# Adequacy of Transport Infrastructure: Seaports

## Working Paper

This Working Paper is the third in a series of Working Papers which disseminates the results of a large research project into the adequacy of Australia's transport infrastructure over the next 20 years. The assessment covers all four modes of transport - road, rail, air and sea - with the primary focus on freight.

Bureau of Transport and Communications Economics

# WORKING PAPER 14.3

# Adequacy of transport infrastructure
# Seaports

ISSN 1036-739X
ISBN 0 642 22407 2



This publication is available free of charge from the Manager, Information Services, Bureau of Transport and Communications Economics, GPO Box 501, Canberra, ACT 2601.

Printed by the Department of Transport, Canberra

**FOREWORD**

The National Transport Planning Taskforce (NTPT) was established in October 1993 by the former Minister for Transport and Communications to report on national infrastructure needs and operational improvements required to meet future demands for freight transport.

The Bureau of Transport and Communications Economics was commissioned by the NTPT to carry out assessments of the adequacy of road, rail, seaport and airport infrastructure. In doing this it has attempted to adopt a strategic multimodal orientation. A summary of the Bureau's work is given in *Building for the Job: A Strategy for Australia's Transport Network, Commissioned Work* vol. 1 produced by the NTPT.

The project was undertaken under the leadership of Mark Harvey and John Miller. Officers who contributed specific components included Johnson Amoako, Jane Brockington, Peter Collins, Glen D'Este, Bozena Dziatkowiec, Edwina Heyhoe and Chikkegowda Puttaswamy. Other officers of the BTCE, particularly Maurice Haddad, also made valuable contributions.

Details of the research undertaken for each component of the study are provided in a series of six working papers. Each paper describes the methodology used, future demand, and results of the adequacy analysis, and gives options for future research. This paper provides details of Australian seaport infrastructure and information on bulk and non-bulk freight demand, and details of the basis for the conclusions regarding expenditure.

Much of the seaport adequacy work was done by Edwina Heyhoe and Glen D'Este in conjunction with consultants Maunsells Pty Ltd. The dedication of all the Bureau staff involved, the consultants, and the staff of the various port authorities, the NSW Department of Mineral Resources, Travers Morgan and the Department of Transport who cooperated in supplying considerable information and constructive comments, has been appreciated.

Russ Reynolds
Research Manager

Bureau of Transport and Communications Economics
Canberra

December 1994

## CONTENTS

## FIGURES

## TABLES

# ABSTRACT

This paper examines the adequacy of seaport infrastructure at 14 major Australian ports. The analysis is a technical assessment of existing infrastructure that is based on the berth occupancy ratios and demand projections for the period 1995-96 to 2014-15. Inadequacies are identified and the costs of projects to remedy the inadequacies are presented where available. The findings are supplemented by referring to recent studies undertaken by the port authorities.

The study concludes that there is underutilised capacity at most Australian ports which will enable them to meet the demand in the next 20 years. The projects on which costs are available total $638 million. Combined with projects not costed, it is considered unlikely that infrastructure spending on the 14 ports will exceed $1 billion over the next 20 years.

It has not been possible to undertake an assessment of economic adequacy, due to data and modelling limitations. A future study of this nature might seek to advance the analysis by including a technical assessment based on delays to ships or freight, and an economic assessment.

## KEY FINDINGS

- There is underutilised berth capacity at most Australian ports which will enable them to meet expected demand over the next 20 years. Any capacity driven investment that occurs is likely to be modest.
- The investment projects for which costs are available sum to $638 million. At a rough guess, the total port infrastructure expenditure for the next 20 years is unlikely to exceed $1 billion.
- Many of the planned investments are aimed at improving the competitiveness of ports by expanding the types of ships and cargo that can be handled or by improving the land transport interfaces. In other cases, facilities are being relocated for land use, safety or efficiency reasons.

# CHAPTER 1 INTRODUCTION

The Bureau of Transport and Communications Economics was asked by the National Transport Planning Taskforce (NTPT) to undertake an assessment of the adequacy of the transport infrastructure in Australia for the next 20 years.

The assessment covered all four modes of transport - road, rail, sea and air. The emphasis of the study was on the movement of freight. However passengers were considered when they influenced the movement of the freight or were considered to be of national significance.

This working paper concentrates on the adequacy of the seaport infrastructure. It is one of a series of six designed to expand on the results and the methodology presented in the Bureau report written for the NTPT.

## THE SEAPORTS ASSESSED

To reduce the task to manageable proportions, the Bureau only considered a limited range of infrastructure that is considered to be of national significance.

The 14 seaports chosen were those which handle significant quantities of coastal bulk and non-bulk freight. The ports included: the major capital city ports, Sydney, Melbourne, Brisbane, Adelaide, Fremantle and Darwin; the four large Tasmanian ports Hobart, Burnie, Launceston and Devonport because of the significance of the coastal trade between the mainland and Tasmania; and the large regional non-dedicated ports of Cairns, Townsville, Port Kembla and Newcastle (figure 1.1). The Port of Sydney includes the terminals at Sydney and Botany.

The study has focused on national non-dedicated ports. Ports that are dedicated to a few exported goods such as Gladstone, Weipa, Hay Point, Dampier and Port Hedland were omitted.

The study considered the adequacy of port infrastructure for the 20 years until 2014-15.

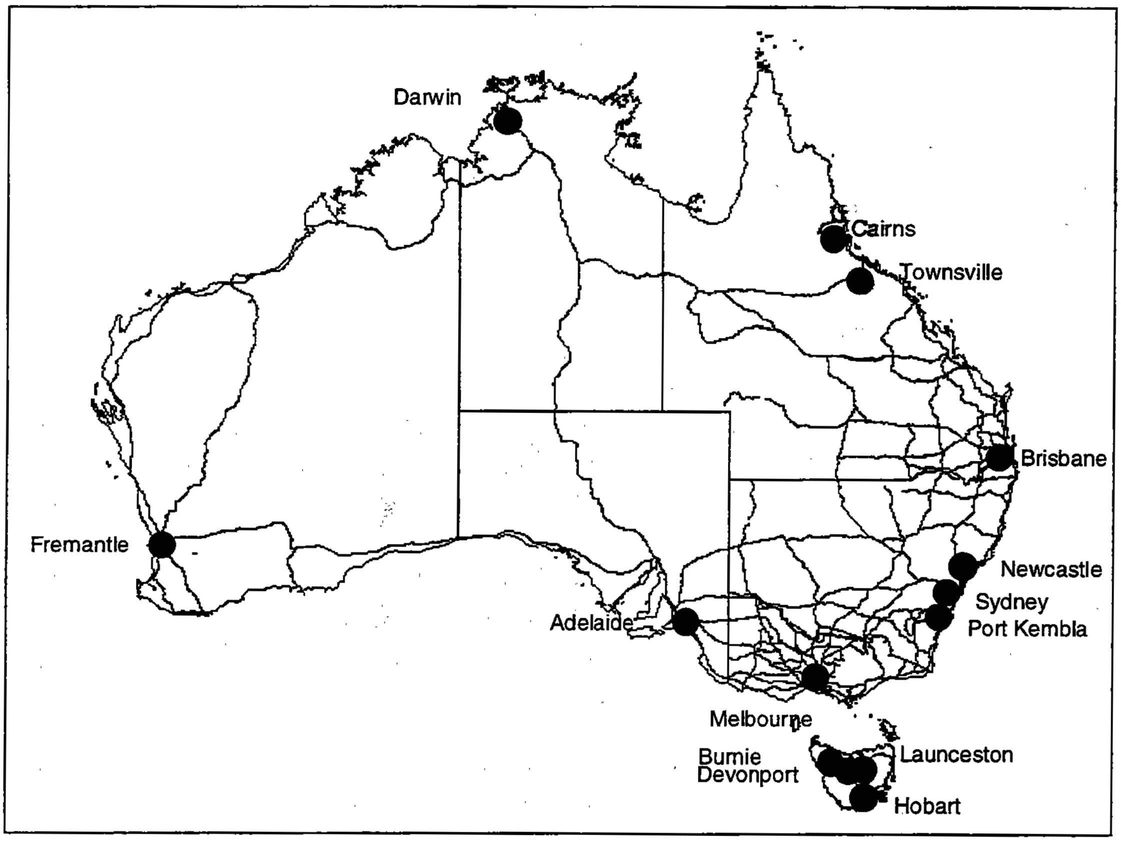



**Figure 1.1 Seaports examined**

## NEED FOR A STRATEGIC APPROACH

The strategic nature of this study needs to be emphasised. The study does make estimates of the dollar values of the investments likely to be warranted, but these should be regarded as broad orders of magnitude only. It would be a grave misrepresentation to interpret the findings as setting out a recommended investment program. The aim was not to produce a program of specific infrastructure projects and itemised costing. The techniques employed are designed to highlight areas where a full scale cost-benefit analysis would most probably indicate that investment in additional infrastructure is warranted within the 20 year period. The techniques are not substitutes for proper cost-benefit analyses, but point to areas where more detailed evaluations might usefully be undertaken as well as to areas where this is not the case. The results of the study should therefore be valuable in alerting governments to parts of the national transport network infrastructure that are likely to require attention over the next 20 years, and the likely magnitude of the financial resources required.

**OUTLINE OF REPORT**

This paper gives the demand forecasts, adequacy methodology and results for the port infrastructure.

The report begins with a description of the type of analysis aimed for in the study, followed by a description of the sea freight task in Australia and the infrastructure of the ports covered in the study. Then it examines the expected future demand and the methods for deriving that demand. The seaport infrastructure adequacy chapter covers the methods for calculating the technical adequacy, the results of this assessment, likely future infrastructure investment and maintenance costs. The following chapter discusses some of the factors that may affect adequacy that were not included in the analysis, including the interface between the ports and land transport. The concluding chapter outlines the main findings and discusses potential future work. Appendix II has tables of demand for 1992-93, 1995-96 and 2014-15. Specialists in maritime industries may find the detailed statistics in the appendices of interest.

# CHAPTER 2 ASSESSING INFRASTRUCTURE ADEQUACY

This chapter addresses questions of the meaning of 'adequacy' of transport infrastructure and how this might be assessed. Two definitions of adequacy have been employed by the Bureau, one technical and the other economic. How the Bureau has applied these definitions to the different transport modes has been shaped by the characteristics of the modes and availability of data and models. The depth in which the Bureau has been able to analyse adequacy is therefore very uneven between modes. Although for ports only a limited assessment has been possible, it is still important to bear in mind the ideal, and this serves as the basis for subsequent discussions about future directions that might be taken in adequacy assessment work. The first part of the chapter discusses definitions of adequacy and the second part reviews some of the practical issues faced in attempting to apply these definitions.

## DEFINING ADEQUACY

### The concept of adequacy

'Adequacy' of transport infrastructure is taken as referring to whether or not additional investment is required in the infrastructure. The requirement to invest is a consequence of the infrastructure providing a poor level of service, such as high operating costs, long service times or unreliability. Poor service can have a variety of causes including shortages of capacity, physical deterioration and obsolescence due to changes in technology, demand, input prices or safety requirements.

Specifying just what is meant by a 'poor' level of service is not straightforward. If efficient use of resources is the objective, whether service can be considered poor and the infrastructure requires upgrading is an economic question involving a weighing up of the capital cost of investing against the benefits in terms of improved levels of service. The technique for doing this is social cost-benefit analysis. However, undertaking a cost-benefit analysis is a complex, data intensive and time consuming task. Simpler and quicker means are needed to identify investment projects where detailed assessment is likely to be warranted, and to make decisions about smaller investments where application of cost-benefit analysis techniques would not be worthwhile. The common procedure is to employ a 'rule of thumb' whereby upgrading is considered necessary when the quality of service provided by a piece of infrastructure deteriorates below some minimum acceptable level. As an example, for ports, multi-user berth capacity is considered inadequate when the berth occupancy ratio exceeds sixty per cent.

## Technical adequacy

From the notion of 'rules of thumb' providing a rough indication of whether investment is needed, the Bureau has derived its definition of 'technical adequacy'. Transport infrastructure is deemed to be technically adequate if its physical or performance characteristics are above minimum acceptable levels. The definition can be applied either to physical or performance characteristics. An example of a physical characteristic is tonnes per hectare, that is, the total throughput divided by the back up area of the berth. For performance characteristics, the minimum could be specified either in technical terms, for example, hours of delay per ship, or in cost terms, for example delay costs per ship.

Given that infrastructure adequacy is essentially an economic question, determining the level of minimum technical standards should be done bearing in mind the standard that is likely to be warranted on economic grounds. One approach is to assume that, *on average across the country,* current standards for infrastructure of a given type are roughly right in economic terms. The physical or performance characteristics of a large number of sections of infrastructure can then be compared and those with the poorest standards deemed to be technically inadequate. Precisely where to draw the line between adequate and inadequate remains a matter for judgment. In the absence of information about economically warranted standards, natural breaks in the continuum of standards and perceptions about reasonable standards could be drawn upon.

## Economic adequacy

An assessment of adequacy using a technical definition can only be regarded as providing a rough guide to whether upgrading is economically justified. A piece of infrastructure which is inadequate in the technical sense could be adequate in the economic sense if the cost of upgrading was high in relation to the benefits. Conversely, if the benefits of upgrading exceeded the costs, it would be economic to invest even where the infrastructure was technically adequate.

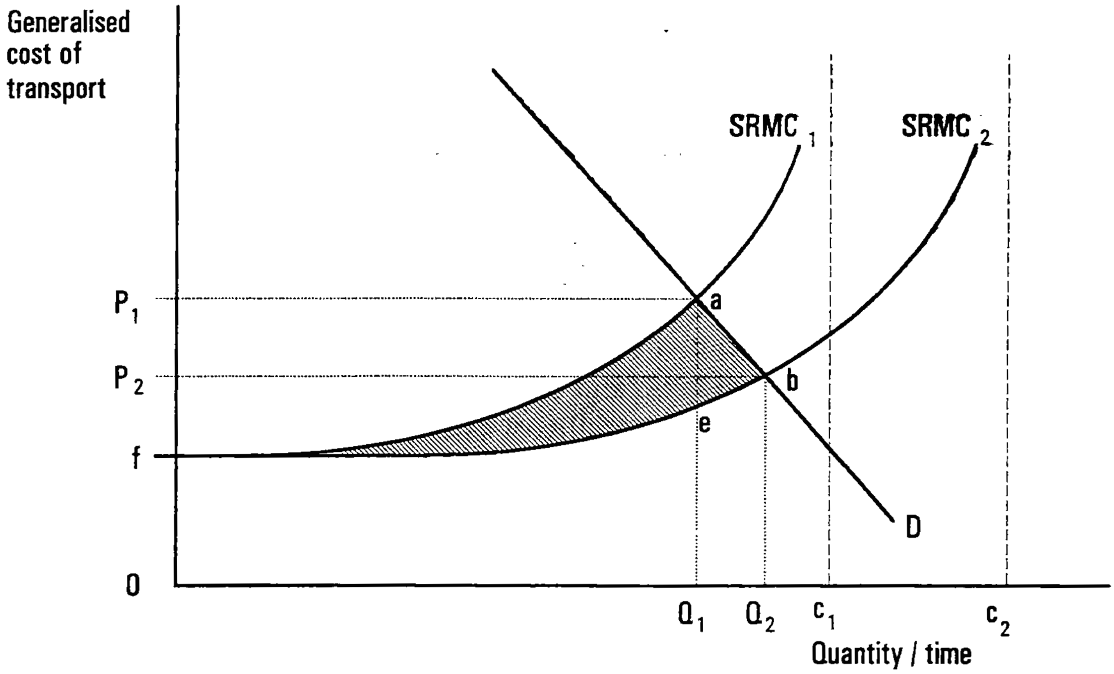



**Figure 2.1 Benefits from capacity expansion**

The 'economic adequacy' approach employed by the Bureau is based on social cost-benefit analysis. An investment is economically warranted at a point in time if:

1 the present value of benefits exceeds the present value of costs; *and*

2 there is no net welfare gain from delaying the investment.

The first condition is intended to ensure that the resources invested will earn at least what they could if used elsewhere in the economy and the second condition aims to ensure optimal timing. Transport infrastructure is deemed to be economically adequate at a point in time if investment to improve the level of service provided is not economically warranted.

To explain the economic concept of adequacy in more detail, figure 2.1 shows a demand curve and two 'short-run marginal social cost' (SRMC) curves for the use of a piece of infrastructure. Quantity provided or demanded per period of time is graphed on the horizontal axis and 'generalised social cost' of infrastructure use on the vertical axis. This 'generalised social cost' consists of all the costs associated with use of the infrastructure regardless of to whom they accrue. In the case of ports, generalised costs would include construction and maintenance of the berths, piloting and towage, time to ships and shippers, pollution and provision and operation of equipment. Valuing externalities, such as pollution, and time for freight entails significant measurement problems which are not addressed in this conceptual discussion.

The marginal cost of infrastructure use is the cost imposed by an *additional* user. The short run refers to the time frame in which it is not possible to invest to change the infrastructure. Capital costs and fixed operating costs of infrastructure are excluded because they will not be affected in the short term by infrastructure usage. The short-run marginal social cost curve, $SRMC_1$ rises as usage rises towards maximum capacity ($c_1$) and operating costs, delays and unreliability increase. If the maximum capacity was increased, say to $c_2$ the short-run marginal cost curve would shift to the right - to $SRMC_2$.

The demand curve ($D$) shows the quantity demanded of infrastructure usage at each level of generalised cost incurred by users. Users incur their own costs plus taxes and charges associated with use of the infrastructure. To simplify the exposition, it is assumed that taxes and charges are levied in amounts such that user pays the short-run marginal social cost of the resources consumed. This is the economically optimal price. As a result of the capacity expansion, users gain from a reduction in generalised cost from $P_1$ to $P_2$ and so increase their use from $Q_1$ to $Q_2$. The net gain to society from expanding infrastructure capacity is equal to the shaded area (*abf*) in figure 2.1.[1] Clearly, the shaded area and hence the benefits from expanding capacity will be greater in size, the higher demand is in relation to capacity.

A social cost-benefit analysis would compare the capital cost of the capacity expansion with the discounted present value of gains per period time. The first condition in the above definition of economic adequacy requires that the latter exceed the former before capacity could be considered inadequate.

If infrastructure could be expanded in finely divisible amounts, one would keep on adding to capacity as long as the present value of benefits from one dollar's worth of additional expenditure on capacity exceeded one dollar. In practice, however, capacity can often only be expanded in sizeable lumps. In many cases this is due to economies of scale in construction as it is cheaper to reach a given capacity level with one large capital work than to do so via a series of smaller investments increasing capacity in steps. In other cases, this is attributable to technical characteristics; for example, the number of berths handling a particular type of cargo must be an integer.

**The optimal time to invest**

Although capacity may be lumpy, the time at which to invest is divisible. This leads to the second condition in the definition of economic adequacy, which ensures optimal timing. Even when the present value of benefits exceeds costs, it may still be preferable to delay an investment. Assuming that the upgrade

---

1 The area between the two SRMC curves from $0$ to $Q_1$ (*aef*) represents the saving in costs on existing throughput. The area from $Q_1$ to $Q_2$ (*abe*) is the gain to society associated with the generated demand. It is the difference between the gain to users represented by the height of the demand curve and the social cost of meeting the additional demand represented by the height of the $SRMC_2$ curve.

will be permanent, if the investment project was delayed by one year, society would forgo the benefits from the project for that year. As an offset, society could gain by investing the funds required for one year elsewhere and could earn interest. Assuming perfect capital markets, so that the interest rate equals the discount rate, which in turn equals the opportunity cost of capital, society would gain $rK$ where $r$ is the discount rate and $K$ the capital cost of investment. Hence an investment would be better delayed so long as $B(t) < rK$, where $B(t)$ is the benefits in year $t$.[2] If demand is growing over time, annual benefits will grow as well, so the time will eventually be reached when investment is warranted. This illustrated in figure 2.2. Time is graphed on the horizontal axis and annual benefits and costs on the vertical axis. Two annual benefit curves are shown along with the value of $rK$. The annual benefit curves have been drawn as rising at an increasing rate because, as the demand curve in figure 2.1 moves rightward over time, the distance between the $SRMC_1$ and $SRMC_2$ curves increases. If the annual benefit curve labelled $A$ applied, the investment would be warranted immediately. In this case, the optimal time to invest occurred in the past. In the case of the $B$ curve, it would be better to delay the investment until time $T_B$.[3]

---

2 This condition is sometimes expressed as: a project should be delayed if the 'first year rate of return' is below the discount rate, that is, $\dfrac{B(1)}{K} < r$.

3 It is assumed that the benefit function is continuous and monotonically increasing. With investment occurring at time $T$ and continuous compounding, the net present value of benefits and costs is: $NPV = \int_T^{\infty} B(t)e^{-rt}dt - Ke^{-rT}$. This equation must be differentiated with respect to $T$ and set equal to zero to obtain the optimum time to invest: $\dfrac{dNPV}{dT} = -B(T)e^{-rT} + rKe^{-rT} = 0$; which reduces to: $B(T) = rK$. The second order condition for a maximum is that, in the region of the optimum: $-e^{-rt}\dfrac{dB}{dt} < 0$ which holds if $\dfrac{dB}{dt} > 0$. Thus the annual gain from implementing the project must be growing over time. The optimal timing condition derived here assumes that the project has an infinite life. There may be periodic maintenance costs and replacement costs which occur at definite times following initial construction. Deferral of the initial investment also defers these. NPV could then be expressed as:

$$NPV = \int_T^{\infty} B(t)e^{-rt}dt - Ke^{-rT} - k_1e^{-r(T+x_1)} - k_2e^{-r(T+x_2)} - \ldots - k_ne^{-r(T+x_n)}$$

where the $k$'s are periodic maintenance of replacement expenditures each one occurring $x$ years after time $T$. The optimum timing condition then becomes: $B(T) = r\left(K + k_1e^{-rx_1} + k_2e^{-rx_2} + \ldots + k_ne^{-rx_n}\right)$. Thus one could use the simple optimal timing condition derived previously but augment $K$ by an amount equal to the present value of these periodic maintenance and replacement costs. For maintenance costs which occur every year and are the same for each, it is simpler to reduce annual benefits by the amount.

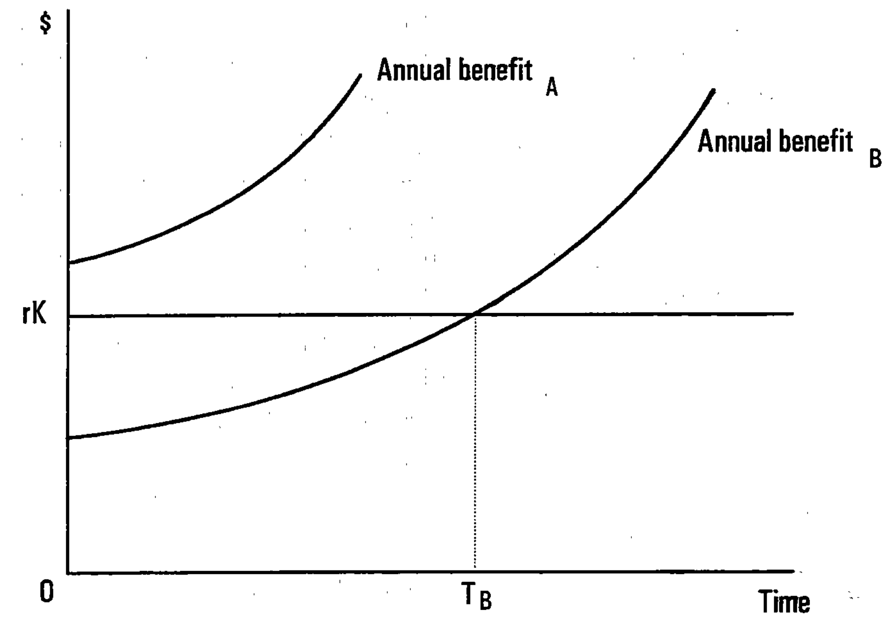



**Figure 2.2 Optimal timing of investments**

In order to explore some of the relationships, it is assumed that annual benefits are growing at a constant rate over time, that is, $b(1+g)^t$ where $b$ is the benefit in year zero from undertaking the investment and $g$ is the annual growth rate in benefits.[4] Substituting the formula for annual benefit into the optimal timing condition, the optimal time to invest is $\frac{ln(rK/b)}{ln(1+g)}$. From this it can be seen that a higher discount rate and capital cost will delay the optimum time while higher benefits and growth in benefits will bring it forward.

The benefit-cost ratio (BCR) (the present value of benefits divided by the present value of capital costs) from the investment under the assumption that benefits grow at a constant rate is $\frac{b(1+g)^T}{K[r-ln(1+g)]}$, where $T$ is the time of implementation. Thus the BCR grows over time at the growth rate. If the investment is undertaken at the optimal time, the formula for the BCR reduces to $\frac{1}{1-ln(1+g)/r}$. The $b$ and $K$ terms drop out of the equation altogether. From this equation it can be seen that with a positive growth rate and optimal timing,

4 If the demand curve shifts rightward at a constant growth rate, benefits from infrastructure expansion will in fact rise faster because the gap between marginal costs with and without the investment rises as figure 2.1 shows.

the BCR can never lie below one. A project having a BCR below one would, with optimal timing, be delayed into the future, by which time its BCR would have risen above one. At the optimal time, how far the BCR lies above one will depend on the size of the growth rate relative to the discount rate. If the project has its optimal time in the past as illustrated by the annual benefit curve *A* in figure 2.2, the BCR will be higher still, depending on how late the project is. Application of the optimal timing criterion to identify investment projects and timings therefore means that BCRs will be above one, and significantly so where growth rates in benefits are high relative to the discount rate and where there is already substantial underinvestment.

### Non-capacity expanding investments

The SRMC curves in figure 2.1 were drawn such that the investment shifts the SRMC curve to the right. Short-run marginal costs at low outputs remain unchanged. The improvements in service levels eventuate because there is more capacity to handle any given volume of demand. Some investments will shift the SRMC curve downward as well as or instead of to the right. An example would be an investment to save on variable maintenance costs. Even if there is no congestion whatsoever the principles for assessing whether the investment is warranted and estimating the optimal time are the same. In terms of figure 2.1, the demand curve would pass through the flat parts of the SRMC curves. The annual benefit would still be measured by the area bounded by the two SRMC curves and the demand curve.

### Non-optimal pricing

To simplify the exposition, it was assumed in the discussion of figure 2.1 that taxes and charges were levied in the amounts such that users always paid the short-run marginal social cost. This is the optimum pricing rule to achieve economic efficiency because the marginal user, that is, the user on the borderline in deciding whether or not to use infrastructure, is faced with the full cost he or she imposes on society. In practice, prices will never perfectly reflect marginal costs and may be quite different. Where prices differ from marginal costs, measurement of benefits from infrastructure upgrading will be more complicated than just the shaded area in figure 2.1.[5] If prices are above marginal costs, infrastructure will be underutilised compared with the most efficient level, and less investment will be required. Conversely, if

5 Benefits in the form of increased willingness-to-pay would be measured with reference to the demand curve and actual generalised costs incurred including taxes and charges. Benefits in the form of net cost savings would be measured as the areas under the marginal social cost curves.

infrastructure is underpriced, there will be more congestion than the most efficient level and additional investment will be required.

## APPLYING THE DEFINITIONS

The extent to which the Bureau has been able to apply the definitions of technical and economic adequacy to each mode of transport in the adequacy assessments described in the present series of working papers has depended on the availability of data and the availability of models to forecast future levels of service as demand grows and infrastructure is upgraded.

### Demand projections

The present study aims to assess adequacy over the 20 year period 1995-96 to 2014-15 inclusive. Demand projections over this period are therefore an important first step, and this is the subject of the next chapter. Data on recent levels of utilisation are vital for making demand projections, and some forecasting techniques also require time series data.

As demand rises towards capacity, levels of service will fall, which will choke off some of the demand. Investment in new capacity can have the opposite effect, stimulating demand. In order to keep the effects of demand growth, that is, rightward movement of the demand curve, separate from effects of congestion on demand, that is, movements along the demand curve, it has been assumed when making the demand projections that service levels provided by the infrastructure remain unchanged. Figure 2.3 illustrates this. A demand curve is shown moving rightward over five time periods. The price level P represents the generalised cost at time 1 when the demand curve is at $D_1$. Over time, as demand grows, if the generalised cost remained at P, quantity demanded would follow the series of Q's along the horizontal axis. This would be the quantities the demand projections aim to estimate. If changes in service levels were taken into account, the quantities would be found at the intersections of the demand and cost curves.

### Data requirements

An essential component of the research has been a comprehensive program of data collection on the infrastructure being studied. The difficulties encountered by the Bureau in this part of the work have uncovered major deficiencies that exist in knowledge about the physical and performance characteristics and the usage of transport infrastructure in Australia.

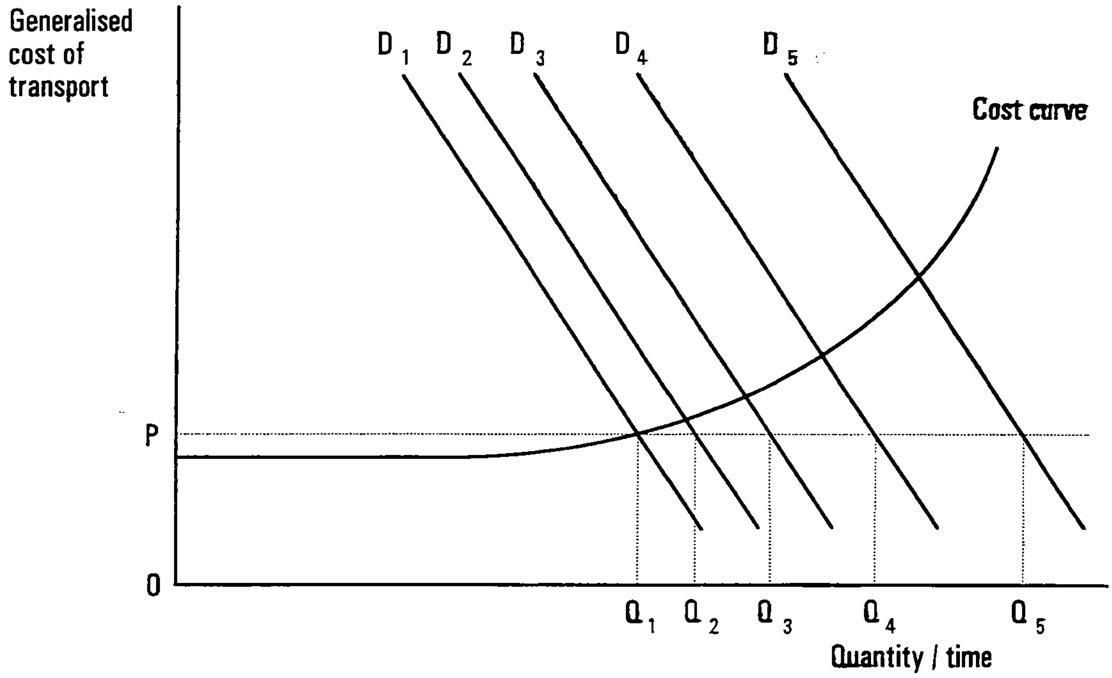



**Figure 2.3 Quantity of transport demanded at a constant level of service**

*Technical assessments*

The basic data required are some physical characteristics of each individual piece of infrastructure and details on levels of utilisation. With this information a technical assessment can be carried out by comparing the physical characteristics of each section of infrastructure against predetermined standards or against one another to highlight the worst infrastructure. Utilisation data are essential where physical characteristics are expressed in relation to throughput, for example, TEU per berth metre. It might be useful to consider the results of the technical assessment alongside data on utilisation, because a piece of infrastructure of low standard but poor utilisation may not be inadequate in the economic sense.

A more sophisticated form technical assessment is based on performance characteristics such as delays, times taken, reliability or operating costs. This requires either data on current service levels or a model which will estimate them. A model normally requires much more detailed data on physical characteristics and utilisation than would be needed for a technical assessment of physical characteristics. Projection of future service levels if forecast demand was to be loaded onto existing infrastructure would also require modelling.

A technical assessment may be employed to identify investment projects and, if the projects can be costed, estimates of the costs of likely future investment needs can be derived. The investments identified would be those which would bring the level of service up to a specified level.

### *Economic assessments*

A problem with moving from a technical to an economic definition of adequacy is that economic adequacy cannot be assessed without specifying how the infrastructure is to be upgraded in order to estimate the costs and benefits of doing so. If alternative ways of achieving the same service improvement are available, all alternatives need to be analysed and compared. As already noted, the technical assessment can assist in identifying projects.

In the present strategic exercise, full scale cost-benefit assessments of potential infrastructure investments are not feasible. The economic assessment work undertaken must necessarily be rudimentary in nature and so only provides a broad guide as to whether investments are warranted. If the data and models are available to predict levels of service provided by infrastructure such as would be required for a technical assessment of performance characteristics, a basic economic analysis is possible provided some additional information requirements are met. These additional requirements include capital costs of investment projects and data on operating costs, including values of time and reliability where these are major benefits from investment projects.

## CONCLUSION

The approach to assessing infrastructure adequacy outlined above offers great flexibility in terms of the depth of analysis, and this is essential given the variations in degrees of data availability and ease of modelling between the modes. At the lowest level is the technical assessment of physical characteristics of infrastructure. The next level is a technical assessment based on current and projected infrastructure performance in terms of service levels. This has the advantage that it can formally incorporate demand projections. In some cases, by using the technical assessment to identify potential projects and estimating the costs of these projects, it has been possible forecast future investment needs. Finally, if it is possible to specify investment projects and estimate costs and benefits, there is the economic assessment. This too may be undertaken in varying degrees of depth ranging from a 'back of the envelope' calculation to a major cost-benefit study. The study described in the present series of working papers, with its strategic focus, would not aim to go beyond cost-benefit studies at a rudimentary level.

# CHAPTER 3 CURRENT INFRASTRUCTURE AND DEMAND

Adequacy of infrastructure depends on the infrastructure itself, how it is utilised and the demand for its use. This chapter examines the infrastructure at each of the ports considered and the volume of cargo currently transported in Australia, as well as briefly considering the importance of sea transport to the Australian economy.

## INFRASTRUCTURE

A port is comprised of a series of integrated components all of which contribute to the port's overall performance. This study has only considered the seaport infrastructure, which is defined as the berths and storage areas, not the equipment at the terminals such as the cranes, loaders/unloaders (for bulk cargo), forklifts, and reefer points, although the availability of this equipment will significantly affect the capacity of the terminals.

Appendix I contains information on individual berths, including the equipment available and commodities handled.

Berths have been divided into four categories: international container berths, other non-bulk berths, dry bulk berths and liquid bulk berths. International container berths are those designated for lift-on lift-off container ships, with container cranes on the wharf. Brotherson Dock at Port Botany is an example. The other non-bulk berth category comprises berths handling ro-ro cargo and general cargo, and berths used for a mixture of bulk and non-bulk cargo. Dry bulk berths are used solely for dry bulk cargo. The final category is for liquid bulk cargo such as petroleum products.

Table 3.1 provides a summary of the current seaport infrastructure at the 14 Australian seaports considered in the study. Melbourne has the largest numbers of non-bulk berths, and also the largest number of international container terminals. Sydney and Brisbane are next largest to Melbourne in terms of numbers of container berths. Adelaide and Fremantle have almost as many non-bulk berths as Melbourne in total, but they have very few international container berths. The remaining non-bulk berths currently have small capacities.

TABLE 3.1 SEAPORT INFRASTRUCTURE

| Seaport | International container berths* | Other non-bulk berths | Dry bulk berths | Liquid bulk berths | Uncovered area (ha) |
|---|---|---|---|---|---|
| Adelaide | 2 | 17 | 6 | 2 | 128.2 |
| Brisbane | 5 | 7 | 8 | 7 | 55.9 |
| Burnie | 0 | 3 | 1 | 1 | 3.4 |
| Cairns | 0 | 9 | 1 | 1 | 0.7 |
| Darwin | 0 | 3 | 1 | 1 | na |
| Devonport | 0 | 3 | 2 | 2 | 5.9 |
| Fremantle | 4 | 15 | 5 | 4 | 30.9 |
| Hobart | 0 | 6 | 1 | 1 | 5.2 |
| Launceston | 0 | 2 | 6 | 1 | 8.5 |
| Melbourne | 13 | 20 | 7 | 4 | 85.2 |
| Newcastle | 0 | 3 | 14 | 0 | 9.6 |
| Port Kembla | 0 | 5 | 7 | 2 | na |
| Sydney | 10 | 8 | 7 | 8 | 142 |
| Townsville | 0 | 3 | 4 | 1 | 6.6 |

* Dedicated container berths with container cranes.
na Not available

*Source* BTCE derivation, Maunsells (1994).

Of the ports shown in the table, Newcastle and Port Kembla have the most dry bulk berths and Sydney and Brisbane the most liquid bulk berths. As with the non-bulk berths there are differences in the capacities of the dry bulk berths. At the Port of Newcastle most of the cargo is handled at the designated coal berths, while other dry bulk berths have smaller capacity.

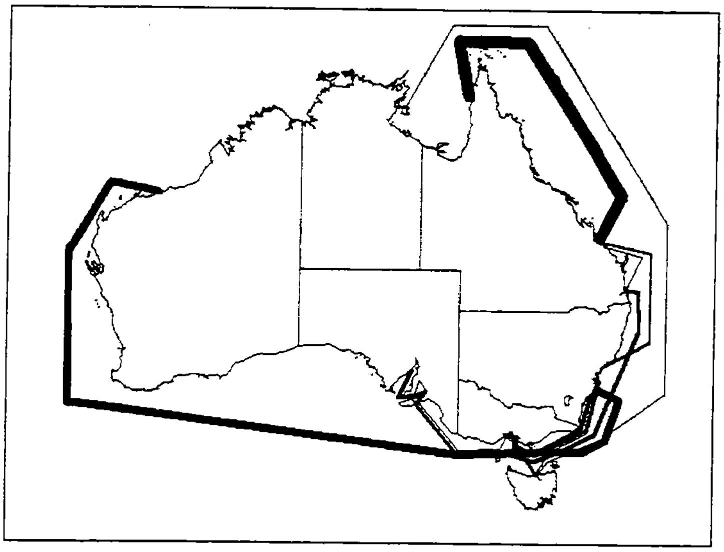
## DEMAND

Table 3.2 shows the tonne-kilometres of freight moved in Australia in 1991. Road, rail and sea each carry approximately a third of the tonne-kilometres transported. The majority of goods carried by sea are bulk commodities.

TABLE 3.2 FREIGHT MOVEMENTS ROAD, RAIL, SEA AND AIR: 1991

| | Road urban | Road non urban | Rail government | Rail private | Sea | Air | Total |
|---|---|---|---|---|---|---|---|
| Tonne-kilometres (billions) | 34.1 | 61.2 | 52.0 | 37.0 | 97.0 | 0.2 | 281.4 |
| Percentage | 12 | 22 | 18 | 13 | 34 | 0.1 | 100 |

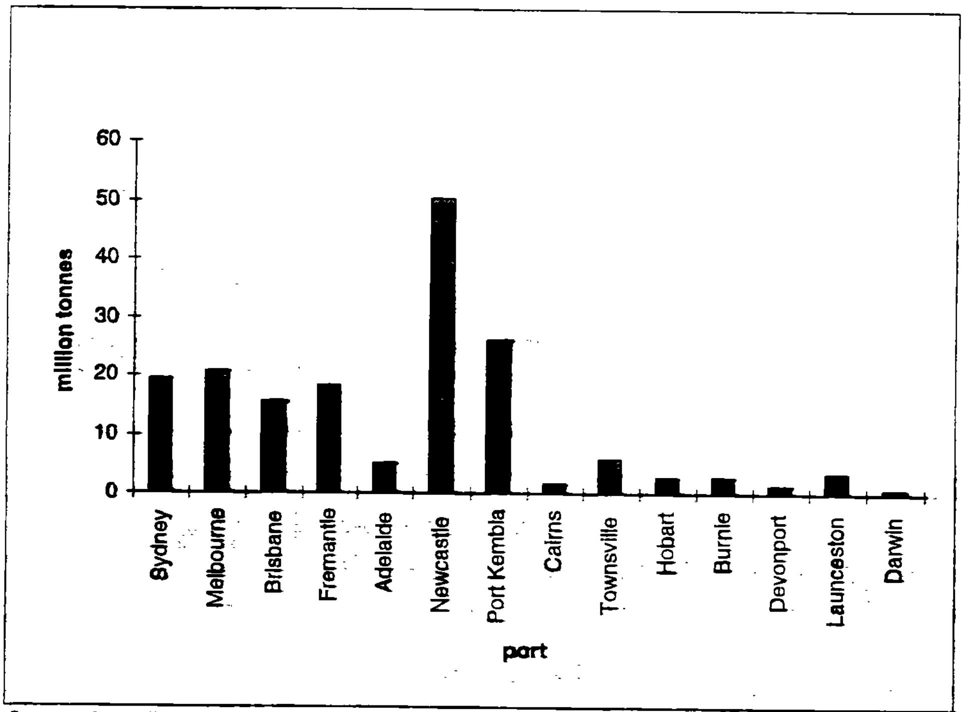
*Note* Urban areas are those with populations greater than 40 000.
*Source* Cosgrove and Gargett (1992).



*Source BTCE.*

**Figure 3.1 Seaport tonnage for 1992-93**

Figure 3.1 shows the tonnages between different parts of Australia in 1992-93, the largest flows are between the Pilbara region and Sydney and along the coast of Queensland. The greatest volume of containerised cargo moves between Melbourne and Tasmania. The tonnages exported have been omitted because the large volumes exported from the Pilbara would overwhelm the remainder of the traffic.




*Source* Australian Transport Council port performance indicators June 1993.

**Figure 3.2 1992-93 throughput**

There was 45M tonnes moved by sea around Australia in 1992-93. This is relatively modest compared to total exports of approximately 330M tonnes with the Pilbara region accounting for 103M tonnes, Newcastle 44M tonnes, Hay Point in Queensland 37M tonnes, and 22M tonnes from Gladstone. The tonnage exported is approximately eight times that imported.

Figure 3.2 shows the total throughput through each of the ports in 1992-93 examined in the study, the coal exporting ports of Newcastle and Port Kembla dominate all the ports in terms of tonnage.

Table II.1 in appendix II gives a detailed breakdown of the freight volumes handled at each of the ports in 1992-93.

# CHAPTER 4 FUTURE DEMAND

The demand forecasts are a key part of the adequacy assessment. This chapter explains the methodology for developing the forecasts, the assumed economic environment, and the projected demand. The demand forecasts are presented in a more detailed form in tables II.2 and II.3 in appendix II.

## DEMAND METHODOLOGY

Demand for port services has been forecast by drawing on past trends and expected future developments. The basic methodology was to estimate port cargo flows for 1995-96 on the basis of recent trade tonnages and then to extrapolate these figures to 2014-15 by applying growth rates determined for each port and major cargo type.

For bulk goods the growth rates were derived from the expected growth in the major commodities of each port. The principal assumptions were that:

- exports will grow in line with GDP growth; however, there will be greater growth at ports concentrating on primarily raw material exports such as coal and less growth at ports handling predominantly agricultural products such as wool;
- growth in imports will be slightly lower than exports on the basis that domestic growth will be lower than export growth; and
- liquid and dry bulk cargo have the same growth rate for all ports.

For containers and other non-bulk goods, growth rates were estimated using the following methodology:

- growth in exports was related to the expected national GDP growth and then adjusted to reflect the growth in different regions;
- growth in imports was related to the expected population growth of each port city and surrounding hinterland; and
- non-containerised non-bulk cargoes were assumed to have the same growth rates as containerised cargoes.

The bulk freight growth rates for Port Kembla and Newcastle were adjusted with information from the New South Wales Department of Mineral Resources.

The new figures are based on the volume of coal expected to be mined in the Illawarra and Hunter regions.

The growth rates were applied to the latest available volumes for all the ports. For some ports, information was not available in all categories. There were also ports for which there was no breakdown between the proportions of cargo being imported and exported. In this case it was assumed that half of the non-bulk cargo was imported and the other half exported. For bulk goods all cargo was assumed to be exported.

## ECONOMIC ASSUMPTIONS

Demands on the current infrastructure will grow with population and economic activity. An obvious starting point for estimating future demands is to look at previous trends in freight movements. These are set in broad terms in table 4.1 for the four transport modes, along with the contribution of each sector to GDP. The modes show marked differences in tonne-kilometre growth rates over the period 1987 to 1991. Air freight has been the fastest growing, although in comparison with the others it is very small in size. The growth in sea transport has been small, at only 1 per cent. The GDP percentages include passenger transport, which makes air transport much more significant relative to the other modes.

TABLE 4.1 TRANSPORT SECTOR GROWTH RATES AND CONTRIBUTION TO GDP

| *Sector* | *Annual growth rates tonne-km: 1987-1991 (per cent)* | *Contribution to GDP: 1993-94 (per cent)* |
|---|---|---|
| Air transport | 4.6 | 1.2 |
| Road transport and storage | 3.5 | 2.8[1] |
| Rail transport | 2.4 | 0.5 |
| Sea transport | 1.0 | 0.5 |
| **Total economy** | | **100.0** |

*Note* Road transport contributed 2 per cent with storage 0.8 per cent.

*Source* ABS (1994).

Latest available demand figures for each section of infrastructure for each mode have been projected to the base year of 1995-96 and then onwards to 2014-15 by applying growth rates. The underlying assumptions for the domestic forecasts are as follows:

- an average annual increase in population of around 1 per cent, with regional variations incorporated;

- no significant increases in fuel prices;
- no significant fluctuations in currency exchange rates; and
- Australia's economic activity growing at 3 per cent per annum on average throughout the 1990s.

The key assumptions for demand are those relating to population growth and to economic growth. The highest growth regions are projected to be the coastal belts extending from Cairns to Sydney, and particularly the Gold Coast and Sunshine Coast regions in Queensland. In contrast, some of the rural regions have been experiencing population decline and this is expected to continue.

Underlying assumptions for the international forecasts of demand, particularly as they impact on Australia's imports and exports, include that Europe and Japan are in a recessionary downwards phase, but that in the long term, growth in the Japanese economy will continue to outstrip Europe and North America. Growth in some of the recently industrialised Asian economies such as Taiwan and Korea is expected to surpass even Japanese growth.

The major assumption affecting freight demand is the growth in economic activity. While it can be anticipated that fluctuations will occur around the 3 per cent level, the likelihood of sustained long periods either below or above is considered small. Periods of recession such as those experienced in the early 1990s would probably be followed by periods of greater than average economic growth. An oil shock was also considered but its impacts are considered likely to be offset by shifts to alternative fuels and to more fuel efficient vehicles or modes of transport. Consequently, the effect on mobility is likely to be relatively small. Overall, the transport demand projections have been found not to be very sensitive to changes in the underlying assumptions over the plausible range.

## FORECASTS

Table 4.2 gives the projected growth rates at all the ports until 2014-15.

For containerised cargoes the largest growth is expected at the Queensland, Northern Territory and Western Australian ports. The lowest growth is expected in Tasmania and South Australia. The two largest container ports, Melbourne and Sydney, have similar growth rates, less than one per cent for imports and slightly over two per cent for exports.

The annual growth rates for bulk freight are projected to be between one and two per cent for imports and two and three per cent for exports at all ports except Newcastle and Port Kembla. The growth rate expected at Newcastle is 1.6 per cent and at Port Kembla just above zero. Growth at these ports is

TABLE 4.2 LONG-TERM GROWTH TRENDS FOR FREIGHT AT AUSTRALIAN PORTS

*(per cent per annum)*

| | Containers | | Bulk freight | |
|---|---|---|---|---|
| *Port* | *Import* | *Export* | *Import* | *Export* |
| Adelaide | 0.6 | 1.9 | 2.0 | 3.0 |
| Brisbane | 1.8 | 5.6 | 2.0 | 2.5 |
| Burnie | 0.5 | 1.5 | 1.5 | 2.0 |
| Cairns | 1.4 | 4.4 | 1.5 | 2.0 |
| Darwin | 1.7 | 5.3 | 2.0 | 3.0 |
| Devonport | 0.5 | 1.6 | 1.5 | 2.0 |
| Fremantle | 1.4 | 4.6 | 2.0 | 2.5 |
| Hobart | 0.2 | 0.6 | 1.5 | 2.0 |
| Launceston | 0.4 | 1.2 | 1.5 | 2.0 |
| Melbourne | 0.7 | 2.2 | 2.0 | 2.5 |
| Newcastle | 0.2 | 0.6 | 1.6 | 1.6 |
| Port Kembla | 0.5 | 1.7 | 0.1 | 0.0 |
| Sydney | 0.8 | 2.4 | 2.0 | 2.5 |
| Townsville | 0.8 | 2.5 | 1.5 | 2.0 |

*Source* Travers Morgan (1994); for Newcastle and Port Kembla, NSW Department of Mineral Resources (pers. comm. 1994).

restricted by the amounts of coal that are expected to be mined in the surrounding regions.

Table 4.3 presents projections of cargo volumes and growth rates of containers and dry and liquid bulk cargoes for 1995-96 and 2014-15.

Over the 20 year period, the ranking of major container ports remains unchanged, with Melbourne expected to handle over 900 000 TEUs, Sydney 750 000 TEUs and Brisbane 580 000 TEUs in 2014-15. Brisbane is expected to be the fastest growing container port followed by Fremantle and Darwin. In the dry bulk goods category, Newcastle and Port Kembla will continue to dominate. Newcastle is expected to handle over 75M tonnes and Port Kembla 26M tonnes, with the other 12 ports handling small amounts of dry bulk cargo. As noted previously, the study has focused on national non-dedicated ports so ports such as Gladstone, Weipa, Hay Point, Dampier and Port Hedland (which currently export 163M tonnes per annum) were not studied. The largest quantities of liquid bulk cargo will continue to be handled by Sydney, Fremantle and Brisbane.

TABLE 4.3 SEA TRANSPORT DEMAND: 1995-96 TO 2014-15

| | *Containers* | | | | *Dry bulk cargo* | | | | *Liquid bulk cargo* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Seaports* | *1995-96 ('000 teus)* | *2014-15 ('000 teus)* | *Change 1995-96 to 2014-15 (%)* | *Change per annum (%)* | *1995-96 ('000 teus)* | *2014-15 ('000 teus)* | *Change 1995-96 to 2014-15 (%)* | *Change per annum (%)* | *1995-96 (Mt)* | *2014-15 (Mt)* | *Change 1995-96 to 2014-15 (%)* | *Change per annum (%)* |
| Sydney | 573.3 | 755.9 | 31.9 | 1.5 | 0.8 | 1.2 | 50 | 2.2 | 12.4 | 18.9 | 52 | 2.2 |
| Newcastle | 4.0 | 4.3 | 7.5 | 0.4 | 55.0 | 75.0 | 36.4 | 1.6 | 0.3 | 0.5 | 67 | 2.7 |
| Port Kembla | na | na | na | 1.1 | 26.4 | 26.4 | 0 | 0 | 0.2 | 0.4 | 100 | 3.7 |
| Melbourne | 704.4 | 933.1 | 32.5 | 1.5 | 1.5 | 2.5 | 67 | 2.7 | 2.4 | 3.6 | 50 | 2.2 |
| Brisbane | 241.5 | 578.9 | 139.7 | 4.7 | 5.8 | 8.9 | 53 | 2.3 | 7.9 | 12.1 | 53 | 2.3 |
| Cairns | 6.9 | 11.8 | 71.0 | 2.9 | na | na | na | 2.0 | na | na | na | 2.0 |
| Townsville | 14.4 | 19.7 | 36.8 | 1.7 | 4.4 | 6.4 | 45 | 2.0 | 1.0 | 1.4 | 40 | 1.8 |
| Adelaide | 57.8 | 77.3 | 33.7 | 1.5 | 4.1 | 6.7 | 63 | 2.6 | 0.4 | 0.6 | 50 | 2.2 |
| Fremantle | 157.2 | 302.1 | 92.2 | 3.5 | 8.7 | 13.3 | 53 | 2.3 | 8.5 | 13.0 | 53 | 2.3 |
| Burnie | 84.8 | 105 | 23.8 | 1.1 | 1.3 | 1.8 | 38 | 1.7 | 0.2 | 0.3 | 50 | 2.2 |
| Devonport | 31.6 | 38.6 | 22.2 | 1.1 | 0.6 | 0.9 | 50 | 2.2 | 0.2 | 0.3 | 50 | 2.2 |
| Launceston | 45.7 | 54.4 | 19.0 | 0.9 | 2.9 | 4.1 | 41 | 1.8 | 0.2 | 0.2 | 0 | 0 |
| Hobart | 33.9 | 37.2 | 9.7 | 0.5 | 1.6 | 2.2 | 38 | 1.7 | 0.6 | 0.8 | 33 | 1.5 |
| Darwin | 5.8 | 11.2 | 93.1 | 3.5 | na | na | na | 2.0 | na | na | na | 2.0 |
| Total | 1 961.3 | 2 929.5 | 49.4 | 2.1 | 113.1 | 149.4 | 32 | 1.5 | 34.3 | 52.1 | 52 | 2.2 |

na Not available

*Source* Travers Morgan (1994); for Newcastle and Port Kembla, NSW Department of Mineral Resources (pers. comm. 1994).

# CHAPTER 5 SEAPORT INFRASTRUCTURE ADEQUACY

The seaport analysis was restricted to a technical assessment based on berth utilisation measures rather than the more comprehensive economic analysis described in chapter 2. The planned investments referred to were obtained from the plans of the port authorities rather than independent analysis. From these planned investments, some estimates of future expenditure needs are put forward. The final section of this chapter looks at the maintenance costs incurred for seaport infrastructure.

## METHODOLOGY

Seaport capacity can be measured by the level of cargo throughput and by the delays that are experienced for ships and cargo as congestion rises. How many ships and how much cargo will result in a given level of congestion is a complex question as it depends on:

- the mix of vessel and cargo types;
- the configuration of berths and shore facilities;
- the flexibility in berth allocation;
- the availability and efficiency of cargo handling equipment;
- working hours and labour availability and productivity; and
- the pattern of ship arrivals and cargo exchanges per ship call.

For the technical assessment, the approach adopted was to develop indicators which provide an assessment of the degree of utilisation of infrastructure.

In calculating occupancy for years beyond 1992-93, it has been assumed that cargo handling productivity (in terms of tonnes per berth hour or equivalent) will increase at a rate of 2 per cent per annum throughout the study period.

The analysis was undertaken for non-bulk, dry bulk and liquid bulk berths at each port. It is important to note the definitions of the three berth type categories. Non-bulk berths include all container, general cargo berths and berths that handle some bulk cargo. Dry and liquid bulk berths are those berths that handle only bulk cargo.

The key indicator that has been used for the assessment of adequacy is the berth occupancy ratio, that is, the percentage of time that a berth has a ship alongside it. The analysis was complicated by the fact that many berths, especially non-bulk berths, are used for a variety of cargo types, which makes it difficult to derive reliable and comparable measures of productivity. In particular, some general cargo berths also handle bulk cargoes, and this will tend to inflate an indicator such as tonnes per berth metre. Furthermore, there can be considerable variation in the degree of utilisation of berths in a particular port, particularly for general cargo berths. Some ports have a stock of general cargo berths (Adelaide Inner Harbor berths, Brisbane River berths, Yarra River berths, Sydney Harbour berths) that are nominally available for use for appropriate combinations of vessel and cargo but have very low utilisation. This reduces average utilisation rates on a port-wide basis. These problems mean that the results in table 5.1 should be interpreted with some care. The degree of flexibility in berth allocation would need to be assessed to ensure the reliability of the berth occupancy figures.

As general guide, a general user berth is likely to be adequate until the berth occupancy ratio rises above 60 per cent. Where the berth is used by a single user (who is able to schedule the shipping) the berth can still be adequate at berth occupancy ratios of up to 90 per cent.

Detailed simulation with computer models of all aspects of port operation including the estimated delays is the most reliable technique for evaluating berth and port capacity. However, it was not feasible to develop simulation models for the 14 seaports being considered in this study and data on ship delays are unavailable. It has therefore not been possible to undertake any technical assessments based on infrastructure performance, or any economic assessments of port infrastructure needs.

## TECHNICAL ASSESSMENT

Table 5.1 shows berth occupancy for each port and berth type. Comparing these with the benchmark of 60 per cent, the only areas with potential for capacity problems appear to be the dry bulk berths at Port Kembla and Newcastle in 2014-15. However, these are single user berths and, as noted above, single user berths can tolerate much higher berth occupancy.

The main conclusion from the technical assessment is that there is underutilised capacity at most Australian ports so that facilities are expected to be adequate for the freight task over the next 20 years. Reasons for this excess capacity include service competition between ports, indivisibilities in investment, improvements in port productivity and changes in ship technology.

TABLE 5.1 BERTH OCCUPANCY RATIOS

*(per cent)*

| Port | Year | Non-bulk | Dry bulk | Liquid bulk | All berths |
|---|---|---|---|---|---|
| Adelaide | 1992-93 | 12.5 | 26.9 | 3.3 | 15.0 |
| | 2014-15 | 15.1 | 30.5 | 3.9 | 17.7 |
| Brisbane | 1992-93 | 20.1 | 19.4 | 23.7 | 20.8 |
| | 2014-15 | 34.7 | 21.6 | 26.4 | 28.6 |
| Burnie | 1992-93 | 28.6 | 23.9 | 4.0 | 22.8 |
| | 2014-15 | 25.2 | 21.1 | 3.6 | 20.1 |
| Cairns | 1992-93 | na | na | na | na |
| | 2014-15 | na | na | na | na |
| Darwin | 1992-93 | na | na | na | na |
| | 2014-15 | na | na | na | na |
| Devonport | 1992-93 | 16.1 | 12.9 | 7.8 | 12.8 |
| | 2014-15 | 13.8 | 13.0 | 7.9 | 11.9 |
| Fremantle | 1992-93 | 30.8 | 39.2 | 26.7 | 31.8 |
| | 2014-15 | 35.1 | 44.8 | 30.5 | 36.3 |
| Hobart | 1992-93 | na | na | na | 28.2 |
| | 2014-15 | na | na | na | 27.2 |
| Port Kembla | 1992-93 | 12.3 | 50.0 | 4.5 | 30.1 |
| | 2014-15 | 16.1 | 65.4 | 5.9 | 39.3 |
| Launceston | 1992-93 | na | na | na | 13.6 |
| | 2014-15 | na | na | na | 13.5 |
| Melbourne | 1992-93 | 21.8 | 12.8 | 22.1 | 20.4 |
| | 2014-15 | 21.5 | 14.5 | 25.3 | 20.7 |
| Newcastle | 1992-93 | 10.8 | 41.1 | 0.0 | 35.8 |
| | 2014-15 | 15.7 | 59.9 | 0.0 | 49.2 |
| Sydney/Botany Bay | 1992-93 | 31.7 | 8.3 | 24.7 | 25.4 |
| | 2014-15 | 30.2 | 11.9 | 27.7 | 26.0 |
| Townsville | 1992-93 | 18.8 | 30.3 | 17.5 | 24.4 |
| | 2014-15 | 18.6 | 32.0 | 17.5 | 25.1 |

na Not available

*Source* Maunsell Consultants (1994).

## FORECAST INVESTMENT NEEDS

### Overall assessment

Based on the low berth occupancy ratios in table 5.1, capacity shortages will not be a factor in most major infrastructure investments. Ports for which capacity may become a problem already have plans in place to ensure capacity is expanded ahead of demand. Many planned investments are aimed at improving the competitiveness of ports by expanding the facilities to handle a wider range of ships and cargo, and at improving the efficiency of the land transport interface and links. In other cases facilities are being relocated for land use, safety or efficiency reasons.

In this sense, the ports follow a similar pattern to rail, where the need to maintain or improve the level of customer service and to improve operating efficiencies are key investment determinants.

Table 5.2 shows planned projects and expected expenditure over all ports. This list was compiled from the plans published by the port administrators and the *One Nation* statement. For those projects where costs are available the total estimated cost is $638M, but even including projects for which no costs are available total expenditure on the 14 ports considered in this study is not expected to exceed $1B.

### Assessment of individual ports

#### *Adelaide*

As indicated by berth occupancy rates, capacity at Port of Adelaide is currently adequate and is expected to remain so. The figures in the table tend to understate occupancy at active non-bulk berths, since 80 per cent of trade is handled through four of the 21 non-bulk berths. However allowing for this factor, occupancy at the Outer Harbor container berths is still only some 20 per cent. A new rail link and intermodal terminal are being constructed at the Outer Harbor Container Terminal with *One Nation* funding, to facilitate landbridging of containers.

#### *Brisbane*

Brisbane is Australia's fastest growing port - total throughput tonnage is forecast to grow by some 66 per cent from 1995-96 to 2014-15. Although overall trade is increasing, trade at Hamilton berths on the Brisbane River is declining.

TABLE 5.2 ADEQUACY OF SEAPORTS AND PLANNED DEVELOPMENT PROJECTS

| *Seaport* | *Adequate* | *Projects under way, planned or committed* | *Cost ($ million)* |
|---|---|---|---|
| *New South Wales* | | | |
| Sydney | Y | Possible relocation of facilities from Sydney Harbour | 100 |
| Newcastle | Y | Development of Basin Area for general cargo | 60 |
| | | Additional bulk cargo berths on Kooragang Island | na |
| Port Kembla | Y | Extension of coal terminal | 35 |
| *Victoria* | | | |
| Melbourne | Y | Further development at Webb and Swanson docks | na |
| | | Relocation of Coode Island bulk liquids facility | 200 |
| *Queensland* | | | |
| Brisbane | Y | Further development at Fisherman Islands | 160 |
| Cairns | Y | Further development of general cargo facilities | na |
| Townsville | Y | Additional outer harbour berths, dredging and improved land links | na |
| *South Australia* | | | |
| Adelaide | Y | - | - |
| *Western Australia* | | | |
| Fremantle | Y | - | - |
| *Tasmania* | | | |
| Burnie | Y | Expansion of general cargo facilities | na |
| Devonport | Y | Lengthen swinging basin and East Devonport general cargo berth | 8 |
| Launceston | Y | New general cargo berth | na |
| Hobart | Y | New cold store | 5 |
| *Northern Territory* | | | |
| Darwin | Y | Relocation of port to new site at East Arm | 70 |

na Not available

Source: Maunsell Consultants (1994).

However, trade will continue to increase at Fisherman Islands. Current facilities appear to be adequate to accommodate the growth over the next 20 years, although non-bulk berth occupancy at Fisherman Islands may exceed 60 per cent by 2014-15. Considerable development is under way or planned, as Port of Brisbane moves to concentrate its activities at Fisherman Islands. Recent developments have centred on improving port access through construction of a standard gauge rail link to Fisherman Islands under *One Nation* funding, and on improvements in road links. The Port of Brisbane had its *Key Port Brisbane Strategic Plan* (1992) endorsed by the Queensland Government in 1992, and has further port development plans involving construction of further facilities at Fisherman Islands to accommodate trade growth and relocation of operations from Hamilton. The development, estimated to cost $160M, is currently scheduled for around 2010.

*Cairns*

Cairns Port Authority operates a multi-purpose port with principal trades of petroleum products, fertilisers and general cargo for the Cape York and Gulf regions. Cairns Port Authority has recently undertaken construction of new general cargo wharves, and so will have adequate facilities to meet projected growth. As the port is located between the city of Cairns and two World Heritage listed areas its potential for expansion is limited.

*Darwin*

Darwin is a diverse port with a relatively small trade volume. Construction of new port facilities is under way at East Arm, and following their completion in 1996 the Port of Darwin should have adequate capacity for the remainder of the period. The new facility incorporates a terminal for a possible Alice Springs-Darwin railway and is capable of significant expansion if trade growth with Asia and landbridging opportunities eventuate. The cost of the current investment is $70M.

*Fremantle*

Fremantle has comparatively high berth utilisation, but recent studies undertaken by Fremantle Port Authority suggest that capacity will be adequate throughout the period. A 1993 study by the authority concluded that Fremantle's container and general cargo facilities can accommodate forecast trade growth to 2020.

*Melbourne*

Melbourne is Australia's largest general cargo seaport and has the highest container throughput (733 000 TEUs in 1992-93). An assessment of capacity of all facilities has been undertaken by the Port of Melbourne Authority (PMA) as part of the *Victorian Ports Land Use Strategy (1991)*. Taking into account forecast productivity improvements, the PMA has estimated that existing facilities will have sufficient capacity for the next 20 years, with the exception of the container terminals. The long-term strategy for the port includes consolidation of general cargo operations at key sites (Swanson, Appleton and Webb docks) and provision of a port-rail terminal and a new access road to Webb Dock. The relocation of hazardous cargo facilities from Coode Island is also under consideration at a cost of $200M.

*Sydney*

Port operations at Sydney are split between Sydney Harbour and Botany Bay. The current Maritime Services Board (MSB) strategy for Sydney is to optimise utilisation of facilities at Sydney Harbour whilst allowing for some development at Botany Bay to meet trade demands. Estimates of current and future berth occupancies suggest that facilities will be adequate throughout the study period for all cargo types. Major infrastructure development is more likely to be initiated by possible closures of facilities in Sydney Harbour and their transfer to Botany Bay. Total expenditure on port development is estimated at $100M over the period to 2010.

*Newcastle*

Activities at the port of Newcastle are dominated by dry bulk (coal, minerals, cement, grain, woodchips) loading and unloading at facilities operated by BHP and other specialist operators. General cargo volumes are small but growing. Berth occupancy and productivity at the dry bulk berths is high - berth occupancy is forecast to average around 60 per cent by 2014-15 and at Newcastle coal berths is currently around 80 per cent. High and increasing productivity will largely ensure that capacity is adequate despite these high levels of berth occupancy. There are plans by Port Waratah Coal Services to build additional coal berths on Kooragang Island. Newcastle is also planning to consolidate general trade facilities in the Basin Area berths and develop container handling facilities by building 450 metres of new container berths. The general trade development will cost $60M.

*Port Kembla*

Port Kembla has very similar trade to Newcastle, primarily handling coal exports. Expansion of the privately managed Port Kembla Coal Terminal, if required, is planned. The cost of the development is $35M.

*Townsville*

Trade at Townsville is predominantly dry bulk (nickel, cement, sugar and fertiliser) and liquid bulk (petroleum and molasses) with small tonnages of general cargo. Using *One Nation* funding, Townsville Port Authority has undertaken considerable port redevelopment involving dredging and land reclamation, and construction of a rail loop and bulk cement terminal. Further plans include progressive development of up to nine additional berths, improvements to road and rail links and deepening channels. Overall the port appears to have adequate capacity over the study period but high berth occupancies at particular berths (currently 61 per cent at bulk nickel berth) may necessitate implementation of the planned developments.

### *Burnie*

The Tasmanian ports (Burnie, Devonport, Launceston and Hobart) currently have adequate capacity and with improvements in productivity expected to outstrip trade growth, capacity at existing facilities is forecast to remain adequate throughout the study period. However, further developments are planned at all Tasmanian ports to improve facilities and competitiveness. The Port of Burnie has recently completed a $27M expansion program including a new container crane and berth extension, and is planning to expand its cargo storage area by land reclamation.

### *Devonport*

The Devonport Port Authority is planning extensions at its major general cargo berth and dredging works to accommodate vessels of up to 210 metres in length. The cost of this development is $8M.

### *Launceston*

The Port of Launceston has is planning to construct a new berth for general cargo operations.

### *Hobart*

The Marine Board of Hobart is planning construct new cold storage facilities to facilitate export of agricultural produce, particularly to Japanese markets. The cost of the cold store is $5M.

## MAINTENANCE

The major elements of port infrastructure maintenance are:

- channel dredging;
- sea wall and breakwater repairs;
- servicing of navigational aids;
- repairs to buildings, roads, utilities and equipment; and
- corrosion mitigation and restoration works.

The relative importance of these components will vary from port to port depending on the particular physical characteristics of the port and the age and composition of port structures. For instance, siltation is a major problem at estuarine ports, such as Newcastle. At these ports, channel dredging is the major maintenance task, whereas at deep-water ports, siltation is not a problem. At ports with many old timber and concrete wharves, the long-term effects of salt water corrosion will be the major maintenance problem. The situation is further complicated by the long expected life of channels and berths (30-50 years) and the strong dependence of the rate of deterioration on local conditions. Given the site-specific nature of port maintenance, it is difficult to make any general statements about the magnitude or pattern of maintenance costs.

# CHAPTER 6 OTHER ISSUES AFFECTING PORT ADEQUACY

## PORT AND MARITIME ISSUES

The foregoing assessment of the adequacy of Australian ports and likely development scenarios has been undertaken on the basis of current conditions and modest improvements in port productivity. However, there are several factors that may have a significant impact on the capacity and adequacy of Australian ports in the foreseeable future. These factors include:

- further improvements in waterfront productivity;
- changes in the characteristics of vessels visiting Australian ports and the pattern of arrivals;
- inter- and intra-port competition;
- Electronic data interchange (EDI) and information technology; and
- resurgence in coastal shipping.

Over the past decade there have been significant increases in net handling rates at Australian container terminals, and reductions in ship turnaround times. This has reduced time at berth and produced an effective increase in cargo handling and hence port capacity. In the forecasts of berth occupancy rates and adequacy only modest further improvements in productivity have been taken into consideration. The Bureau of Industry Economics (1993) report on *International Performance Indicators - Waterfront* found that container crane productivity at Australian terminals (Brisbane, Sydney, Melbourne, Adelaide and Fremantle), in terms of TEU per crane per annum, was less than half that at major Asian ports and markedly less than major ports in Europe and North America. This suggests that there is considerable underutilised crane capacity available at Australian container terminals and that, with improvements in productivity and changes in work practices, it may be possible to double throughput with Australia's existing stock of container cranes.

Trends in world shipping may also impact on port capacity. The expected increase in fixed day vessel scheduling for containerised cargo will tend to spread demand and make it more predictable. This will result in more efficient utilisation of facilities and, together with improved waterfront productivity, will tend to delay the need for capacity driven infrastructure development. On the other hand, the trend towards globalisation of container shipping may see either fewer ship visits but by larger ships or more visits by smaller ships. If the trend is towards larger ships then there may need to be investment in channels and cargo handling equipment, but if the trend is towards a larger number of visits by smaller vessels then the need for investment may be delayed. Similar possibilities are evident in the dry and liquid bulk sectors. Which scenario eventuates will depend on the global strategies of shipping companies and the future pattern of Australia's trade.

In a competitive port environment, individual port and terminal operators may choose to invest in infrastructure in order to win and retain trade, the aim being to create a port system that meets the operational requirements of shipping companies. In these cases, investment may be undertaken and capacity increased on the basis of commercial considerations rather than economic or technical considerations. Inter-port competition could conceivably affect the pattern of shipping services and alter the balances of demand and capacity at Australian ports. For example, an increase in landbridging could accelerate the need for infrastructure investment at the gateway port while creating over-capacity at other ports.

EDI and other information technology services have the potential to improve the productivity of port operations through greater efficiency and coordination of port services and activities. The goal of EDI is to facilitate the movement of cargo through the port so that cargo spends a minimum of time within the port system. This can increase the capacity of the port and ultimately reduce the need for investment in port infrastructure, particularly storage facilities. An example of the impact of information technology has been a significant reduction in truck queuing. At Melbourne, the introduction of EDI technology and better scheduling of truck arrivals has largely eliminated the problem truck queuing, while at Sydney, there have been significant improvements. Additional improvements to efficiency can be made by increasing the proportion of trucks that are full both entering and leaving the port. There is great potential for operational efficiencies through information technology.

It has been suggested that there may be a resurgence in coastal shipping as an alternative to road and rail for long distance cargo movements such as Melbourne-Perth. If this eventuates, the volumes are likely to be small compared to current port throughputs and the technology is likely to involve small ro-ro vessels. Most ports in Australia currently have underutilised ro-ro facilities, so the need for additional port infrastructure is likely to be small.

All these factors have the potential to significantly alter the need for investment in port infrastructure over the next 20 years and should be taken into consideration in any detailed analysis of proposed port investment.

**ROAD AND RAIL INTERFACE**

The adequacy of a port cannot be considered in isolation from the interface between the ports and land transport. The links from ports to rail terminals and freight forwarding centres in Sydney, Melbourne, Brisbane, Adelaide and Fremantle are considered in more depth in the BTCE Working Paper 14.5. Some of the most significant problems are examined here.

For Port Botany, current rail links are considered to be adequate for projected trade growth but road access is hampered at both Sydney Harbour and Botany ports by the high levels of congestion on Sydney roads. Completion of the Glebe Island bridge will alleviate congestion problems around the Port of Sydney, while problems at Port Botany would be alleviated by the construction of a direct road link between the port and major freight origins and destinations in the west of Sydney.

The Port of Melbourne has completed a special road from the port to South Dynan rail terminal and the Western Ring Road is under construction using *One Nation* funding. This construction will reduce the problems experienced in moving freight to and from the port.

At the Port of Brisbane, there are congestion problems on the port road links that pass near or through the central business district to reach cargo destinations. Goods travelling between port and the industrial areas have a relatively uncongested route via arterial roads. The rail link in Brisbane has spare capacity but delays are experienced during morning and afternoon peaks. Substantial *One Nation* investment on both road and rail port links should alleviate the problems.

There are few congestion problems on the roads at the Port of Fremantle and *One Nation* funding has been used to improve rail transfer arrangements on the North Wharf.

There are few problems of road congestion in Adelaide and the rail link between the port and rail terminal is being upgraded with *One Nation* funding.

Investments under *One Nation* funding and planned follow-up projects are contributing significantly to the alleviation of problems arising from congestion on the road and rail network and truck queuing. The major problems that remain are congestion in the extended road network in Sydney, Melbourne and Brisbane.

# CHAPTER 7 CONCLUSIONS AND FUTURE WORK

## CONCLUSIONS

The broad conclusion is that there is underutilised capacity at most Australian ports, so facilities are expected to be adequate for the freight task over the next 20 years. Capacity driven investment is likely to be modest and those ports for which capacity may become a problem already have master planning strategies in place to ensure that capacity is increased ahead of demand. Over the next 20 years, major infrastructure investment at Australian ports is more likely to be initiated as a result of land use planning or competitive pressures.

Many planned investments are aimed at improving the competitiveness of ports by expanding the scope of cargo and the types of ships that can be handled, and at improving the efficiency of the land transport interface and links with the surrounding road and rail network. In other cases facilities are being relocated for commercial, safety or efficiency reasons.

The total cost of planned port projects for which costs are available is $638M and additional infrastructure spending is not expected to take the total necessary expenditure on ports above $1B over the next 20 years.

Significant projects likely to be undertaken at Australian ports in the period to 2014-15 include:

- Brisbane: further development of Fisherman Islands facilities;
- Darwin: relocation of port operations to new site at East Arm;
- Melbourne: further development at Webb and Swanson Dock container terminals and possible relocation of Coode Island liquid bulk facility;
- Newcastle: development of Basin Area for general cargo and possibly new berths at Kooragang Island;
- Port Kembla: extension of coal terminal;
- Sydney: new general cargo, liquid and dry bulk berths at Botany Bay, dependent on any closure of operations in Sydney Harbour; and
- Townsville: additional berths and channel deepening.

The performance of ports is also influenced by the congestion on connecting road and rail links. There are significant congestion problems on the roads in Sydney, Melbourne and Brisbane.

## FUTURE WORK

Any further research into seaport infrastructure adequacy should aim to be a more detailed analysis of the type described in chapter 2. Doing this would require further information about port capacity, delays and demand, along with levels of service provided, time costs and investment costs.

As has been previously emphasised, this study was strategic in nature and restricted to the major parts of the infrastructure. The study assumed that all berths within a particular category (non-bulk, dry and liquid bulk) are interchangeable without substantial investment. This is not necessarily true. Ports are complex operations with a number of integrated components. Capacities of individual berths depend on the depth of water, the commodities handled and the type and capacity of handling equipment. The overall capacity of a port is affected by the channel depth and interchangeability of berths. The extent to which one berth can be substituted for another depends on equipment, depths of water, types of commodities and long-term leasing arrangements. Storage areas at ports, and arrival patterns of ships, may also have to be considered in assessing capacity. Thus in order to complete a more detailed analysis of port capacity the effects of individual berths, equipment and cargo need to be determined.

If current delays to ships and cargo could be obtained, whether from actual data or modelling, it would be possible to undertake a technical assessment based on the performance of the infrastructure. Incorporating the delay information and capacity estimates discussed above would allow the level of service of the ports to be estimated, as was done for the intercity roads assessment.

An alternative method of technical assessment, used in the airport study, is to extrapolate infrastructure investment needs on the basis of forecast demand. This method assumes that the current infrastructure provided is, on average, roughly right in relation to demand. Unfortunately, this type of assessment is not possible for seaports due to the current oversupply of berth infrastructure.

To expand the study to an economic assessment, estimates of ship operating costs, the cost of delays and investment project costs need to be obtained. Estimating the cost of delays due to congestion is difficult, because if delays at a particular port are anticipated, ship operators may compensate by calling at an alternative port and landbridging. The value of time for freight must also be determined. Identifying investment projects can be problematic also, as there will sometimes be a variety of investment choices available, such as dredging of currently available berths and improving the equipment.

Data availability was less of a problem for seaports than for the other transport modes. The information on port infrastructure and equipment, which is contained in appendix I, is particularly comprehensive. However, some difficulties were experienced in obtaining information on the demand for services from port infrastructure, particularly in discovering the types of commodities handled by individual berths. Some of the smaller ports complained that the number of government requests for information were stretching their resources.

The greatest challenge researchers face in undertaking future port assessment work is to develop models that will adequately estimate the individual berth and port capacity and the delays to ships and shippers. While these types of models have been developed for individual ports, they are very resource intensive and, given the number of ports being considered, may be outside the scope of this type of study.

# APPENDIX I PORT INFRASTRUCTURE

This appendix contains detailed information on the infrastructure and equipment available at each of the ports in the study. There is also additional information on the types of cargoes handled at each berth in some cases.

The list was prepared by Maunsells Pty Ltd.

Note that where a berth is listed but no equipment, we know the berth is used for ro-ro cargo but not what equipment is available.

## PORT OF ADELAIDE

### Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Inner Harbor - Princess | 1 | 102 | 4.9 | 2.3 | | |
| Inner Harbor No. 2-3 | 2 | 249 | 8.2 | 3.7 | 5 000 | |
| Inner Harbor No. 10-12 | 3 | 448 | 8.5 | 3.9 | 1 000 | |
| Inner Harbor No. 13-17 | 4 | 632 | 9.1 | 8.8 | 12 000 | |
| Inner Harbor No. 18-20 | 3 | 509 | 9.8 | 6.3 | 10 000 | |
| Inner Harbor No. 25 | 1 | 240 | 10.0 | 8.9 | | |
| Inner Harbor No. 29 | 1 | 247 | 10.7 | 4.2 | | |
| Outer Harbor No. 1-2 | 2 | 368 | 11.0 | 8.0 | 7 000 | |
| Outer Harbor No. 3-4 | 2 | 364 | 11.0 | 10.0 | 7 500 | |
| Outer Harbor No. 6 | 2 | 450 | 12.0 | 14.4 | | |
| *Dry bulk berths* | | | | | | |
| Inner Harbor No. 27 | 1 | 264 | 9.8 | 5.0 | 700 | |
| Inner Harbor H,K | 2 | 425 | 7.3 | 7.0 | | |
| Osbourne / Penrice | 3 | 487 | 7.3 | 49.2 | | |
| *Liquid bulk berth* | | | | | | |
| Inner Harbor | 2 | 354 | 8.5 | 0.2 | | |

### Cranage

| | |
|---|---|
| Inner Harbor No.13-17 | Two 6.5 tonne travelling wharf cranes |
| Outer Harbor No.6 | Two container cranes |

### Loaders / unloaders

| | |
|---|---|
| Inner Harbor No.27 | Bulk grain loader |
| Inner Harbor - H | Fixed loader |

### Ro-ro facilities

| | |
|---|---|
| Inner Harbor - Princess | Shore ramp |
| Inner Harbor No.25 | Shore ramp, ships quarter ramp |
| Outer Harbor No.3-4 | Ships quarter ramp |
| Outer Harbor No.6 | Ships quarter ramp |

## PORT OF BRISBANE

### Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks (t) |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Hamilton No. 1-10 | 7 | 1450 | 49.1 | 22.4 | 16 000 | 2500 |
| Fisherman Islands No. 1-5 | 2 | 249 | 8.2 | 3.7 | 5 000 | |
| *Dry bulk berths* | | | | | | |
| Fisherman Islands | 2 | 480 | | | | 60 000 |
| Pikemba - grain | 2 | 256 | 10.5 | 7.0 | 66 000t | 60 000 |
| Pikemba - QCL | 1 | 220 | 9.8 | | | 129 000 |
| Gibson Is - Incitec | 2 | 272 | 10.1 | | | |
| Colmslie | 1 | 270 | 10.1 | | t20 000 | |
| *Liquid bulk berths* | | | | | | |
| Fisherman/Bulwer Islands | 2 | 580 | 12.8 | | | |
| Lytton/Pinkemba/Murarrie | 5 | 1012 | 9.1 | | | |

### Cranage

| | |
|---|---|
| Hamilton No. 3 | Wharf crane |
| Fisherman Islands | 5 container cranes |

### Loaders / unloaders

| | |
|---|---|
| Hamilton | Mineral sands conveyor |
| Fisherman Islands | Grain conveyor |
| | Woodchip conveyor |
| | Shiploader (coal) |
| Pinkemba | Shiploader (grain) |
| Bulwer Island - QCL | Clamshell bucket (clinker) |
| Gibson Island - Incitec | Shiploader |

### Ro-ro facilities

| | |
|---|---|
| Hamilton Nos 1 & 3 | Ramps for ro-ro car carriers |
| Fisherman Islands | Ships quarter ramp |

# PORT OF BURNIE

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Breakwater No. 4 | 1 | 183 | 10.5 | 3.4 | 2 500 | |
| Breakwater No. 6 | 1 | 198 | 11.5 | | 1 500 | |
| Breakwater No. 7 | 1 | 216 | 11.5 | | | |
| *Dry bulk berths* | | | | | | |
| Breakwater No. 5 | 1 | 213 | 10.5 | | | |
| *Liquid bulk berth* | | | | | | |
| Breakwater No. 1 | 1 | 85 | 10.0 | | | |

## Cranage

| | |
|---|---|
| Breakwater No. 6 | Container crane |
| Breakwater No. 7 | Two container cranes |

## Loaders / unloaders

| | |
|---|---|
| Breakwater No. 5 | Bulk loader |

## Ro-ro facilities

| | |
|---|---|
| Breakwater No. 4 | Shore ramp |
| Breakwater No. 5 | |
| Breakwater No. 7 | |

# PORT OF CAIRNS

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks (t) |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Trinity Inlet No. 1-3 | 3} | 595 | 8.4 | | 1 271 | |
| Trinity Inlet No. 4-6 | 3} | | 8.4 | 0.5 | | 18 500 |
| Trinlet Inlet No. 7-8 | 2 | 250 | 9.3 | | | |
| Smiths Creek | 1 | 53 | 8.3 | 0.2 | 1 225 | |
| *Dry bulk berths* | | | | | | |
| Trinity Inlet No. 12 | 1 | 183 | 10.5 | | | 234 000 |
| *Liquid bulk berth* | | | | | | |
| Trinity Inlet No. 10 | 1 | 189 | 9.3 | | | |

## Cranage

| | |
|---|---|
| Trinity Inlet No. 6 | Wharf crane |

## Loaders / unloaders

| | |
|---|---|
| Trinity Inlet No. 5 | Pipeline (molasses) |
| Trinity Inlet No. 12 | Gantry loader |

## Ro-ro facilities

# PORT OF DARWIN

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks (t) |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Fort Hill Wharf | 1 | 300 | 12 | | 7 000 | |
| Stokes Hill Wharf - Inner | 1 | 292 | 9 | | | |
| Stokes Hill Wharf - Outer | 1 | | 4.5 | | | |
| *Dry bulk berths* | | | | | | |
| Iron Ore Wharf | 1 | 142 | 12.0 | | | 234 000 |
| *Liquid bulk berth* | | | | | | |
| Iron Ore Wharf | as | above | | | | |

## Cranage

| | |
|---|---|
| Fort Hill Wharf | Gantry crane |

## Loaders / unloaders

| | |
|---|---|
| Iron Ore Wharf | Belt loader (ore)<br>6 pipelines |

## Ro-ro facilities

| | |
|---|---|
| Fort Hill Wharf | Semi-bouyant bridge |

# PORT OF DEVONPORT

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks (t) |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| East No. 1 | 1 | 115 | 7.0 | 2.1 | 900 | |
| East No. 2 | 1 | 180 | 10.0 | 1.9 | 1 608 | |
| East No. 3 | 1 | 118 | 10.0 | 0.7 | | |
| *Dry bulk berths* | | | | | | |
| West No. 1 | 1 | 150 | 9.0 | 0.5 | | 36 335 |
| West No. 3 | 1 | 167 | 7.5 | | 2 750 | |
| *Liquid bulk berth* | | | | | | |
| West No. 4 | 1 | 198 | 11.0 | 1.2 | 7 200 | 11 000 |
| West No. 5 | 1 | 40 | 8.5 | | | 1260 |

## Cranage

| | |
|---|---|
| East No. 1 | Travelling, luffing, slewing crane |

## Loaders / unloaders

| | |
|---|---|
| West No. 1 | Cement loader |
| West No. 4 | Grain conveyor |
| | 4 pipelines |
| West No. 5 | Livestock race |
| | LPG and tallow pipelines |

## Ro-ro facilities

| | |
|---|---|
| East No. 1 | Stern ramp |
| East No. 2 | Stern ramp |
| East No. 3 | Ships ramp |

## PORT OF FREMANTLE

### Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| North Quay No. 1-3 | 3 | 574 | 11.0 | 2.9 | 5 162 | |
| North Quay No. 4-9, 11/12 | 8 | 1511 | 11.0 | 22.3 | 13 588 | |
| Victoria Quay C-E | 3 | 604 | 11.0 | 2.8 | 11 842 | |
| Victoria Quay F-H | 3 | 685 | 11.0 | 2.9 | 8 494 | |
| *Dry bulk berths* | | | | | | |
| Aluminia Jetty | 1 | 224 | 11.6 | | | |
| Kwiniana Jetty | 1 | 291 | 16.8 | | | |
| Steelsworks Jetty | 1 | 500 | 12.2 | 8.0 | 12 000 | |
| Bulk Cargo Jetty | 2 | 480 | 13.4 | | | |
| *Liquid bulk berths* | | | | | | |
| North Quay No. 10 | 1 | 187 | 11.0 | 0.6 | 6 542 | |
| Oil Refinery Jetty | 3 | 215 | 12.8 | | | |

### Cranage

| | |
|---|---|
| North Quay No. 1-2 | Luffing crane |
| North Quay No. 4-5 | Two container cranes |
| North Quay No. 6-7 | Wharf crane |
| North Quay No. 8-9 | Mobile harbour crane |
| North Quay No. 10 | Luffing crane |
| North Quay No. 11-12 | Twin lift Paceco |
| Victoria Quay C-E | Two luffing cranes |
| Victoria Quay F-G | Two luffing cranes |

### Loaders / unloaders

| | |
|---|---|
| Oil Refinery Jetty | Three flow booms |
| Alumina Jetty | Loader |
| Kwinana Jetty | Four bulk loader system (grain) |
| Steelworks Jetty | Loader / unloader |
| Bulk Cargo Jetty | Ywo bulk unloaders |

### Ro-ro facilities

| | |
|---|---|
| North Quay No. 4-5 | |
| North Quay No. 12 | Stern ramp |
| North Quay No. 6-7 | |
| North Quay No. 8-9 | |

# PORT OF HOBART

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Macquarie No. 1-3 | 3 | 497 | 6.1 | | 12 053 | |
| Macquarie 4-5 | 2 | 379 | 11.2 | 3.7 | 7 175 | |
| Macquarie No. 6 | 1 | 189 | 10.1 | 0.7 | 3 942 | |
| *Dry bulk berths* | | | | | | |
| Spring Bay | 1 | 244 | 10.7 | | | |
| Princess No. 2-3 | 1 | 95 | 7.6 | 0.3 | 1 916 | |
| *Liquid bulk berth* | | | | | | |
| Selfs Point | 1 | 111 | | | | |

## Cranage

5 mobile cranes

## Loaders / unloaders

## Ro-ro facilities

| | |
|---|---|
| Princess | Ships ramp |
| Macquarie No. 2-3 | Ships quarter ramp |
| Macquarie No. 5-6 | Two adjustable ramps |

## PORT KEMBLA

### Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| BHP ro-ro berth | 1 | 50 | 11.0 | | | |
| Eastern Basin ro-ro | 1 | 50 | 9.2 | | | |
| Multipurpose berth | 1 | 175 | 16.3 | | | |
| Outer Harbour No. 6 | 2 | 600 | 7.8 | | | |
| *Dry bulk berths* | | | | | | |
| BHP discharge berth | 2 | 588 | 13.0 | | | |
| BHP products berth | 2 | 412 | 11.0 | | | |
| Eastern Basin - grain | 1 | 270 | 16.3 | | | |
| Eastern Basin - coal | 2 | 497 | 11.6 | | | |
| *Liquid bulk berth* | | | | | | |
| Outer Harbour - oil | 1 | 77 | 9.5 | | | |
| Outer Harbour No. 4 | 1 | 228 | 4.5 | | | |

### Cranage

| | |
|---|---|
| BHP Products | 4 luffing cranes |
| BHP Discharge | 2 luffing cranes |

### Loaders / unloaders

| | |
|---|---|
| Eastern Basin - coal | 4 ship loaders |
| BHP Discharge No. 1 | Belt conveyor |
| BHP Discharge No. 2 | 3 grab cranes |
| Easter Basin - grain | 2 gantry ship loaders |

### Ro-ro facilities

| | |
|---|---|
| BHP ro-ro berth | |
| Eastern Bain ro-ro | Stern ramp |

# PORT OF LAUNCESTON

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Bell Bay No. 2 | 1 | 87 | 8.4 | 4.7 | | |
| Bell Bay No. 5 | 1 | 314 | 9.0 | 3.8 | 2 675 | |
| *Dry bulk berths* | | | | | | |
| Bell Bay No. 1 | 1 | 153 | 10.8 | | | |
| Bell Bay No. 3 | 1 | 153 | 11.2 | | 744 | |
| Inspection Head | 2 | 334 | 9.9 | | 1 948 | |
| Long Reach | 2 | 446 | 11.2 | | | |
| *Liquid bulk berth* | | | | | | |
| Bell Bay No. 4 | 1 | 55 | 11.5 | | | |
| Power Station Berth | 1 | 26 | 12.3 | | | |

## Cranage

| | |
|---|---|
| Bell Bay No. 1 | Two grabbing cranes |
| Bell Bay No. 2 | Grabbing cranes |
| Bell Bay No. 3 | Travelling crane |
| Bell Bay No. 5 | Travelling crane |
| | Mobile harbour crane |

## Loaders / unloaders

| | |
|---|---|
| Bell Bay No. 1 | Conveyor (alumina) |
| Bell Bay No. 4 | 4 pipelines |
| Long Reach | 2 woodchip loaders |
| Power Station Berth | 3 pipelines |
| Inspection Head | 2 grain unloaders |
| | 2 pipelines (tallow) |

## Ro-ro facilities

| | |
|---|---|
| Bell Bay No. 1 | Ramp |
| Bell Bay No. 1 | Ramp |

# PORT OF MELBOURNE

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Swanson West | 4 | 944 | 13.1 | 24.0 | 8 500 | |
| Swanson East | 4 | 884 | 13.1 | 20.0 | 14 000 | |
| Appleton Dock B-D | 3 | 636 | 10.7 | 5.3 | 25 024 | |
| South Wharf | 7 | 1 523 | 8.5 | 4.0 | 17 485 | |
| Webb Dock | 4 | 853 | 7.0 | 28.5 | 1 089 | |
| Inner East Station Pier | 1 | 220 | 10.9 | | 5 934 | |
| Victoria Dock | 9 | 1 823 | 9.4 | 23.0 | 21 791 | |
| *Dry bulk berths* | | | | | | |
| North Wharf No. 9 | 1 | 128 | 8.5 | | | |
| South Wharf No. 25 | 1 | 215 | 11.0 | | | |
| South Wharf No. 33 | 1 | 215 | 13.1 | | | |
| Yarraville No. 1 | 1 | 178 | 7.1 | | | |
| Yarraville No. 5-6 | 2 | 434 | 9.4 | | | |
| Appleton Dock E-F | 1 | 344 | 10.7 | | | |
| *Liquid bulk berth* | | | | | | |
| Maribyrnong | 1 | 178 | 10.0 | | | |
| Holden Dock | 1 | 183 | 13.1 | | | |
| Gellibrand Pier | 1 | 289 | 11.8 | | | |
| Breakwater Pier | 1 | 213 | 11.8 | | | |

## Cranage

| | |
|---|---|
| Swanson Dock East | 4 container cranes |
| Swanson Dock West | 5 container cranes |
| Appleton Dock | 2 luffing cranes |
| Webb Dock | 2 container cranes |

## Loaders / unloaders

## Ro-ro facilities

| | |
|---|---|
| Victoria Dock No. 5-6 | 2 ramps |
| South Wharf No. 15 | Floating ramp |
| Webb Dock No. 2 | Ramp |

# PORT OF NEWCASTLE

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Throsby 1 / Lee 5 | 2 | 366 | 9.7 | 1.3 | 4 392 | |
| Basin 1,2,4 | 3 | 742 | 11.6 | 7.7 | | |
| *Dry bulk berths* | | | | | | |
| Basin No. 3 | 1 | 245 | 11.6 | | | |
| Dyke Wharves No. 1-2 | 2 | 476 | 12.8 | | | |
| Dyke Wharves No. 4-6 | 3 | 633 | 7.0 | | | |
| Kooragang Island No. 2-4 | 3 | 683 | 11.6 | 0.6 | | |
| BHP Steelworks No. 2-6 | 4 | 912 | 7.9 | | | |
| *Liquid bulk berth* | | | | | | |

## Cranage

| | |
|---|---|
| Basin No. 4 | Gantry crane<br>Floating crane |

## Loaders / unloaders

| | |
|---|---|
| Kooragang Island No. 2 | 2 grab unloaders |
| Kooragang Island No. 4 | 2 unloaders |
| Basin No. 3 | 4 gantry grain loaders |
| Dyke Wharves No. 2 | Shiploader (ore) |
| Dyke Wharves No. 4-6 | 3 coal loaders |
| Kooragang Island No. 4 | Coal loader |

## Ro-ro facilities

| | |
|---|---|
| Basin No. 4 | Stern ramp |

## PORT OF SYDNEY

### Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks (ha) |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Darling Harbour No. 4-10 | 6 | 1 450 | 9.8 | 21.0 | 46 638 | |
| White Bay No. 4-6 | 4 | 950 | 10.5 | 9.3 | 9 730 | |
| Glebe Island No. 1-2 | 2 | 468 | 11.7 | 9.9 | | |
| Brotherson Dock No. 1-3 | 5 | 1 000 | 15.3 | 42.3 | | |
| Brotherson Dock No. 4-6 | 3 | 936 | 15.3 | 38.6 | | |
| *Dry bulk berths* | | | | | | |
| Glebe Island No. 1-2 | 2 | 349 | 8.4 | 1.5 | | 6 |
| Blackwattle Bay | 3 | 335 | 2.8 | 1.7 | | |
| Johnstons Bay | 2 | 350 | 7.2 | 1.0 | | |
| *Liquid bulk berth* | | | | | | |
| Gore Cove No. 1-2 | 2 | 455 | 9.5 | 1.28 | | |
| Berrys Bay No. 1-2 | 2 | 345 | 8.2 | 0.43 | | |
| Kurnell No. 3 | 3 | 636 | 9.8 | | | |
| Bulk Liquids Berth | 1 | 215 | 19.0 | 15.0 | | |

### Cranage

| | |
|---|---|
| Darling Harbour | 2 mobile cranes |
| White Bay | Wharf crane |
| Johnstons Bay | 2 grabbing cranes |
| Brotherson Dock No. 1-3 | 5 container cranes |
| Brotherson Dock No. 4-6 | 4 container cranes |

### Loaders / unloaders

| | |
|---|---|
| Glebe Island No. 8 | Pneumatic discharge for soda ash |

### Ro-ro facilities

| | |
|---|---|
| Darling Harbour | 2 quarter ramps |
| Brotherson Dock No. 3 | Ramp |
| White Bay No. 3 | Ramp |

# PORT OF TOWNSVILLE

## Berthage

| | No. | Length (m) | Depth (m) | Open area (ha) | Covered area (ha) | Silos/ tanks |
|---|---|---|---|---|---|---|
| *Non-bulk berths* | | | | | | |
| Inner Harbour No. 4 | 1 | 228 | 5.2 | 1.6 | | |
| Inner Harbour No. 8 | 1 | 213 | 5.5 | 0.4 | | |
| Inner Harbour No. 10 | 1 | 160 | 5.0 | 2.6 | | |
| *Dry bulk berths* | | | | | | |
| Inner Harbour No. 2 | 1 | 254 | 5.8 | 0.8 | | |
| Inner Harbour No. 3 | 1 | 254 | 5.8 | 1.2 | | |
| Inner Harbour No. 7 | 1 | 183 | 5.1 | | | |
| Inner Harbour No. 9 | 1 | 228 | 5.5 | | | |
| *Liquid bulk berth* | | | | | | |
| Inner Harbour No. 1 | 1 | 270 | 5.2 | | | |

## Cranage

| | |
|---|---|
| Inner Harbour No. 2 | Travelling crane |
| Inner Harbour No. 3 | Container crane |
| Inner Harbour No. 8 | Fixed crane |
| Inner Harbour No. 10 | Luffing crane |

## Loaders / unloaders

| | |
|---|---|
| Inner Harbour No. 4 | Molasses pipeline |
| Inner Harbour No. 7 | Mineral concentrates, phosphate rock and ore loader |
| Inner Harbour No. 9 | Raw sugar loader |

## Ro-ro facilities

| | |
|---|---|
| Inner Harbour No. 3 | Ramp |
| Inner Harbour No. 4 | Ramp |

# APPENDIX II DEMAND FORECASTS

The following tables contain information on the actual demand in 1992-93, and forecast demand for both 1995-96 and 2014-15. The information is: categories of container cargo measured in TEUs, other non-bulk cargo, liquid and dry bulk cargo. The container cargo is further disaggregated into incoming and outgoing containers.

TABLE II.1 SEAPORT DEMAND, 1992-93

| | *Containers ('000 TEUs)* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Inwards* | | | *Outwards* | | | | *Other non-bulk '000 tonnes* | *Bulk (Mt)* | |
| *Port* | *Full* | *Empty* | *Total* | *Full* | *Empty* | *Total* | *Total* | | *Dry* | *Liquid* |
| Adelaide | 14.2 | 8.1 | 22.3 | 24.0 | 1.4 | 25.4 | 47.7 | na | na | na |
| Brisbane | 57.7 | 42.9 | 100.6 | 101.4 | 10.1 | 111.5 | 212.1 | 535.3 | 5.4 | 7.4 |
| Burnie | 27.0 | 10.8 | 37.8 | 38.9 | 5.4 | 44.3 | 82.1 | na | na | na |
| Cairns | na | na | na | na | na | na | 6.3 | na | na | na |
| Darwin | na | na | na | na | na | na | 5.3 | na | na | na |
| Devonport | na | na | na | na | na | na | 30.7 | na | na | na |
| Fremantle | 53.8 | 20.5 | 74.3 | 60.7 | 7.8 | 68.5 | 142.8 | 597.1 | 8.2 | 8.0 |
| Hobart | 10.0 | 1.9 | 11.9 | 21.4 | 0.2 | 21.6 | 33.4 | 143.8 | 1.5 | 0.6 |
| Launceston | 14.1 | 6.6 | 20.7 | 20.9 | 2.9 | 23.8 | 44.6 | 58.3 | 2.8 | 0.1 |
| Melbourne | 292.0 | 42.6 | 334.6 | 283.5 | 56.9 | 340.4 | 675.0 | 1627.1 | 1.4 | 2.2 |
| Newcastle | na | na | na | na | na | na | na | 853.3 | 49.6 | 0.2 |
| Port Kembla | na | na | na | na | na | na | na | 1874.6 | 24.2 | 0.2 |
| Sydney | 280.5 | 16.2 | 296.7 | 182.3 | 73.2 | 255.5 | 552.2 | 800.0 | 0.7 | 11.6 |
| Townsville | na | na | na | na | na | na | 13.7 | 354.5 | 4.1 | 1.0 |

na Not available

*Source* Travers Morgan (1994).

TABLE II.2 SEAPORT DEMAND, 1995-96

| | Containers ('000 TEUs) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Inwards | | | Outwards | | | | Other non-bulk | Bulk (Mt) | |
| Port | Full | Empty | Total | Full | Empty | Total | Total | '000 tonnes | Dry | Liquid |
| Adelaide | 14.9 | 10.3 | 25.1 | 30.3 | 2.4 | 32.7 | 57.8 | na | na | na |
| Brisbane | 60.9 | 50.5 | 111.4 | 119.4 | 10.7 | 130.1 | 241.5 | 572.3 | 5.8 | 7.9 |
| Burnie | 27.4 | 11.3 | 38.7 | 40.7 | 5.4 | 46.1 | 84.8 | na | na | na |
| Cairns | na | na | na | na | na | na | 6.9 | na | na | na |
| Darwin | na | na | na | na | na | na | 5.8 | na | na | na |
| Devonport | na | na | na | na | na | na | 31.6 | na | na | na |
| Fremantle | 56.1 | 23.4 | 79.6 | 69.5 | 8.1 | 77.6 | 157.2 | 638.3 | 8.7 | 8.5 |
| Hobart | 10.1 | 1.9 | 12.0 | 21.7 | 0.2 | 21.9 | 33.9 | 151.5 | 1.6 | 0.6 |
| Launceston | 14.3 | 6.9 | 21.2 | 21.7 | 3.0 | 24.6 | 45.8 | 61.4 | 2.9 | 0.2 |
| Melbourne | 298.2 | 45.5 | 343.7 | 302.6 | 58.1 | 360.7 | 704.4 | 1739.4 | 1.5 | 2.4 |
| Newcastle | na | na | na | na | na | na | na | 853.3 | 55.0 | 0.2 |
| Port Kembla | na | na | na | na | na | na | na | 2048.5 | 26.4 | 0.2 |
| Sydney | 287.3 | 17.4 | 304.7 | 195.7 | 75.0 | 270.7 | 575.4 | 855.3 | 0.8 | 12.4 |
| Townsville | na | na | na | na | na | na | 14.4 | 373.4 | 4.4 | 1.0 |

na Not available

*Source* Travers Morgan (1994); for Newcastle and Port Kembla, NSW Department of Mineral Resources (pers. comm. 1994).

TABLE II.3 SEAPORT DEMAND, 2014-15

| | Containers ('000 TEUs) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Inwards | | | Outwards | | | | Other non-bulk '000 tonnes | Bulk (Mt) | |
| *Port* | *Full* | *Empty* | *Total* | *Full* | *Empty* | *Total* | *Total* | | *Dry* | *Liquid* |
| Adelaide | 16.7 | 14.7 | 31.3 | 43.3 | 2.7 | 46.0 | 77.3 | na | na | na |
| Brisbane | 85.4 | 142.3 | 227.7 | 336.2 | 15.0 | 351.2 | 578.9 | 873.4 | 8.9 | 12.1 |
| Burnie | 30.1 | 15.0 | 45.1 | 54.0 | 6.0 | 59.9 | 105.1 | na | na | na |
| Cairns | na | na | na | na | na | na | 11.8 | na | na | na |
| Darwin | na | na | na | na | na | na | 11.2 | na | na | na |
| Devonport | na | na | na | na | na | na | 38.6 | na | na | na |
| Fremantle | 73.1 | 55.1 | 128.2 | 163.4 | 10.6 | 173.9 | 302.1 | 974.1 | 13.3 | 13.0 |
| Hobart | 10.4 | 2.2 | 12.6 | 24.4 | 0.2 | 24.6 | 37.2 | 210.7 | 2.2 | 0.8 |
| Launceston | 15.4 | 8.6 | 24.0 | 27.2 | 3.2 | 30.4 | 54.4 | 85.3 | 4.1 | 0.2 |
| Melbourne | 340.4 | 68.8 | 409.2 | 457.5 | 66.4 | 523.9 | 933.1 | 2654.6 | 2.5 | 3.6 |
| Newcastle | na | na | na | na | na | na | na | 1818.7 | 75 | 0.5 |
| Port Kembla | na | na | na | na | na | na | na | 3592.0 | 26.4 | 0.4 |
| Sydney | 334.3 | 27.3 | 361.6 | 307.1 | 87.2 | 394.3 | 755.9 | 1305.3 | 1.2 | 18.9 |
| Townsville | na | na | na | na | na | na | 19.7 | 519.2 | 6.4 | 1.4 |

na Not available

*Source* Travers Morgan (1994); for Newcastle and Port Kembla, NSW Department of Mineral Resources (pers. comm. 1994).

## REFERENCES

### ABBREVIATIONS

| | |
|---|---|
| ABS | Australian Bureau of Statistics |
| AGPS | Australian Government Publishing Service |
| BTCE | Bureau of Transport and Communications Economics |
| MSB | Maritime Services Board of New South Wales |
| NTPT | National Transport Planning Taskforce |
| PMA | Port of Melbourne Authority |

ABS 1994, *National Income, Expenditure and Product,* Catalogue no. 5206.0 , ABS, Canberra.

Australian Transport Council 1993, *Port Performance Indicators,* Department of Transport and Communications, Canberra June.

BTCE 1995, *Adequacy of Transport Infrastructure: Airports,* Working Paper no. 14.4, BTCE, Canberra.

—— 1995, *Adequacy of Transport Infrastructure: Urban Roads,* Working Paper no. 14.5, BTCE, Canberra.

—— 1995, *Adequacy of Transport Infrastructure: Rail,* Working Paper no. 14.2, BTCE, Canberra.

—— 1995, *Building for the Job: A Strategy for Australia's Transport Network, Commissioned Work* vol. 1, NTPT, Canberra.

Bureau of Industry Economics 1993, *International Performance Indicators - Waterfront Australia,* AGPS, Canberra.

Centre for Transport Policy Analysis, Wollongong (Unpub.)

Cosgrove. D. and Gargett. D. 1992, 'The Australian domestic transport task', *Australian Transport Research Forum,* 17, vol. 1, pp. 231-49, Bureau of Transport and Communications Economics, Canberra.

Fremantle Port Authority 1993, *Victoria Quay Study Report*, Fremantle Port Authority, Fremantle, Western Australia.

Keating, P. J. 1992, *One Nation*, AGPS, Canberra.

Maunsells Pty Ltd 1994, Sea terminal infrastructure: final report, Report to BTCE, Canberra, September.

MSB 1992, *Corporate Plan 1992-95*, MSB New South Wales.

*One Nation. See* Keating 1992.

Port of Brisbane Authority 1992, *Key Port Brisbane Strategic Plan to 2005 and Beyond*, Port of Brisbane Authority, Brisbane.

PMA 1991, *Victorian Ports Land Use Strategy: Draft Final Report*, December, PMA, Melbourne.

Travers Morgan 1994, Report to BTCE, Canberra.

## ABBREVIATIONS

| | |
|---|---|
| ABS | Australian Bureau of Statistics |
| BTCE | Bureau of Transport and Communications Economics |
| EDI | Electronic data interchange |
| GDP | Gross domestic product |
| M | Million |
| NTPT | National Transport Planning Taskforce |
| PMA | Port of Melbourne Authority |
| TEU | Twenty foot equivalent unit |
| MSB | Maritime Services Board of New South Wales |