these anchorages only Cairns Anchorages 1, 2, 3 and 6 are used by large cargo vessels and therefore included in this analysis (see figure 4-3). Note that only Port of Cairns anchorages are depicted in figures as the scope of this study does not extend to other anchorage areas. Call data for other anchorages is presented to assist in defining call data of relevance to this study.

The subject anchorages were used in 2011 by a range of ship types:

- General cargo (40 per cent of anchorage calls)
- Bulk carrier (18 per cent of anchorage calls)
- Tanker (18 per cent of anchorage calls)

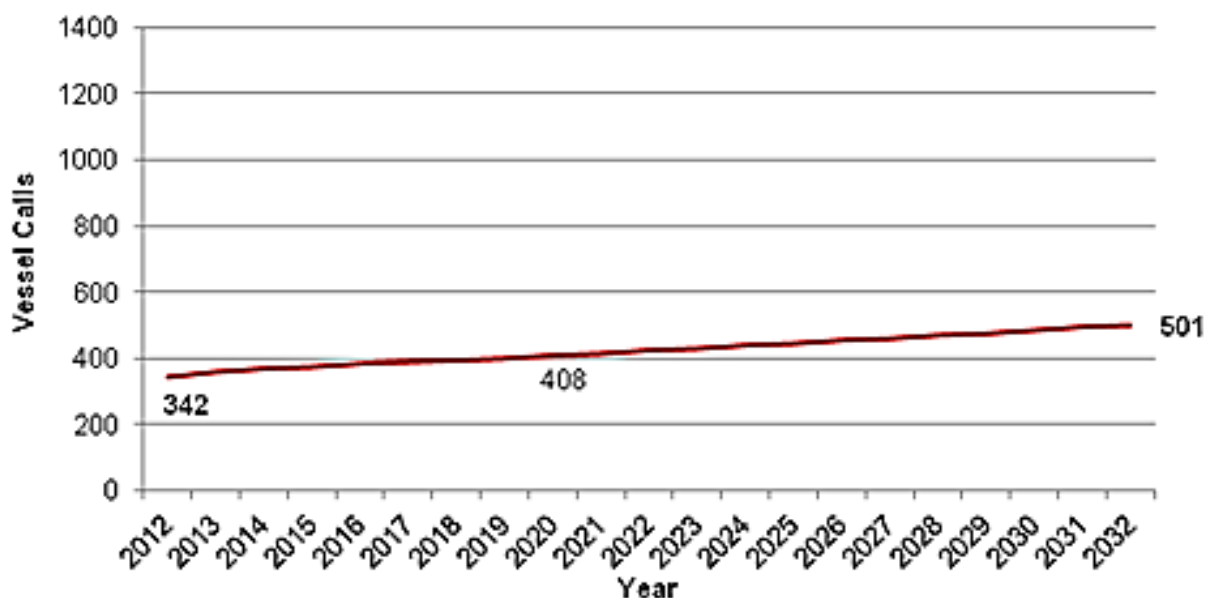
- Passenger (15 per cent of anchorage calls)
- Others (nine per cent comprising drill-ship, tug/offshore supply, naval, and landing-craft).

Typically, ships spent no more than 12 hours at anchor reflecting the general use of the anchorages at the Port of Cairns for either short cruise-ship visits or waiting for tidal assistance to enter the port.

The current scale of the use of ship anchorages at the Port of Cairns can be summarised as minor with an average of less than one ship call per day using the anchorages for typically stays of only several hours.

#### 4.5.3 Future demand for ship anchorages at the Port of Cairns

PGM Environment (2012) forecasts a probable case of approximately two per cent per year growth in ship calls over the period 2012-2032 (financial year end numbers). This growth is primarily driven by general cargo and passenger (cruise) ships, with the number of calls rising from a 2012 base of 342 to 408 in 2020, and 501 in 2032 (figure 4-4).



**Figure 4-4:** Forecast ship call numbers “probable case” for Port of Cairns (2012-2032) as extracted from PGM Environment 2012

Ship call numbers are forecast to increase, albeit slowly, at the Port of Cairns. Despite this, it is likely that the future demand for ship anchorages over the study period will decrease if the planned accommodation of large cruise-ships via channel access upgrades occurs. The proposed upgrades will also benefit all ships entering the port by reducing competition for ship anchorages between cruise-ships and commercial vessels. If improved port access is assumed, the future share of ship arrivals directly entering the Port of Cairns could increase to over 95 per cent. It should be noted that there is likely to be some sporadic/unforeseen demand for anchorages due to port closures, berth conflicts,



and/or climatic events. As such, a buffer or reserve anchorage capacity needs to be permanently maintained to support port operations.

The future scale of the use of ship anchorages at the Port of Cairns in future can be summarised as possibly becoming negligible from an already minor position, and if planned port access does not eventuate, then the future scale will likely continue to be minor.

## 4.6 Demand for and use of ship anchorages at the Port of Townsville

### 4.6.1 Current profile of ship anchorages at the Port of Townsville

The anchorage area servicing the Port of Townsville (see figure 4-5) is located approximately 7 km north-east of the port and the city of Townsville and approximately 2 km to the east-south-east of Magnetic Island. The ship anchorage area defined for this study totals an area of 23,762 ha (essentially all outside of the port limits of Townsville) and does not currently have any designated anchorage points.

The coastal proximity of the anchorage area means anchored ships are highly visible to residents and visitors alike to Townsville and Magnetic Island. Additionally, the anchorage area is transited by commercial and recreational fishing vessels and tourism operators accessing the Reef and World Heritage Area islands. The anchorage area is located in a General Use Zone of the Marine Park. The anchorage area is immediately adjacent to a Marine Park Habitat Protection Zone and located within approximately 2 km of Conservation Park and Marine National Park Zones that fringe Magnetic Island. A Marine National Park Zone, that includes Great Palm Island and potentially culturally significant sites, is located more than 15 km to the north of the anchorage area. In addition, Bowling Green Bay, a Ramsar listed wetland with high aesthetic and cultural value, is located over 10 km away to the south of the ship anchorage.

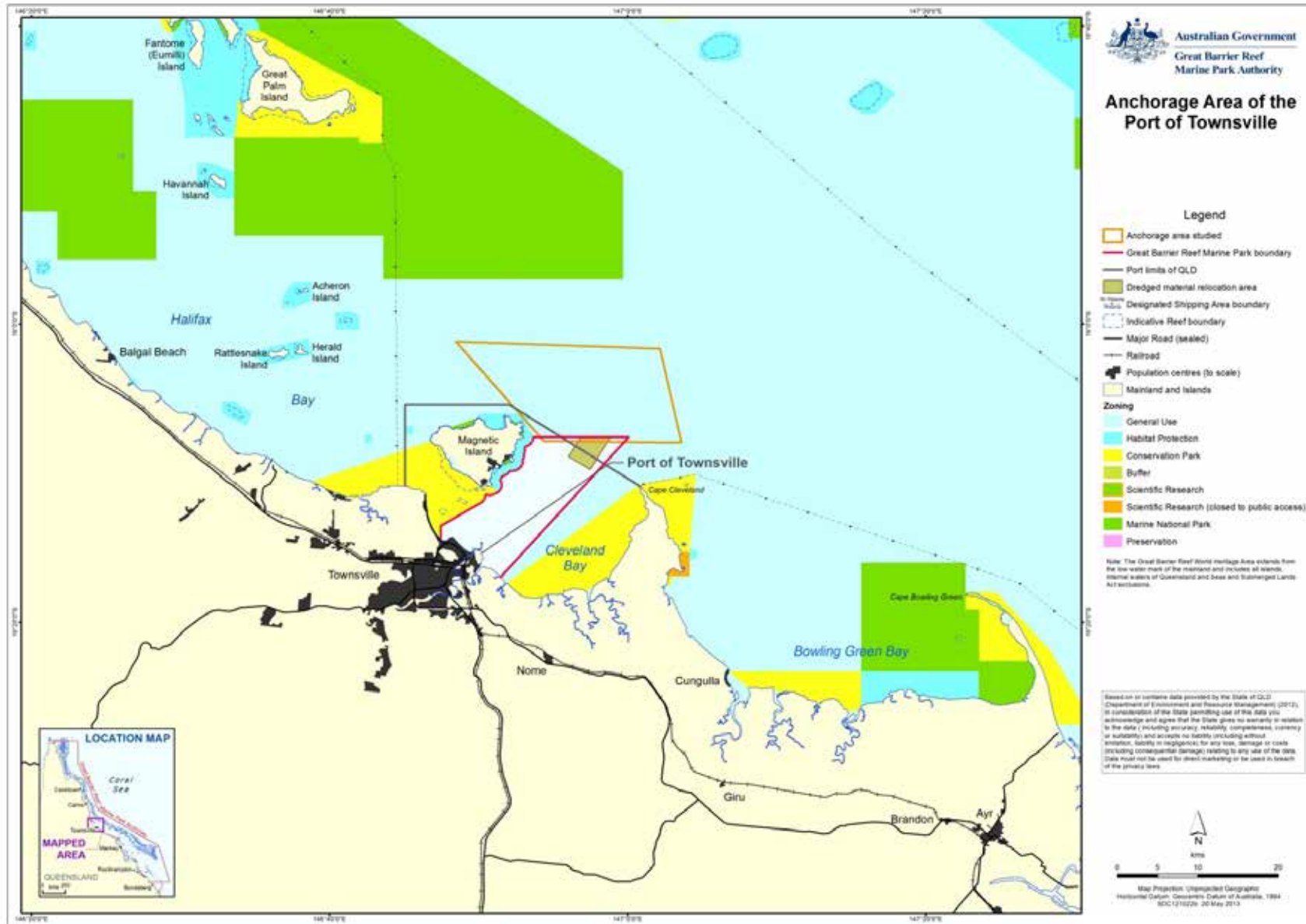
The seabed habitat type in the area is “*mainly bioturbated, comprising of soft sediments, mainly silts and soft mud with a coarser biogenic carbonate component*” (Cruz-Motta and Collins 2004, Pitcher et al. 2007 in GHD 2012a). There are no hard coral reefs in the anchorage area, however, some solitary corals are sparsely distributed throughout and fringing coral reefs are located nearby at Magnetic Island (3 km from the anchorage area). Patchy, low biomass seagrass meadows are known to have previously occurred within the anchorage area, but recent studies have not been completed to confirm their ongoing persistence. Mangroves are located within Cackle Bay on Magnetic Island, approximately 18 km south-west of the anchorage area. The anchorage area is known to be utilised by a large range of megafauna species of conservation significance, including the Australian snubfin dolphin, inshore bottle nosed dolphins, marine turtles, humpback whales and sharks. However, this area is also likely to be utilised by other marine megafauna, EPBC Act listed migratory wetland and marine birds (GHD 2012a).

The commercial fisheries that operate out of Townsville and specifically report catch from the anchorage area (grid numbers J21 and K21) are line, net, pot and trawl (otter) fisheries (refer to figure 4-3). The primary target species across these

are prawns (trawl), crabs (pot), and shark (all fishery types). The line fishers that operate in the anchorage area target grey and Spanish mackerel (Department of Agriculture, Fisheries and Forestry (DAFF) 2012).

The EIA (GHD 2012a) of this study determined that:

*“the anchorage area is not considered to contain significant geomorphic features or important habitat core to feeding or breeding of any protected species. However, the anchorage area is a part of a matrix of habitat and environmental features which supports the diversity for which the Reef is recognised”.*



**Figure 4-5:** Map of the current anchorage area of the Port of Townsville

#### 4.6.2 Current demand for ship anchorages at the Port of Townsville

Based on MSQ historic vessel movements data for vessels over 50 m in length over the period 1 January 2009 to 30 September 2012, there are currently around a total of 730 ship arrivals per year at the Port of Townsville. This number includes a number of naval vessel arrivals as well as cruise-ships. In 2011 and 2012, around 55-60 per cent of ship arrivals proceeded directly to anchor each year. In 2010, around 40 per cent of vessels went to directly anchor with the majority of ships proceeding directly to berth.

**Table 4-5:** Total ship visits to the Port of Townsville and share using ship anchorages, 2009-2012 (\* No data available for 2009 at the Port of Townsville. Source: MSQ data/GHD analysis.)

Port of Townsville	2009	2010	2011	2012 (Nine months)
Total ship arrivals	668	731	726	550
Total direct to berth*	n.a.	462	322	226
Total direct to anchor*	n.a.	269	404	324
Per cent direct to berth	n.a.	63%	44%	41%
Per cent direct to anchor	n.a.	37%	56%	59%

However, out of the ships which proceed directly to anchor, a number (eight in 2011) were recorded as first “Drifting Townsville” (i.e. idling or floating around, not at anchor) for a few hours prior to entering the port. These ships were not physically anchored in one location but were, likewise, not under steam to any destination. Some passenger (cruise) ships also only anchor for a short period and then proceed to sea without entering port (five calls in 2011).

All ships were recorded as using one anchorage area “Townsville Anchorage” as there are currently no designated anchorage areas at Port of Townsville. The Townsville anchorage area assessed in this project has been determined in consultation with the Regional Harbour Master. Refer section 1.4 for further information.

The Townsville Anchorage was used in 2011 by a range of ship types (as defined in MSQ statistics):

- Bulk carrier (46 per cent of anchorage calls, spending on average around 3.5 days at anchor)
- General cargo (24 per cent of anchorage calls, spending on average around two days at anchor)

- Tanker (9 per cent of anchorage calls, spending on average around 1.5 days at anchor)
- Vehicles carrier (7 per cent of anchorage calls, spending on average around one day at anchor)
- Container ship (5 per cent of anchorage calls, spending on average around one day at anchor)
- Others (10 per cent comprising cement carrier, gas tanker, livestock carrier, passenger ship, supply vessel, ro-ro cargo, and landing craft).

The Townsville Anchorage is also used on occasion for port removals, where a ship temporarily leaves the port to await a move to a subsequent berth in the same port (25 instances in 2011), and for a temporary wait at anchor after departing the port on route to sea (15 instances in 2011). The reason for this is unclear, but could be related to the ship master awaiting instructions on next destinations or weather-related factors).

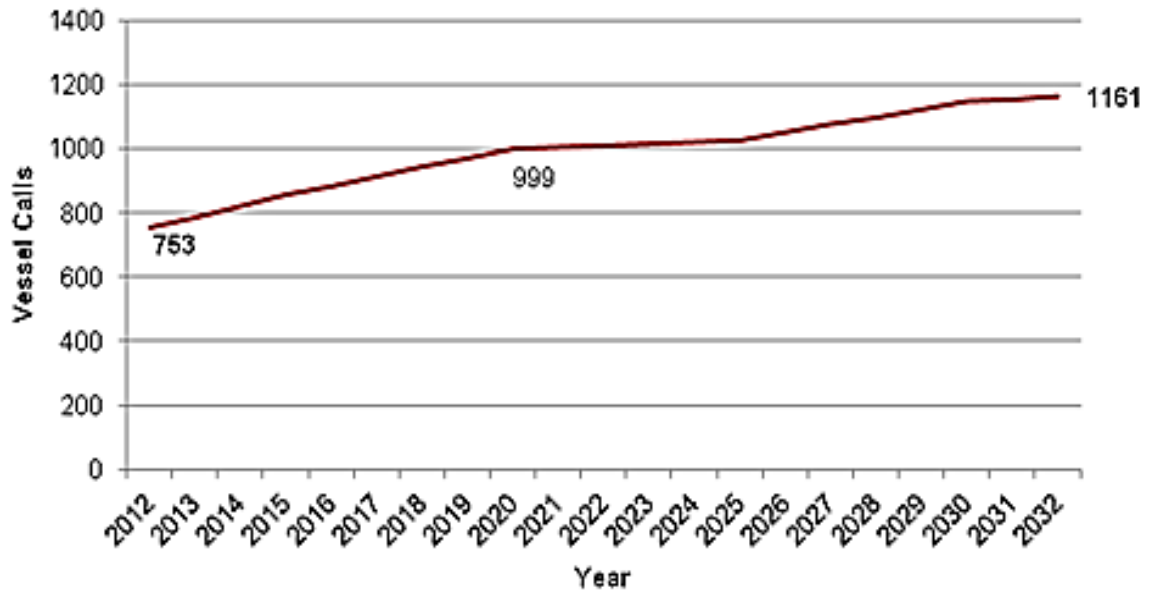
It is worth noting that two out of nine operational berths at the Port of Townsville have been offline since October 2011 (due to come back on line again in 2013). This may have altered anchorage demand in the last quarter of the 2012 calendar year statistics presented in this study.

The current scale of the use of ship anchorages at the Port of Townsville can be summarised as minor with an average of around one ship call per day (including removals and departures) using the anchorages for typically stays of only several days (average of three days for all ships in 2011).

#### **4.6.3 Future demand for ship anchorages at the Port of Townsville**

PGM Environment (2012) forecasts a probable case of around two per cent per year growth in ship calls over the period 2012-2032 (financial year end numbers), primarily driven by bulk carriers (the trade volume increasing and larger ships used). If berth upgrades and port expansion plans proceed, the number of calls are forecast to rise from a 2012 base of 753 to 999 in 2020 and 1161 in 2032 (figure 4-6).

With forecast ship call numbers increasing, albeit slowly, at the Port of Townsville, it is likely that the future demand for ship anchorages over the next 20 years will increase at a rate similar to the increase forecast in ship call numbers. However, as port infrastructure is upgraded and expanded, it is also likely that certain types of ships will not have to wait at anchor for a berth (i.e. container ships, vehicle carriers and some general cargo ships). This will have the effect of a lower growth rate in the demand for anchorage over the next 20 years. This may be compensated to some degree by Townsville handling coal ships, amongst other potential bulk trade vessels, in the future, which generally require some of the calls to use anchorages.



**Figure 4-6:** Forecast ship call numbers “probable case” for Port of Townsville (2012-2032) as extracted from PGM Environment 2012

The future scale of the use of ship anchorages at the Port of Townsville over the next 20 years can be summarised as possibly remaining minor with the demand possibly increasing by around one third in 2032 compared with today. This equates to less than two ship calls per day requiring the use of anchorage. Based on preliminary observations, this limited future growth in anchorage demand can be accommodated in the existing anchorage areas, particularly if designated anchorages and/or more densely organised anchorages are used within the defined anchorage area.

#### 4.7 Demand for and use of ship anchorages at the Port of Abbot Point

##### 4.7.1 Current profile of ship anchorages at the Port of Abbot Point

The anchorage area servicing the Port of Abbot Point (see figure 4-7) is located approximately 5 km north-north-west of the port and does not have any designated anchorage points. The ship anchorage area defined for this study totals an area of 58,818 ha (partly inside of the port limits of Abbot Point).

The only facilities at Abbot Point are associated with the operation of the existing port. The port does not have a residential centre; the nearest residential centre is at Bowen, located approximately 30 km south of Abbot Point. The anchorage area at Abbot Point does not, therefore, have a high level of visibility to residents and visitors to Bowen. The anchorage area is transited principally by commercial vessels servicing the Port of Abbot Point and fishing vessels returning to ports north or south of Abbot Point. The anchorage area is not typically transited by tourism operators accessing the Reef.

The anchorage area is located in a General Use Zone of the Marine Park. Habitat Protection, Marine National Park and Conservation Park Zones are located at

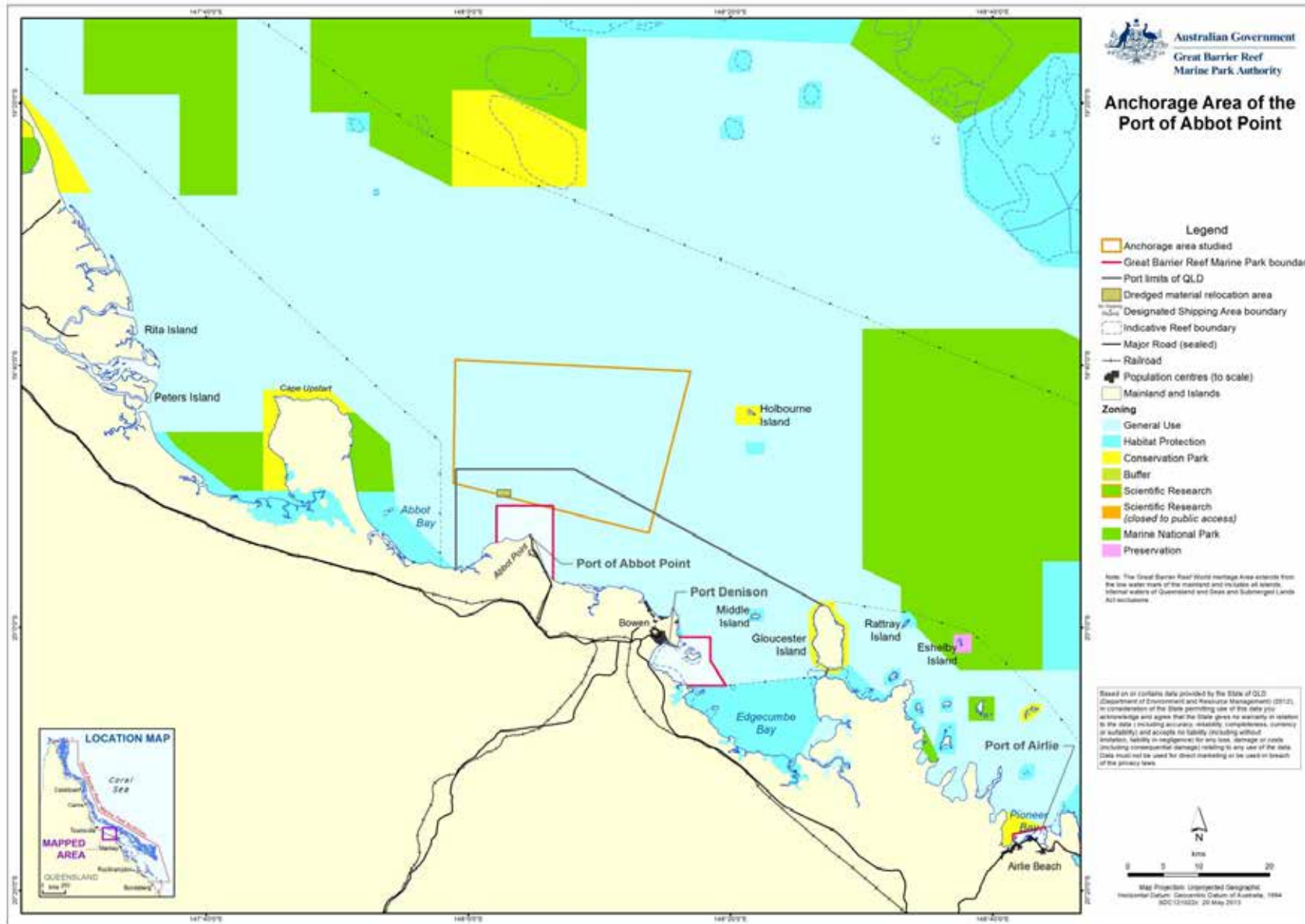
least 9 km west and inshore of the anchorage area. Sites of significant cultural value are located onshore of the anchorage area, up to 10 km away, in the form of shell middens and rock fish traps. The Caley Valley Wetland is located at Abbot Point, approximately 10 km south from the anchorage area and is listed under the Directory of Important Wetland in Australia (DIWA 2001).

The seabed in this area is relatively flat and recent surveys indicate that sediments across the anchorage area are *“likely to be comprised of sands and silts, predominantly terrigenous in source”* (GHD 2012a). Recent studies have confirmed that seagrasses and coral reefs are not present in the anchorage area. Coral reefs are located 8 km away to the east at Nares Rock and Holbourne Island, and approximately 6 km to the west at Camp Island. Mangroves and other sensitive ecosystem receptors are also known to occur over 5 km away along the coast of Abbot Point, particularly to the south-west of the anchorage area. The anchorage area is known to provide habitat for EPBC listed fish and given the diversity of megafauna and avifauna observed coastally at Abbot Point. The anchorage area is also expected to be transited by marine reptiles, dugong, cetaceans, elasmobranchs and EPBC listed wetland migratory and marine birds afforded protection under the World Heritage listing of the Reef.

Line, net, pot and trawl (beam and otter) are the most predominant commercial fisheries that operate in the areas associated with the Port of Abbot Point anchorage area (grid numbers M22 and L22) (refer to figure 4-5). The target species of these industries are prawns and scallops from the trawl fisheries, and shark from net fishery. Line fisheries operating across the anchorage area target transient Spanish mackerel (DAFF 2012).

The EIA (GHD 2012a) of this study determined that:

*“the anchorage area is characterised by open seabed with patchily distributed benthic fauna and flora. The anchorage area does not support unique features or habitats requiring a higher level of management protection, as reflected by the Marine Park General Use Zoning of the anchorage. Species represented are not unique and are well represented locally in the geography outside of the anchorage area”*.



**Figure 4-7:** Map of the current anchorage area of the Port of Abbot Point



#### 4.7.2 Current demand for ship anchorages at the Port of Abbot Point

Based on MSQ historic vessel movements data for vessels over 50 m in length over the period 1 January 2009 to 30 September 2012, there are currently around a total of 180 ship arrivals per year (all coal ships) at the Port of Abbot Point. Of these around 60-80 per cent involve ships proceeding directly to anchor. In 2009, around 80 per cent of ships proceeded direct to berth which is likely to have been related to cargo availabilities at the terminal.

**Table 4-6:** Total ship visits to the Port of Abbot Point and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis)

Port of Abbot Point	2009	2010	2011	2012 (Nine months)
Total ship arrivals	200	232	179	121
Total direct to berth	155	52	76	24
Total direct to anchor	45	180	103	97
Per cent direct to berth	78%	22%	42%	20%
Per cent direct to anchor	23%	78%	58%	80%

All ships were recorded as using one anchorage area “Abbot Point Anchorage”, and all were bulk carriers (i.e. arriving to load coal for export). There are currently no designated anchorage areas at Port of Abbot Point. The Abbot Point anchorage area assessed in this project has been determined in consultation with the Regional Harbour Master. Refer section 1.4 for further information. Ships in 2011 spent on average around three days at anchor (with 8 instances of between 13-19 days).

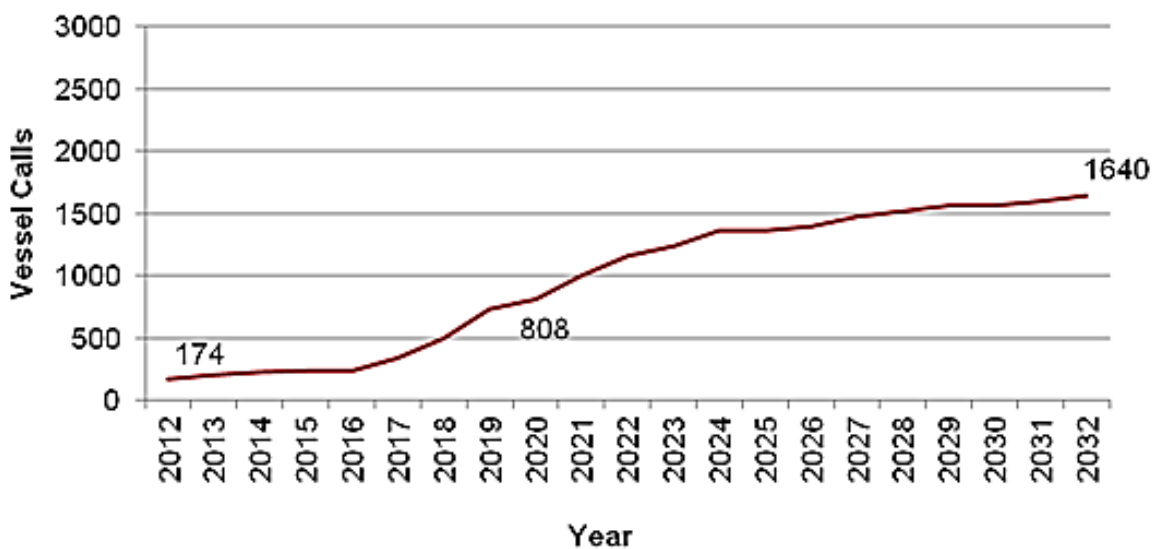
The current scale of the use of ship anchorages at the Port of Abbot Point can be summarised as minor with an average of less than one ship call per day using the anchorages for typical stays of only several days (average of three days for all ships in 2011).

#### 4.7.3 Future demand for ship anchorages at the Port of Abbot Point

PGM Environment (2012) forecasts a probable case of around 11 per cent per year growth in ship calls over the period 2012-2032 (financial year end numbers). Growth is driven by expected coal ships serving the various port expansion plans with the number of calls rising from a 2012 base of 174 to 808 in 2020, and 1640 in 2032 (figure 4-8).

Ship call numbers are forecast to increase significantly at the Port of Abbot Point. It is likely that the future demand for ship anchorages will increase at a similar rate. Given the historical fluctuations in the share of ships using anchorages, it is difficult to predict whether the future share of ships proceeding direct to anchor will change. However, some coal producers at Abbot Point will control coal exports from mine to overseas port which means that they are in a better position to also control the scheduling of their shipping.

The future scale of the use of ship anchorages at the Port of Abbot Point can be summarised as becoming of more significance with the demand possibly increasing by around nine times in 2032 compared with today. This equates to around 2.5 ship calls per day requiring the use of anchorage. Based on preliminary observations, this future growth in anchorage demand should be able to be accommodated in the existing anchorage areas, particularly if designated anchorages and/or densely organised anchorages are used.



**Figure 4-8:** Forecast ship call numbers “probable case” for Port of Abbot Point (2012-2032) as extracted from PGM Environment 2012

#### 4.8 Demand for and use of ship anchorages at the Port of Hay Point (including Dalrymple Bay)

##### 4.8.1 Current profile of ship anchorages at the Port of Hay Point

The anchorage area for ships servicing the Port of Hay Point (see figure 4-9) are located immediately adjacent to the port terminals. The anchorage area of Hay Point port has a number of designated anchorages. The Port of Hay Point ship anchorage area defined for this study is the largest of the five major ports and totals an area of 157,284 ha. The Port of Hay Point ship anchorage area includes one designated inner anchorage area inside port limits, with the other larger designated area outside port limits. The nearest residential centre is Sarina, approximately 10 km south of Hay Point. While the anchorage area does not have

a high level of visibility from Sarina, the scenic vista surrounding the anchorage area may still be considered remarkable, exception or unique in the context of the World Heritage Listing for residents and visitors to Mackay and Sarina, north and south of the Port of Hay Point respectively.

Compared to locations such as Cairns, the anchorage area is likely to be transited by only a low volume of tourism operators accessing the Reef and islands within the World Heritage Area. However, the anchorage area is transited by large commercial ships servicing the Port of Hay Point, and also commercial and recreational fishing vessels operating out of centres north and south of the port.

The anchorage area at Hay Point is located in a General Use Zone of the Marine Park and is surrounded by protected habitat at varying distances. A Habitat Protection Zone is located immediately west of the anchorage area, while there are several small Habitat Protection Zones encompassing fringing coral reefs surrounding the anchorage area, of which the closest is located approximately 5 km to the south of a designated anchorage. Conservation Park Zones are located approximately 5 km west, as well as approximately 15 km north and north-east of the anchorage area. Marine National Park Zones are located more than 5 km north and east of the anchorage area.

The commercial fisheries that operate in the vicinity of the Port of Hay Point anchorage area (grid number O25) are line, net, pot and trawl (beam and otter), targeting (primary product) prawns and scallops (trawl) (refer to figure 4-9). The line fishery in this sector reported coral trout and shark as the primary target product (DAFF 2012).

Recent surveys indicate that sediments across the anchorage area are *“likely to be comprised of sands and silts, predominantly terrigenous in source”* (GHD 2012a). The anchorage area is surrounded by a number of islands (from 2 to 13 km away), some with fringing coral reefs, but no solitary corals occur within the anchorage area. Low density seagrass meadows and algae are known to occur within deepwater near the coastally located anchorages. Mangroves and intertidal mudflats provide coastal habitat adjacent to the anchorage area, however, these are interspersed with rocky reefs and intertidal rocky shoals. Turtle, dugong, and cetaceans considered iconic for the Reef and having high cultural value are known to transit the anchorage area. Low density deepwater seagrasses associated with the anchorage area may be utilised by dugong and marine turtles as feeding habitat. The anchorage provides habitat for these protected marine fauna in addition to a range of EPBC listed fish and marine and migratory avifauna.

The EIA (GHD 2012a) of this study determined that:

*“the anchorage area supports open seabed habitat which provides for movement corridors and connectivity, however, these habitats are not unique within the anchorage area and are well represented elsewhere across the World Heritage Area. No core feeding or breeding habitat for any protected species is present at the anchorage area, however, it is a part of a matrix of habitat and environmental features which supports the diversity for which the Reef is recognised”.*

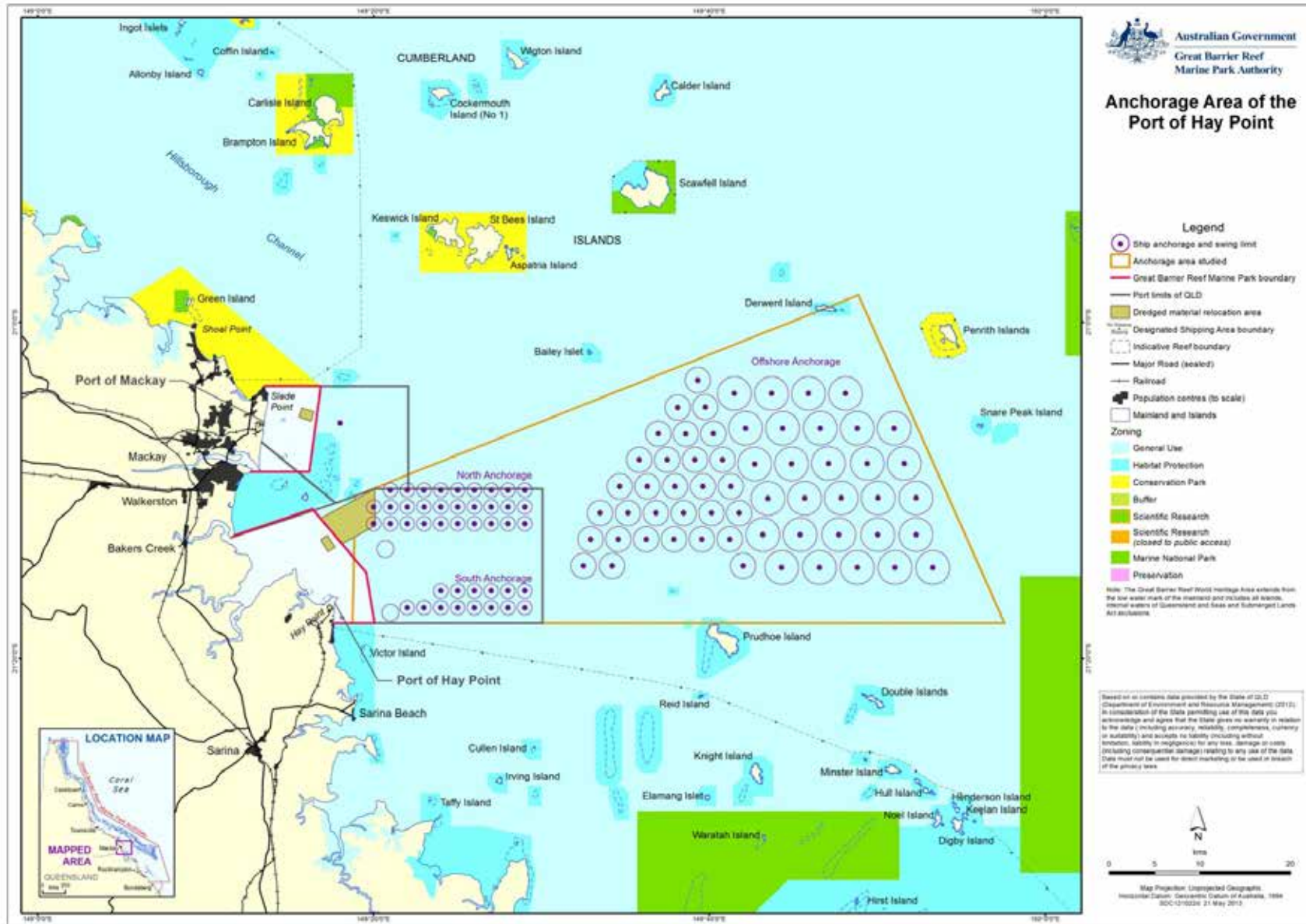


Figure 4-9: Map of the current anchorage area of the Port of Hay Point

#### 4.8.2 Current demand for ship anchorages at the Port of Hay Point

Based on MSQ historic vessel movements data for vessels over 50 m in length over the period 1 January 2009 to 30 September 2012, there are currently around a total of 800 ship arrivals per year (all coal ships) at the Port of Hay Point. This number is currently down from 2009 and 2010 levels of around 1000-1100 ship calls. Nearly all ships (99 per cent) proceed directly to anchor from sea to await a berth. This is different to Abbot Point and means that Hay Point has the highest requirement of the five ports for anchoring. Demand at Hay Point reflects the nature of the coal trade at the port and the connecting coal supply chains from mine to port.

**Table 4-7:** Total ship visits to the Port of Hay Point and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis)

Port of Hay Point	2009	2010	2011	2012 (Nine months)
Total ship arrivals	1107	1020	796	575
Total direct to berth	5	10	9	3
Total direct to anchor	1102	1010	787	572
Per cent direct to berth	0%	1%	1%	1%
Per cent direct to anchor	100%	99%	99%	99%

Ships (bulk carriers loading coal) were recorded as using dedicated, numbered anchorages (in 2011):

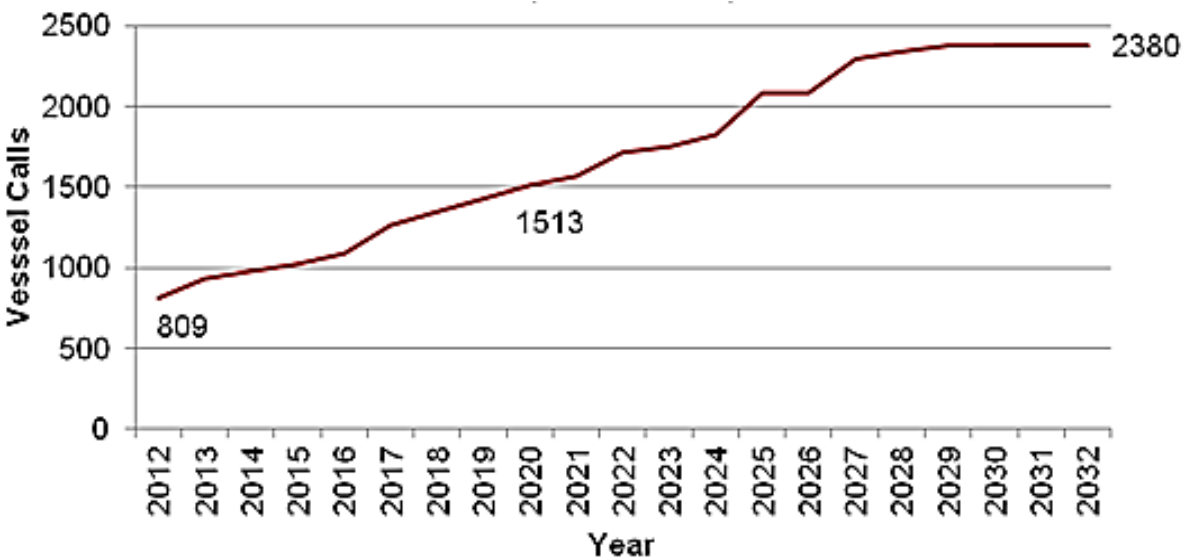
- North Anchorages (1-29) – mainly waiting for DBCT berths (but also for Hay Point Coal Terminal (HPCT) berths)
- Offshore Anchorages (1-41) – also mainly waiting for DBCT berths (but also HPCT berths)
- South Anchorage (1-14) – mainly for HPCT berths (but also DBCT berths).

Based on a sample of ship calls for two months in 2011, ships spent on average around 19 days at anchor. In some instances ships remain at anchor for between one and two months. There are also instances of ships moving from one anchorage area to another within the Port of Hay Point, ships being removed from a berth to anchor and then back to berth, and also ships departing to sea again after being at anchor without proceeding to a berth. Demand and anchor use at Hay Point reflects the nature of the coal trade at the port and the connecting supply chains from the mine to the port. This extended anchor time also reflects ships moving into and out of anchor to load different coal products.

The current scale of the use of ship anchorages at the Port of Hay Point can be summarised as significant. There are 102 dedicated points for ships to anchor within the anchorage area, with an average of around two to three ship calls per day using the anchorages for stays from days to weeks and in some cases up to two months.

**4.8.3 Future demand for ship anchorages at the Port of Hay Point**

PGM Environment (2012) forecasts a probable case of around five to six per cent per year growth in ship calls over the period 2012-2032 (financial year end numbers). Growth is driven by coal ships, particularly in association with approved expansions and the assumed operation of the new Dudgeon Point terminal. The number of calls are forecast to rise from a 2012 base of 809 to 1513 in 2020 and 2380 in 2032 (figure 4-10).



**Figure 4-10:** Forecast ship call numbers “probable case” for Port of Hay Point (2012-2032) as extracted from PGM Environment 2012

Ship call numbers are forecast to increase significantly at the Port of Hay Point. It is likely that the future demand for ship anchorages over the next 20 years will increase at a similar rate. There is a possibility that coal producers using the planned new terminal at Dudgeon Point will also control shipping which provides the potential to better schedule ships to call at a berth direct from sea.

The future scale of the use of ship anchorages at the Port of Hay Point over the next 20 years can be summarised as becoming even more significant with the demand possibly increasing by around three times in 2032 compared with today (i.e. around 6.5 ship calls per day requiring the use of anchorage). Based on existing data, this future growth in anchorage demand will likely test the current capacity of the designated ship anchorages. There could still be sufficient anchorage space particularly if the average ship time at anchor is reduced.

It is worth noting that the forecasting of average future waiting times at anchor is complex, depending on many unknown variables, such as the future efficiency of coal supply chains and the global future supply/demand of the shipping market.

## 4.9 Demand for and use of ship anchorages at the Port of Gladstone

### 4.9.1 Current profile of ship anchorages at the Port of Gladstone

The majority of anchorages servicing the Port of Gladstone (see figure 4-11) are located in an area east-south-east of Facing Island, outside of Gladstone Harbour and the port limits (hereafter referred to as the outer anchorage area). A smaller anchorage area (herein referred to as the inner anchorage area) is located to the west of Facing Island within Gladstone Harbour. The outer anchorage area is located more than 20 km from the Port of Gladstone and in an area of open seabed. The inner anchorage area is located within the port limits and approximately 5 km from the main Port of Gladstone.

The combined ship anchorage area defined for this study totals an area of 24,125 ha, comprising 1403 ha for the inner anchorage and 22,722 ha for the outer anchorage. The inner anchorage area is visible to residents and visitors to Gladstone and the nearby islands within the World Heritage Area. The outer anchorage is located in a General Use Zone of the Marine Park, while the inner anchorage area is outside of the Marine Park. Both anchorage areas are utilised by large commercial ships servicing the Port of Gladstone. They are also regularly transited by commercial and recreational fishing vessels and a low volume of tourism operators accessing the Reef and islands within the World Heritage Area.

Protected habitats occur approximately 5 km west and south of the outer anchorage, including Habitat Protection and Conservation Park Zones. Further afield, approximately 20 km to the north-east, are numerous Marine National and Conservation Park zoned areas associated with the Capricorn Group of reefs. Port Curtis offers value of national importance as wetland habitat and includes all tidal areas in the vicinity of Gladstone. Within the wetland there are a number of culturally significant sites on Facing Island and a number of shipwrecks along the coast.

Recent surveys indicate that sediments across the anchorage area are “*likely to be comprised of sands and silts, predominantly terrigenous in source*” (GHD 2012a). The outer anchorage area is located outside of the port limits in an area of open seabed comprised of soft sediment habitat with sparsely distributed solitary corals. The inner anchorage is characterised by rocky, rubble habitat that supports some soft corals, sponges and live rock, however this habitat is considered to be well represented in adjacent areas and is not unique to the anchorage. Algae and deep water seagrasses have been reported in the area of the outer anchorage but it is not known if they persist. No seagrasses have been mapped by long term monitoring programs as occurring in the inner anchorage. The coastal areas of Port Curtis have intertidal flats and estuarine habitats with extensive mangroves, seagrass beds and salt flats. The seagrass beds provide important habitat for a number of EPBC listed migratory and marine birds and conservation significant marine fauna including fish, dugong and turtles. Habitat providing dugong conservation value has been identified adjacent to the inshore anchorage area. The anchorage areas are likely to provide transitory habitat and some feeding for different megafauna, as well as habitat in support of fishery species.

The commercial fisheries that operate in areas associated with the anchorage areas of Gladstone port (grid number S30) are line, net, pot (crab) and trawl (otter and beam) (refer to figure 4-11). The primary product targeted in this region has been previously reported to be crab (pot), prawns and scallops (trawl), as well as grey and Spanish mackerel (line) (DAFF 2012). Catches have, however, been reduced in recent times.

The EIA (GHD 2012a) of this study determined that:

*“the anchorage area (inner and outer) does not contain any significant geomorphic or physiographic features which are integral to the ongoing ecological functioning of the Reef. The anchorage area does not support unique features or habitats requiring a higher level of management protection, or important feeding or breeding habitat critical for the persistence of any protected species”.*



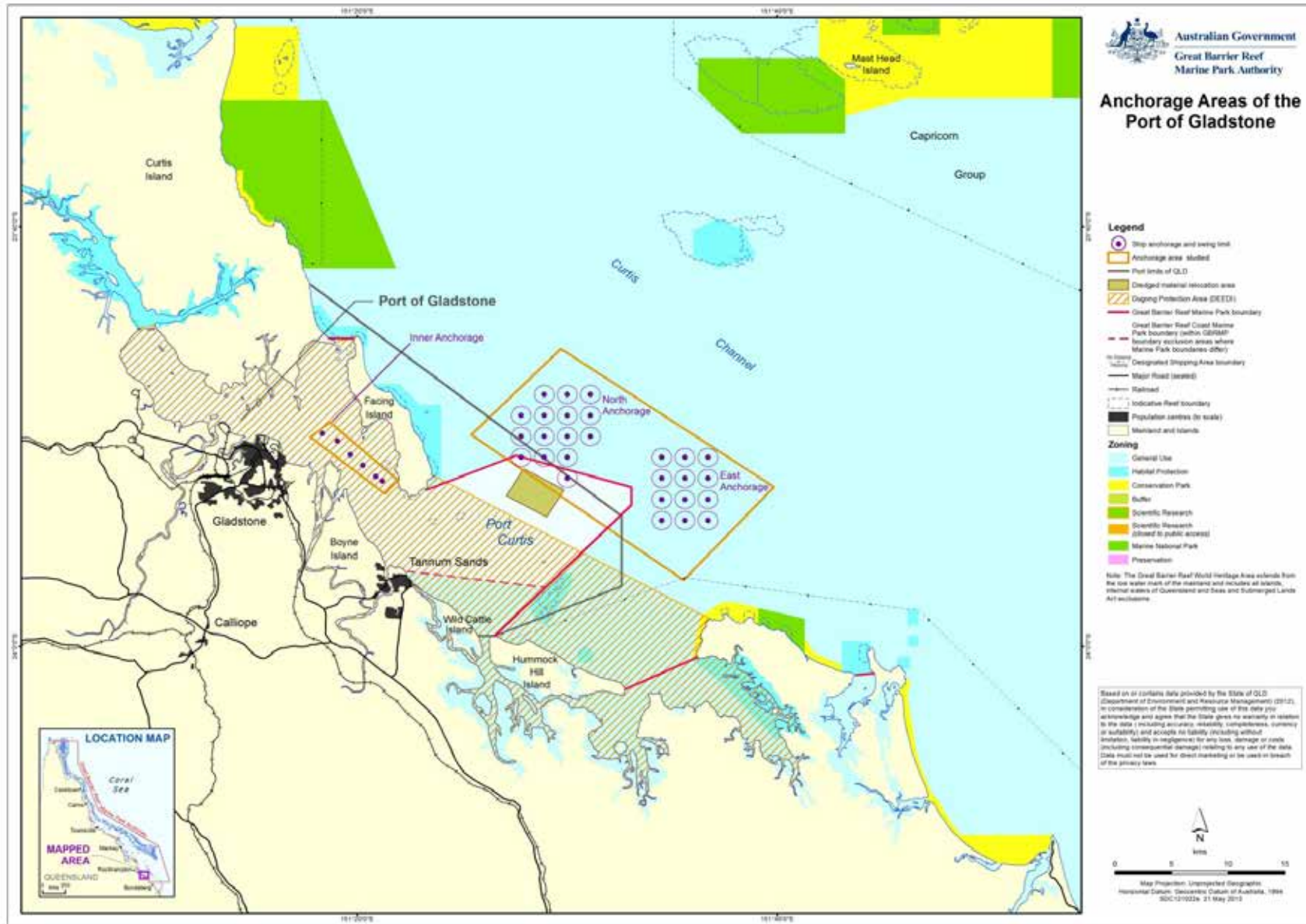


Figure 4-11: Map of the current anchorage area of the Port of Gladstone

#### 4.9.2 Current demand for ship anchorages at the Port of Gladstone

Based on MSQ historic vessel movements data for vessels over 50 m in length over the period 1 January 2009 to 30 September 2012, there are currently around a total of 1500 ship arrivals per year at the Port of Gladstone. Around 80 per cent of ships arriving proceed directly to anchor from sea to await a berth.

**Table 4-8:** Total ship visits to the Port of Gladstone and share using ship anchorages, 2009-2012 (Source: MSQ data/GHD analysis)

Port of Gladstone	2009	2010	2011	2012 (Nine months)
Total ship arrivals	1593	1620	1510	1227
Total direct to berth	341	328	309	233
Total direct to anchor	1252	1292	1201	994
Per cent direct to berth	21%	20%	20%	19%
Per cent direct to anchor	79%	80%	80%	81%

All ships were recorded as using three dedicated anchorage areas in 2011:

- East Anchorage (outer anchorage, numbered locations 1-12), which served 48 per cent of the ship calls anchored
- North Anchorage (outer anchorage, numbered locations 1-14), which served 42 per cent of the ship calls anchored
- Fairway Buoy Anchorage (the inner anchorage area), which served 10 per cent of the ship calls anchored.

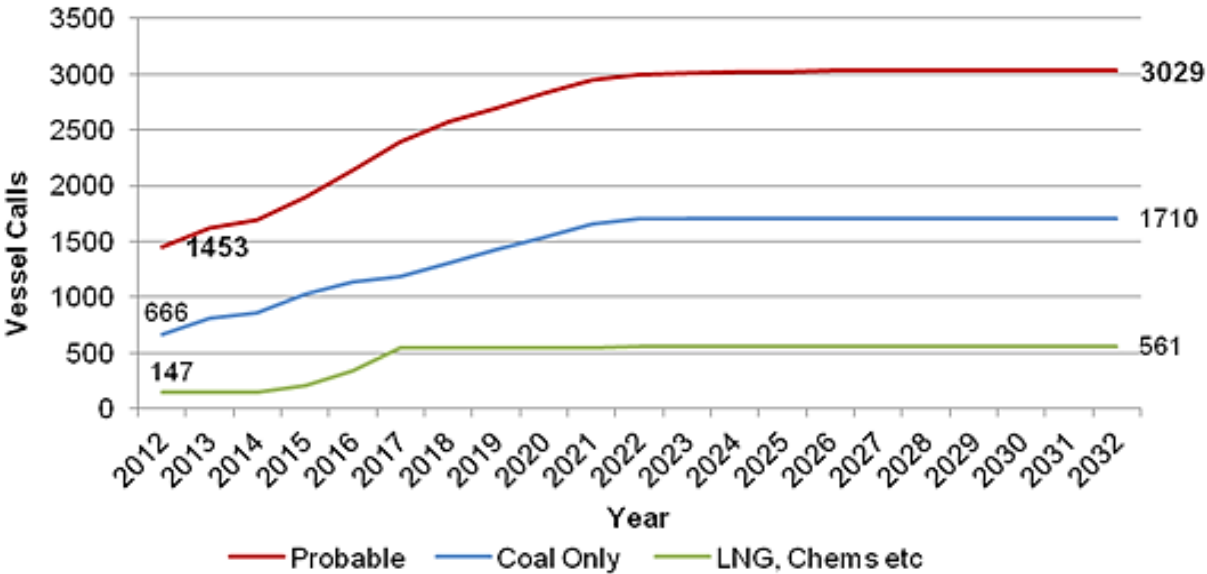
The Gladstone anchorages were used in 2011 by a range of ship types with the majority of ships being bulk carriers (coal and ores) followed by general cargo, tankers and other types of ships. Ships spent on average around four days at anchor. There are, however, instances of ships spending several weeks at anchor while others were located at anchor for only a few hours.

The outer anchorages were used on occasion for removals from port (13 instances in 2011 – mainly bulk carriers), and for a temporary wait at anchor after departing the port on route to sea (32 instances in 2011). The inner anchorage (Fairway Buoy Anchorage) was also used for intra-port movements of dredgers and barge carriers.

The current scale of the use of ship anchorages at the Port of Gladstone can be summarised as moderate; there are 32 dedicated points for ships to anchor in organised designated anchorage areas, particularly in the outer anchorages with 27 points. An average of around three ship calls per day (including removals and departures) using the anchorages for typically stays of only several days (average of four days for all ships in 2011).

**4.9.3 Future demand for ship anchorages at the Port of Gladstone**

PGM Environment (2012) forecasts a probable case of around three-to-four per cent per year growth in all ship calls over the period 2012-2032 (financial year end numbers). This is principally driven by coal ships (growing four to five per cent per year) and LNG ships (growing six to seven per cent per year). The number of ship calls are predicted to rise from a 2012 base of 1453 (147 LNG ships) to 2800 (561 LNG ships) in 2020, and 3029 (561 LNG ships) in 2032 (figure 4-12).



**Figure 4-12:** Forecast ship call numbers “probable case” for Port of Gladstone (2012-2032) as extracted from PGM Environment 2012

Ship call numbers are forecast to increase moderately at the Port of Gladstone. It is likely that the future demand for ship anchorages will increase at a lesser rate than the increased forecast in overall ship call numbers. This is likely to be caused by the dedicated shipping and berthing operations of LNG exports, whereby controlled shipping can be scheduled to call at an LNG berth direct from sea. Controlled shipping may be facilitated by planned channel duplication, which is yet to be assessed.

The future scale of the use of ship anchorages at the Port of Gladstone can be summarised as becoming more significant with the demand possibly increasing by around 1.8 times in 2032 compared with today (i.e. around six ship calls per day requiring the use of anchorage). Based on preliminary observations, this future growth in anchorage demand should be able to be met by the current capacity of the designated ship anchorages, assuming that average ship time at anchor does not increase significantly beyond current levels.

#### 4.10 **Use of anchorages during severe cyclone events**

Ship anchorages are affected by severe cyclone events which typically impact the Reef ports along the coast from Cairns to Hay Point. In a severe cyclone event, ships are instructed by the RHM, in advance of the cyclone arriving, to leave both port and anchorages (i.e. evacuated) to open sea (within or outside of the reef). These events require a certain operational recovery time for both ports and anchorages (typically several days depending on the severity of the event and the damage caused to port infrastructure). Anchorages play an important role in recovery situations as they can often be used in advance of a port re-opening. This aids the speed of operational recovery of a port, and associated inland supply chains.

#### 4.11 **Ability to control ship anchoring demand and use**

The ability of a port authority or RHM to control the demand and use of ship anchorages is fairly limited beyond providing designated areas with an ultimate capacity based on safety and navigational restrictions. There are various parties that influence shipping movements (and therefore anchorage) with differing commercial objectives:

- The product exporter may have control over the arrangement of shipping if the contract terms between the seller (e.g. the Australian exporter) and the buyer (e.g. the overseas importer) include delivery by ship to the overseas port destination. This currently does not happen that often in Queensland.
- The product importer may have control over the arrangement of shipping if the contract terms between the seller (e.g. the Australian exporter) and the buyer (e.g. the overseas importer) require the exporter to deliver the cargo to port and load it only onto the ship nominated by the importer (versus a ship controlled by the exporter). This is generally current practice.
- The shipping company and the ship's master have the discretion when to arrive for cargoes. This can include arriving just-in time for a booked load, or opportunistically waiting at a loading point (at anchor) for the chance of loading a cargo. Opportunistic arrivals are not a practice that currently occurs for ships servicing the five major ports of Queensland (P. Quirk (MSQ) pers. comm., 20 May 2013).
- The terminal operating company, in conjunction with the port authority, may operate queuing rules, notifications and priorities which affect the behaviour of ships at anchor and their proceeding towards anchor from sea.

This complexity of stakeholders means that the efficient operation of supply-chains, terminals and minimisation of the demand for anchorages continues to be a challenge for the market-place using the main Reef ports.

## 5. RANGE OF OPTIONS FOR ANCHORAGE MANAGEMENT

### 5.1 Background and potential management options

This section describes management options for ship anchorages. These potential management options are assessed through the CBA model if future anchorage demands predict a need to expand anchorage areas.

This section (5.1) describes identified generic anchorage management options. Following, in sections 5.2 through to 5.3.5, the relevance of those management options to each of the subject ports is considered with regard to quantifiable benefits and costs. Following analysis of this generic list, a more refined list of management options was assessed by the CBA modelling (refer section 7) for ports where future demand for anchorages outstrips available anchorage space.

The examination and initial screening of the various identified options presented in this section occurred as part of the CBA workshop with relevant stakeholders (refer section 3) and involved a number of discussion topics:

- Possible economic and commercial impacts
- Possible environmental impacts with the goal of achieving net environmental gains
- Possible ship safety and emergency response impacts
- Possible other user and social impacts
- Possible transfer of safety and environmental impacts beyond the study area and other borders. Note: This is considered a negative impact as negative impacts potentially still remain, but in other locations, including outside of the Marine Park and Australian national borders.

#### 5.1.1 Overview of an identified set of port ship anchorage management options

GHD initially scoped, using discussions with marine engineering and shipping consultants combined with a literature review, a set of potential ship anchorage management options. Via workshoping with targeted stakeholders, agreement was reached as to the full range of potential options for the management of ship anchorage at the five ports of interest to be considered under this project. These options are shown in table 5-1. As noted above, these agreed options were subject to further review to determine their relevance prior to analysis using the CBA modelling in section 7.

**Table 5-1:** Overview of potential ship anchorage management options

Option	Name	Description
1	Business as usual	Current practice at the GBR 5 main ports
2	Improved	Improving current practice through efficiencies and/or using different locations

<b>Option</b>	<b>Name</b>	<b>Description</b>
<b>3</b>	All-at-Port	All arriving ships proceed direct to waiting berths in Port
<b>4</b>	All-in-Port limits	All anchorages only in port limits
<b>5</b>	Fixed-Moored	All ships moored to fixed structures in anchorage areas
<b>6</b>	All-at-Sea	All ships wait at sea, unmanaged, and proceed direct to port
<b>7</b>	Scheduled Arrivals	All vessels are scheduled with a port arrival management system (all ships at sea with anchorages)
<b>8</b>	Scheduled Arrivals plus Anchorage	Option 7 in combination with (limited) anchorages
<b>9</b>	Demand Management	Restrictions on the level of ship arrivals and/or anchorage pricing mechanisms
<b>10</b>	Port consolidation Strategy	Consolidating the existing GBR 5 main ports
<b>Others</b>	Various other	Further mix of options 1 -10, and other possible technical alternatives

### **5.1.2 Business-as-usual option**

The “Business-as-usual” option forms the Base Case (Without Strategy) scenario for the subsequent CBA modelling. This option uses current practices to manage future demand for ship anchorages at the five main ports. In general, current practices would mean that any short-fall in the future of the supply of ship anchorages would be met by an increase in the current number of anchorages.

Current practices will not be the same at all of the five main ports. For instance, the ports of Townsville and Abbot Point do not currently have designated anchorages, while Hay Point and Gladstone do.

### **5.1.3 Improved option**

The “Improved” option is a possible approach for managing future demand which modifies or optimises current practices within current ship anchorage areas, such that under future demand scenarios, negative impacts are minimised or avoided. For instance, an improved practice would be to implement designated anchorages where there are none (i.e. Townsville and Abbot Point) to avoid anchoring in any particularly environmentally sensitive areas.

Improved options of this type may not be possible for all of the five main ports, particularly those which currently have designated anchorages (i.e. Gladstone and

Hay Point) and/or current anchorages with minimal or no remaining environmentally sensitive areas.

#### **5.1.4 All-at-port option**

The “All-at-port” option is a possible approach to managing future demand for ship anchorages at the five main ports by constructing an adequate number of ship-waiting berths (quays or jetties) as part of the port infrastructure within current port limits. These ship-waiting berths would then prevent the need to expand current anchorage areas to meet the future demand for ship anchorages.

The number and type of ship-waiting berths would not be the same at each of the five main ports. For instance, the berths at Hay Point and Abbot Point are weather exposed jetty-type berths, while in Gladstone and Townsville the berths are typically quay or nearby jetty structures as part of relatively protected harbours.

#### **5.1.5 All-in-port limits option**

The “All-in-port limits” option is an approach for managing future demand for ship anchorages at the five subject ports by concentrating any future required expansion of anchorages to locations within current port limits. This approach assumes all new port expansions are conducted within current port limits.

The use of this approach to managing future demand for ship anchorages would not be the same at all of the subject ports. Some ports already have anchorage areas which extend beyond, or are outside of, current port limits (e.g. Abbot Point, Hay Point, and Gladstone). Further, in some locations there is the possibility of insufficient space within current port limits (including for ship safety) to accommodate any required future expansion in anchorages.

#### **5.1.6 Fixed-moored option**

The “Fixed-moored” option is a possible approach for managing future demand for ship anchorages at the five subject ports by installing fixed mooring structures (buoy or single-point moorings) in an appropriate anchorage expansion area. The size of the fixed-mooring structures would depend on the depth of water, sea conditions and type of vessel to be moored (e.g. large, un-laden, Cape-size coal ships).

The rationale behind this approach is to reduce or eliminate the ongoing (and potentially scattered) occurrence of anchor-drop/retrieval impacts on the sea-floor and the impacts of anchor-chain movements as ships swing at anchor.

#### **5.1.7 All-at-sea option**

The “All-at-sea” option is a possible approach for managing future demand for ship anchorages by deciding not to expand current anchorages, with the resulting effect that ships without anchorage in the current area having to wait at sea. This would require the ships to idle at sea, drift or be anchored at another permitted location elsewhere in Australia or outside of Australia.

This approach is assumed not to include the management of the scheduling of vessel arrivals at port which means it is effectively a future 'Do Nothing' scenario for ship anchorages.

#### **5.1.8 Scheduled arrivals without anchorage option**

The "Scheduled arrivals" option provides for the removal of all designated anchorages with all vessels proceeding direct from sea to a berth in the port based on scheduled ship arrivals.

This approach can be considered to be less feasible than the others as it would require a change in long-accepted practice of port and shipping operations currently in place within Queensland.

#### **5.1.9 Scheduled arrivals with anchorage option**

The "Scheduled arrivals with anchorage" option includes the maintenance of the current anchorage areas, without further expansion, and the implementation of a scheduled ship arrival system. This system would queue vessels into and out of the anchorage area according to cargo/product availability and optimal steam time of vessels. This system influences vessel behaviour as it does not benefit ships to race to a load location. Instead, the system promotes the use of the sea voyage to the port to ensure ships proceed efficiently (do not speed-up) and anchor at the port for minimum periods of time. This approach can allow for growth in ship calls without expansion of anchorage areas. The time at anchor is linked to the flexibility required by the terminal operators at the port to ensure efficient loading of cargoes and use of the berths.

The use of this approach to manage future demand for ship anchorages will not be the same at all of the five main ports. For instance, some ports (Hay Point and Abbot Point) only handle bulk carriers for the export of coal. This makes it potentially easier to manage and schedule all arriving ships for anchoring. Other ports (Townsville and Gladstone) handle a mixture of import and export cargoes using different ship types. This adds complexity to managing ship arrivals at anchorages.

#### **5.1.10 Demand management option**

The "Demand management" option is a possible approach for managing future demand for ship anchorages by limiting either:

- (a) The number of ships calling at a port, or
- (b) The length of time at anchor using pricing disincentives.

In the case of (a), trade through a port would be effectively capped by a restriction on the maximum number of ship calls at a port which would avoid any need to expand anchorages in the future.

In the case of (b), the efficiency and capacity of current anchorage areas are assumed to be increased by reducing the average time at anchor to a required level using pricing penalties. Under this situation vessels that sit at anchor beyond a certain time pay a fee. This can be combined with a 'base' levy for the use of



anchorage to incentivise ships going direct to berth from sea. This method continues to allow for the future growth in ship calls at a port, but avoids the possible future need to expand current anchorage areas. It is possible that this method would also result in ships 'idling' at sea and/or anchoring elsewhere along the coast in permitted areas or outside of Australia in order to avoid the cost of paying for extended stays at port anchorages.

#### **5.1.11 Port consolidation strategy option**

The "Port consolidation strategy" option is a possible approach for managing future demand for ship anchorages by consolidating common port trades (e.g. coal) at the most suitable (least impacting) location. The strategy would use existing port infrastructure and limits. This approach would focus any impacts from expanded anchorages to a single well-suited location able to accommodate any possible future growth in ship calls. As such, it would be a strongly interventionist approach and assumes that the complexities of multiple port ownerships and the need to change connecting inland infrastructure (e.g. rail) could be solved.

#### **5.1.12 Other options**

An alternative approach to address some impacts realised through anchoring is a technical solution to anchoring used by some advanced ship designs known as "dynamic positioning". Dynamic positioning allows a ship to maintain a stationary position without the need to anchor (i.e. be fixed to the seabed by chain). It is used by certain offshore vessels involved in the oil and gas industry where deep-water affects anchoring efficacy. A number of modern cruise-ships are also equipped with dynamic positioning.

This approach assumes that a significant part of the future shipping fleet calling at the five main ports would be equipped with dynamic positioning and, therefore, able to wait in a stationary position in designated expanded anchorages without the seabed being impacted by conventional anchors and chains. This technological solution does not, however, account for impacts other than environmental.

Other options for managing future demand for ship anchorages at the five main ports mainly involve combining several of the identified options.

### **5.2 Results of examining the potential relevance of identified ship anchorage management options for the five main ports**

The relevance of the identified management options for the five ports under assessment was considered with regard to four criteria:

- Possible economic and commercial impacts
- Possible environmental impacts with the goal of achieving net environmental gains
- Possible ship safety and emergency response impacts
- Possible other user and social impacts.

Review against these criteria identifies three clear options (in addition to Business-as-usual) as potentially relevant to the five main ports:

- “Improved current practices” option which relates to using designated anchorages where none are currently used, such as in Townsville or Abbot Point
- “Scheduled arrivals with anchorage” option and
- A mixture of options, being a possible combination of the first two relevant options.

Review noted challenges with the other identified anchorage manage options for implementation at the ports under study. These are noted for each of the options as follows.

The “All-at-port” option was not considered relevant for further CBA modelling as a number of existing port anchorage areas (e.g. Hay Point and Gladstone) are either outside of or extending beyond existing port limits. The concept of having all ship anchorages within existing port limits has practical limits in terms of ship safety, and physical space to accommodate ship demand. In terms of environmental impact management, port limits were considered to be an arbitrary division of space.

The “Fixed-moored” option was also considered to likely require significant costs. Furthermore, significant one-time impacts on the seabed environment caused by the need to secure each fixed mooring at multiple locations on the seabed were considered expected to occur under this option. The fixed-moorings also have the potential to become hazards for navigation when not in use by ships and may require significant management during severe weather events. This option was also built into the CBA model for further quantification as appropriate.

The “All-at-sea” option was considered to pose increased risks to safety and emergency response capability. This option also results in increased travelling distance to berth reducing terminal operations flexibility and likely increasing inefficiencies as a result of ships not arriving on schedule. This option was, therefore, not considered to be relevant for inclusion in the CBA model.

The “Scheduled arrivals without anchorage” option was considered to be impractical in terms of terminal operations and flexibility for implementation at Queensland ports. Currently none of the coal ports located within the World Heritage Area direct all vessels to berth from sea. Terminal management operations also make this an unlikely/unfeasible option. This option was only considered possible where a single exporter fully controls an integrated supply chain from mine to terminal to overseas port with the exporter also controlling the shipping. In practice, this rarely happens and therefore this option was not considered to be relevant for inclusion in the CBA model.

The “Demand management” option involving the capping of port throughput and ship calls was considered not to be relevant to the ports under assessment. This is principally due to the likelihood of an excessive economic impact required to adopt this option and the limited practicality of implementing and regulating a ‘demand cap’. Consequently, this option was not considered to be relevant for inclusion in the CBA model.

The “Demand management using anchor pricing” option method involving the use of an anchor pricing mechanism to increase anchor use efficiency was considered to be likely to pose significant costs to shipping. The required levels of penalty pricing needed to create a beneficial change in anchoring behaviour were considered to be high, equivalent to demurrage costs. It was considered possible that anchor pricing could also result in ships idling at sea and/or anchoring in other permitted locations. However, an anchor pricing mechanism would allow for increased ship arrivals in the future compared with a demand cap which would constrain international seaborne trade through the Reef’s main ports. This is able to be further quantified through the CBA modelling and this option was built into the model framework for assessment.

The “Port consolidation strategy” option was considered likely to pose excessively high commercial, social and economic impacts as a consequence of the strategy requiring change to existing port and landside infrastructure to realise consolidation from multiple cargo ports to single cargo ports. This strategy is also challenged by the complexity of multiple port ownerships that operate in competition for cargoes. For this reason this option was not built into the CBA model for quantification against future anchorage demand at each of the ports. However, any future strategy for ports within the World Heritage Area, or whole-of-state ports strategy, should, to some degree, favour the consolidation of future trade growth to those ports best suited to and equipped for the trade. As such, deep water access ports with expansion capability without significantly impacting upon social and environmental would be favoured by any predevelopment impact assessment.

The “Ship dynamic positioning” technological solution was not considered to be relevant for CBA model analysis. The majority of ships requiring anchorage at the five main ports within the next 30 years are not predicted to be fitted with dynamic positioning capability. It was considered that ship dynamic positioning as a way of remaining stationary, also has associated risks if ship systems fail (power, etc.) such that ships could possibly drift increasing risk of accident.

In summary, a refined list of potential management options is considered to be of relevance for assessment under the CBA model. These include:

- “Improved current practices”
- “All-at-port”
- “All-in-port limits”
- “Fixed-moored”
- “Scheduled arrivals with anchorage”
- “Demand management anchor pricing”
- A mixture of options.

The relevance of each of these options to each of the subject ports is dependent upon port specific conditions.

The potential net benefits of each of the management options for each of the five subject ports are described in the following sections 5.3 through to 5.3.5.

Commentary regarding the performance of suitable or relevant management options is provided with regard to the individual port operations and environment.

### 5.3 **Relevance of identified ship anchorage management options for each of the five ports under study**

#### 5.3.1 **Relevant ship anchorage management options for the Port of Cairns**

The possible future relevance of the identified ship anchorage management options specifically for the Port of Cairns was considered with regard to four criteria:

- Possible economic and commercial impacts
- Possible environmental impacts with the goal of achieving net environmental gains
- Possible ship safety and emergency response impacts
- Possible other user and social impacts.

An overview of the results of the examination for the Port of Cairns is contained in table 5-2.

Ship anchorage at the Port of Cairns was considered to be primarily related to tidal access issues at the port which affect both cargo and cruise/passenger ships. Currently vessels with draft restrictions are required to wait at anchor for appropriate tide conditions or, in the case of some cruise ships, are currently too large to enter port under all conditions. Future plans to improve channel and port access (yet to be assessed) would likely reduce the current demand for anchorage.

Some cruise/passenger ships which call at Cairns already have ship dynamic positioning capability but this would not be used if they were able to enter the port in the future.

The expected relatively low growth in ship calls (around two per cent per year, refer to section 4.5.3) at the Port of Cairns over the next 20 years was also considered to support continuing anchorage practices.

The current practices of ship anchoring were considered to have minimal future impact for the environment and other users beyond that which has already occurred. Ship safety and the ability to rapidly respond to any maritime incident are considered to be excellent under existing arrangements given the close proximity of the main anchorage area to the port.

In conclusion, current practices with the future planned improvements in channel and port access were envisaged as relevant anchorage management options in the future for the Port of Cairns. It should be noted that the possible environmental impacts of any future channel/port access improvements at the Port of Cairns are considered to be outside the scope of this study.

**Table 5-2:** Overview of ship anchorage management options and relevance for Port of Cairns

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
1	Business-as-usual	Yes (supports tidal access & cruise-ships)	Minimal (occurred)	Excellent (close to port)	Minimal (current)	Yes
2	Improved	Yes (when port access dredged)	Possibly (via less use of anchorages)	Excellent (close to port)	Possibly (via less use of anchorages)	Yes
3	All-at-Port	High negative	Uncertain	Excellent (in port)	Possibly (via no use of anchorages)	No
4	All-in-Port limits	Likely no change	Likely no change	Likely no change	Likely no change	Part of 1
5	Fixed-Moored	High negative	Likely negative	Likely negative	Likely no change	No
6	All-at-Sea	Negative	Uncertain	Likely negative	Uncertain	No
7	Scheduled Arrivals	Uncertain	Uncertain	Uncertain	Uncertain	No
8	Scheduled Arrivals plus Anchorage	Benefits & costs to be evaluated	Possibly benefits or no change	Uncertain	Possibly benefits or no change	No

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
9	Demand Management	High negative	Uncertain	Uncertain	Uncertain	No
	(a) Capped ship arrivals					
	(b) Anchorage pricing	Negative	Likely no change	Likely no change	Likely no change	No
10	Port consolidation Strategy	High negative	Uncertain	Uncertain	Uncertain	No
Others	(a) Ship dynamic positioning	High negative	Potentially (no anchorage used)	Uncertain	Likely no change	Part (cruise ships)
	(b) Mixed options	-	-	-	-	1 and 2

### **5.3.2 Relevant ship anchorage management options for the Port of Townsville**

The possible future relevance of the identified ship anchorage management options specifically for the Port of Townsville was considered with regard to four criteria:

- Possible economic and commercial impacts
- Possible environmental impacts with the goal of achieving net environmental gains
- Possible ship safety and emergency response impacts
- Possible other user and social impacts.

An overview of the results of the examination for the Port of Townsville is contained in table 5-3.

Ship anchorage at the Port of Townsville was considered to be typical of a port with multiple trades and visited by multiple ship types requiring operational flexibility. Most of the current anchorage area is outside of the port limits and it is undesignated.

The expected relatively low growth in ship calls (around two per cent per year, refer to section 4.6.3) at the Port of Townsville over the next 20 years was also considered to support continuing anchorage practices. There is, however, possibility to improve existing anchorage management by implementing designated anchorage areas, particularly recognising that future ship call growth will be possibly underpinned by bulk carriers requiring anchorage.

The current practices of ship anchoring were considered to have minimal future impact for the environment and other users beyond that which has already occurred. Ship safety and the ability to rapidly respond to any maritime incident are considered to be excellent under existing arrangements given the close proximity of the main anchorage area to the port. Environmental, economic and social benefits may, however, be realised if anchorage areas were designated at this port.

In conclusion, current practices, with the possibility of designating anchorage areas as a future improvement, were envisaged as relevant anchorage management options in the future for the Port of Townsville.

**Table 5-3:** Overview of ship anchorage management options and relevance for Port of Townsville

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
1	Business-as-usual	Yes	Minimal (occurred)	Excellent (close to port)	Minimal (current)	Yes
2	Improved	Yes (efficiencies)	Uncertain	Excellent (close to port)	Uncertain	Yes
3	All-at-Port	High negative	Uncertain	Excellent (in port)	Possibly (via no use of anchorages)	No
4	All-in-Port limits	Likely negative (uncertain if feasible)	Uncertain	Likely negative (navigation issues)	Uncertain / Possible	No
5	Fixed-Moored	High negative	Likely negative	Likely negative	Likely negative	No
6	All-at-Sea	Negative	Uncertain	Likely negative	Uncertain	No
7	Scheduled Arrivals	Uncertain	Uncertain	Uncertain	Uncertain	No
8	Scheduled	Benefits &	Possibly	Uncertain	Possibly benefits	No



Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
	Arrivals plus Anchorage	costs to be evaluated	benefits or no change		or no change	
<b>9</b>	Demand Management (a) Capped ship arrivals	High negative	Uncertain	Uncertain	Uncertain	No
	(b) Anchorage pricing	Negative	Likely no change	Likely no change	Likely no change	No
<b>10</b>	Port consolidation Strategy	High negative (uncertain for coal)	Uncertain	Uncertain	Uncertain	No
<b>Others</b>	(a) Ship dynamic positioning	High negative	Potentially (no anchorage used)	Uncertain	Likely no change	Part (cruise ships)
	(b) Mixed options	-	-	-	-	1 and 2

### **5.3.3 Relevant ship anchorage management options for the Port of Abbot Point**

The possible future relevance of the identified ship anchorage management options specifically for the Port of Abbot Point was considered with regard to four criteria:

- Possible economic and commercial impacts
- Possible environmental impacts with the goal of achieving net environmental gains
- Possible ship safety and emergency response impacts
- Possible other user and social impacts.

An overview of the results of the examination for the Port of Abbot Point are contained in table 5-4.

Ship anchorage at the Port of Abbot Point was considered to be typical of a single commodity coal export port. It was noted that part of the current anchorage area is inside of the port limits and anchorage drop points are undesignated.

The expected relatively significant growth in future ship calls (around 11 per cent per year, refer to section 4.7.3) at the Port of Abbot Point was considered to support improving current anchorage practices by implementing designated anchorage areas. The option of scheduled arrivals with designated anchorages was also considered to be relevant. However, there is some discussion that scheduled arrivals may possibly result in ships idling more at sea and/or anchoring elsewhere than if more designated anchorages were provided.

The current practices of ship anchoring with the current size of port operations were considered to have minimal impact for the environment and other users beyond that which has already occurred. Ship safety and the ability to rapidly respond to any maritime incident are considered to be excellent under existing arrangements given the close proximity of the main anchorage area to the port. Environmental and economic benefits may, however, be realised if anchorage areas were designated at this port.

In conclusion, current practices with designated anchorage areas as a future improvement and possibly scheduled ship arrivals if and when anchorage demand dictates, were envisaged as relevant anchorage management options in the future for the Port of Abbot Point.

**Table 5-4:** Overview of ship anchorage management options and relevance for Port of Abbot Point

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
1	Business-as-usual	Yes	Minimal (occurred)	Excellent (close to port)	Minimal (current)	Yes
2	Improved	Yes (efficiencies)	Uncertain	Excellent (close to port)	Uncertain	Yes
3	All-at-Port	High negative	Uncertain	Excellent (in port)	Possibly (via no use of anchorages)	No
4	All-in-Port limits	Likely negative (uncertain if feasible)	Uncertain	Likely negative (navigation issues)	Uncertain / Possible	No
5	Fixed-Moored	High negative	Likely negative	Likely negative	Likely negative	No
6	All-at-Sea	Negative	Uncertain	Likely negative	Uncertain	No
7	Scheduled Arrivals	Uncertain	Uncertain	Uncertain	Uncertain	No
8	Scheduled Arrivals plus Anchorage	Benefits & costs to be evaluated	Possibly benefits or no change	Uncertain	Possibly benefits or no change	Possibly (but link to Hay Point)
9	Demand	High negative	Uncertain	Uncertain	Uncertain	No

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
	Management					
	(a) Capped ship arrivals					
	(b) Anchorage pricing	Negative	Likely no change	Likely no change	Likely no change	No
<b>10</b>	Port consolidation Strategy	High negative (re alternative port routing)	Uncertain	Uncertain	Uncertain	No
<b>Others</b>	(a) Ship dynamic positioning	High negative	Potentially (no anchorage used)	Uncertain	Likely no change	No
	(b) Mixed options	-	-	-	-	1, 2 and 8

### **5.3.4 Relevant ship anchorage management options for the Port of Hay Point**

The possible future relevance of the identified ship anchorage management options specifically for the Port of Hay Point was considered with regard to four criteria:

- Possible economic and commercial impacts
- Possible environmental impacts with the goal of achieving net environmental gains
- Possible ship safety and emergency response impacts
- Possible other user and social impacts.

An overview of the results of the examination for the Port of Hay Point is contained in table 5-5.

Ship anchorage at the Port of Hay Point was considered to be typical of a single commodity coal export port. However, there are currently two sets of terminal operations, each requiring anchorage demand. This is expected to increase to a third set in the future with planned expansion at Dudgeon Point also requiring anchorage use. It was noted that the current inner anchorage area is inside of the port limits, and that anchorages are designated. The expected relatively moderate growth in future ship calls (around five to six per cent per year, refer to section 4.7.3) at the Port of Hay Point, from a relatively large base, was considered likely to put pressure on the existing capacity of the current designated anchorage areas. This will be further evaluated in the CBA modelling and suggests that scheduled arrivals with designated anchorages are relevant management strategies likely to be required at this port in future.

A further option of charging for anchoring (anchor pricing, a type of demand management as defined by Option 9 in table 5-5) was considered as possibly relevant. However, it was also considered commercially problematic. To significantly reduce the average length of stay at anchor prices would need to be high, which could result in ships idling more at sea and/or anchoring elsewhere than if fees were not applied to use of designated anchorages. This could also shift anchoring to another port in Queensland which did not have fees for use of designated anchorages.

The current practices of ship anchoring in designated areas with the current size of port operations were considered to have minimal impact for the environment and other users beyond that which has already occurred. Ship safety and the ability to rapidly respond to any maritime incident are considered to be good under existing arrangements given the close proximity of the main anchorage area to the port, albeit that some anchorages are located further offshore.

In conclusion, current practices with designated anchorage areas were envisaged as relevant if future demand can be accommodated by the existing capacity of the designated anchorage areas. In the scenario where future demand cannot be met by the current anchorage capacity, then scheduled arrivals in combination with dedicated anchorages and/or anchorage pricing were envisaged as relevant anchorage management options for the Port of Hay Point.

**Table 5-5:** Overview of ship anchorage management options and relevance for Port of Hay Point

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
1	Business-as-usual	Yes	Minimal (occurred)	Excellent (close to port)	Minimal (current)	Yes
2	Improved	Yes (efficiencies)	Uncertain	Excellent (close to port)	Uncertain	Yes
3	All-at-Port	High negative	Uncertain	Excellent (in port)	Possibly (via no use of anchorages)	No
4	All-in-Port limits	Likely negative (uncertain if feasible)	Uncertain	Likely negative (navigation issues)	Uncertain / Possible	No
5	Fixed-Moored	High negative	Likely negative	Likely negative	Likely negative	No
6	All-at-Sea	Negative	Uncertain	Likely negative	Uncertain	No
7	Scheduled Arrivals	Uncertain	Uncertain	Uncertain	Uncertain	No
8	Scheduled Arrivals plus Anchorage	Benefits & costs to be evaluated	Possibly benefits or no change	Uncertain	Possibly benefits or no change	Possibly (but link to Hay Point)

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
9	Demand Management	High negative	Uncertain	Uncertain	Uncertain	No
	(a) Capped ship arrivals					
	(b) Anchorage pricing	Negative	Likely no change	Likely no change	Likely no change	No
10	Port consolidation Strategy	High negative (re alternative port routing)	Uncertain	Uncertain	Uncertain	No
Others	(a) Ship dynamic positioning	High negative	Potentially (no anchorage used)	Uncertain	Likely no change	No
	(b) Mixed options	-	-	-	-	1, 2 and 8

### **5.3.5 Relevant ship anchorage management options for the Port of Gladstone**

The possible future relevance of the identified ship anchorage management options specifically for the Port of Gladstone was considered with regard to four criteria:

- Possible economic and commercial impacts
- Possible environmental impacts with the goal of achieving net environmental gains
- Possible ship safety and emergency response impacts
- Possible other user and social impacts.

An overview of the results of the examination for the Port of Gladstone is contained in table 5-6. Ship anchorage at the Port of Gladstone was considered to be typical of a port with multiple trades and visited by multiple ship types requiring operational flexibility. It was noted that the current main anchorage area is outside of the port limits, with the smaller area being inside port limits. All existing anchorage areas are designated.

The expected small to moderate future growth in all ship calls (around three to four per cent per year, refer to section 4.9.3) at the Port of Gladstone was considered to support continuing anchorage practices. Gas carriers (LNG ships) typically require only a small amount of anchorage as they principally operate on a direct to berth from sea scheduled form of operation. There is, however, a possible need to adopt additional or alternate anchorage management options for appropriate management of increasing numbers of coal ships (bulk carriers).

The option of charging for anchoring (anchor pricing, a type of demand management), avoiding the need to expand existing anchorage areas, is possibly relevant for Gladstone. However, it was also considered commercially problematic. To significantly reduce the average length of stay at anchor, prices would need to be high, which could result in ships idling more at sea and/or anchoring elsewhere than if fees were not applied to use of designated anchorages. This could also shift anchoring to another port in Queensland which did not have fees for use of designated anchorages.

In the scenario of current anchorages being unable to accommodate future numbers of coal ships, and in the absence of an anchorage pricing mechanism, then the option of scheduled arrivals combined with dedicated anchorages may be relevant. This would require existing designated anchorages being re-designated into coal ship and non-coal ship anchorages.

The current practices of ship anchoring were considered to have minimal future impact for the environment and other users beyond that which has already occurred. Ship safety and the ability to rapidly respond to any maritime incident are considered to be excellent under existing arrangements given the close proximity of the main anchorage area to the port.

In conclusion, current practices with designated anchorage areas were envisaged as relevant if future demand can be accommodated by the existing capacity of the



designated anchorage areas. In the scenario where future demand cannot be met by the current anchorage capacity, then anchorage pricing and/or scheduled arrivals in combination with dedicated anchorages particularly for coal ships were envisaged as relevant anchorage management options for the Port of Gladstone.

**Table 5-6:** Overview of ship anchorage management options and relevance for Port of Gladstone

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
1	Business-as-usual	Yes	Minimal (occurred)	Excellent (close to port)	Minimal (current)	Yes
2	Improved	No (already designated areas)	No (already designated areas)	No (already designated areas)	No (already designated areas)	No
3	All-at-Port	High negative	Uncertain	Excellent (in port)	Possibly (via no use of anchorages)	No
4	All-in-Port limits	Technically unfeasible	Uncertain	Likely negative (navigation issues)	Uncertain / Possible	No
5	Fixed-Moored	High negative	Likely negative	Likely negative	Likely negative	No
6	All-at-Sea	Negative	Uncertain	Likely negative	Uncertain	No
7	Scheduled Arrivals	Uncertain	Uncertain	Uncertain	Uncertain	No
8	Scheduled Arrivals plus Anchorage	Benefits & costs to be evaluated	Possibly benefits or no change	Uncertain	Possibly benefits or no change	No (exception being for coal ships)

Option	Name	Assessed Criteria (Potential Net Benefits)				
		Economic / Commercial impacts	Environmental impacts	Ship safety / Response impacts	Other user impacts	Relevant for future
9	Demand Management	High negative	Uncertain	Uncertain	Uncertain	No
	(a) Capped ship arrivals					
	(b) Anchorage pricing	Negative	Likely no change	Likely no change	Likely no change	Possibly
10	Port consolidation Strategy	High negative (re. alternative port routing)	Uncertain	Uncertain	Uncertain	No
Others	(a) Ship dynamic positioning	High negative	Potentially (no anchorage used)	Uncertain	Likely no change	No
	(b) Mixed options	-	-	-	-	1, (8), 9

## 6. OVERVIEW OF AN EXISTING VESSEL ARRIVAL MANAGEMENT SYSTEM

### 6.1 Background

Under section 5, it was noted that a number of potential anchorage management options may be applicable to each of the ports under study. Of these, the “All-in-port” and “Fixed-mooring” options may not be cost effective but are included in the CBA modelling to enable better quantification. Other options, including improving current practice by designating anchorages where none currently exist and adopting scheduled arrivals are, however, likely scenarios for future anchorage demand management. In particular, scheduled arrivals may be appropriate for management of coal ship arrivals if future demand outstrips availability of anchorage areas. The use of such a management option is evaluated in the CBA modelling (reported in section 7) for those ports where a future expansion in shipping anchorages is identified based on forecast demand.

This section provides a case study overview of a vessel arrival system which has application to the ports assessed under this project. This case study identifies potential considerations for implementation of such a system in Queensland.

#### 6.1.1 Overseas

A review of international practice with regard to vessel arrival systems for anchorage management reveals that such systems are currently in place for locations including the River Schelde in Europe, the Turkish Straits/Bosporus in Europe, the Suez Canal in the Middle East/Africa and in Australia at the Port of Newcastle. Of these, the system operating at the Port of Newcastle is the most relevant to the management of anchorages in the World Heritage Area. The approaches used elsewhere in the world have been designed and are operated for tidal assistance (River Schelde), traffic separation (Turkish Straits) and transit convoy planning (Suez Canal) and are, therefore, not as relevant to the requirements of Queensland ports.

Some global oil companies (e.g. BP) and some global bulk agricultural traders (e.g. Cargill) have developed ship charter contracts to encourage shipping companies to slow-steam or optimise ship speeds between supply and delivery ports. These contracts aim to match scheduled arrival dates at berths with availability of cargo. This discourages the behaviour of ships racing to a load location, as can occur with some ships arriving in Queensland to load coal. The advantage of ship slow-steaming is not only economic (fuel cost savings) but is also environmental (reduced greenhouse gas emissions). These contractual developments between cargo-owners (exporters/importers) and shipping companies are independent of any port anchorage management and should support the operation of vessel arrival systems aimed at managing anchorage supply/demand and ship queues as well as providing environmental benefits (reduced anchorage area foot-prints and ship greenhouse gas emissions). Such developments applied to the global coal trade would be advantageous to managing the Australian seaborne coal export trade.

### **6.1.2 Australia**

Although not specifically aimed at reducing environmental impacts associated with expanding anchorages, vessel arrival management systems may result in environmental benefits as an indirect consequence of reducing ship queues at anchor. The management, or scheduling, of the arrival of ships has a potential value-add benefit of helping to respond to the threat of climate change, a major threat to the Reef (GBRMPA 2009), through a reduction in ship greenhouse gas emissions, as well as a reduction in other potentially harmful ship emissions (particulates, sulphur dioxide, etc.).

The management of vessel arrivals at a port should not be to the detriment of efficient terminal operations. For instance, if scheduling results in too few ships being available to load product, this would realise an economic cost and potentially also an environmental one.

Although there are a number of commercial and environmental benefits potentially associated with managing vessel arrivals at coal (and also iron ore) export ports, there are also some emerging concerns as to the flow-on impacts of ships behaviour en-route to the port and possible safety risks to both ships and the environment in other locations. These risk aspects have yet to be established and would require future investigation prior to the adoption of a vessel arrival system. A vessel arrival management system is currently being investigated in Western Australia for iron ore exports at Port Hedland, the world's largest bulk export port and this process may provide, in future, some information of relevance. Identifying potential risks associated with adopting a vessel arrival system for Queensland ports is beyond the scope of this study. The focus here is to identify whether such a system is favourable from a cost benefits perspective as a management strategy under future anchorage demand requirements.

In Australia, the Port of Newcastle's Vessel Arrival System (VAS) for coal ships provides a case study on the operation of such anchorage management systems of relevance to Queensland ports. It also highlights some issues, and provides some guidance, on how such a strategy could be applied to the management of anchorages at the main coal ports in Queensland if future demand is demonstrated to outstrip anchorage availability.

## **6.2 Port of Newcastle's Vessel Arrival System (VAS)**

The following is a review of the Port of Newcastle's Vessel Arrival System based on an examination of relevant literature, including submissions to regulators and government. The following also captures information from industry sourced during consultation.

### **6.2.1 History of the VAS at Newcastle**

The Port of Newcastle's VAS had its origins with record queues of ships in 2007 when numbers of ships at anchor reached over 80 with some ships waiting in excess of 30 days at anchor prior to berthing. Some coal ships entered into the behaviour of 'sprinting' the last part of the voyage to the Port of Newcastle to be better placed in a queue awaiting coal loading. As a consequence fuel costs and ship greenhouse gas emissions increased due to increased sailing speeds and

increased fuel consumption. Vessels did not always achieve a priority position in the queue as a result of sprinting. In addition to those costs, the Newcastle anchorages are exposed to sudden storms and changes in sea conditions and in 2007 the coal ship “Pasha Bulker” grounded which provided the final impetus for adopting a change in the way vessel anchorage at this port was managed.

Following review of options and requirements a trial of a VAS began in 2009 at the Port of Newcastle. The trial resulted in the implementation of an enforced VAS system supported by legislation in 2010. The industry peak body, Shipping Australia Ltd, identified during consultation that the shipping community was originally sceptical of the benefits which would be realised by the VAS implementation. At the time the key driver of ship queues was believed to be a combination of the sale terms of the coal (i.e. sellers not controlling the shipping) and certain inefficiencies in the Hunter Valley Coal Supply Chain (HVCSC) in meeting market demand.

### **6.2.2 Operation of the VAS at Newcastle**

The key aspects of the VAS as currently operated by Newcastle Port Corporation (NPC) are as follows:

- Ships are limited to waiting at anchor to a maximum of 48 hours. For a ship to be allowed to be at anchor, it must have complied with (compulsory/legislated) arrival notification rules.
- Ships which do not comply with anchoring rules, as a form of penalty, lose their place in the queue.
- Ships are required to provide a notification of wanting to berth to load coal 14 days out from the Port of Newcastle. The Newcastle Port Corporation (NPC) track vessels to check conformity to rules and advised protocols. At seven days out, the ship will be provided with a notified arrival time that aligns with when the ship is expected to come to anchor.
- NPC are aware that ship masters may be tempted to anchor elsewhere along the coast in Australia and in order to avoid this situation ships are effectively queued while in transit to the Port of Newcastle.

The operation of the VAS has resulted in reduced queues at anchor of coal ships, effectively reducing the demand for anchorages. The effect of reducing queuing has also been to reduce commercial penalties paid by coal exporters to buyers (ship waiting or “demurrage” costs). Shipping companies have benefited as a result of the reduced costs associated with slow-steaming (fuel savings), and less fuel consumption implies a reduction in ship emissions.

There are, however, some concerns by Australian marine safety authorities that behaviours adopted by ships on route to the Port of Newcastle like slow-steaming, idling, or anchoring outside of Australia may decrease the ability of Australian marine safety authorities to communicate and respond to these ships if problems (safety incidents) develop.

### **6.2.3 Potential opportunities and issues for Queensland coal ports**

The possible application of a Newcastle-type VAS, if required, offers the main Queensland coal ports and the environment a number of opportunities:

- Instead of having to expand anchorages to meet demand, with possible subsequent incremental negative environmental impacts, anchorage demand can be contained to existing areas.
- Economic benefits for coal exporters (less demurrage) and shipowners (reduced fuel costs and improved ship productivity).
- Reduced ship fuel related greenhouse gas and other emissions.

The main issues of implementing a Newcastle-type VAS concern:

- Potential flow-on risks to ship safety and the environment in other locations outside of the coal ports and potentially across jurisdictional borders. It is likely that multi-jurisdictional arrangements would be needed to mitigate this risk and avoid simply transferring it.
- Queensland's complexity of coal ports are owned/managed by different entities and include ports handling coal ships in addition to other trades. This is likely not to be a severe impediment, but rather an issue of cost and governance.
- Likely need for regulatory approval and legislation. This is a one-time but detailed process which would involve a number of government and management authorities.
- Cost of managing a VAS for one or more ports. The existence of the ship monitoring systems operated for the Reef may provide some capability required for a VAS; this would require further investigation if a VAS option were to be considered for implementation.

On balance, a VAS for the management of anchorages appears to offer improvements over the current practice of expanding anchorage areas, but it also carries risks in terms of possible flow-on impacts to ship safety, although this has yet to be evidenced. A VAS remains a relevant anchorage management option and has been assessed within the CBA modelling described in the following section.

## 7. ECONOMIC APPRAISAL

### 7.1 Background

This section draws together, using a CBA framework, the various findings from GHD (2012), targeted stakeholder consultation information on social issues for each of the five main ports in the study area as presented in section 3, the forecasts of future anchorage demand presented in section 4 and the results from examination of the relevance of various ship anchorage management options presented in section 5.

As noted under section 2, a number of steps are followed in the CBA modelling. The first step is to use the forecast demand for ship anchorages to determine whether an expansion in current ship anchorage area is required at a port to meet future demand. If future demand does outstrip available anchorage, the CBA model then evaluates which anchorage management options are optimal for avoiding the need for future expansion of the ship anchorage area. For those ports where an expansion is not identified to be required under future anchorage demand, the CBA model considers whether improving the current management would provide relevant benefits. In this regard, model outcomes can include implementing designated ship anchorage areas where none exist if net environmental gain is identified. Note that the benefits of changing management strategies are only considered where demand outstrips available anchorage.

### 7.2 Description of the CBA model

An Excel-based CBA model was developed for the comparison of current anchoring practices (the Base Case) with alternative anchorage management options under future anchorage demand. Appendix A provides an overview of the model, details assumptions used in the modelling, and provides model outputs. A beneficial result of the model would be one which avoids the physical expansion of the current anchorage area and provides net gains to society.

The options that were incorporated into the model (and hence were quantified and monetised in the modelling) comprised:

- Current practices assuming organised designated anchoring (the default Base Case)
- Improving current practices
- “All-at-port”
- “Fixed-moored”
- “Scheduled arrivals with designated anchorages”
- “Demand management anchorage pricing”.

The modelling process considers whether a combination of any of these options would benefit anchorage management.

The CBA model design captured possible estimated costs and benefits relating to:

- The amount of physical increase in anchorage area that may be required in the future based on forecast ship calls using anchorages for the next 30 years.



- The capital and operating costs associated with the options, for example, installation and management of fixed offshore moorings or the development of ship-waiting berths in ports.
- The value of the potential environmental impacts of physically expanding the anchorage areas.
- The value of the potential fisheries catch loss of the physically expanded anchorage area.
- The daily cost of ship's time when at anchor.
- The fuel and greenhouse gas savings of ships slow-steaming.
- Other user (reef tourism vessels and recreational boats) costs associated with potentially having to divert around areas due to physically expanded anchorages. This includes consideration of the loss of value of the tourism and recreational experience and value attached to ship-viewing from the shore (both negative and positive).
- The cost of any increased incidence of ship-anchor related accidents in terms of incident response, fatalities and serious injuries.
- The value of the commercial activity associated with the local provisioning of ships while at anchor.

The data used in support of these possible cost and benefits estimate was sourced from:

- Future demand - PGM Environment 2012 study on GBRMPA port ship forecasts. This study is considered to provide the best industry data currently available.
- The capital and operating costs associated with the options – GHD marine engineering group, using industry experience and currently up to date data regarding operational costs.
- Potential environmental impact costs – Queensland government marine habitat values applied for loss of environment offset calculations. This data is currently used to identify the economic costs associated with loss of environmental assets and is, therefore, considered to be applicable to this project.
- Potential fisheries catch loss costs – Australian government commercial fisheries catch value data. This is industry standard data which provides a proxy estimate of costs associated with loss of access to resource.
- The daily cost of ship's time when at anchor – Clarksons shipping databases using 10-year averages for relevant ship types. This is industry standard data.
- The fuel and greenhouse gas savings of ships slow-steaming – Data sourced from Clarksons fuel cost databases (ship fuel consumptions and fuel costs), the Australian government, RightShip and the IMO. This is industry standard data.
- Other user costs associated with potentially having to divert around areas due to physically expanded anchorages – some data available from reports released by James Cook University and the Reef and Rainforest Research Centre has informed information developed within GHD regarding the economics of users of the Reef.

- The cost of accidents – Australian government (Austroads) values data (adjusted) and AMSA/GBRMPA incidents reporting. This is industry standard data.
- The economics of local provisioning of ships while at anchor – GHD best estimates using currently available data.

Information used to support the model is considered to be best available, industry accepted, data. Where limited or no evidence is available to confirm predicted values data was not modelled. This principally related to an inability to confirm consistent costs associated with impacts to other users of anchorage areas as a result, for example, of diverting through or around an anchorage. The CBA model spreadsheet provided within Appendix Two provides commentary on the data sources used for each component/parameter and the confidence of these data.

The CBA model output compared the various modelled anchorage options against current practices in terms of NPV, which is a measure of the net social welfare gain of using a management option. This approach takes account of combined quantified and monetised commercial, economic, social and environmental impacts where these are supported by data.

Given the step-wise approach of the CBA model, if a port was identified as not requiring future expansion of an anchorage area, then the applicability of different anchorage management options for avoiding the need for expansion was not further evaluated by the CBA model.

For those ports where existing anchorage areas are considered to be sufficient for future demand requirements, it may be possible to improve current practice where anchorages are currently undesignated. This may realise a net environmental gain. The anchorage areas assessed in this project have been conservatively defined in consultation with RHMs. Any reduction in anchorage areas beyond current minimum requirements (i.e. less than those currently identified) are likely to have operational, safety and economic impacts for both ports and commodity supply-chains. These effects would require additional analysis.

Findings for each of the ports from application of the CBA model are provided below.

### 7.3 **Economic appraisal for the Port of Cairns**

Building off environmental impact assessment completed under phase 1 of this project (GHD 2012a), the CBA model input assumed that no incremental environmental gains could be realised from moving the existing anchorage at the Port of Cairns to an alternative location. Furthermore, it was forecast that the anchorage demand over the period 2012-2032 was able to be accommodated by the current anchorage area and practices. The forecast demand for anchorages in Cairns is sensitive to future ship calls and the average time spent at anchor. The latter is a complex variable difficult to forecast. The Port of Cairns has established trade patterns and historical data used for the modelling from MSQ and future demand requirements reported by PGM (2012), are considered to be the best available information at the time of reporting.

The CBA model assumptions determined that by 2032 only between one and two ships calling per day would require anchorage with an average waiting time at anchor of approximately 12 hours. Given this, it was determined that the current capacity of eight anchored ships did not require any expansion. As anchorages are already designated for the Port of Cairns and relocation of these did not indicate any benefits no improvements to the existing management arrangements were identified by the CBA modelling process.

As noted under section 4.5, there is a large diversity in the types of ships that call at the Port of Cairns. This forecast lack of need to expand anchorage capacity in Cairns and the maintaining of existing management is sensitive to demand predications being robust and planned expansions facilitating better access to the port.

Results of the Economic Appraisal completed by this project, therefore, suggest that the current practice of anchoring at the Port of Cairns within the designated areas is likely to produce the least cost for the desired net environmental outcome over the next 30 years.

#### **7.4 Economic appraisal for the Port of Townsville**

Building off environmental impact assessment completed under phase 1 of this project (refer GHD 2012a), the CBA model input assumed that no incremental environmental gains could be realised from using anchorages located elsewhere at the Port of Townsville than those assessed herein. Furthermore, it was forecast that the anchorage demand over the period 2012-2032 was able to be accommodated by the area assessed with the improved practice of implementing organised designated areas for anchorage. The CBA model assumptions determined that by 2032 only around two ships calling per day would require anchorage and, with an assumed average waiting time at anchor of three days, these ships could be accommodated in the current anchorage area (or an equivalent designated area). The forecast demand for anchorages in Townsville is sensitive to future ship calls and the average time spent at anchor. The latter is a complex variable difficult to forecast. The Port of Townsville has established trade patterns and historical data used for the modelling from MSQ and future demand requirements reported by PGM (2012), are considered to be the best available information at the time of reporting.

As noted under section 4.6, there is a large diversity in the types of ships that call at the Port of Townsville. This forecast lack of need to expand anchorage capacity in Townsville and improve anchorage management by designating anchor drop points is sensitive to demand predications being robust and planned expansions facilitating better access to the port.

Results of the Economic Appraisal completed by this project, therefore, suggest that the current practice of anchoring at the Port of Townsville, with the improvement of implementing organised designated areas, is likely to produce the least cost for the desired net environmental outcome over the next 30 years.

## 7.5 **Economic appraisal for the Port of Abbot Point**

Building off environmental impact assessment completed under phase 1 of this project (GHD 2012a), the CBA model input assumed that no incremental environmental gains could be realised from using anchorages located elsewhere at the Port of Abbot Point than those assessed herein. Studies recently completed for Abbot Point (reported in GHD 2012b) have noted a number of anchorage locations could be considered applicable to the management of future shipping requirements at the port. The anchorage area assessed by this CBA project is comparable to those outlined by GHD (2012b) and Eco Logical Australia and Open Lines (2012) with regard to area and environment. Findings from this project are, therefore, considered to be robust to the adoption of any of the anchorage areas reported in GHD (2012b) in future.

It was forecast that the anchorage demand over the period 2012-2032 was able to be accommodated by the current anchorage area being used with the improved practice of implementing organised designated areas for anchorage. The CBA model assumptions determined that by 2032 around three to four ships calling per day would be requiring anchorage. With an assumed average waiting time at anchor of three days, these ships could be accommodated in the current anchorage area or an equivalent designated area. The forecast demand for anchorages at Abbot Point is, however, sensitive to future ship call numbers and average time spent at anchor. The latter is a complex variable difficult to forecast. With potential significant expansion planned for Abbot Point using historical MSQ data to predict future average wait times can be challenging. Data used for the modelling, particularly PGM (2012), is however considered to be the best available information at the time of reporting. Improved management of anchorage arrangements would provide opportunity to reduce potential future impacts.

Results of the Economic Appraisal completed by this project suggest that the current practice of anchoring at the Port of Abbot Point, with the improvement of implementing organised designated areas, is likely to produce the least cost for the desired net environmental outcome over the next 30 years. As this port is a single commodity, coal export, facility there is opportunity to consider use of a VAS to facilitate management of anchorage use. Further investigation regarding the potential benefits would be required before that system was implemented, however, it may offer opportunity to reduce the spatial area used for vessel anchorage.

## 7.6 **Economic appraisal for the Port of Hay Point**

Building off environmental impact assessment completed under phase 1 of this project (GHD 2012a), the CBA model input recognised there were likely incremental environmental costs associated with moving or expanding the existing anchorage at the Port of Hay Point. Furthermore, the model predicted that the anchorage demand over the period 2012-2032 at Hay Point was not able to be accommodated by the current anchorage area, which supports around 100 designated anchorages. The existing anchorage area is predicted to require expansion by 2026 under a scenario of 5 ship calls per day requiring anchorage with an assumed average waiting time at anchor of 19 days, assuming no change in management arrangements are made. The forecast demand for anchorages at

Hay Point is sensitive to future ship calls and the average time spent at anchor. While the latter is a complex variable difficult to forecast, the Port of Hay Point has established trade patterns. The historical data used for the modelling from MSQ, and future demand requirements reported by PGM (2012), are considered to be the best available information at the time of reporting.

The CBA progressed to compare current practice (Base Case) management with four alternative anchorage management options of relevance to Hay Point. These included the “All-at-port”, “Fixed-moored”, “Scheduled arrivals with designated anchorages” and “Demand management pricing” options. Detail of the modelling assumptions and findings for the Port of Hay Point are provided in Appendix A.

Results of the CBA modelling for the Port of Hay Point identify that the anchorage option of “Scheduled Arrivals with designated Anchorages” could provide the greatest net social welfare gain (NPV) for a period of the next 30 years. The main driver of the net gain is the estimated savings in ship fuel costs assumed when ships are scheduled.

The next best option, “Fixed-moored”, assumes that some gain is made in environmental values compared with the current practice of designated anchoring.

The “All-at-port” option is ranked third due to the relatively high level of investment required in constructing waiting-only jetties at the port.

The “Demand management pricing” option is ranked last due to the level of the additional cost penalties imposed on ship owners and the coal industry to obtain possible reductions in waiting times at anchor required to free-up sufficient capacity for increased future ship calls at the port.

Implementation of a VAS at the Port of Hay Point may also realise benefits for the Port of Abbot Point if a VAS was also considered for that location given the commonalities in management governing each location.

## **7.7 Economic appraisal for the Port of Gladstone**

Building off environmental impact assessment completed under phase 1 of this project (GHD 2012a), the CBA model input assumed that no incremental environmental gains could be realised from moving the existing designated anchorages to alternative locations. In fact, in the case of the inner anchorage, environmental losses could be realised. It was forecast that the anchorage demand over the period 2012-2032 was able to be accommodated by the current anchorage area and practice being used. The CBA model assumptions determined that by 2032 around seven ships calling per day would be requiring anchorage, and with an assumed average waiting time at anchor of four days, these ships could be accommodated in the current anchorage areas. However, the CBA model indicates that if average waiting times exceed four days then additional anchorages may be required. The CBA model did not differentiate between the inner and outer anchorages, but assumed a combined area for analysis (refer section 4.9.1). The combining of the two areas is not likely to impact the conclusions of the CBA model given the larger size of the outer area and ships currently using both areas.

Results of the Economic Appraisal completed by this project, therefore, suggest that the current practice of anchorage management at the Port of Gladstone is likely to produce the least economic cost for the desired net environmental outcome over the next 30 years. However, this finding is sensitive to the assumed (i.e. current) average waiting times of ships at anchor. Historical data used for the modelling from MSQ and future demand requirements reported by PGM (2012), are considered to be the best available information at the time of reporting.

Expansion of the existing designated anchorages would not be considered an environmentally beneficial solution to increased demand. If average waiting times increase in future then opportunities to improve anchorage management would need to be considered. This may include designating specific anchorages for coal vessels and adopting a partial VAS for those anchorages.

## 8. CONCLUSIONS

### 8.1 Ship anchorage management options for the five main ports

The CBA modelling has estimated that only the Port of Hay Point has a definitive future requirement for the physical expansion of current anchorages (from around a current 100 organised ship anchorage locations to 129 by 2032). All other anchorage areas assessed are able to support future anchorage demand. Improvements in management at a number of locations are, however, considered appropriate for net societal gain as follows:

- Port of Cairns – sufficient physical capacity such that there is no predicted need to expand the existing anchorage if planned improved channel and port access eventuates in the future.
- Port of Townsville – sufficient physical capacity such that there is no predicted need to expand the assessed anchorage area particularly with the adoption of organised designated anchorage areas. As this is a mixed commodity port use of a VAS is not predicted to realise significant benefits.
- Port of Abbot Point – sufficient physical capacity such that there is no predicted need to expand the existing anchorage with the adoption of organised designated anchorage areas. If a reduced area of anchorage than that assessed herein was desired, use of a VAS may be appropriate for this location.
- Port of Gladstone – sufficient physical capacity such that there is no predicted need to expand the existing anchorages especially given growth of gas export trades results in the likelihood of scheduled arrivals from sea direct to berth. However, this is sensitive to the average waiting times of ships at anchor. If waiting times increase beyond four days strategies to manage existing anchorages to avoid requirement to expand could include redesignating some anchorages as exclusive coal ship anchorages and adopting a VAS only for those anchorages.

Unlike the other locations modelled, the anchorage at the Port of Hay Point is predicted to require expansion by around 30 per cent by 2032 unless more efficient use is made of current anchorages. Expansion of the existing anchorage would realise environmental and socio-economic impacts and alternative anchorage management options to avoid expanding the anchorage area were considered through iterative modelling.

Out of the four ship anchorage management options of relevance to Hay Point the most preferred outcome for net societal gain, including net environmental gain, is achieved using scheduled arrivals (adopting a VAS) combined with organised anchorages. However, this result should be set in the context of emerging concerns relating to some potential flow-on impacts of scheduled arrivals that would require further evaluation prior to implementation of a VAS. Furthermore, the quantified benefits of scheduled arrivals, including savings in ship greenhouse gas emissions, are particularly sensitive to ship owners maintaining slow steaming for a part of their voyage to the load port.

The CBA modelling also shows that the option of anchorage demand management pricing is highly costly to induce the desired effect of reducing average waiting times at anchor. The consequence of such an option would most likely be for ships to float at sea or anchor elsewhere to avoid paying for anchorages at levels equivalent to the daily cost of operating ships.

## 8.2 **Implications of the Economic Appraisal results for future environmental management strategies at the five main ports**

This report provides findings of the CBA phase of this study. This is the second phase of work. The third and final phase of work which will be completed in early 2013 will use information developed within this phase of work and from the impact assessment phase of work to develop potential management strategies for the anchorages at the five main ports. This will cover:

- Review of applicable legislation.
- Notarisation of the key environmental values and impacts and sensitivities.
- Identification of the relevant stakeholders for consultation and management of the implementation of any management strategies.
- Environmental management strategies incorporating principles and direction, objectives and targets, action plans, and an implementation and evaluation framework.

The economic appraisal work has provided some direction for the development of Environmental management strategies for the five main ports. Key findings of importance in developing up relevant management strategies across the ports are that:

- The key port requiring future management intervention to avoid any physical expansions of anchorages will be the Port of Hay Point.
- Use of scheduled ship arrivals combined with designated anchorages is a cost effective management strategy for future demand requirements at the Port of Hay Point. Use of scheduled ship arrivals may also benefit management of anchorages at the Ports of Abbot Point and Gladstone.
- Adoption of any VAS would require further investigation on some emerging concerns regarding transfer of risk. It would also require investigation into the key requirements for successful adoption of such an approach, including with regard to legislative and management jurisdictional requirements, for implementation at any of the ports.
- Use of designated anchorages at Townsville and Abbot Point will avoid potential increase in environmental risk under increasing shipping forecasts.



## 9. REFERENCES

Australian Government 2011, *Securing a clean energy future - the Australian Government's Climate Change Plan*, Commonwealth of Australia, viewed 8/10/2012, [http://site.rightship.com/resources.ashx/downloads/43/fileName/3E1A79622E5C8AF19C58D5392B60722D/Calculating\\_and\\_Comparing\\_CO2\\_Emissions\\_from\\_Ships\\_-\\_Aug\\_2011.pdf](http://site.rightship.com/resources.ashx/downloads/43/fileName/3E1A79622E5C8AF19C58D5392B60722D/Calculating_and_Comparing_CO2_Emissions_from_Ships_-_Aug_2011.pdf).

Department of Agriculture, Fisheries and Forestry (DAFF) 2012, *Coastal Habitat Resources Information System (CHRIS)*, viewed 08/10/2012, <http://chrisweb.dpi.qld.gov.au/chris/>.

Department of State Development, Infrastructure and Planning (DSDIP) 2012, *Great Barrier Reef Ports Strategy 2012–2022*, Commonwealth of Australia.

Eco Logical Australia and Open Lines 2012, *Abbot Point Cumulative Impact Assessment Part C – Impact Assessment Chapter 13 – Shipping*, prepared for Abbot Point Working Group.

Environment Australia 2001, *A Directory of Important Wetlands in Australia*, Commonwealth of Australia.

GHD 2012a, *Environmental Impact Assessment – Identification of Impacts and Proposed Management Strategies associated with Ship Anchorages in the Great Barrier Reef World Heritage Area*, prepared for the Great Barrier Reef Marine Park Authority.

GHD 2012b, *Terminals 0, 2 and 3, Abbot Point, Queensland, Public Environment Report*, report for North Queensland Bulk Ports Corporation Limited.

Great Barrier Reef Marine Park Authority (GBRMPA) 2009, *Great Barrier Reef Outlook Report 2009*, Commonwealth of Australia.

PGM Environment 2012, *Review of the environmental implications of existing and projected future shipping activities in the Great Barrier Reef region*, draft report to BHP Billiton.

RightShip 2011, *Calculating and Comparing CO2 Emissions from Ships*, RightShip Proprietary Limited.

Appendix A

## CBA Model for Anchorage Options, Port of Hay Point (full analysis given expansion indicated)

**Table A-1:** Model parameters used for the World Heritage Area Ship Anchorage Management Options assessment (output of the Port of Hay Point example, run December 2012).

	Assumptions	Units	Input Value	Comment	Source
<b>General</b>					
General	Evaluation period (Years)	Years	30	CBA evaluation period	GHD
	Year 1	Year	2012	Start year of CBA evaluation	GHD
	CBA Project Discount Rate (Real)	Per cent	7.00%	Typical Government/Treasury used level (real means net of inflation)	GHD
	CAPEX annual cost escalation rate	Per cent	0.0%	Future CAPEX value if nominal calculation	GHD
	Costs & Benefits annual escalation rate	Per cent	0.0%	Future values if nominal calculation	GHD
	Exchange Rate, 1 US\$ =	A\$	1.00	Converts ship and fuel US\$ costs to A\$	GHD analysis
	Cost of Ship Fuel	US\$/T	\$670	Singapore IFO 380 cst (heavy) fuel oil, average for 2012	Clarksons SIN
	Cost of Fishing & Reef Tourism Vessel Fuel (MDO/MGO)	A\$/litre	\$0.96	Singapore MDO=Marine Diesel Oil / MGO=Marine Gas Oil, average for 2012	Clarksons SIN
<b>Ship anchorages</b>					
Current anchoring assumptions (Year 0)	Max. (Equiv.) Designated Anchor Locations - Capesize ships	Number ships	50	Based on organised designated anchor locations	GHD estimates
	Max. (Equiv.) Designated Anchor Locations - Panamax ships	Number ships	50	Based on organised designated anchor locations	GHD estimates
	Max. (Equiv.) Designated Anchor Locations - Other ships	Number ships	0	Based on organised designated anchor locations	GHD estimates
	Assumed minimum area using organised designated	Hectares	12,500	Based on organised designated anchor locations	GHD estimates
	Currently Designated Anchor Locations	Yes/No	No	Current method of using anchorages - designated locations or variable within	GHD
Other anchorage assumptions	Minimum area required per anchored Capesize ship	Hectares	125	Assumed for both Capesize and Panamax requirements	GHD estimates
	Minimum area required per anchored Panamax ship	Hectares	125	Assumed for both Capesize and Panamax requirements	GHD estimates
	Minimum area required per anchored Other ship	Hectares	125	Assumed for both Capesize and Panamax requirements	GHD estimates
	Contingency anchorages in addition to arrivals demand	Per cent	5%	To cater for port removals, anchoring on departure (assume Capesized anchorages)	GHD estimates
	Fixed Offshore Mooring - CAPEX/unit	A\$	\$1,000,000	Assumed CAPEX of a simple single point mooring (or SBM)	GHD estimates
	Fixed Offshore Mooring - OPEX/year/unit	Per cent	2%	Operating Expenditure - maintenance and management cost	GHD estimates
	Per cent of Daily Ship Op Cost for 1-day wait reduction	Per cent	100%	Assumed required pricing level for ship owner to avoid waiting at anchor	GHD
	Maximum achievable wait reduction thru Anchor Pricing	Days	7	Assumed maximum effect of anchor penalty pricing	GHD
<b>Other commercial maritime</b>					
Port assumptions	Ship Waiting Berth (Capesize equiv.) - CAPEX/berth	A\$	\$10,000,000	Total cost for jetty/wharf (if inner harbour berth upgrade then \$10 mln./berth)	GHD estimates
	Ship Waiting Berth - OPEX/year/berth (% of CAPEX)	Per cent	2%	Maintenance/management costs	GHD estimates
	Waste Reception/Disposal Facilities - CAPEX as % of Berth	Per cent	10%	Total design and construction costs	GHD estimates
	Waste Reception/Disposal Facilities - OPEX/yr. (% CAPEX)	Per cent	5%	Maintenance/management/disposal costs	GHD estimates
Ship assumptions	Average 10-year Operating Cost Capesize bulker	US\$/day	\$45,100	Based on 10 year average (2003-2012) 6-month time charter rates for 150,000 dwt	Clarksons/GHD analysis
	Average 10-year Operating Cost Panamax bulker	US\$/day	\$21,600	Based on 10 year average (2003-2012) 6-month time charter rates	Clarksons/GHD analysis

Assumptions		Units	Input Value	Comment	Source
	Average 10-year Operating Cost Other vessels	US\$/day	\$0	Assumed zero since only applied to bulk carriers (coal ships) for options	GHD
	Capesize bulker Fuel Saving at sea when scheduled	T/day	7	Based on 25% saving of typical 55 T/day loaded x 50% for in ballast at 14 knots	Clarksons/GHD analysis
	Panamax bulker Fuel Saving at sea when scheduled	T/day	4	Based on 25% saving of typical 32 T/day loaded x 50% for in ballast at 14 knots	Clarksons/GHD analysis
	Other Vessel Fuel Saving at sea when scheduled	T/day	0	Assumed zero since only applied to bulk carriers (coal ships) for options	GHD
	Capesize bulker Days of Saved Fuel at sea	Days	7	Assumed as a result of scheduled arrivals option	GHD
	Panamax bulker Days of Saved Fuel at sea	Days	7	Assumed as a result of scheduled arrivals option	GHD
	Other Vessel Days of Saved Fuel at sea	Days	0	Assumed zero since only applied to bulk carriers (coal ships) for options	GHD
	Implementation Cost of Port Vessel Arrival System	A\$	\$1,000,000	Assumed One-time implementation cost (based on Newcastle Port example)	GHD estimates
	Ongoing Cost of Port Vessel Arrival System (% CAPEX)	Per cent	10%	Assumed Running/management cost (based on Newcastle Port example)	GHD estimates
<b>Environment</b>					
Expanded anchorage area assumptions	Share of Expanded area with Environmental values	Per cent	100%	Assumed conservatively all of value reflecting offset approach to calculating cost	GHD
	Share of Area with value directly lost by anchoring	Per cent	100%	Assumed conservatively all of lost reflecting offset approach to calculating cost	GHD
	Share of Area with value directly lost by Fixed Mooring	Per cent	80%	Assumed as consequence of installing Fixed Offshore Mooring structures	GHD
	Value of Area directly lost (one-time)	A\$/hectare	\$50,000	Assumed lost in year of expansion, value based on Queensland marine values	GHD
	Value of Area directly lost (ongoing)	A\$/hectare/year	\$50,000	Assumed lost over next 19 years, based on Queensland approach (i.e. max. 20 years)	GHD
Vessel-related assumptions	Ship Fuel Greenhouse Gas Emissions/T of Fuel used	T-CO2	3.11	Based on Heavy Fuel Oil	RightShip/IMO
	Cost of Ship Fuel Greenhouse Gas Emissions	A\$/T	\$23	Weighted for mix of CO2, SO2 and particulates etc. per tonne equivalent	Australian Government
	Average non-air Pollution by ship per anchor visit	Kg	10	Rubbish and other pollutants weighted by occurrence	GHD
	Cost of cleaning-up non-air Vessel Pollution	A\$/Kg	\$5	Assumed mix of commercial & volunteer (leisure-time)	GHD
	Fishing Vessel Fuel Greenh. Emissions/T of Fuel used	T-CO2	3.21	Based on Diesel Oil	RightShip/IMO
	Reef Tour Vessel Fuel Greenh. Gas Emissions/T of Fuel used	T-CO2	3.21	Based on Diesel Oil	RightShip/IMO
	Recreational Boat Fuel Greenh. Gas Emissions/T of Fuel used	T-CO2	3.21	Based on Diesel Oil	RightShip/IMO
	Conversion factor, 1 Tonne of MDO/MGO = Litres	Litres	1130	Used to convert litres of fuel to tonnes of fuel	GHD
Cost of Non-trading Vessel Fuel Emissions (weighted)	A\$/T-CO2	\$23	Fixed 2012-2015 CO2 price per Australian Govt. scheme (assumed future price)	Australian Government	
<b>Other anchorage users</b>					
Commercial fishing assumptions	Average 10-year Operating Cost Fishing Vessels	A\$/day	\$1000	Assumed	GHD
	Average Fishing Vessel Fuel Consumption at Sea	Litres/hour	94	When transiting anchorage areas	GHD
	Average Diversion Time thru expanded anchorage	Hours	0.5	Assumed Extra voyage time caused by expanded anchorage areas	GHD
	Commercial Fishing Trips through expanded anchorage	Number/year	1000	Assumed To/from other fishing grounds	GHD
	Loss of Catch in expanded anchorage area	Kg/hectare/year	1000	Assumed Loss of catch caused by anchoring in expanded	ABARE/GHD analysis

	<b>Assumptions</b>	<b>Units</b>	<b>Input Value</b>	<b>Comment</b>	<b>Source</b>
				anchorage areas	
	Average Value of Catch lost	A\$/Kg	\$10	Assumed value of Loss of catch caused by anchoring in expanded anchorage areas	ABARE/GHD analysis
Commercial tourism (reef operators)	Average 10-year Operating Cost Reef Tourism Vessels	A\$/day	\$1000	Assumed	GHD
	Average Reef Tourism Vessel Fuel Consumption at Sea	Litres/hour	94	When transiting anchorage areas	GHD
	Average Diversion Time thru expanded anchorage	Hours	0	Extra voyage time caused by expanded anchorage areas	GHD
	Commercial Tourism Trips through expanded anchorage	Number/year	1000	Assumed	GHD
	Reef tourists impacted by expanded anchorage areas	Number/year	0	Assumed	GHD
	Value of Loss to Individual Tourist	A\$/person	\$10	Assumed Price reduction tourist prepared to pay for reduced experience	GHD
Recreational boating	Average 10-year Operating Cost Recreational Boats	A\$/day	\$0	Assumed not relevant for leisure users	GHD
	Average Recreational Boat Fuel Consumption at Sea	Litres/hour	24	When transiting anchorage areas	GHD
	Average Diversion Time thru expanded anchorage	Hours	0	Extra voyage time caused by expanded anchorage areas	GHD
	Recreational trips through expanded anchorages	Number/year	5000	Assumed	GHD
	Individuals impacted by expanded anchorage areas	Number/year	0	Assumed	GHD
	Value of Loss of Leisure to Individual	A\$/person	\$10	Assumed	GHD
<b>Other social/community</b>					
Aesthetic impact assumptions	Decline in value of vistas thru expanded anchorages	A\$	\$0	Assumed one-time decline in property values at significant expansion of anchorage	GHD
	Number of residential properties with decline in value	Number	0	Assumed	GHD
	Additional ship viewing attraction	Persons/year	0	Additional ship viewing attraction caused by expanded anchorages	GHD
	Time spent on viewing attraction (incl. travel to/from)	Hours	0	Assumed	GHD
	Additional ship viewing attraction, leisure time value	A\$/hour/person	\$25	Assumed	GHD
Ship accident assumptions	Increased ship accidents caused by ship scheduling	Number/year	0	Expected (risk) occurrence of ship accidents of idling ships at sea	GHD
	Cost of managing/responding to ship accidents offshore	A\$/accident	\$25,000	Assumed	GHD
	Increased loss of seafarer life caused by ship scheduling	Number/year	0	Expected (risk) occurrence of loss of seafarer life during accident of idling ships at sea	GHD
	Increased injury of seafarers caused by ship scheduling	Number/year	0	Expected (risk) occurrence of injury to seafarers during accident of idling ships at sea	GHD
	Value of loss of seafarer life	US\$/person	\$1,496,997	Assumed 60% of Australian Other user (see below)	GHD
	Value (cost) of seafarer injury	US\$/person	\$344,542	Assumed 60% of Australian Other user (see below)	GHD
Other user accident assumptions	Increased Other user accidents due to expansions	Number/year	0	Assumed	GHD
	Cost of managing/responding to inshore accidents	A\$/accident	\$10,000	Assumed	GHD
	Increased loss of life due to expansions	Number/year	0	Assumed	GHD
	Increased injuries due to expansions	Number/year	0	Assumed	GHD
	Value of loss of Other user life (fatality)	A\$/person	\$2,494,995	Assumed fatality value equivalent to road fatalities (Austroads 2008, 2012 adjusted)	Austroads/GHD
	Value (cost) of Other user serious injury	A\$/person	\$574,236	Assumed injury value equivalent to road fatalities (Austroads 2008, 2012 adjusted)	Austroads/GHD
Ship crew supplies assumptions	Share of ship calls in expanded area provisioned	Per cent	10%	Assumed	GHD
	Average value of supplies per trip to anchored ship	A\$/supply trip	\$5000	Assumed	GHD
	Efficiency margin of supply value (producer surplus)	Per cent	10%	Assumed more margin made by local business than national or overseas business	GHD

**Table A-2:** CBA Analysis of the World Heritage Area Ship Anchorage Management Options for Port of Hay Point (Input values in italics, DR = discount rate)

Option/Strategy	DR	Units	Year								
			0	2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)	2018 (7)	2019 (8)
<b>Base Case: Without Option/Strategy</b>											
Anchorage Demand and Capacity/Supply		Forecast Total Required Ship Calls at Port for cargo	Number	809	858	909	964	1,021	1,083	1,148	1,216
		<i>Forecast Share of Required Ship Calls Direct to Berth</i>	Per cent	1%	1%	1%	1%	1%	1%	1%	1%
		Forecast Total Required Ship Calls Direct to Anchor	Number	801	849	900	954	1,011	1,072	1,136	1,204
		Forecast Share Calls Capesize bulkers to Anchor	Per cent	50%	50%	50%	50%	50%	50%	50%	50%
		Forecast Share Calls Panamax bulkers to Anchor	Per cent	50%	50%	50%	50%	50%	50%	50%	50%
		Forecast Share Calls Other Ships to Anchor	Per cent	0%	0%	0%	0%	0%	0%	0%	0%
		Forecast Capesize bulker Calls Direct to Anchor	Number	400	424	450	477	506	536	568	602
		Forecast Panamax bulker Calls Direct to Anchor	Number	400	424	450	477	506	536	568	602
		Forecast Other Ship Calls Direct to Anchor	Number	0	0	0	0	0	0	0	0
		Forecast Days Capesize bulker willing to Anchor	Number	19	19	19	19	19	19	19	19
		Forecast Days Panamax bulker willing to Anchor	Number	19	19	19	19	19	19	19	19
		Forecast Days Other Ships willing to Anchor	Number	0	0	0	0	0	0	0	0
		Maximum Anchor Demand for Capesize bulkers	Number	21	22	23	25	26	28	30	31
		Maximum Anchor Demand for Panamax bulkers	Number	21	22	23	25	26	28	30	31
		Maximum Anchor Demand for Other ship types	Number	0	0	0	0	0	0	0	0
		Contingency for additional Anchor Demand	Number	2	2	2	2	3	3	3	3
		Maximum Total Ship Demand for Anchorages	Number	44	46	49	52	55	59	62	66
		Required minimum Anchorage area	Hectares	5472	5800	6148	6517	6908	7323	7762	8228
		Actual available Anchorage area (based on min.)	Hectares	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
		Shortfall in Ship Anchorage area	Yes/No	No	No	No	No	No	No	No	No
		Required Anchorage area expansion	Hectares	0	0	0	0	0	0	0	0
		Total Anchorage Area (incl. expansion)	Hectares	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
		Expansion in equivalent Capesize anchor drop points	Number	0	0	0	0	0	0	0	0
		Supply in anchor drop points	Number	100	100	100	100	100	100	100	100
		Shortfall in anchor drop points (required expansion)	Number	0	0	0	0	0	0	0	0
		Expansion affects vistas and property values	Yes/No	No	No	No	No	No	No	No	No
		Expansion ship viewing attraction	Yes/No	No	No	No	No	No	No	No	No
		Expansion affects Other user accident levels	Yes/No	No	No	No	No	No	No	No	No
		Expansion triggers Port Vessel Arrival System	Yes/No	No	No	No	No	No	No	No	No
		Ships anchored in expanded area per day	Number	0	0	0	0	0	0	0	0
		Ships anchored in expanded area provisioned	Number	0	0	0	0	0	0	0	0
		Non-emission ship pollution in expanded area	Kg	0	0	0	0	0	0	0	0

				Year								
Option/Strategy		DR	Units	0	2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)	2018 (7)	2019 (8)
<b>Base Case: Without Option/Strategy</b>												
Cost Impacts of Anchorage Expansions	Lost area with Environmental Value		Hectares	0	0	0	0	0	0	0	0	0
	Cumulative Lost area with Environmental Value		Hectares	0	0	0	0	0	0	0	0	0
	Per cent ongoing lost environmental value (20 year max)		Per cent	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Cost of Lost Environmental area, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Lost Environmental area, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Non-emission pollution clean-up, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Non-emission pollution clean-up, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cumulative Expanded Anchorage area		Hectares	0	0	0	0	0	0	0	0	0
	Lost Fish Catch from Expanded Anchorage area		Kg	0	0	0	0	0	0	0	0	0
	Cost of Lost Commercial Fish Catch, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Lost Commercial Fish Catch, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Op. Cost of Fishing boat diversions, undiscounted	0%	A\$ '000	\$21	\$21	\$21	\$21	\$21	\$21	\$21	\$21	\$21
	Op. Cost of Fishing boat diversions, discounted	7%	A\$ '000	\$19	\$18	\$17	\$16	\$15	\$14	\$13	\$12	
	Fuel Cost of Fishing boat diversions, undiscounted	0%	A\$ '000	\$45	\$45	\$45	\$45	\$45	\$45	\$45	\$45	\$45
	Fuel Cost of Fishing boat diversions, discounted	7%	A\$ '000	\$42	\$39	\$37	\$34	\$32	\$30	\$28	\$26	
	Emissions Cost of diverting Fishing boats, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Emissions Cost of diverting Fishing boats, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Reduced Tourism Experience, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Reduced Tourism Experience, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Op. Cost of Tourism boat diversions, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Op. Cost of Tourism boat diversions, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Fuel Cost of Tourism boat diversions, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Fuel Cost of Tourism boat diversions, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Emissions Cost of diverting Tourism boats, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Emissions Cost of diverting Tour. boats, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Reduced Leisure Experience, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of Reduced Leisure Experience, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

Option/Strategy	DR	Units	Year								
			0	2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)	2018 (7)	2019 (8)
discounted											
Op. Cost of Recreational boat diversions, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Op. Cost of Recreational boat diversions, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Fuel Cost of Recreational boat diversions, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Fuel Cost of Recreational boat diversions, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Emissions Cost of diverting Recreational boats, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Emissions Cost of diverting Recreational boats, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Decline in property values, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Decline in property values, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Incr. other user accidents, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Incr. other user accidents, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Incr. other user fatalities, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Incr. other user fatalities, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Incr. other user injuries, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of Incr. other user injuries, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Cost Impact of Anchor Expansions, undiscounted	0%	A\$ '000		\$66	\$66	\$66	\$66	\$66	\$66	\$66	\$66
Total Cost Impact of Anchor Expansions, discount.	7%	A\$ '000		\$62	\$58	\$54	\$50	\$47	\$44	\$41	\$38
Benefits of Anchorage Expansions	Value of Ship viewing attraction, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Value of Ship viewing attraction, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Value of Provisioning Ships at anchor, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Value of Provisioning Ships at anchor, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<b>Option 3: All-at-Port</b>											
Benefits (with Option/Strategy)	Avoidance of Costs of Base Case, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Avoidance of Costs of Base Case, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Costs (with Option/Strategy)	CAPEX ship waiting berths, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	CAPEX ship waiting berths, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cumulative CAPEX ship waiting berths	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	OPEX ship waiting berths, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	OPEX ship waiting berths, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	CAPEX waste reception facilities, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	CAPEX waste reception facilities, discounted	7%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cumulative CAPEX ship waste reception facilities	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
OPEX waste reception facilities, undiscounted	0%	A\$ '000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	



	Option/Strategy	DR	Units	Year									
				0	2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)	2018 (7)	2019 (8)	
CBA Results (with Option/Strategy) (Note: Assumes no environmental & social impacts at the Port due to waiting berths)	OPEX waste reception facilities, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship viewing attraction, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship viewing attraction, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship provisioning, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship provisioning, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Total Costs with Option/Strategy, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Total Costs with Option/Strategy, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Net Cashflow, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Net Cashflow, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Net Present Value (NPV)	7%	A\$ '000		\$36,841								
Benefit-Cost-Ratio (BCR)				1.32									
<b>Option 5: Fixed-Moored</b>													
Benefits (with Option/Strategy)	No Benefits compared to Base Case, undiscounted	0%	A\$ '000		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	No Benefits compared to Base Case, discounted	7%	A\$ '000		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Costs (with Option/Strategy)	CAPEX offshore fixed moorings, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	CAPEX offshore fixed moorings, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cumulative CAPEX offshore fixed moorings	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	OPEX offshore fixed moorings, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	OPEX offshore fixed moorings, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Extra Lost area with Environmental Value		Hectares		0	0	0	0	0	0	0	0	0
	Cumulative Extra Lost area with Environmental Value		Hectares		0	0	0	0	0	0	0	0	0
	Extra Loss of Environmental area, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Extra Loss of Environmental area, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Total Costs with Option/Strategy, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Costs with Option/Strategy, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
CBA Results (with Option/Strategy) (Note: n/a means Not Applicable)	Net Cashflow, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Net Cashflow, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Net Present Value (NPV)	7%	A\$ '000		\$97,420								
	Benefit-Cost-Ratio (BCR)				0.00								
<b>Option 8: Scheduled Arrivals plus Anchorages</b>													
Benefits (with Option/Strategy)	Avoidance of Costs of Base Case, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Avoidance of Costs of Base Case, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Ship Fuel Saved (slow-steaming)		Tonnes		0	0	0	0	0	0	0	0	0
	Ship Emissions Saved (slow-steaming)		Tonnes		0	0	0	0	0	0	0	0	0
	Ship Fuel Cost savings (slow-steam), undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Ship Fuel Cost savings (slow-steam), discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

	Option/Strategy	DR	Units	Year								
				0	2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)	2018 (7)	2019 (8)
	discounted											
	Ship emissions cost savings (slow-steaming), undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Ship emissions cost savings (slow-steaming), discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Total Benefits with Option/Strategy, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Total Benefits with Option/Strategy, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Costs (with Option/Strategy)	CAPEX of Port Vessel Arrival System, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	CAPEX of Port Vessel Arrival System, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cumulative CAPEX of Port Vessel Arrival System	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	OPEX of Port Vessel Arrival System, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	OPEX of Port Vessel Arrival System, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship viewing attraction, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship viewing attraction, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship provisioning, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of lost ship provisioning, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of increased accidents offshore, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of increased accidents offshore, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of increased fatalities offshore, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of increased fatalities offshore, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of increased injuries offshore, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Cost of increased injuries offshore, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Total Costs with Option/Strategy, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Total Costs with Option/Strategy, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
CBA Results (with Option/Strategy)	Net Cashflow, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Net Cashflow, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Net Present Value (NPV)	7%	A\$ '000	\$186,226								
	Benefit-Cost-Ratio (BCR)			233.88								
<b>Option 9(b): Demand Management Pricing</b>												
Benefits (with Option/Strategy)	Avoidance of Costs of Base Case, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Avoidance of Costs of Base Case, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Costs (with Option/Strategy)	Anchor reservation pricing (all arrivals), undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Anchor reservation pricing (all arrivals),	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

Option/Strategy	DR	Units	Year								
			0	2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)	2018 (7)	2019 (8)
discounted											
Cost of lost ship viewing attraction, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of lost ship viewing attraction, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of lost ship provisioning, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of lost ship provisioning, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of increased accidents offshore, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of increased accidents offshore, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of increased fatalities offshore, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of increased fatalities offshore, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of increased injuries offshore, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cost of increased injuries offshore, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Costs with Option/Strategy, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Costs with Option/Strategy, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
CBA Results (with Option/Strategy)											
Net Cashflow, undiscounted	0%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Net Cashflow, discounted	7%	A\$ '000		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Net Present Value (NPV)	7%	A\$ '000		\$1,744,768							
Benefit-Cost-Ratio (BCR)				0.08							

The following three tables are keys for the above tables (table A1 and table A2).

**Table A-3:** Discount table (Discount factor 7.00%)

Year	0	2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)	2018 (7)	2019 (8)
<b>Discount Factor</b>	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582

**Table A-4:** Analysis key results for Net Present Value (NPV) analysis (run: December 2012) for the World Heritage Area Ship Anchorage Management Options for Port of Hay Point (Run over 30 years with a discount rate = 7.00%, all values are in AUS\$)

Project option/Strategy description	NPV ('000)	Ranking
Option 3: All-at-Port	\$36,841	3
Option 5: Fixed-Moored	\$97,420	2
Option 8: Scheduled Arrivals plus Anchorages	\$186,226	1
Option 9(b): Demand Management Pricing	-\$1,744,768	4
<b>Sensitivity Settings</b>		
Capital Expenditure (CAPEX) change	-	
Costs (excl. CAPEX) change	-	
Benefits change	-	

**Table A-5:** Full description of the option numbers

Option number	Full description	Short description
3	All ships direct to port at waiting berths	3: All-at-Port
5	All ships moored to fixed structures in anchorage areas	5: Fixed-Moored
8	Scheduled Arrivals combined with anchorages	8: Scheduled Arrivals plus Anchorages
9(b)	Anchorage Demand Management using Pricing	9(b): Demand Management Pricing

**GHD**

145 Ann Street Brisbane QLD 4000  
GPO Box 668 Brisbane QLD 4001  
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

**© GHD 2013**

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

G:\41\25379\WP\440232\_Cost Benefit Analysis.docx

**Document Status**

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Rev A	Guy Reynolds	Steve Kanowski	* On File	Kerry Neil	* On File	04-Dec-2012
Rev B	Guy Reynolds	David Petch	* On File	Kerry Neil	* On File	18-Dec-2012
Rev 0	Guy Reynolds	David Petch	* On File	Kerry Neil	* On File	5-Feb-2013
Rev 1	Guy Reynolds	David Petch	* On File	Kerry Neil	* On File	8-Mar-2013
Rev 2	Guy Reynolds	David Petch	* On File	Kerry Neil	* On File	25-Mar-2013
Rev 3	C. Sims	Kerry Neil	* On File	Kerry Neil	* On File	18-Jun-2013
Rev 4	C. Sims	Kerry Neil	* On File	Kerry Neil	* On File	23-Jun-2013