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Transport for NSW

Northern Sydney Freight Corridor Program – Updated Stage 1 Business Case

16 December 2011

Deloitte Touche Tohmatsu
ABN 74 490 121 060

Grosvenor Place
225 George Street
Sydney NSW 2000
PO Box N250 Grosvenor Place
Sydney NSW 1220 Australia

[redacted]
Tel: +61 (0) 2 9322 7000
Fax: +61 (0) 29322 7261
www.deloitte.com.au

Mr James Griffin
Senior Project Manager
Level 5, Tower A, Zenith Centre
821 Pacific Highway, Chatswood
NSW, 2007

16 December 2011

Our Ref:

Dear James

Re: Northern Sydney Freight Corridor Program – Updated Stage 1 Business Case

Please find attached our updated report for the Northern Sydney Freight Corridor Upgrade Program Updated Stage 1 Business Case. The report and evaluation has been updated with the latest costing information provided by Transport for NSW.

If you would like to clarify any aspect of this report or discuss other related matters then please do not hesitate to contact me at [redacted] or telephone [redacted].

[redacted]

[redacted]

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Contents

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1 Executive Summary

1.1 Background

Transport for NSW is leading the development of the Business Case to identify the optimal scope of works for network improvements required to support freight and passenger operations on the Strathfield to Broadmeadow section of the Main North Line, alternatively known as the Northern Sydney Freight Corridor (NSFC).

This analysis provides an update to the economic and financial assessment of the Stage 1 works, which was undertaken by SAHA International and presented in September 2010. The updated analysis includes revisions to both project costs and benefits based on more recent work. The updates to the evaluation include the following:

- Revised capital cost estimates based on refined project scope
- Delay in the project benefit evaluation by on year to reflect the revised project program.

1.2 Rail Freight Demand and Capacity

Previously the Outline Business Case (May 2010) developed weekly demand estimates based on an 'average day' where all days were assumed the same through the week. The current analysis uses a refined approach, to allow for variable demand through the week as well as by time of day. The identification of peak day demand is important since it is the determining factor is assessing rail freight capacity constraints.

Peak day demand was determined by analysis of the Standard Working Timetable which showed the train demand on the busiest day of the week. From this information it is evident that for 'A' schedules (interstate intermodal traffic), demand is largely in the core period (04.01-22.00), reflecting the time sensitive nature of this cargo, whereas 'C' schedule (regional intermodal, steel, coal and grain) trains run both in the core and the non-core (22.01-0.400) periods.

The peak day demand was compared to the average day demand[1] to derive a series of factors to determine total weekly train demand by train type. A minor adjustment was applied in these calculations which assumed some peak spreading in the future, with a more even distribution of demand over the week as forwarders seek to maximise the remaining available train path capacity.

The weekly demand forecasts for 'A' schedule trains which were initially developed as unconstrained estimates, would be unlikely to be achieved in the absence of significant investment in rail freight capacity. Consequently, a ramp-up profile was applied which lagged demand growth in the short term but increased growth once the Stage 1 works were completed by 2016. For 'C' schedule trains the level of expected demand growth was much lower representing an annual increase of less than 3.7% per annum and these forecasts were utilised directly in the analysis.

The current and future supply of freight train capacity was provided by the Project Control Group and has been disaggregated by time of day and by direction. The capacity analysis indicates that the number of paths increases significantly with the project upgrade, particularly for the core period, with the number of 'A' schedule paths increasing by 130% in the Down direction and 120% in the Up direction. It should be noted that the Stage 1 works does not provide for any increase in 'C' schedule train capacity.

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[1] Total weekly demand divided by 7.

Based on this information, a number of steps were undertaken to derive constrained rail freight demand forecasts for the base case and the project case including:

- The capacity analysis indicated an imbalance in the Down and Up capacity in both the base case and the project case. It was assumed that train movements in each direction would balance over the day, and therefore the difference in core period 'A' train capacity between the Up and the Down would be rectified by a shift in demand from the core to the non-core period
- In the core period, the lagged growth 'A' train demand profile was constrained to reflect the 'A' schedule core capacity
- 'C' schedule demand was also constrained to reflect the 'C' schedule train core period capacity
- In the base and project cases, in the non-core period where 'C' train demand was greater than 'C' train capacity, the excess 'C' trains were reallocated to available non-core 'A' train paths, subject to capacity
- Both transferred 'A' (directional imbalance) and 'C' train (excess non-core demand) growth is accommodated until non-core 'A' train path capacity is exhausted.

Based on the above, in the base case for 'A' schedule trains, demand is forecast to become capacity constrained in the core period by 2015 in the Up direction and 2018 in the Down direction. In this situation, all future growth in freight is assumed to be catered for by road transport and 'A' schedule train volumes are held constant. For 'C' schedule trains, capacity remains available in the non-core period, and additional growth in this traffic can be accommodated in the future.

In the with project case, the additional capacity allows additional freight traffic to be transported by rail compared to the base case and this differences in rail freight demand forms the basis of the benefit estimation described below.

1.3 Project Costs

The capital cost estimates have been updated based on a revised scope of works for the Stage 1. These include the following project components:

- North Strathfield rail underpass;
- Hexham passing loop;
- Epping to Pennant Hills 3rd track; and
- Gosford passing loops.

The capital costs used in the evaluation are summarised in Table E.S.1. These estimates are expressed in 2011 dollars and have been adjusted to remove contractor margin and client contingency. To reflect the growth in real incomes over time, the labour component of the capital costs was increased by 1% per annum. A capital to labour ratio of 2:1 was assumed which meant that 33% of capital cost was increased to reflect this change. The resultant undiscounted capital cost estimates based on P50 and P90 levels of probability are shown in Table E.S.1.

Table E.S.1: Capital Cost Estimates ($ million)

	Stage 1 P50	Stage 1 P90
Outturn cost	984	1,053
Cost estimate excluding escalation	849	907
Cost less client contingency and margin	697	745
Cost with real inflation	706	755
Discounted capital cost	530	566

Source: Transport for NSW

1.4 Project Benefits

The Stage 1 works package provides increased core period capacity. It is reasonable to assume that core period paths would command a premium price to meet the scheduling of arrival times at the point of destination, and hence would carry higher value freight than using non-core paths where there is less conflict with passenger services and hence more capacity.

For the 'A' schedule traffic which is transported by rail largely using the core period capacity, a 10% uplift in the value of the benefits likely to accrue to shippers as a result of the project has been applied. This includes the following benefit categories: 'time savings', 'operating costs' and 'customer benefits'. Other benefits include those resulting from a mode shift from road to rail as a result of increased rail freight capacity and include road decongestion cost savings, reduced externality costs and reduced road crash costs.

Furthermore, additional wider economic benefits could occur as a result of the project which includes labour market and productivity impacts not captured by the conventional appraisal.

1.5 Evaluation Approach

The corridor upgrade was compared with the base case using a discounted cash flow technique on the basis of a real discount rate of 7% in accordance with ATC, Infrastructure Australia, NSW Treasury and RailCorp investment appraisal guidelines. Project capital expenditure is assumed to take effect from 2010/11 and all values are expressed in constant 2011 dollars. The benefits of the project were assessed over a 30 year evaluation period as per the Australian Transport Council and Infrastructure Australia guidelines.

1.6 Economic Evaluation Results

The economic evaluation results are summarised in Table E.S.2. These show the costs and benefits of the Stage 1 works package incremental to the project base case. The economic evaluation (under the P90 cost estimate scenario) produces a positive economic return, with a BCR of 2.7 and a NPV of approximately $1.2 billion. This is due to the significant increase in capacity provided by this option compared to the base case. Under the P50 cost estimate scenario the BCR increases to 2.9.

Within the benefit components, the largest contributor to the benefit stream is the reduction in freight transport operating costs resulting from a switch in freight transportation from road to rail being passed on by freight operators through lower prices. This result is consistent with the findings of the current ARTC Melbourne to Brisbane Inland Rail Study where freight operating cost benefits also represent the largest component of project benefits. These benefits would occur to either freight transport operators (producer surplus) which would result in lower costs and increased profits or to freight consignees (consumer surplus) as a result of lower shipment costs. The distribution of these benefits to these different parties would be dependent on the competitive structure of the freight logistics industry. In all likelihood, these benefits would be shared between these two groupings. The inclusion of wider economic benefits increases the economic returns.

Table E.S.2: Economic Evaluation Results at 7% Real Discount Rate (P90 Cost Estimates)

	Stage 1 (incremental to base case)
Total Undiscounted Capital Costs ($ mn)	755
Project Costs (present value (PV) $ mn):	
Capital Costs	566
Maintenance costs	103
Total Project Costs	669
Freight Benefits (PV $ mn)	
Transit time savings	7
Operating cost savings	1,302
Road freight decongestion	20
Customer reliability benefits	101
Externality cost savings	166
Crash cost savings	199
Residual value	46
Total benefits	1,841
Summary excluding WEBS	
NPV ($ mn)	1,172
NPV/I	2.1
BCR (ratio)	2.7
IRR (%)	15%
BCR (including WEBS)	3.0

Note: figures may not sum due to rounding

1.7 Sensitivity Analysis

The economic evaluation involves making estimates of a number of factors which are subject to uncertainty. These include assumptions which impact on both the project costs and benefits. The sensitivity test analysis indicates that the results are most sensitive to the assumptions regarding discount rate, capital cost and traffic assumptions. However, despite these changes the economic evaluation results remain positive.

Table E.S.3 summarises the range of economic results based on the P50 and P90 costs estimates for 4.4%, 7% and 10% discount rates.

Table E.S.3: Range Economic Results

Scenario			
	4.4% discount rate	**7% discount rate**	**10% discount rate**
P50 cost estimate	4.2	2.9	2.0
P90 cost estimate	4.0	2.7	1.9

1.8 Financial Evaluation

The financial evaluation concentrates on the financial costs and benefits which accrue as a result of the project. In this study these are limited to capital and maintenance costs, as well as increased track access revenue to the track operator as a result of increased freight tonnages. The results of the financial evaluation are shown in Table E.S.4. It is evident that Stage 1 option does not provide a positive financial return.

Table E.S.4: Financial Evaluation Results at 7% Real Discount Rate (P90 Cost Estimates)

	Stage 1 (incremental to base case)
Total Undiscounted Capital Costs ($ mn)	755
Project Costs (present value (PV) $ mn):	
Capital Costs	566
Maintenance costs	103
Total Project Costs	669
Freight Benefits (PV $ mn)	
Track access fees	358
Residual value	46
Total benefits	404
Summary excluding WEBS	
NPV ($ mn)	-265
NPV/I	-0.5
BCR (ratio)	0.6
IRR (%)	4%

Note: figures may not sum due to rounding

1.9 Conclusions

The evaluation indicates that there is economic merit in implementing the Stage 1 works package with a BCR 2.7, well in excess of the level required for project viability. However, the project does not provide a viable financial return with additional track access revenue below the level of increased capital and operating expenditure as a result of the project.

2 Introduction

2.1 Background

Transport for NSW is leading the development of the Business Case to identify the optimal scope of works for network improvements required to support freight and passenger operations on the Strathfield to Broadmeadow section of the Main North Line, alternatively known as the Northern Sydney Freight Corridor (NSFC).

This report provides an update to the economic and financial assessment of the proposed Stage 1 works package which represents the initial capital investment in the corridor to be completed between 2010/11 and 2016/17. An outline business case for the Stage 1 works as well as upgrade options for the full corridor was presented to Infrastructure Australia in October 2009 as well as a subsequent submission to IA which was prepared in 2010. This updated analysis includes revisions to both project costs and benefits for the Stage 1 package of works.

This report includes the following sections:

- Section 3 - Project background
- Section 4 - Approach to evaluation
- Section 5 - Rail freight demand
- Section 6 - Project costs and benefits
- Section 7 - Wider economic benefits
- Section 8 - Evaluation results.

The Benefit-Cost Analysis (BCA) includes detailed information and analysis on the expected social, economic and environmental impacts of the project. The analysis of Wider Economic Benefits (WEB’s) takes the BCA results further by examining the likely broader impacts of the project associated with industry productivity, imperfect competition and agglomeration economies. However, data problems surrounding labour supply elasticities, productivity estimates for firms using rail as part of their logistics chains and tax trade-offs limited the depth of the WEB analysis. Hence, the WEB results should be used as indicative only.

The financial analysis focuses on the direct costs and returns to rail system operators, and hence excludes consumer surplus and producer surplus benefits from the assessment.

2.2 The NSFC Program

The original services brief for the Appraisal and Outline Business Case provided a summary of the objectives of the NSFC project. The Australian Government provided funding of $840 million to TCA under the Nation Building Program for NSFC Project’s initial design and planning phase. The NSFC project objectives of capacity, efficiency, productivity, reliability and availability, safety and sustainability as applied to the study corridor are summarised in Table 2.1.

Table 2.1: NSFC Project Objectives and System Requirements Study Project Outcomes

Objective	Project Outcomes
Capacity	Improved capacity for freight services on the Strathfield-Newcastle rail line to meet growing transport demands. Flow-on capacity benefits to the entire Melbourne – Sydney – Brisbane corridor by removing the capacity bottleneck through northern Sydney. Road congestion benefits flowing from diversion of freight from road to rail.
Efficiency	Rail operational efficiencies flowing from improved reliability, reduced transit times, reduced congestion and greater capacity. Reductions in road maintenance expenditures flowing from diversion of freight from road to rail.
Productivity	Improved productivity of rolling stock and train crew resources flowing from improved reliability and transit times.
Reliability and Availability	Reduce (and long term eliminate) current peak period restrictions on freight service availability, providing greater flexibility in rail arrival and departure times to meet customer needs. Improved reliability contributing to improved rail market share and lower cost structures. Benefits to freight customers from improved rail reliability and availability.
Safety	Reduced road accidents by facilitating increased rail market share and fewer road heavy vehicle safety incidents.
Sustainability	Reduced air pollution, greenhouse emissions, noise flowing from diversion of freight from road to rail.

At its meeting in May 2008, the Australian Transport Council (ATC) agreed on a comprehensive reform program for land transport, including the development of an efficient rail freight system guided by a National Transport Policy (ATC 2008). As part of this requirement, Infrastructure Australia has recognised upgrading of the North-South rail corridor as a national priority. This is part of a broader objective set by IA:

> *Infrastructure Australia supports significant investment in Australia's rail freight network; and Infrastructure Australia considers that a new National Freight Strategy needs to be developed for our freight networks to improve planning, investment and decision making, as part of a complete Integrated National Transport Plan.* (Australian Government 2009, National Infrastructure Priorities, Canberra, May.)

The Australian Rail Track Corporation (ARTC) has a business requirement of being able to provide capacity to:

- Reduce and ultimately eliminate peak-period restrictions on freight services
- Meet future growth in freight path demand (with flexibility to accommodate alternative future demand scenarios)
- Cope with peaks in freight demand at certain times of the day (with flexibility to accommodate alternative time-of-day demand scenarios in the future)

- Provide back-up paths to allow late-running freight services to enter the Sydney area when they have missed their allotted path
- Ensure availability of freight paths during passenger service disruptions.

The Stage 1 package of infrastructure upgrades in the study corridor has been developed to deliver a significant increase (approximately double) in core period (0400 hours to 2200 hours) rail freight capacity compared to the existing situation as well as delivering a small average transit time saving to freight services in the corridor (10 minutes).

The works will reduce conflicts between freight and passenger services, with consequential flow-on reliability benefits to passenger services, however, (as a conservative assumption) these have not been quantified within the economic evaluation. In addition, certain of the works (such as North Strathfield Rail Underpass) are a pre-requisite to future passenger service frequency increases, although the latter will require additional scope not included within the Stage 1 works and accordingly benefits are not attributable to Stage 1 in isolation.

Further stages of infrastructure investment have been developed which includes Stage 1 as well as additional improvement which would follow on from the initial works packages. These are not assessed in this report. The key issues for TCA in developing a business case for funding the rail upgrade program were seen as:

- Assessing which options should be implemented in terms of:
  - Benefits and costs
  - Enhancing rail capacity for passengers and freight
  - Meeting the performance targets of Railcorp and ARTC
  - Contribution to meeting Governments' objectives for transport (Table 2.1).
- Estimating the forecast demand for passenger and freight services
- Identifying, estimating and allocating the distribution of benefits and costs
- Determining the scheduling of works to deliver early benefits to rail operators and users
- Assessing the indirect rail passenger benefits
- Assessing the financial impacts of the rail upgrades for operators and users of the rail system.

This report provides an update of the economic and financial assessment of the Stage 1 works package.

2.3 November 2011 Update

This analysis provides an update to the economic and financial assessment of the Stage 1 works, which was undertaken by SAHA International and presented in September 2010. Since this time, assumptions relating to project definition and timing have been updated and refined which affects the timing and quantum of the capital costs. The revised project program also impacts on project benefits which are assumed to start one year later (2017).

2.4 Other Studies

A significant volume of analysis has already been undertaken to date in relation to the project. These include:

- North Sydney Freight Corridor, Preliminary Economic Evaluation - SAHA International, late 2008
- Passenger Forecasts for Main North Freight Draft Report - Halcrow MWT February 2009
- Northern Sydney Rail Corridor Freight Demand Assessment, Final Project Findings - SAHA International February 2009
- Northern Sydney Freight Corridor Systems Requirements Study – Worley Parsons, December 2009 (Unvalidated Draft)
- Business Requirements for Northern Sydney Freight Corridor Program - RailCorp October 2009
- Northern Sydney Freight Corridor – Rail Freight Business Requirements - ARTC May 2009
- North Sydney Freight Corridor Freight Demand Estimation - ARTC July 2009; and
- North West Rail Link Economic Appraisal Update, Final Report, Douglas Economics, May 2010.

The above documents were reviewed by Deloitte in the formulation of the methodology for the assessment of options as part of the Business Case. In addition, these reports were supplemented by various other documents and discussions with both the various project consultants as well as the Project Control Group (PCG) including Transport for NSW, ARTC and RailCorp.

3 Project Background

3.1 Forecast Growth in the Sydney – Brisbane Freight Market

Various studies have forecast the demand for freight on the eastern seaboard of Australia. In addition to the studies referred to in Section 2.3 of particular relevance to this study are:

- Sydney-Brisbane Corridor Strategy - AusLink (2006)
- Melbourne-Brisbane Corridor Strategy - Auslink (2006)
- Demand Projections for AusLink Non-Urban Corridors: Methodology and Projections, Working Paper 66, BTRE (2006)
- Estimating Urban Traffic and Congestion Cost Trends for Australian Capital Cities, Working Paper 71, BTRE (2007)
- Melbourne – Brisbane Inland Rail Alignment Study - ARTC (2009)
- Inter-City Traffic Projections - BITRE (2009)
- Northern Sydney Rail Freight Demand Assessment - SAHA (2009).

Overall, these studies have highlighted the high rate of growth that is likely to characterise the Sydney-Brisbane freight corridor over the period relevant to the development of the Business Case for the NSFC. Much of this forecast increase in demand is expected to be driven by population growth and growth in real incomes. Table 3.1 summarises the key results for inter-capital freight movements forecast by the Bureau of Infrastructure, Transport and Regional Economics (BTRE/BITRE) for the Sydney-Brisbane corridor. These forecasts are based on origin-destination container movements for Sydney-Brisbane interstate traffic. While these forecasts provide base estimates, they do not include the significant volume of inter-regional freight flows between Broadmeadow and Sydney which are also relevant to the upgrade program. Further, these forecasts are based on the then available current rail capacity for container freight when the forecasts were made by the BITRE (i.e., no assumed capacity enhancements including ARTC’s current East Coast upgrade program).

Table 3.1: BTRE Demand Projections: Origin – Destination Sydney – Brisbane Corridor (Non Bulk)

Variable	1999	2025
Road ('000 t)	3,845	10,861
Rail ('000 t)	848	963
Total ('000 t)	4,693	11,824
Rail share (%)	18.1	8.1
	Average annual growth rates (%)	
Road 1999-2025	4.1	Road 1999-2025
Rail 1999-2025	0.5	Rail 1999-2025
All modes 1999-2025	3.6	All modes 1999-2025

In order to develop investment plans to meet forecast demand for rail passenger and freight flows in the Broadmeadow-Sydney corridor, the Transport Project Division of Transport for NSW commissioned Deloitte to undertake a detailed analysis of rail freight demand in that corridor. In contrast to the BITRE forecasts in Table 3.1, the Deloitte forecasts were based on ARTC estimates that rail freight volumes could increase significantly as a result of improvements in transit times and reliability and increases in energy costs. This required consideration of both inter-capital and inter-regional rail freight flows involving the following commodity groups:

- Containers
- Coal
- Grain and grain products
- Steel
- Building products.

It should be noted that the demand forecasts whilst based on a detailed market assessment involving significant consultation with freight market stakeholders, it has not utilised logit modelling to estimate demand for different levels of service. This more detailed assessment should be undertaken in the next phase of the project.

The results of that analysis are summarised in Table 3.2. The main drivers of demand were growth in GDP/ GSP, population and factors specific to individual commodity markets such as steel. The estimates cover a range of possible scenarios including climate change, oil price movements, coal production, modal shares between road and rail transport, and demographic factors influencing the demand for building products, etc. This generated "low" and "high" forecasts of demand for rail freight.

Table 3.2: Annual Rail Tonnages Carried in Each Market Segment ('000 tonnes)

Market segment	2008	2018		2028		2038	
	2008	Low	High	Low	High	Low	High
Interstate Intermodal	1,659	5,035	9,738	6,388	15,297	8,098	20,979
Regional Intermodal	782	970	1,081	1,165	1,315	1,388	1,629
Port of Newcastle	0	0	0	4,320	4,320	4,320	4,320
Steel	1,215	1,392	1,615	1,572	2,057	1,771	2,607
Grains and Grain products	568	628	641	690	715	738	776
Coal	5,150	6,881	14,903	5,253	14,657	1,000	15,503
Building Products	160	160	1,180	160	1,680	160	1,680
TOTAL	**9,534**	**15,066**	**29,157**	**15,299**	**40,041**	**13,155**	**47,314**
TOTAL (w/o Wyong)	**9,534**	**15,066**	**24,157**	**15,299**	**35,041**	**13,155**	**42,314**
TOTAL (incl. Port of Newcastle)	**9,534**	**15,066**	**29,157**	**19,549**	**44,361**	**17,475**	**51,634**

Source: SAHA (2009), Northern Sydney Rail Corridor Freight Demand Assessment, Sydney.

These forecasts were translated into train movement equivalents, as shown in Table 3.3.

Table 3.3: Forecast Train Trip Movements per Week (per direction)

Market segment	2008	2018		2028		2038	
	2008	Low	High	Low	High	Low	High
Interstate Intermodal	20	53	102	58	140	65	166
Regional Intermodal	9	12	13	14	16	17	20
Port of Newcastle	-	-	-	29	29	29	29
Steel	12	13	15	15	20	17	25
Grains and Grain products	8	9	9	10	10	11	11
Coal	18	29-80	47-116	19-59	51-132	6	40-120
to Port Kembla	11	11	19	6	19	6	7
to power stations	28	17-69	17-69	13-54	21-85	-	21-85
Wyong coal mine	-	-	11-28	-	11-28	-	11-28
Building Products	3	3	19	3	27	3	27
Total	71	118-170	207-276	119-159	264-345	117	289-369
Total (without Wyong)	71	118-170	196-248	119-159	253-317	117	278-341
Total (incl. Port of Newcastle)	71	118-170	207-276	148-188	293-374	146	318-399

Source: SAHA (2009), Northern Sydney Rail Corridor Freight Demand Assessment, Sydney.

From these “low” and “high” estimates of forecast demand for freight, ARTC derived a “mid-range” set of forecasts for use in the economic analysis. These forecasts are discussed in more detail in section 4.1. Under the Base Case (or ‘without project’ situation), it was assumed that intermodal freight would divert to road transport when track access for rail freight services reached a capacity constraint. The base case is discussed in more detail in section 4.5.1.

3.2 Forecast Road Traffic Growth

For the Sydney-Newcastle corridor, the BITRE (2009) has forecast an annual average rate of increase in vehicle traffic of 1.55% as shown in Table 3.4. Light vehicle traffic is forecast to increase at the higher rate of 1.63% a year, with the main generator being growth in private car usage for journey to/from work between the Central Coast and the Sydney metropolitan area.

Table 3.4: Forecast Growth in Traffic for the Sydney – Newcastle Corridor

Average traffic levels (vehicles per day)					
Light vehicles		Heavy vehicles		All vehicles	
2005	2030	2005	2030	2005	2030
48,077	72,043	4,857	5,640	52,934	77,683
Average annual traffic growth (per cent per annum)					
1.63		0.60		1.55	

Source: BITRE 2009

3.3 Sydney's Transport Challenge

Total vehicle kilometres travelled (VKT) in Sydney increased from 29.2 billion in 1990 to 40.51 billion in 2005, and are forecast to increase to 54.71 billion by 2020, which represents a 35% increase over the period 2005-2020. A significant component of this task is passenger transport which almost doubled between 1977 and 2004. In terms of passenger car equivalent units (PCU), the BTRE (2007) forecast an increase of 38% between 2005 and 2020.

The Sydney urban public transport task is greater than that of any of Australia's other capital cities, attributable mainly to the large numbers of passengers using rail over relatively long distances. The share of UPT in Sydney represented around 13% of the total passenger transport task in 2003 (BTRE 2007) and has remained fairly constant at that level since 1977. In 2006, while public transport accounted for 22.1% of all journeys to/from work in Sydney, approximately 74.6% of peak hour commute trips to the CBD were on public transport (NSW State Plan 2008).

Over the period 1971 to 2003, the freight task in Sydney grew at an average annual rate of 3.8%, increasing from 2.82 billion net tonne-kilometres to 10.39 billion net tonne-kilometres. Subsequently, the freight task in Sydney is forecast to grow at around 3.0% per annum to 2020, increasing to 17.85 billion net tonne-kilometres (BTRE 2007).

With these forecast increases in the passenger and freight transport tasks for Sydney and assuming that there would not be any significant changes to road and rail infrastructure in the Sydney region, the cost of congestion is expected to increase from $3.5 billion in 2005 to $7.8 billion in 2020 (BTRE 2007). Under this scenario, the major component of this cost will be delay costs to businesses. This is likely to have major impacts on the social amenity of Sydney as a city in which to live and work, and on its competitiveness in attracting investment capital and businesses to locate in Sydney.

Projects such as the Northern Sydney Freight Corridor and the Southern Sydney Freight Line have the potential to ease infrastructure capacity constraints and contribute to an amelioration of this forecast increase in the cost of congestion for Sydney. This also assumes that intermodal capacity would expand as freight operators managed the forecast increase in demand for rail freight and a shift from road to rail transport as a result of the rail upgrades.

3.4 Project Scope

The NSFC is among the most heavily utilised general freight corridors in Australia forming part of the East Coast interstate (Melbourne – Sydney - Brisbane) freight rail network which passes through Sydney and the Central Coast. In addition, the Main North Line is also a major passenger train corridor linking Sydney with the Central Coast and Newcastle via Hornsby. The study corridor is shown in Figure 3.1.

Figure 3.1: Northern Sydney Freight Corridor

Source: Transport for NSW

A number of recent studies have identified that improving reliability of trains through the Sydney rail network could have a significant impact on attracting more freight traffic to rail on the Melbourne – Sydney – Brisbane corridor. Given the construction of the Southern Sydney Freight Line, the focus is now on Northern Sydney rail access to address this issue.

Infrastructure investment to address current problems surrounding track capacity for northern rail access in Sydney could positively impact its competitive position *vis-à-vis* road transport by addressing:

- The availability of rail track - rail infrastructure is shared between freight and passenger train paths and priority in use of train paths is given to passenger services including restrictions for rail freight access during peak periods
- Signalling which limits capacity in the corridor
- Alignment problems which restrict freight train lengths and operating speeds
- Capacity and reliability which are key metrics in determining freight mode choice.

At the same time, road freight transport is facing higher levels of unreliability due to increasing congestion on the Sydney urban road network and on the F3 which links Sydney and Newcastle as well as the Pacific and New England Highways to northern NSW and Brisbane. This increasing level of road congestion highlights the need to improve rail freight services on the NSFC to ensure the overall transport task is more efficiently managed.

Several advantages are likely to accrue to rail freight users from upgrading the Northern Sydney rail corridor:

- Improved service quality by increasing track capacity to absorb increasing numbers of freight services. Without the upgrade, rail will lose freight market share placing more freight on road leading to greater congestion and loss of economic efficiency and growth. Similarly, under a “do-nothing” scenario, passenger services will become increasingly congested and constrained and service quality will diminish compared with the transport investment
- Improved rail competitiveness by reducing transit times and increasing on-time arrival reliability, in part by overcoming delays en route
- Increased rail modal share will lessen congestion pressures on the road network in terms of demands for capacity expansion and higher maintenance costs
- Operating windows for freight through the Sydney metropolitan area will become more flexible and hence provide operators and customers with greater operational options to better suit their business requirements.

The business case includes an economic and financial assessment to determine the merit of investing in infrastructure upgrades in the corridor in order to provide a step change in rail competitive position compared to road in attracting freight.

3.5 Project Sections

The long length of the study corridor (approximately 152km[2]) combined with the different operating characteristics of the rail system and the topographical features along the route means that for ease of analysis, the NSFC has been disaggregated into a number of sections. These include:

1. Flemington – North Strathfield
2. North Strathfield Junction
3. North Strathfield to Epping
4. Epping
5. Epping to Hornsby
6. Hornsby
7. Hornsby – Berowra
8. Berowra – Cowan – Hawkesbury River
9. Hawkesbury River – Woy Woy
10. Woy Woy – Gosford – Fassifern
11. Fassifern – Broadmeadow
12. Broadmeadow – Woodville Junction.

For each section a number of operational and infrastructure upgrades were identified. These alternatives were assessed through a Multi Criteria Assessment (MCA) framework to determine the degree to which the Project Objectives are met under each option. Subsequently, a short list of options has been determined.

Following these workshops and subsequent approval from the Project Control Group (PCG), a number of work package options have been developed which address the most pressing infrastructure bottlenecks in the NSFC.

It should be noted that investment required on the Northern Line and on the North West Rail Link project to improve passenger capacity has been treated separately to the NSFC project.

[2] Source: Worley Parsons, Northern Sydney Freight Corridor Systems Requirements Study

4 Approach to Evaluation

4.1 Introduction

This section provides an overview of the approach to be undertaken in the economic and financial evaluation. It is proposed that the evaluation will follow standard methodologies for assessing projects of this nature. These include:

- Australian Transport Council's National Guidelines for Transport System Management in Australia, 2006, Volume 3
- RailCorp's Manual for the Evaluation of Capital Projects (undated)
- NSW Treasury's NSW Government Guidelines for Economic Appraisal (2007)
- Infrastructure Australia's Prioritisation Methodology (2008)
- ARTC's Economic Analysis Standard Methodology
- DOTARS (2006), AusLink Investment Program: National Projects - Notes on Administration, Canberra.

Based on our experience of undertaking economic and financial appraisals in different jurisdictions, these various approaches are generally consistent with each other, albeit for a few minor issues. It is proposed that any significant differences in assumptions or approach will be discussed and agreed with the PCG. The impact of potential differences in input assumptions will be tested in the sensitivity analysis.

4.2 Steps in the Methodology

A Benefit-Cost Analysis (BCA) approach was used to estimate the economic and financial worth of the project. The methodology involves the following steps:

- Defining the project objectives and scope
- Defining the project options which form the basis of the economic and financial evaluation
- Defining the base case against which the project options are compared
- Identifying the costs and benefits that might be expected in moving from the base case to each of the options
- Identifying and agreeing the core parameters of the evaluation (e.g. time scale, base year for prices to calculate present dollar values, discount rate)
- Where possible, quantifying the costs and benefits over the expected lifecycle and discounting future values to express them in current equivalent values
- Generating performance measures including the Net Present Value (NPV), Benefit Cost Ratio (BCR), Net Present Value per unit of capital Invested (NPVI) and Internal Rate of Return (IRR) using discounted cash flow techniques over the evaluation period
- Testing the sensitivity of these performance measures to changes in the underlying assumptions utilised.

4.3 Economic versus Financial Evaluation

4.3.1 General

The financial and economic evaluations apply conventional benefit cost analysis procedures commonly used in transport project evaluations. Investment evaluations which are conducted from the wider economy or community's perspective are termed economic evaluations whereas those evaluations conducted from the producer's perspective only are known as financial evaluations. The costs and benefits considered in economic and financial evaluations are summarised in Table 4.1.

Table 4.1: Benefits and Costs Considered in Economic and Financial Evaluations

Category	Economic	Financial
Project capital costs	Yes	Yes
Operation and maintenance costs	Yes	Yes
Producer benefits	Yes	Yes
User net benefits	Yes	No
Non user benefits	Yes	No

4.3.2 Economic Evaluation

Economic appraisals assess the total costs and benefits of a project to the community. As such, economic appraisals encompass the costs and benefits accrued and incurred by many different stakeholders, including the project proponents, users, government and the community in general.

An economic appraisal takes into account costs and benefits which are not necessarily derived directly from market based transactions including, in this study, value of travel time, reliability, accidents, and highway externalities and congestion. Economic evaluations also take into account the opportunity costs of resources used in the project. Consequently, taxes and subsidy payments are deducted as they simply represent transfer payments by Government and do not represent the resource cost of producing a good or service.

The net economic benefit as a result of this project is summarised as follows:

Benefit = Rail User Benefit + Non Rail User Benefit + Externality Benefits + Net Incremental Revenue

4.3.3 Financial Evaluation

Financial appraisals assess the financial viability of a project from the perspective of operators. Financial appraisals are concerned only with the financial returns delivered to operator stakeholders and do not take into account the costs or benefits derived by other parties and the wider community.

Financial costs and benefits include capital, operating and maintenance costs; and operation revenues over the same evaluation period used in the BCA. In the case of this study, these are limited to include track access charges and fare passenger revenues to the track owner. As per the economic evaluation, all prices are expressed in constant 2011 prices. Net financial benefits are estimated as follows:

Financial Benefit = Incremental Revenue – (Net Capital Costs + Net Incremental Operation and Maintenance Costs)

4.4 Key Economic Assumptions and Parameters

Key parameters used in the evaluation are discussed as follows:

Discount rate: A 7% per annum real discount rate will be adopted in the evaluation to calculate present values. This study will also undertake sensitivity tests at the discount rates of 4.4% and 10%.

Price Year: All costs and benefits in the evaluation are presented in 2011 constant prices.

Evaluation period: An evaluation period of 30 years from the end of the capital investment is adopted for this study. This was based on the approach suggested in the Infrastructure Australia guidelines. Sensitivity analysis has been undertaken to assess the impact of a 50 year evaluation period as suggested in the Federal Government Nation Building guidelines[3].

Evaluation criteria: The criteria used in the evaluation include the Net Present Value (NPV), the NPVI, the Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR). Brief definitions of these criteria are as follows. The NPV is the present value of the project's benefits minus the present value of the project's costs. The project is deemed worthwhile if its NPV is greater than zero.

The NPVI is the NPV divided by the present value of the capital investment. In the case of a budget constraint, the project with the highest NPVI is chosen. The BCR is the present value of benefits divided by the present value of costs. A project is worthwhile if the BCR is greater than 1.0. The IRR is the discount rate at which the NPV equals zero. An IRR greater than the project discount rate indicates a potentially worthwhile project.

Economic and financial evaluation: The current study includes both an economic and a financial evaluation. The economic evaluation considers the project from a community perspective and considers the costs and benefits which are both internal and external to the operator including government organisations, private sector enterprises, individuals and the environment. Some of these effects are not directly quantified in market based monetary terms such as time savings, noise and air quality. The financial evaluation concentrates on the costs and benefits which accrue solely to the operator which in this case is Government. The financial analysis focuses on revenue flows, capital and operating costs

[3] Notes on Administration for the Nation Building Program, Australian Government, The Department of Infrastructure, Transport, Regional Development and Local Government, July 2009.

for key stakeholders; it does not include externalities or private benefits such as time savings.

4.5 Evaluation Options

4.5.1 Base Case

The appraisal compares the NSFC upgrade option against the base case or without project case. To be economically and financially worthwhile, the estimated benefits of a NSFC option must exceed the costs in comparison to the base case. The specification of the base case is especially important in estimating project benefits, which in most cases, are calculated in net terms (i.e. option minus the base case).

A 'do-minimum' base case is adopted in the analysis. This assumes that no additional capital investment in transport infrastructure is implemented other than that already committed by Government. Under this scenario it is assumed existing assets would be maintained to a level which would retain their current level of serviceability but does not allow for future capital enhancement. Likewise, for any committed new infrastructure, asset condition is maintained to a safe operable level. Under this scenario, it is possible that the assets' level of service could deteriorate over time if demand growth were sufficient to lead to capacity constraints on the network.

For the rail network this means that there would only be limited investment with the completion of the committed projects (including the Southern Sydney Freight Line and Port Botany rail improvements) as well as ongoing maintenance of existing assets. For freight services the base case implies the current number of freight paths in the corridor is maintained which results in significant operational restrictions to freight access during the passenger peak periods. Future tonnage growth will be constrained by lack of capacity and freight growth in the corridor is therefore likely to be largely accommodated by road transport particularly intermodal interstate container traffic.

For passenger services, the analysis includes the implementation of the South West Rail Link and the North West Rail Link projects, although only the latter project has any influence on the costs and benefits of the NSFC upgrade. Apart from these projects, there is likely to be deterioration in service reliability as passenger demand increases which place the network under increasing strain. However, the analysis has not included any such benefits for this project component. Further details of the implications of these base case assumptions are included in section 5.2.

For the highway network, it was assumed that there would be no provision for the costs of capacity enhancement of major roads such as F3, the Pacific or New England Highways other than existing commitments. Capacity enhancements over and above what is already committed, is assumed to occur independently of this project. Improvements to road transport efficiency are assumed to reflect enhancements to the road network as contained in current forward works programs committed by Government through budget appropriations. It was assumed that current mass and dimension limits would be maintained as per reforms agreed by ATC.

4.5.2 Proposed Upgrade Option

In the work undertaken in 2009 and 2010, a number of freight upgrade options were considered including capacity enhancements within the existing rail corridor as well as a tunnel option between north Sydney and the Hawkesbury River, a freight bypass around Newcastle and an 'Out of Corridor' option which combined both the tunnel and Newcastle Bypass options. The results of the outlines business case indicated that the upgrade to the existing corridor provided the highest economic and financial returns and this option has been the subject of further development in 2011.

In addition, two interim investment options were also assessed which reflected lower capital investment alternatives to deliver partial upgrade solutions. Both of these options (Stage 1 and Stage 2) were also found to deliver significant economic benefits. The current analysis takes forward the 2009/10 work in assessing the Stage 1 option package of works further. The proposed work includes the following:

- North Strathfield rail underpass
- Epping to Pennant Hills 3rd track
- Gosford passing loops
- Hexham passing loop.

Table 4.2 summarises the different benefits of the Stage 1 option.

Table 4.2: Benefits Summary

Alternative	Average transit time saving (minutes)[1]	Passenger benefits
Stage 1	10	No

Source: Study estimates

1. Incremental to base case

The components of the upgrade has been developed to ensure that there is compatibility with potentially more expensive future upgrade options which could deliver additional benefits. Moreover, the initial upgrade works have been developed to ensure that there would be no stranded assets should additional investment occur in the future. The approach to quantifying these impacts is discussed in more detail in the next section.

4.6 Theoretical Underpinnings

4.6.1 Introduction

In order to fully understand where benefits will accrue it is useful to consider the theory which will be applied in the analysis. The economic evaluation assesses benefits of alternative options according to changes in consumer, producer surplus and resource costs. The capital costs incurred by each option can be offset against benefits to freight and passenger traffic (such as changes in travel time, changes in vehicle operating costs, safety and reliability), benefits to transport producers (such as changes in rail transport operating costs) and any benefits to non-users (congestion relief benefits and externalities).

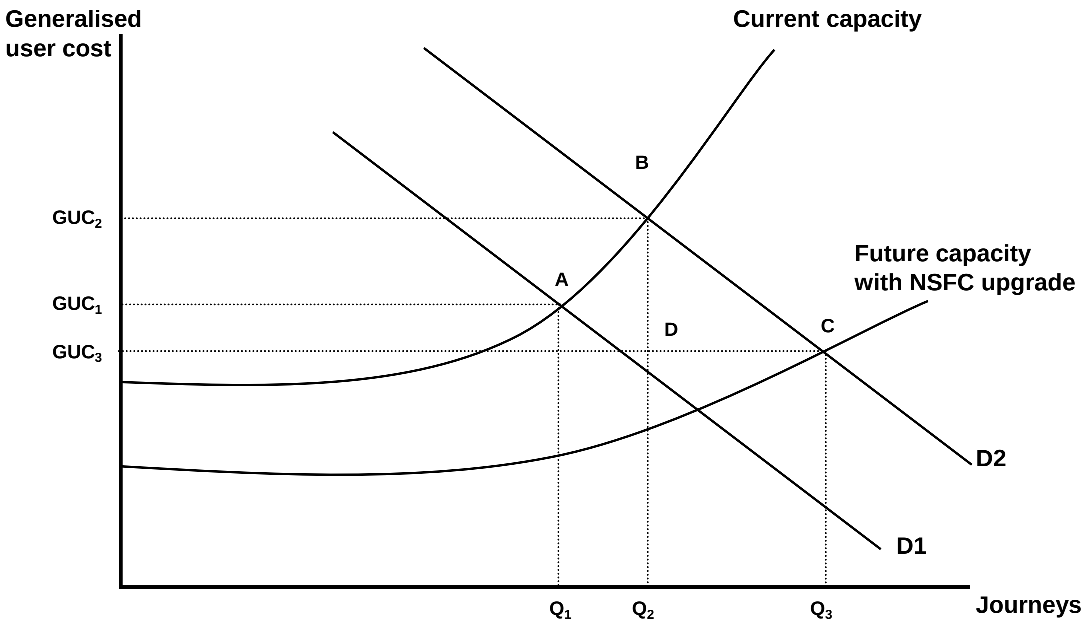
In determining these impacts, it is important to differentiate between the different markets upon which the project will impact. The upgrade of the NSFC will have impacts in both the rail and road markets. The analysis has not considered coastal shipping as the impact on this market is likely to be minimal.

4.6.2 Rail Market

Figure 4.1 summarises the assessment of impacts for the rail freight market. The figure shows the two demand forecasts with two capacity provisions with the NSFC upgrade and the base case (or current capacity). With the current capacity and demand (D1), the equilibrium number of rail journeys is Q_1 and the equilibrium cost is GUC_1 (Point A). Over time, growth in demand leads to a shift in the demand curve from D_1 to D_2. This growth in demand increases the number of trips from Q_1 to Q_2. With existing levels of rail infrastructure, the average generalised cost increases (due to increased congestion) to GUC_2.

Implementation of the NSFC upgrade reduces the average generalised cost since it provides benefits compared to the base case by providing savings in journey time, increased reliability etc. This leads to the supply curve moving down and to the right to reach a new equilibrium position at C. At this point, the number of journeys has increased to Q_3.

Figure 4.1: Rail Market Impacts



Existing rail users (Q_2) have a benefit of ($GUC_2 – GUC_3$) * Q_2. However, the reduction in average generalised cost stimulates more rail trips which are either diverted from road or are entirely new rail journeys. The quantum of these new trips is (Q_3-Q_2). The total benefit to these users is therefore ($GUC_2 – GUC_3$) * ($Q_3 – Q_2$) * ½. This is shown by the triangle BCD.

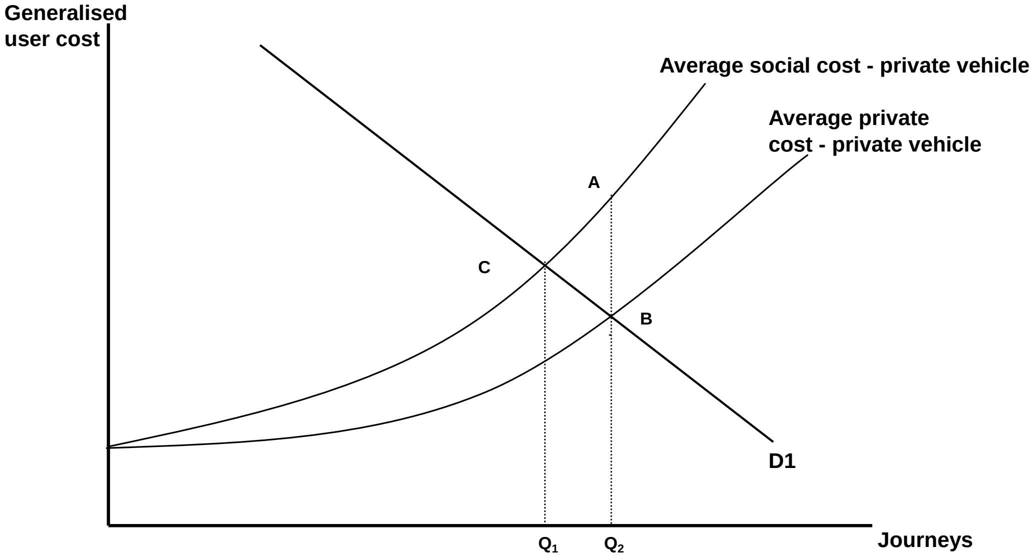
In addition, there is a producer surplus gain in this situation through an increase in revenue to the rail operator, offset against increased track costs, resulting from the additional number of rail trips. The value of this producer surplus benefit is the number of additional trips ((Q_3-Q_2) * the average track access fee or fare.

4.6.3 Road Market

Without the NSFC project, due to capacity constraints on rail, the growth in freight traffic will largely be accommodated by additional road transport. Without additional road capacity, this will result in more congestion with the cost of road travel increasing for all users. This situation is summarised in Figure 4.2 which shows the average private and social cost of private vehicle use.

The optimal private vehicle flow is where the average social cost and the demand curve intersect (Point C) which results in the number of journeys being Q_1. However, since private vehicle users do not perceive the full congestion and externality costs they impose on others, the equilibrium point is reached where the average private cost and the demand curve meet resulting in the number of journeys being Q_2.

Figure 4.2: Road Market Impacts



From a society viewpoint, ($Q_2 – Q_1$) represents an excessive flow as it leads to negative impacts on others. Consequently, the additional traffic beyond Q_1 can be seen to be generating a cost which equates to the area ABC.

The upgrade of the NSFC will encourage a switch of modes to rail from road and consequently the number of private vehicle trips will be reduced from Q_2 to Q_1. This reduction represents a benefit to the project as it reduced the congestion and externality costs on society as a whole.

The approach to quantifying these benefits is described in the following section.

5 Rail Freight Demand Capacity

5.1 Rail Freight Demand Forecasts

5.1.1 Introduction

A number of adjustments have been made to the rail freight forecasts developed by SAHA (discussed in Section 3). These include the following:

- ARTC has undertaken further analysis to estimate a range of freight demand scenarios for the forecast years based on different levels of probability
- Since the original 2009 work, ARTC has revised the short term ramp-up of interstate intermodal rail demand to reflect the latest observed container volumes as well as taking into consideration the impact of the global financial crisis which has dampened growth in the past two years and subsequently the short term forecasts are lower than previously estimated
- Inclusion of five additional regional intermodal trains for cotton and containerised grain which were previously not included in the analysis.

The following sections describe the more detailed demand and capacity analysis which has been undertaken to reflect in the current assessment which includes a number of refinements including peak day and time of day analysis for train demand and differences in line capacity by direction. The analysis assesses two types of traffic:

- 'A' schedules which include interstate intermodal trains
- 'C' schedules include regional intermodal, steel, coal, grain and bulk trains.

The 'A' schedule trains are generally the most time sensitive and consequently require train paths at certain times of the day, whereas 'C' schedule trains are less time sensitive and utilise capacity throughout the day.

5.1.2 Peak Day Demand

The Outline Business Case developed weekly demand estimates based on an 'average day' where all days were assumed the same through the week. The current analysis refines this approach to allow for variable demand through the week as well as by time of day. The identification of peak day demand is important since it is the determining factor is assessing rail freight capacity constraints.

Peak day demand was determined by analysis of the Standard Working Timetable which showed the train demand on the busiest day of the week. For 2010 this is summarised by direction and by time of day in Table 5.1. It is evident that for 'A' schedules, there is only demand in the core period, reflecting the time sensitive nature of this cargo, whereas 'C' schedule trains run both in the core and the non-core periods.

Table 5.1: Peak Day Demand Profile – 2010

Train type	Core period (04.01-22.00)	No-core period (22.01-04.00)	Total (24 hours)
Down direction			
'A' schedule	4	0	4
'C' schedule	7	5	12
Total	**11**	**5**	**16**
Up direction			
'A' schedule	3	0	3
'C' schedule	6	4	10
Total	**9**	**4**	**13**

Source: Standard Working Timetable, 2010

The peak day demand was compared to the average day demand[4] to derive a series of factors to determine total weekly train demand by train type. In 2010, it was found that for 'A' schedule trains the peak day demand, in the core period, represented 140% of the average day. For 'C' trains the demand was even more peak focussed with a peak to average demand ratio of 175%.

With the growth in demand, it can be expected that there will be a degree of peak spreading with a more even distribution of demand over the week as forwarders seek to maximise the remaining available capacity. Consequently, based on advice from ARTC, the peak day demand factors were assumed to reduce over time with a 10% reduction in the peak by 2020 and a 15% reduction by 2030. The impact of peak spreading on the 'peak day to average day factors are summarised in Table 5.2.

Table 5.2: Peak Day to Average Day Factors

	'A' schedule trains	'C' schedule trains
2010	140%	175%
2020	126%	158%
2030	119%	149%

Source: ARTC

The 'peak day to average day' factors in Table 5.2 were applied to the peak day demand and multiplied by 7 to estimate the total weekly demand. The demand profiles for are summarised in the following section.

[4] Total weekly demand divided by 7.

5.1.3 Unconstrained Demand

Total weekly train demand was derived by applying the approach outlined above and the consequent train forecasts are summarised in Table 5.3. The demand is segmented into 'A' schedule and 'C' schedule trains with each group having different operating characteristics which impacts on the level of train path capacity utilisation. The forecasts shown in Table 5.3 would be unlikely to be achieved in the absence of significant investment in rail freight capacity and therefore represent unconstrained estimates. These forecasts form the basis for the capacity analysis and subsequent benefit calculations described below.

Table 5.3: NSFC Freight Train Demand (Trains per Direction per Week)[1]

	2010[2]	2020	2030	2040
'A' schedule				
Interstate intermodal	20	64	102	119
'C' schedule				
Regional intermodal	14	18	20	23
Steel	12	16	21	25
Coal, grain and bulk	22	31	29	21
Sub total	48	65	70	69
Total	**68**	**129**	**172**	**188**

Source: ARTC/ SAHA demand modelling

1. Based on P50 estimate of ARTC/ SAHA train demand forecasts.
2. In 2010 there is an imbalance in train demand between the Down and the Up directions. This imbalance is assumed to no longer occur post 2015 on a daily basis to ensure an equalisation of rolling stock utilisation.

5.1.4 Demand Ramp-up

Table 5.3 indicates that the major expected growth in rail freight demand is likely to come from 'A' schedule trains (interstate intermodal traffic). These demand volumes were drawn from SAHA's earlier report which in turn broadly adopted ARTC's estimates as given. However, it is evident that for interstate intermodal these growth rates imply a significant growth in demand between 2010 and 2030. In the short term (2012-14 – 16% per annum growth is forecast) especially, it doubtful in the absence of significant investment in rail freight capacity that such growth will be realised. Consequently, a ramp-up profile was applied to restrain short term interstate intermodal growth to more realistic levels. This adjustment resulted in a lagged growth ramp-up profile which is summarised in Table 5.4.

Table 5.4: Interstate Intermodal Ramp-up Adjustment

Period	Unconstrained demand growth profile (% pa)	Lagged demand growth profile (% pa)
2010-11	5%	5%
2011-12	11%	11%
2012-18	16%	12%
2019-21	6%	12%

Source: Deloitte

The lagged growth ramp-up is lower prior to the implementation of the NSFC project in 2015. However, the growth in interstate intermodal traffic is still significant, and represents the gradual adjustment of the rail freight market to the expected NSFC project upgrade as well as other infrastructure improvements. During this period there will be other rail corridor improvements completed between Sydney and Melbourne and Sydney and Brisbane as well as the potential opening of the Moorebank intermodal terminal in Sydney which is likely to stimulate demand for interstate intermodal rail freight.

Under the lagged demand growth profile shown in Table 5.5, interstate container demand will achieve the unconstrained level by 2022. After that point growth is assumed to be at the same level as the unconstrained forecasts shown in Table 5.3 subject to rail system capacity constraints. The unconstrained and the lagged ‘A’ schedule train demand forecasts are shown in Table 5.5.

Table 5.5: Lagged ‘A’ Schedule Train Demand Forecasts (trains per direction per week)

Period	Unconstrained demand	Lagged demand
2010	20	20
2015	36	33
2020	64	58
2021	67	64
2022	71	71

Source: Deloitte

For ‘C’ schedule trains, the unconstrained demand profile represents an annual increase of less than 3.7% per annum and these forecasts have been utilised directly in the analysis.

5.2 Rail Freight Capacity

5.2.1 Introduction

The determination of the number of rail freight paths in the study corridor is complicated by a number of factors including:

- The limitations imposed by sharing line infrastructure with passenger services and the lack of available freight paths in peak periods given the priority given to passenger services
- The provision of freight capacity at times of day which is not attractive to operators
- The mix and interaction of different freight train types such as intermodal and bulk trains which have different operational performance particularly at different loading levels
- The operational practice of running additional freight train services on an ad-hoc basis when capacity becomes available.

In the Outline Business Case assessment no time of day analysis was undertaken and all freight demand was allocated across the supply of paths for the whole day. Updated information received from RailCorp which shows the estimated number of rail freight paths in the base case and the option case. These estimates are disaggregated by time of day and facilitate the identification of the number core period freight paths (which are largely used by 'A' schedule trains as this is the most time sensitive of freight commodities) and non-core paths.

5.2.2 Train Path Assumptions

RailCorp data relating to train path capacity is summarised in Table 5.6. The information indicates that the current practical capacity for 'A' schedule trains in the study corridor is 15 per day in the Down direction and 13 in the Up direction. In the core period, the equivalent capacity is 7 trains and 5 trains per day in the Down and Up directions respectively. The capacity for 'C' schedule trains is 6 to 7 paths in the core period (depending on direction).

Table 5.6: Train Path Assumptions (total sustainable paths)

Base Case			Additional		Total Stage 1		
'A'	'C'	Total	New 'A'	@70%	'A'	'C'	Total
Down direction - 24 hours							
15	12	27	14	10	25	12	37
Up direction - 24 hours							
13	10	23	13	9	22	10	32
Down direction – core period (04.01 – 22.00)							
7	7	14	13	9	16	7	23
Up direction - 24 hours – core period (04.01 – 22.00)							
5	6	11	9	6	11	6	17

Source: RailCorp/ Project Control Group

In the 'with project' case there is an increase in 'A' schedule rail freight capacity as a result of the upgrade option works, the number of available 'A' schedule train paths increases by 13-14 paths per day depending on direction. In the core period, capacity increases to 13 paths in the Down direction and 9 paths in the Up direction.

However, it is not possible to utilise 100% of these paths and maintain on-time freight train reliability. Discussions with the PCG indicate that on-time running can be maintained only to the point where 70% of freight train paths are utilised[5]. Consequently, the practical rail freight capacity as a result of the Stage 1 works is estimated to increase core period capacity by 9 paths in the Down direction and 6 in the Up direction.

Overall, the number of paths increases significantly in the all day metric as well as during the core period. For the core period, the number of 'A' schedule paths increases by 130% in the Down direction and 120% in the Up direction. Thus it can be seen that the increase in core period capacity is the main outcome of the proposed capital works program. It should also be noted that the Stage 1 works does not provide for any increase in 'C' schedule train capacity.

5.2.3 Freight Train Path Usage Assumptions

Based on the lagged train demand forecasts, it is possible to derive the equivalent number of rail freight paths which would be reliably utilised if capacity were available to accommodate this demand. An adjustment was made in the analysis to reflect the number of paths used by each freight train type. Discussions with the PCG have indicated that 'A' schedule trains are assumed to utilise one path per train, whereas 'C' schedule trains are assumed to occupy 1.2 'A' schedule paths.

A number of steps were undertaken to derive constrained rail freight demand forecasts for the base case and the project case including:

- The capacity analysis indicated an imbalance in the Down and Up capacity in both the base case and the project case. It was assumed that train movements in each direction would balance over the day, and therefore the difference in core period 'A' train capacity between the Up and the Down would be rectified by a shift in demand from the core to the non-core period
- In the core period, the lagged growth 'A' train demand profile was constrained to reflect the 'A' schedule core capacity
- 'C' schedule demand was also constrained to reflect the 'C' schedule train core period capacity
- In the base and project cases, in the non-core period where 'C' train demand was greater than 'C' train capacity, the excess 'C' trains were reallocated to available non-core 'A' train paths, subject to capacity
- Both transferred 'A' (directional imbalance) and 'C' train (excess non-core demand) growth is accommodated until non-core 'A' train path capacity is exhausted.

Based on the above, in the base case for 'A' schedule trains, demand is forecast to become capacity constrained in the core period by 2015 in the Up direction and 2018 in the Down direction. In this situation, all future growth in freight is assumed to be catered for by road transport and 'A' schedule train volumes are held constant. For 'C' schedule trains, capacity remains available in the non-core period, and additional growth in this traffic can be accommodated in the future.

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[5] It should be noted that the additional freight train paths are utilised at different points in time but these paths are not necessarily reliable to the same extent and consequently the chance of delay is increased.

In the with project case, the additional capacity allows additional freight traffic to be transported by rail compared to the base case and this differences in rail freight demand forms the basis of the benefit estimation described below. The forecast future freight volumes and reliable path usage are summarised in Tables 5.7 to 5.10.

It is evident that the upgrade provides additional capacity compared to the base case which means that additional rail freight traffic can be accommodated in future years, especially in the core period.

Table 5.7: Constrained Train Demand Estimates (Down Direction) – Base Case (trains per week)

Year	Core Period			Non-core Period			Weekly Total		
	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total
2010	20	28	48	-	20	20	20	48	68
2015	33	28	61	-	29	29	33	57	90
2020	42	28	70	-	37	37	42	65	107
2025	42	28	70	-	41	41	42	69	111
2030	42	28	70	-	41	41	42	69	111
2035	42	28	70	-	41	41	42	69	111
2040	42	28	70	-	41	41	42	69	111

Source: Study estimates, figures may not sum due to rounding.

Table 5.8: Constrained Train Demand Estimates (Down Direction) – Project Case (trains per week)

Year	Core Period			Non-core Period			Weekly Total		
	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total
2010	20	28	48	-	20	20	20	48	68
2015	33	28	61	-	29	29	33	57	90
2020	58	28	86	-	37	37	58	65	122
2025	84	28	112	-	41	41	84	69	153
2030	96	28	124	-	41	41	96	69	166
2035	96	28	124	-	41	41	96	69	166
2040	96	28	124	-	41	41	96	69	166

Source: Study estimates, figures may not sum due to rounding.

Table 5.9: Constrained Train Demand Estimates (Up Direction) – Base Case (trains per week)

Year	Core Period			Non-core Period			Weekly Total		
	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total
2010	20	24	44	-	24	24	20	48	68
2015	30	24	54	3	33	36	33	57	90
2020	30	24	54	12	40	51	42	65	107
2025	30	24	54	12	45	57	42	69	111
2030	30	24	54	12	45	57	42	69	111
2035	30	24	54	12	45	57	42	69	111
2040	30	24	54	12	45	57	42	69	111

Source: Study estimates, figures may not sum due to rounding.

Table 5.10: Constrained Train Demand Estimates (Up Direction) – Base Case (trains per week)

Year	Core Period			Non-core Period			Weekly Total		
	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total	'A' schedule	'C' schedule'	Total
2010	20	24	44	-	24	24	20	48	68
2015	30	24	54	3	33	36	33	57	90
2020	58	24	82	-	40	40	58	65	122
2025	66	24	90	18	45	63	84	69	153
2030	66	24	90	30	45	75	96	69	166
2035	66	24	90	30	45	75	96	69	166
2040	66	24	90	30	45	75	96	69	166

Source: Study estimates, figures may not sum due to rounding.

5.3 Rail and Road Freight Task Assumptions

The data shown in Tables 5.7 to 5.10 is expressed in weekly volumes, which are converted to annual equivalents by multiplying by an annualisation factor of 50[6]. This implies that the rail system will be operational for 50 weeks per year with the remaining 2 weeks representing RailCorp possession time for asset maintenance.

In order to calculate the tonnages of freight which are transported by road and rail in the analysis, the operating assumptions shown in Table 5.11 are applied. The payload assumptions are based on the freight forecasting work undertaken by SAHA (2009), and the utilisation rates are study assumptions based on the likely availability of back-haul cargoes for each product.

Table 5.11: Train Operating Assumptions

	'A' schedule	'C' schedule
Payload (tonnes)[1]	1,150	1,600
Utilisation (per cent)[2]	75%	60%

Notes:

1. Source: SAHA Freight Forecasting Report
2. Source: Study assumptions

The total net tonne-kilometres for base case and the upgrade options were derived by multiplying the total number of tonnes of each freight type by the length of the study corridor. For 'A' schedule traffic, the benefits from mode switching were assumed to occur from the point of origin to destination. In order to calculate the appropriate road and rail distances a weighted average (based on tonnages sourced from ARTC) was applied. These results of this analysis are summarised in Table 5.12 which indicates that road offers a small distance saving compared to rail in the Sydney – Brisbane and Melbourne – Brisbane corridors. The weighted average distance by mode indicates that road is some 119 km shorter than rail. In mode choice terms, this distance saving is offset by other factors such as cost, reliability, availability and local factors which might favour rail compared to road for a particular freight type.

[6] Based on 4 weekends of track maintenance per year and reduced services over the Christmas period.

Table 5.12: Assumed Route Distances by Mode for Intermodal Traffic

Corridor	Rail	Road	Tonnage (%)
Sydney – Brisbane	980	970	38%
Melbourne – Brisbane	1,900	1,670	51%
Brisbane – Perth	5,100	5,100	6%
Brisbane – Adelaide	2,730	2,730	5%
Weighted average	**1,783**	**1,664**	

Source: ARTC, North – South Rail Corridor Study, DOTARS (2006)

For 'C' schedule traffic the benefit of mode switching was also assumed to occur from point of origin to destination. The average one way trip length for bulk and steel products was estimated to be 400km[7].

The above calculations result in the derivation of total net tonne kilometres by freight type for road and rail in the base case and the 'with project' case. This is summarised in Table 5.13. It should be noted that in 2028 when Stage 1 rail freight capacity has been reached, additional freight market growth is accommodated by road.

For example, for 'A' schedule freight, the total net tonne-kilometres that rail could transport with existing capacity under the base case was estimated to be 6.5 billion net tonne-kilometres in 2025. However, with the upgrade of track capacity under Stage 1 this could increase to 12.9 billion net tonne-kilometres by 2025. Despite this increase, the majority of Sydney-Brisbane intermodal would still be transported by road as the road tonne-kilometre estimates in Table 5.13 are incremental in this analysis and do not represent the absolute total tonnage transported by road in Sydney – Brisbane corridor. However, the increase in tonnages transported by rail as a result of the upgrade program could lift rail's modal share from around 11% in 2005 to over 40% in 2025, based on the forecasts presented in Table 3.1 and Table 3.2.

In the analysis, no generated demand is assumed, consequently, the estimates of total freight tonnes are assumed to be equal in the two scenarios with only the modal distributions being different. The data in Table 5.13 forms the basis for calculating the costs and benefits in the following sections.

[7] Based on a weighted average analysis of tonnage and distance for steel products and building materials between Port Kembla and Newcastle, grain from North West NSW to Sydney and coal between the Hunter Valley and Port Kembla.

Table 5.13: Rail and Road Freight Task (ntkm million)

	Rail – base case			Rail - upgrade			Road – base case			Road - upgrade		
	A	C	Total	A	C	Total	A	C	Total	A	C	Total
2010	3,076	1,296	4,372	3,076	1,296	4,372	-	-	-	-	-	-
2015	5,018	1,464	6,482	5,018	1,464	6,482	-	-	-	-	-	-
2020	6,459	1,595	8,054	8,844	1,595	10,439	2,226	-	2,226	-	-	-
2025	6,459	1,674	8,133	12,901	1,674	14,574	6,012	-	6,012	-	-	-
2030	6,459	1,693	8,152	14,763	1,693	16,457	8,638	-	8,638	888	-	888
2040	6,459	1,672	8,131	14,763	1,672	16,435	11,083	-	11,083	3,332	-	3,332

Source: Study estimates

1. Figures may not sum due to rounding.
2. Total road and rail net tonne-kilometres between the upgrade case and the base case are different in any particular year due to reduced road distance for 'A' schedule freight compared to rail.

6 Project Costs and Benefits

Values for key parameters have been derived from several sources, including RTA, RailCorp, Austroads, the ATC National Guidelines (ATC 2006), the IA guidelines (Australian Government 2008), and other consultants' reports including those recently conducted for the North – South Strategy Study (ARTC) and the Melbourne to Brisbane Inland Rail Study (ARTC, 2010).

6.1 Project Costs

6.1.1 Capital Costs

The capital cost estimates have been updated based on a revised scope of works for the Stage 1. These include the following project components:

- North Strathfield rail underpass
- Epping to Pennant Hills 3rd track
- Gosford passing loops
- Hexham passing loop.

The capital costs used in the evaluation are summarised in Table 6.1. These estimates are expressed in 2011 dollars and have been adjusted to remove contractor margin and client contingency. To reflect the growth in real incomes over time, the labour component of the capital costs was increased by 1% per annum. A capital to labour ratio of 2:1 was assumed which meant that 33% of capital cost was increased to reflect this change.

Table 6.1: Capital Cost Estimates ($2011 values)

	Stage 1 P50	Stage 1 P90
Outturn costs	984	1,053
Cost estimate excluding escalation	849	907
Cost less client contingency and margin	697	745
Cost with real inflation	706	755
Discounted cost	530	566

Source: Transport for NSW

Variations in the capital cost estimates and the effect on the economic and financial evaluation results are tested as part of the sensitivity analysis.

6.1.2 Recurrent Costs

Estimates of rail infrastructure operating and maintenance costs were derived from discussions with RailCorp. This estimated that the permanent way maintenance costs including maintaining rail track, overhead electricity and associated physical structures for the study corridor was approximately $60 million per annum. Based on a double track for the

152 kilometres length of the study corridor this equates to $0.2 million per track kilometre. This unit figure was increased by 4% to convert to 2011 dollars.

In the upgrade options, additional track is provided at a number of locations which entails additional recurrent cost. Consequently, in the 'with project' option recurrent costs are slightly higher than the base case. Table 6.2 summarises the increase in track kilometres for each option and the net recurrent costs.

Table 6.2: Recurrent Costs

Option	Net increase in track km	Net annual increase in O&M cost ($mn)
Stage 1	15.1	3.2

Source: Study estimates

In addition, the increased rail freight traffic in the 'with project' case will lead to additional track maintenance due to increased wear and tear on the assets. In the analysis a unit rate of $1.56[8] per 1000 net tonne kilometres was applied to the increased rail freight task identified in Table 4.8 to estimate the additional variable track maintenance cost which is summarised in Table 6.3.

Table 6.3: Variable Track Maintenance Cost Summary

	Net increase in net rail tonne-km (million)	Unit cost ($ per million net tonne-km)	Variable cost increase ($ mn)
2020	2,385	0.0015	3.7
2030	8,304	0.0015	12.6
2040	8,304	0.0015	12.6

Source: Study estimates

6.1.3 Residual Value

The upgrade options have been assigned a residual life to the key components of fixed infrastructure with economic lives that extend beyond the evaluation period. For the purposes of the analysis it is proposed that rail capital assets are considered to have a 100 year economic life. This assumes that the asset is continually renewed through the ongoing maintenance and renewal program. The cost of such renewal is included in the rail operating cost calculation.

$$\text{Residual value} = \text{Capital Cost} * \left(\frac{Ec_{life} - Ev_{period}}{Ec_{life}} \right)$$

Where:

- Ec_{life} = economic life of the asset; and
- Ev_{period} = evaluation period.

[8] Booz Allen Hamilton, Priority Freight Train Paths Though Metropolitan Sydney – Economic and Financial Assessment, 1998 updated to 2011 values.

Given the 100 year economic life of rail assets, a 30 year evaluation period implies that assets will have 70% residual life. Table 6.4 summarises the residual values by option used in the evaluation.

Table 6.4: Summary of Residual Value ($ mn)

	P50 Cost	P90 Cost
Capital cost ($ mn)[1]	706	755
Residual value ($ mn) – undiscounted	488	522
Year incurred	2046	2046
Residual value ($ mn) – discounted	43	46

Source: Study estimates – note residual value calculated on un-escalated capital costs.

6.2 Freight Benefits

6.2.1 Introduction

As discussed previously, an economic evaluation includes benefits that accrue to the whole economy, so includes benefits to Government as well as to other parties such as freight customers, rail passengers and the community in general.

The benefits can be split into a number of areas. Some of the benefits are consumer surplus benefits, in that the operator will be offering its customers a superior service. The operator will receive additional revenues from increased tonnage, known as producer surplus. There will also be benefits accruing to non-rail users and the community in general, such as decongestion for remaining road users and from reduced externality costs as a result of a mode shift from truck to rail which will reduce air and noise pollution etc.

In the previous analysis it was assumed that any increase in freight path capacity would result in additional intermodal freight being transported by rail without reference to shippers' market behaviour. However, there is significant evidence to suggest that shippers do not treat all train paths equally. For contestable intermodal freight in order to meet specific arrival and departure times at the three eastern seaboard capital cities, there is a strong shipper preference to utilise core period rail paths (between 4am and 10pm) as these fit best with shipper timetables. Indeed, the current lack of availability of core period paths partly explains why rail freight mode shares has been static or has declined in some markets in recent years.

The Stage 1 works package provides increased core period capacity. It is reasonable to assume that core period paths would command a premium price to meet the scheduling of arrival times at the point of destination, and hence would carry higher value freight than using non-core paths where there is no conflict with passenger services and hence more capacity.

For the intermodal traffic which is transported by rail using the core period paths, a 10% uplift in the value of the per unit of benefit, likely to accrue to shippers as a result of the project, has been applied. This includes the following benefit categories: 'time savings', 'operating costs' and 'customer benefits'.

6.2.2 Freight Transit Time Savings (Consumer Surplus)

The upgrade option provides a transit time saving of 10 minutes. The analysis assumed that this time saving only applied to the time sensitive 'A' schedule freight and not to the 'C' schedule freight. In this market, it is possible that time savings directly benefit the shipper through reductions in inventory and other supply chain costs.

The time value of freight used in this analysis was determined by applying parameter values based on Austroads and the RTA[9]. These assumptions are also consistent with the recent ARTC Inland Rail Study analysis[10]. A composite value was determined based on the average load carried by a 6-axle trailer and a B-Double. The assumed carrying capacity of these vehicles is 25 tonnes and 40 tonnes and the vehicle split 40% (6-axle) and 60% (B-Double) respectively. Based on these assumptions, the average value of freight time was estimated to be $0.82 per tonne hour. In addition, in the future the value of freight time is increased by 1% per annum to reflect a change in real incomes over time which would impact on the value of freight cargoes transported.

The Stage 1 works package provides additional capacity to the NSFC and consequently freight could be attracted from road to rail. The benefit gained by diverted road freight was calculated using the rule of a half whereby the benefit of each diverted tonne is equal to half of the unit accruing to existing freight remaining on the same mode.

6.2.3 Rail and Truck Operating Cost Savings (Producer Surplus)

In commercial freight markets compared with passenger services, prices charged for transport services are assumed to be related to the costs of provision. Thus reductions in transport costs are likely to be shared between transport users (by way of lower prices) and transport providers (by way of higher profits). From an economic efficiency viewpoint, we are indifferent as to where the benefit falls and it is likely that in practice it will be shared depending on the level of contestability in the different markets.

For the purposes of this evaluation, we have identified this benefit as operating cost reductions, thereby occurring as increases in operator producer surplus. As a result of a switch of freight from road to rail there will be cost impacts on road and rail operators. To determine the impact of this effect, unit parameter values from the ARTC Inland Rail Study[11] have been applied. This study estimates that the train operating cost for the coastal route is 2.2 cents per net tonne kilometre. To account for the pick-up and delivery component of the end-to-end trip, this estimate was increased by 50% (based on ARTC modelling in the study corridor) giving a rail operating cost of 3.3 cents per net tonne kilometre. Updated to 2011 values, this equates to 3.4 cents per net tonne kilometre.

Based on the same vehicle mix described in the freight travel time savings above, a weighted resource truck operating cost was estimated to be 4.8 cents per net tonne kilometre. As per the rail operating cost, pick-up and delivery costs were included in the road cost calculation by assuming 50% of road trips were door-to-door and the remainder involved transhipment at a terminal. For these latter trips, operating costs were assumed to be 50% higher to account for this additional cost. The resulting overall road operating cost was estimated to be 6.2 cents per net tonne kilometre (2011 values). Both the road and rail operating cost unit rates were increased by 1% per annum to reflect the change in real operating costs over time (labour, fuel etc).

It should be noted that the above quoted operating cost rates are more applicable to container movements. Operating costs for bulks by rail are likely to be lower than the

[9] RTA Economic Appraisal Manual, Economic Parameters for 2007, page 15 Table 17

[10] ARTC Melbourne – Brisbane Inland Rail Alignment Study, Final Report, ARTC, July 2010

[11] Melbourne to Brisbane Inland Rail Alignment Study, Final Report, ARTC, July 2010

container rail rate, whereas the bulk road unit operating cost rate would likely be higher than the equivalent container rate. Consequently, given the inclusion of steel and bulk products in the calculations, the actual net operating cost difference between road and rail could be greater than calculated in the current evaluation and therefore the benefit calculation is likely to be conservative.

The net impact of the change in truck/ rail operating costs was calculated by multiplying the number of road to rail diverted net tonne kilometre by the difference in the operating costs.

6.2.4 Road Decongestion Costs (Externality Benefit)

The diversion of freight from road to rail as a result of the NSFC upgrade will lead to a reduction in truck kilometres. This reduction will lead to a benefit to the remaining road users by relieving congestion in peak times and speeding up traffic. In the analysis it was assumed that the decongestion effect would apply only to the AM and PM periods. In addition, this impact would only be realised in the urban sections of the study corridor.

For interstate intermodal traffic the following assumptions were made.

Road corridor distance in urban areas:

- Melbourne (north): Dynon Port – Craigieburn = 30km
- Sydney (south): Campbelltown – Chullora = 30km
- Sydney (north): Chullora – Hawkesbury = 55km
- Brisbane (south): Ipswich – Acacia Ridge = 40km
- Total = 155km

Wtd. average road corridor length (source: Table 5.12) = 1,664km

Therefore the average length of road corridor in urban conditions is approximately 10%. In addition, based on RTA[12] literature the proportion of the business peak hours compared to the whole day is approximately 20%. Consequently, the decongestion benefits are applied only to this portion of traffic and time of day.

Therefore, applying a weighted average payload of 31 tonnes to the reduction in truck net tonne-kilometres gives the total reduction in VKT. Based on advice from RailCorp, it is estimated that this 'decongestion benefit' is worth 41 cents per vehicle kilometre. Updated to 2011 values, this equated to 43 cents per vehicle kilometre. This value was assumed to increase by 1% per annum to reflect the increase in real incomes over time.

6.2.5 Freight Customer Reliability and Availability Benefits (Consumer Surplus)

Rail freight service reliability and availability should improve with the project. The main effects of these changes will be to offer the existing rail freight market, and diverting traffic, additional market related benefits. This benefit is likely to only apply to the time sensitive/ market contestable freight which is predominantly the intercity intermodal container tonnages. Monetary values for these service characteristics were derived from recent modelling undertaken by ARTC. Further details relating to the quantification of these benefits is described in Appendix B.

[12] Annual business peak hours =1,800 compared to a total annual number of hours of 8,790. This equates to approximately 20%. Source: RTA Economic Analysis Manual, Appendix B, Table 10.

This modelling allowed changes in rail/ road market share as a result of changes in rail service to be quantified and these are shown in Table 6.5. The total value applied in the analysis was derived as a weighted average (based on distance and tonnage) across a number of corridors since the study route currently carries freight for a number of intercity routes (Melbourne-Brisbane, Sydney-Brisbane, Brisbane-Adelaide and Brisbane-Perth).

Table 6.5: Freight Customer Reliability and Availability Benefits (cents per net tonne kilometre)

Service characteristic	Stage 1
Reliability	0.07
Availability	0.03
Total	0.10

Source: ARTC modelling/ Deloitte estimates

The above reliability value was applied to the existing rail freight volumes (reliability only since this rail traffic will already receive the availability improvement) to derive the benefit of the improved rail freight service. For diverted freight traffic, the rule of a half convention for determining consumer surplus changes for diverted or generated traffic is applied and 50% of the total benefit (reliability and availability) was attributed to this traffic.

Both the reliability and availability unit parameter values were increased by 1% per annum to reflect the change in real incomes over time which would be reflected in the value of freight cargoes.

6.2.6 Reduced Truck Externality Costs (Externality Benefit)

Externality impacts of transport use were quantified following changes in the road and rail modes splits for both freight and passenger traffic between the project options and the base case. Following the upgrade of the NSFC, there is a forecast shift of freight from road to rail. In order to measure these impacts unit parameter values for a range of impacts were applied to the change in road and rail VKT. These values are based on the ATC National Guidelines[13] and are summarised in Table 6.6.

[13] Australian Transport Council, National Guidelines for Transport System Management in Australia, Volume 3 Appraisal of Initiatives, Appendix C

Table 6.6: Unit Externality Parameter Values

Externality	Road freight (c/net tonne-kilometre)			Rail freight (c/net tonne-kilometre)		
	Urban	Rural	Wtd. Ave.	Urban	Rural	Wtd. Ave.
Air pollution	0.97	0.01	0.11	0.33	0.00	0.04
Greenhouse gas	0.07	0.07	0.07	0.03	0.03	0.03
Noise	0.26	0.026	0.05	0.14	0.01	0.03
Water	0.10	0.06	0.06	0.01	0.01	0.01
Nature and landscape	0.26	0.11	0.13	0.08	0.03	0.04
Urban separation	0.22	0.00	0.02	0.08	0.00	0.01
Total			**0.44**			**0.15**

Source: Deloitte estimates based on ATC guidelines

Notes:

1. All values are in 2005 Australian dollars
2. Freight vehicle values are based on heavy vehicle category
3. Rural rail values are derived from the urban rail estimates based on the same proportionate difference between road rural and urban. Average values assume a 10% urban travel and 90% rural travel.

The analysis derives a weighted average externality value for both road and rail freight. These values (updated to 2011 dollars) were applied to the change in net tonne-kilometres to determine the overall reduction in externality costs as a result of the full corridor upgrade. In addition, in the future the value of road freight externalities have been increased by 1% per annum to reflect to change in real incomes over time which would impact on the value of externalities of road freight transport.

6.2.7 Road Crash Cost Savings – Heavy Vehicles (Externality Benefit)

The reduction in road freight will reduce the number of vehicle kilometres travelled by trucks and one consequence of this will be a reduction in the road crashes. Booz Allen and Hamilton[14] estimated crash costs for road and rail freight. These values inflated from 2001 to 2011 dollars are 0.40 cents per net tonne-kilometre for road and 0.038 cents per net tonne kilometre for rail. In the economic analysis, the difference between these values was multiplied by the reduction in road net tonne kilometre with the project compared to the base case to determine the overall level of benefit. Future unit crash cost values were increased by 1% per annum to reflect changes in real incomes over time.

[14] Booz Allen Hamilton 2001, cited in Freight Australia 2003, The Future of Rail Freight Services in Victoria: a proposal to the Government of Victoria from Freight Australia, 21 March 2003

6.2.8 Track Access Revenue Benefits

For the financial analysis, increased revenue will occur to the track operator as a result of increased freight using the NSFC because of increased capacity as well as diverted demand. The additional revenue is calculated by multiplying the net increase in freight demand (measured in net tonne-kilometres) by a track access charge. Based on work undertaken on an earlier study of an inland rail connection between Melbourne and Brisbane[15], this was estimated to be $0.70 per net tonne kilometre. In the analysis this estimate was converted to a 2011 equivalent price and then multiplied by the change in rail net tonne-kilometres as shown in Table 5.13.

6.2.9 Other Benefits

In addition to the above quantified benefits, there will be a number of other impacts which have not been quantified in the current analysis. These include the following:

- Electrification of the NSRU so that passenger trains can also use the new track which allows the surface crossovers to be removed thus improving reliability and maintainability through increased flexibility of possession timing
- Electrification of the ETTT which allows operational flexibility
- Full DDA upgrade of Concorde West station including a new concourse, platform levelling, tactile tiles and canopies
- Full DDA upgrade of Cheltenham station including a new footbridge, platform levelling, tactile tiles and canopies.

[15] North-South Rail Corridor Study – Detailed Study Report, Ernst & Young, 2006

7 Wider Economic Benefits

7.1 Background

In addition to the economic effects identified in conventional benefit-cost analysis, recent research has established that transport investments can result in wider economic benefits (WEBs), which traditionally have not been counted.

Research by the UK Department for Transport (DfT 2006) has led to the publication of methodologies for estimating these wider economic benefits arising from transport investments. These methodologies have now been incorporated into guidance on submissions to Infrastructure Australia. The four broad areas covered under WEBs include:

- **Agglomeration benefits** – these derive from clustering as a result of a transport project and the increased employment densities would lead to higher productivity
- **Increased competition** – Transport improvements may facilitate greater competition between firms by removing barriers preventing firms entering more distant markets, with consumers receiving the resulting benefits
- **Imperfect competition** – since cost benefit assessments are essentially constructed on assumptions of perfect competition, there are additional benefits of a transport project which are not necessarily passed on to customers because of lack of competition. If transport costs are lowered, firms may lower their prices and increase output to satisfy demand. The additional benefit is the product of the difference between marginal cost and price and the increase in output due to reduced transport costs
- **Labour supply** – People may choose to enter the labour market or move to more productive jobs as a result of a reduction in transport costs. These decisions are based on after tax income received, which is covered by the conventional cost benefit analysis. However, the full benefit is measured by the gross income paid by their employer including additional tax revenue received by government

From the UK experience, these wider economic benefits typically add 5% to 40% to the benefits estimated using conventional BCA depending on the type of project (i.e. urban public transport, inter-urban road or rail connections). However, the UK studies were focused mainly on metropolitan areas and the benefits were derived from expectations about major passenger movements as a result of a substantive metropolitan public transport infrastructure projects. There are no applied examples of WEB analysis to freight transport in the UK particularly inter-regional rail freight.

While the upgrade will contribute to improving the reliability of passenger services in the study corridor, it is unlikely to result in a significant reduction in road congestion during commuter travel periods. Hence, it is considered that there will not be any measurable additional benefits through improvements to the labour supply.

Theoretically, the NSFC upgrade may allow further concentration of warehousing and logistics activities which might produce additional agglomeration benefits. We have sought to quantify this impact to some degree based on the estimated reduction in transport costs for freight activities.

Generally, for developed cities such as Sydney, capacity limitations in transport infrastructure do not present a barrier to competition and the entry of new suppliers into a market. Hence, capacity expansion is unlikely to result in increased competition in the wider economy given the existence of a highly competitive road freight market for eastern seaboard freight.

Enabling rail freight to compete with road freight in new markets (for example, for time-sensitive goods) as a result of the reduced travel time will of course result in an increase in competition in the transport sector itself. However, this is likely to flow through to the markets of the transport-using sectors and hence the wider economy as a reduction in cost rather than an increase in competition. Again, this benefit is captured in conventional benefit-cost analysis.

Given that the focus of the NSFC project is on increasing rail track capacity to enhance freight access to and through the Sydney rail network, it would seem that the main source of WEB's would derive from improving the efficiency of freight markets with flow-on benefits to users of freight services. For most of these users, there appears to be a high degree of concentration of activity in Australia relative to that which characterises comparable markets in the UK which suggests that the main source of WEB's would derive from imperfect competition.

As markets are rarely perfectly competitive, firms are able to charge prices higher than their marginal costs. If transport costs are lowered as a result of a transport investment, firms in the imperfectly competitive markets of the transport-using sectors may lower their prices and increase output to satisfy demand. This response results in additional efficiency benefits (gains in welfare) compared to those captured in conventional benefit-cost analysis. The additional benefit is the product of the difference between marginal cost and price and the increase in output due to reduced transport costs. It can be shown that this is equivalent to applying an uprate factor (V) to the conventionally appraised business user benefits (business time savings and reliability gains, BTS + RG) already included in the analysis.[16]

Equation 1: Economic benefit due to increased output in imperfectly competitive markets

$$Benefit = V \times (BTS + RG)$$

Source: DfT (2006)

The uprate factor is the ratio of the price-marginal cost gap to price, i.e. (P – MC)/P (referred to as the "price-cost margin") multiplied by the elasticity of demand (ED) for the imperfect market in question.

Equation 2: Uprate Factor

$$V = \frac{(P - MC)}{P} \times ED$$

Source: DfT (2006)

A perfect calculation would require knowledge of the price-cost margin and elasticity of demand for each of the markets in question. As these two parameters are difficult to generate, DfT provides values based on a review of research on the UK economy.

DfT reviewed a number of estimates of price-cost margins for the UK. According to the best estimates available, prices across all sectors in the UK are, on average, 25% above marginal costs, or a price-cost margin of 0.2.[17] DfT used an aggregate elasticity of demand estimate of 0.5. The net effect of applying the DfT values is thus an uprate factor of 0.1 (i.e. 0.2 x 0.5) – yielding an additional benefit of 10% of the conventionally appraised business user benefits.

[16] See UK Department for Transport (2006) pp. 45-46.

[17] Calculated by substituting P = 1.25MC in (P – MC)/P. That is: (1.25MC – MC)/1.25MC = 0.25MC/1.25MC = 0.2

7.2 Price-Cost Margin

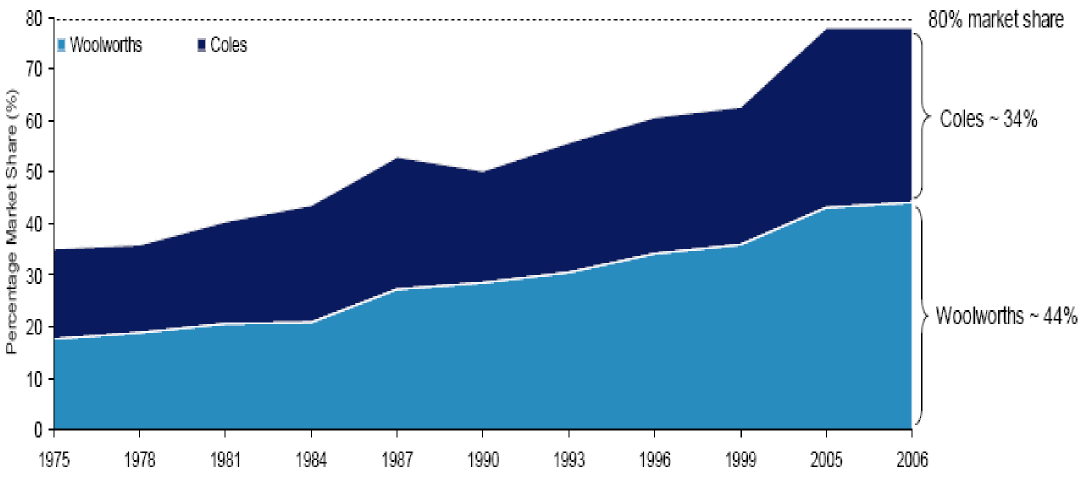
Available evidence suggests that there is a greater degree of market concentration in Australia than in the UK, with firms in these imperfectly competitive markets possessing greater pricing power and the ability to charge a higher mark-up over marginal costs. Hence, it is likely that the additional benefit from increased output is higher in Australia than in the UK.

This derives from the relatively small domestic market base facing local producers in Australia and hence supports the role of imperfectly competitive markets as the primary generator of WEB's. It is expected that as the degree of market concentration increases, then the uprate factor would increase and hence the attribution of WEB's to imperfect competition. On this basis, the uprate factor is likely to be a more important contributor to WEB's in Australia than what could be the case for the UK given the apparent differences in market structure between the two countries.

For example, in the retail grocery market, Woolworths and Coles together account for around 80% of sales. With their broader interests in fuel, liquor and general merchandise, Woolworths and Coles together account for about 40% of national retail sales. This is summarised in Figure 7.1. In contrast, the UK grocery market comprises:

- Tesco PLC: 30.8%;
- Asda Group Ltd: 16.8%;
- J Sainsbury PLC: 16.1%;
- William Morrison Supermarkets PLC: 11.6%;
- Discount retailers (Aldi, Netto and Lidl): 5.9%; and
- Other: 18.8%.

Figure 7.1: Growth in Market Share of Woolworths and Coles (1975 – 2006)



Source: Retail World, ACNielsen

The best way to calculate the additional benefit from increased output as a result of upgrading the NSFC would be to establish an uprate factor that best reflects local conditions and which is likely to be higher than the UK figure. The results of preliminary research into this topic are outlined in the following sections.

Compared to the UK, there is considerably less research into price-cost margins in Australia from which to estimate an Australian specific uprate factor.

OECD (1996) provides an estimate of mark-up ratios[18] in manufacturing industries for 14 OECD countries, including the UK and Australia. It concludes (p 25) an average mark-up ratio in manufacturing industries of 1.15 for the UK (range of 1.03 to 1.67) and 1.20 for Australia (range of 1.10 to 1.61) between 1980 and 1992, implying that mark-up ratios in Australia are on average 33% higher than in the UK.

More recent work by Olive (2002) estimates the mark-up of eight manufacturing industries in Australia, concluding that the average mark-up rate is 26% (p 9). This result is supported in Olive (2004) where the average mark-up rate of eighteen manufacturing industries was found to be approximately 25% (p 10).[19] It is likely that the current mark-up rate is similar, given that the structure of the manufacturing industry (in terms of degree of concentration) has not changed significantly since the study was conducted.

One possible issue with the above studies is that none of them included the services sector. DfT (2006) notes that in the UK service industries typically have higher mark-up ratios than manufacturing industries, citing work by DTI and Small (1997). DfT (p 48) suggested a correction factor of about +0.1 to estimates of price-cost margins from studies that did not include service industries.[20]

In the absence of any specific data on Australian service industries, the DfT correction factor has been adopted.[21] This is a conservative approach, as in reality the correction factor for Australia could be higher given the comparative mark-up ratios for Australia and UK in the manufacturing sector.

The suggested price-cost margin for Australia is then:

$$\frac{(1.25-1)}{1.25}+0.1=0.30$$

7.3 Aggregate Elasticity of Demand

The other variable needed to calculate the uprate factor is the aggregate elasticity of demand for final goods. As mentioned above, UK DfT uses 0.5. This compares to earlier studies in Australia that have assumed 1.0.[22]

There appears to be justification for the higher elasticity value, given that the elasticity of demand for a factor of production, such as transport (which is an input in the production process and has a derived demand), tends to be less price elastic than final goods.[23] This is based on the concept that freight transport demand elasticity (A) is a product of:

- the elasticity of demand for final goods (B);

[18] For the purpose of this report, the mark-up ratio is defined as P/MC.

[19] An earlier study by Martins et al (1996) found an average mark-up ratio for manufacturing industries of 1.24.

[20] Consideration may be needed as to the degree of increased output in the services sector as a result of the project improvements to NSFC. Service industries such as retail and wholesale (which rely heavily on imports) may increase output, whereas industries such as finance or business services may be unaffected. A services industry correction specific to rail freight transport-using industries may be required.

[21] Note that the economic contribution of the services sector is similar for Australia and UK – between 70-80% of GDP depending on definition.

[22] Refer Luk and Hepburn (1993).

[23] Also see Productivity Commission (2006) Appendix F.

- the proportion of the total cost of goods attributable to freight transport costs (C); and
- the elasticity of substitution between factors of production (influencing the likelihood of substitution between transport and other inputs) (D).

This relationship can be expressed as:

Equation 3: Freight transport demand elasticity

$$A = B \times C \times D$$

The elasticity of demand for final goods (B) can therefore be expressed as:

Equation 4: Elasticity of demand for final goods

$$B = A \times 1/C \times 1/D$$

This means that B generally will have a higher value (i.e. be more elastic) than A because:

- 1/C will exceed 1 (freight transport costs are typically a small proportion of total costs); and
- 1/D will be 1 or above (supply changes are likely to be inelastic, particularly in the short to medium-term).

It is very difficult to estimate aggregate demand elasticities. However, using Equation 4, it is possible to infer from estimated elasticities of freight transport demand whether the value is likely to be closer to 0.5 or 1.0. There have been numerous overseas empirical studies of freight transport demand, but very few studies have examined the situation in Australia.

In a recent substantive review of transport demand elasticities from around the world conducted by Graham and Glaister (2004) for DfT, the average freight traffic elasticity with respect to price was found to be -1.07 (the majority of values lay between -0.5 and -1.3). These results are similar to a comprehensive study in 1990 for The World Bank.[24] It found the most likely range of rail freight price elasticities to be between -0.4 and -1.2, and the most likely range of road freight price elasticities to be between -0.7 and -1.1.

According to Starrs (2005), the corresponding ranges for Australia are -0.4 to -1.20 for rail freight price elasticities and -0.5 to -1.1 for road freight price elasticities. Meyrick and Associates (2006) arrived at a weighted range for Victorian rail price elasticities of between -0.7 and -0.9.

The elasticity values quoted in the two preceding paragraphs indicate that the aggregate elasticity of demand for final goods is likely to be closer to 1.0 than 0.5. The higher value has been adopted in the calculation of the uprate factor for Australia. This is consistent with the value of 1.0 assumed in earlier Australian studies.

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[24] Reported in Oum et al (1992).

7.4 Conclusion

Considering the results of the research outlined above, and using Equation 2, an appropriate uprate factor to adopt for Australian conditions is 0.3 (i.e. a price-cost margin of 0.3 multiplied by an aggregate elasticity of demand of 1.0).

In the case of the NSFC project, the uprate factor would be applied to the conventionally estimated freight benefits which leads to an increase in 10% on conventional benefits. The results of including wider economic benefits in the evaluation has been shown separately to the main analysis and is reported in section 8.

8 Evaluation Results

8.1 Introduction

The full corridor upgrade options were compared with the base case using a discounted cash flow technique on the basis of a real discount rate of 7% in accordance with ATC, NSW Treasury and RailCorp investment appraisal guidelines. Project capital expenditure is assumed to take effect from 2010 and all values are expressed in 2011 dollars. The benefits of the project were assessed over a 30 year evaluation period.

8.2 Economic Evaluation Results

Table 8.1 summarises the results of the economic evaluation at 7% real discount rate and indicates the results for the Stage 1 works package incremental to the base case. A more detailed presentation of the results is given in the spreadsheet in Appendix C.

Table 8.1: Economic Evaluation Results at 7% Real Discount Rate (P90 Cost Estimates)

	Stage 1 (incremental to base case)
Total Undiscounted Capital Costs ($ mn)	755
Project Costs (present value (PV) $ mn):	
Capital Costs	566
Maintenance costs	103
Total Project Costs	669
Freight Benefits (PV $ mn)	
Transit time savings	7
Operating cost savings	1,302
Road freight decongestion	20
Customer reliability benefits	101
Externality cost savings	166
Crash cost savings	199
Residual value	46
Total benefits	1,841
Summary excluding WEBS	
NPV ($ mn)	1,172
NPV/I	2.1
BCR (ratio)	2.7

	Stage 1 (incremental to base case)
IRR (%)	15%
BCR (including WEBS)	3.0

Note: figures may not sum due to rounding

The economic evaluation results are summarised in Table 8.1. These show the costs and benefits of the Stage 1 works package incremental to the project base case. The economic evaluation (under the P90 cost estimate scenario) produces a positive economic return, with a BCR of 2.7 and a NPV of approximately $1.2 billion. This is due to the significant increase in capacity provided by this option compared to the base case. Under the P50 cost estimate scenario the BCR increases to 2.9.

Within the benefit components, the largest contributor to the benefit stream is the reduction in freight transport operating costs resulting from a switch in freight transportation from road to rail being passed on by freight operators through lower prices. This result is consistent with the findings of the current ARTC Melbourne to Brisbane Inland Rail Study where freight operating cost benefits also represent the largest component of project benefits. These benefits would occur to either freight transport operators (producer surplus) which would result in lower costs and increased profits or to freight consignees (consumer surplus) as a result of lower shipment costs. The distribution of these benefits to these different parties would be dependent on the competitive structure of the freight logistics industry. In all likelihood, these benefits would be shared between these two groupings.

The inclusion of Wider Economic Benefits increases the economic returns to all options but the ranking of alternatives does not change.

8.3 Sensitivity Analysis

The economic evaluation involves making estimates of a number of factors which are subject to uncertainty. These include assumptions which impact on both the project costs and benefits. Table 8.2 summarises the results for a range of sensitivity tests, with changes in the key variables. The results exclude wider economic benefits.

Table 8.2: Economic Evaluation Sensitivity Test Results (BCR results)

Scenario	Stage 1
Central case results	**2.7**
Discount rate: 4.4%	4.0
Discount rate: 10%	1.9
Capital costs +30%	2.2
Capital costs -30%	3.7
Freight benefits +30%	3.6
Freight benefits - 30%	1.9
Exclusion of real growth in parameter values	2.3
50 year evaluation period	3.2
Core period freight benefits uplift factor = 0%	2.6
Capital costs +30%, benefits -30%	1.5
Capital costs -30%, benefits +30%	4.8

Source: Study estimates

Overall, the sensitivity test analysis indicates that the results are most sensitive to the assumptions regarding discount rate, capital cost and overall level of project benefits, although the ranking of alternatives does not change. The disaggregated economic evaluation results table for a 50 year evaluation is contained in Appendix D.

Table 8.3 summarises the range of economic results based on the P50 and P90 costs estimates for 4.4%, 7% and 10% discount rates.

Table 8.3: Range of Economic Scenario Results (BCR)

Scenario	4.4% discount rate	7% discount rate	10% discount rate
P50 cost estimate	4.2	2.9	2.0
P90 cost estimate	4.0	2.7	1.9

Note: Results exclude wider economic benefits

8.4 Financial Evaluation Results

The financial evaluation concentrates on the financial costs and benefits which accrue as a result of the project. In this study these are limited to capital and maintenance costs, as well as incremental track access fees and passenger fare revenue. The results of the financial evaluation are shown in Table 8.4. The financial evaluation results indicate the Stage 1 works package does generate sufficient additional revenue to produce a positive financial return.

Table 8.4: Financial Evaluation Results at 7% Real Discount Rate (P90 Cost Estimates)

	Stage 1 (incremental to base case)
Total Undiscounted Capital Costs ($ mn)	755
Project Costs (present value (PV) $ mn):	
Capital Costs	566
Maintenance costs	103
Total Project Costs	669
Freight Benefits (PV $ mn)	
Track access fees	358
Residual value	46
Total benefits	404
Summary excluding WEBS	
NPV ($ mn)	-265
NPV/I	-0.5
BCR (ratio)	0.6
IRR (%)	4%

Note: figures may not sum due to rounding

9 Limitations of our Work

9.1 General Use Restriction

This report is prepared solely for the internal use of Transport for NSW. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose set out in our proposal dated 25 November 2011. You should not refer to or use our name or the advice for any other purpose.

Appendix A - References

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Appendix B- Customer Benefits Derivation

Introduction

There are a number of non-price characteristics which combine with transit time to make up rail freight's service offering compared to other modes. Those characteristics, which have been identified as most important in influencing shipper's modal decision making, are reliability and availability.

Definitions of these rail service criteria are contained within the ARTC's Interstate Rail Audit[25]. This defined rail reliability as representing the on-time running performance of train services, defined as the percentage of trains, which arrive within 15 minutes of their scheduled arrival time. Availability is defined as the proportion of the market for which rail is able to offer a broadly equivalent departure/ arrival time as road. Availability is the effective cut-off time for freight loading/ unloading which allows either a freight train to leave on time or as the time for rail freight intermodal containers to be unloaded to allow on-time collection by road hauliers at the destination terminal.

Rail service reliability and availability will improve with the NSFC project and this will create benefits to rail freight transporters and/ or consignees depending on the industry market structure. The main effects of these changes will be to offer the existing rail freight market, and diverting traffic from road, additional non-monetary market related benefits. These benefits are likely to apply to the time sensitive/ market contestable freight which is predominantly inter-capital city intermodal container traffic.

In order to quantify these benefits in monetary terms, the analysis has applied a model developed by the ARTC which estimates transport costs and mode split of the inter capital city intermodal container market. This model estimates modal volumes transported by road, rail and coastal shipping based on a range of input assumptions including both macro-economic and transport industry factors. These include current and future forecasts of the following:

- Population and economic growth by State
- Price of oil
- Price of carbon to compensate for emissions created during transport operation
- US dollar/ Australian dollar exchange rate
- Unit operating costs for road, rail and coastal shipping
- Income and freight price elasticity factors
- Labour costs
- Pick-up and delivery costs.

Based on these factors and their expected change over time, the ARTC model calculates the overall demand for intermodal traffic for each capital city to capital city corridor and subsequently determines the absolute cost of freight transport for each mode. Following the application of the transport mode specific cost factors, the model calculates the freight task for each mode for each corridor.

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[25] ARTC Rail Network Audit Report, Summary Report, April 2001

The introduction of carbon pricing for freight transport and the expected increase in the price of oil means that the relative cost of road freight transport is forecast to increase relative to other modes over time which results in a gradual shift in freight traffic to rail. This trend combined with the completion of ARTC's east coast rail freight infrastructure upgrade program means that rail mode share is predicted to increase over time. In the case of the Sydney to Brisbane corridor, rail mode share is forecast to increase from 11% currently to approximately 40% by 2020.

Study Assumptions

Reliability

The ARTC model and other recent studies[26] have indicated that existing rail freight reliability on the eastern seaboard is 75% (that is 75% of rail freight movements arrive within 15 minutes of their scheduled arrival time). However, with the completion of the NSFC full upgrade this reliability could increase to 90%. It should be noted that this level of reliability is similar to the level currently offered by road.

To determine the benefits as a result of the NSFC upgrade, the ARTC model was used to estimate the value of this improved reliability for each of the inter capital city rail routes relevant to the study corridor including:

- Sydney – Brisbane
- Melbourne – Brisbane
- Brisbane – Perth
- Brisbane – Adelaide.

Based on the existing 75% reliability level, the ARTC's model was used to determine rail's mode share for each corridor. Subsequently, a 77%[27] reliability factor was input into the model to determine the increase in rail mode share following this service improvement. As a result of the increased reliability of rail, the largest increase in mode share was observed in the shortest distance corridor, Sydney – Brisbane where the rail mode share was estimated to increase from 43% to 45% in 2018. In the other longer distance corridors, the effect of improved reliability was less pronounced, as rail already maintains a higher mode share in these corridors. This is summarised in Table B.1.

Table B.1: Forecast Rail Market Share with Improved Reliability With and Without the NSFC Upgrade (2018)

Category	Sydney - Melbourne	Melbourne - Brisbane
Base market share (%)[1]	43%	87%
Upgrade market share (%)[2]	45%	88%

Source: Study estimates based on ARTC modelling

1. Base market share is the rail mode share with 75% reliability.
2. Adjusted market share is the mode share which would be achieved under a higher rail reliability scenario.

Once this change in mode share as a result of improved reliability was determined, the value of this change was quantified by estimating the reduction in rail's transport cost required to achieve the same higher mode share. These calculations are summarised in Table B.2.

[26] Melbourne to Brisbane Inland Rail Alignment Study, Working Paper No. 12, 2009

[27] Reliability North Strathfield – Broadmeadow: 152km/987km = 15% * 90% reliability, reliability Broadmeadow to Brisbane: 835km/987km = 85% * 75% reliability. Weighted average reliability for the whole corridor = 77%.

Table B.2: Derived Reliability Improvement Benefit[1]

Category	Sydney - Brisbane		Melbourne - Brisbane	
	Forward	Back	Forward	Back
Stage 1				
Base cost[2]	98.9	68.6	122.5	67.9
Adjusted cost[3]	96.9	67.2	122.5	67.9
Net cost	2.0	1.4	0.0	0.0
Average net cost[4]	**1.7**		**-**	

Source: Study estimates based on ARTC modelling.
Notes

1. Sydney – Brisbane and Melbourne – Brisbane corridors only as in the other corridors rail's mode share does not change as a result of the increased reliability.
2. Base cost is the rail transport cost with 75% reliability.
3. Adjusted cost is the equivalent rail transport cost to achieve a mode share that would be achieved under a rail reliability scenario as shown in Table B.1.
4. Average net cost is derived as the average of the forward and back net cost for each corridor.

Availability

To determine the benefit of improved availability, a similar process was undertaken as applied in deriving the value of improved reliability. However, in this case the variable used to determine the change in rail mode share was transit time. The transit time saving for the Stage 1 works is 10 minutes. This saving was entered into the ARTC model to determine the reduction in overall corridor transit times and the resultant increase in rail mode share as a result of improved availability[28]. This was compared to the without project market share and these are summarised in Table B.3.

Table B.3: Forecast Rail Market Share with Improved Reliability With and Without the NSFC Upgrade (2018)

Category	Sydney - Melbourne	Melbourne - Brisbane	Brisbane - Perth	Brisbane - Adelaide
Base market share (%)[1]	43%	87%	78%	62%
Upgrade market share (%)[2]	45%	88%	78%	64%

Source: Study estimates based on ARTC modelling

1. Base market share is the rail mode share assuming the without project transit time in the base case.
2. Adjusted market share is the rail mode share which would be achieved with additional transit time savings as a result of the upgrade.

Once this change in mode share as a result of improved availability was determined, the value of this change was quantified by estimating the reduction in rail's transport cost required to achieve the same higher mode share. These calculations are summarised in Table B.4.

[28] By reducing rail freight transit time, the chances of freight being available to be loaded or unloaded at point of origin or destination are increased.

Table B.4: Derived Reliability Improvement Benefit[1]

Category	Sydney - Brisbane		Melbourne - Brisbane		Brisbane - Perth		Brisbane - Adelaide	
	Forward	Back	Forward	Back	Forward	Back	Forward	Back
Stage 1								
Base cost[2]	$98.9	$68.6	$122.5	$67.9	$244.6		$151.1	
Adjusted cost[3]	$98.0	$68.0	$120.9	$67.0	$244.6		$151.1	
Net cost	$0.9	$0.6	$1.6	$0.9	$0.0		$0.0	
Average net cost[4]	**$0.8**		**$1.2**		**$0.0**		**$2.71**	

Source: Study estimates based on ARTC modelling.

Notes

1. Base cost is the rail transport cost with lower availability.
2. Adjusted cost is the equivalent rail transport cost to achieve a mode share which would be achieved with a reduction in freight transit time and an improvement in rail freight availability.
3. Average net cost is derived as the average of the forward and back net cost for each corridor.

Summary of Results

Given the above calculations, the estimated customer service benefit values for each corridor were combined through a weighted averaging process incorporating both the distance in each corridor and the tonnage transported between each origin and destination. This is summarised in Tables B.5.

Table B.5: Summary Customer Benefit Value – Stage 1 Option

Category	Sydney - Brisbane	Melbourne - Brisbane	Brisbane - Perth	Brisbane - Adelaide
Availability ($)	0.8	0.0	0.0	0.0
Reliability ($)	1.7	0.0	0.0	0.0
% tonnage split	38%	51%	6%	5%
Distance (rail)	982	1,925	5,100	2,737
Weighted average – availability benefit (cents per ntk) – (1)		**0.03**		
Weighted average – reliability benefit (cents per ntk) – (2)		**0.07**		
Total (cents per ntk) (1) + (2)		**0.10**		

Source: Study estimates based on ARTC inter-state intermodal traffic modelling.

The above customer benefits were applied to rail freight task estimates summarised in Table 5.13.

Appendix C – Economic Evaluation Results – 30 year evaluation period

Economic Evaluation Results – Stage 1

	Costs				Freight									
Year	Capital costs	Operating costs	Total costs	Residual value	Transit time	Operating costs	Road freight decongestion	Customer benefits	Externality costs	Crash costs	Total freight	Wider economic benefits	Total benefits	Net benefits
2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	4	-	4	-	-	-	-	-	-	-	-	-	-	- 4
2012	41	-	41	-	-	-	-	-	-	-	-	-	-	- 41
2013	94	-	94	-	-	-	-	-	-	-	-	-	-	- 94
2014	284	-	284	-	-	-	-	-	-	-	-	-	-	- 284
2015	263	-	263	-	-	-	-	-	-	-	-	-	-	- 263
2016	64	-	64	-	-	-	-	-	-	-	-	-	-	- 64
2017	5	3	9	-	1	2	0	5	0	0	8	-	8	- 1
2018	-	4	4	-	1	15	0	6	2	2	26	-	26	22
2019	-	6	6	-	1	37	1	7	5	6	55	-	55	50
2020	-	7	7	-	1	62	1	8	8	10	89	-	89	82
2021	-	9	9	-	1	91	1	9	12	14	128	-	128	119
2022	-	11	11	-	1	119	2	10	15	18	165	-	165	155
2023	-	12	12	-	1	137	2	11	18	21	189	-	189	178
2024	-	13	13	-	1	156	2	12	20	24	215	-	215	202
2025	-	14	14	-	1	177	3	12	23	27	242	-	242	228
2026	-	15	15	-	1	199	3	13	25	30	272	-	272	257
2027	-	16	16	-	1	222	3	14	28	34	303	-	303	287
2028	-	17	17	-	1	235	4	15	30	36	320	-	320	303
2029	-	17	17	-	1	237	4	15	30	36	323	-	323	306
2030	-	17	17	-	1	239	4	15	31	37	327	-	327	309
2031	-	17	17	-	1	242	4	16	31	37	330	-	330	313
2032	-	17	17	-	1	244	4	16	31	37	334	-	334	316
2033	-	17	17	-	1	247	4	16	32	38	337	-	337	320
2034	-	17	17	-	1	249	4	17	32	38	341	-	341	323
2035	-	18	18	-	1	252	4	17	32	39	344	-	344	327
2036	-	18	18	-	1	254	4	17	32	39	348	-	348	330
2037	-	18	18	-	1	257	4	18	33	39	352	-	352	334
2038	-	18	18	-	1	259	4	18	33	40	355	-	355	337
2039	-	18	18	-	1	262	4	18	33	40	359	-	359	341
2040	-	18	18	-	1	264	4	19	34	41	363	-	363	345
2041	-	18	18	-	1	267	4	19	34	41	367	-	367	349
2042	-	18	18	-	1	270	4	20	34	41	370	-	370	352
2043	-	18	18	-	1	273	4	20	35	42	374	-	374	356
2044	-	18	18	-	1	275	4	20	35	42	378	-	378	360
2045	-	18	18	-	1	278	4	21	36	43	382	-	382	364
2046	-	18	18	522	1	281	4	21	36	43	386	-	908	890
Total	755	446	1,201	522	28	6,102	94	444	780	935	8,383	-	8,904	7,703
PV total	566	103	669	46	7	1,302	20	101	166	199	1,796	-	1,841	1,172

NPV ($mn)	**1,172**
BCR	**2.75**
IRR (%)	**15%**
NPV/I	**2.1**

Financial Evaluation Results – Stage 1

	Costs				Freight		Net benefits
Year	Capital costs	Operating costs	Total costs	Residual value	Track access	Total freight	
2010	-	-	-	-	-	-	-
2011	4	-	4	-	-	-	- 4
2012	41	-	41	-	-	-	- 41
2013	94	-	94	-	-	-	- 94
2014	284	-	284	-	-	-	- 284
2015	263	-	263	-	-	-	- 263
2016	64	-	64	-	-	-	- 64
2017	5	3	9	-	1	1	- 8
2018	-	4	4	-	5	5	0
2019	-	6	6	-	11	11	6
2020	-	7	7	-	19	19	12
2021	-	9	9	-	28	28	19
2022	-	11	11	-	36	36	25
2023	-	12	12	-	41	41	29
2024	-	13	13	-	46	46	33
2025	-	14	14	-	52	52	38
2026	-	15	15	-	57	57	42
2027	-	16	16	-	64	64	47
2028	-	17	17	-	66	66	49
2029	-	17	17	-	66	66	49
2030	-	17	17	-	66	66	49
2031	-	17	17	-	66	66	49
2032	-	17	17	-	66	66	49
2033	-	17	17	-	66	66	49
2034	-	17	17	-	66	66	49
2035	-	18	18	-	66	66	49
2036	-	18	18	-	66	66	49
2037	-	18	18	-	66	66	49
2038	-	18	18	-	66	66	49
2039	-	18	18	-	66	66	49
2040	-	18	18	-	66	66	49
2041	-	18	18	-	66	66	48
2042	-	18	18	-	66	66	48
2043	-	18	18	-	66	66	48
2044	-	18	18	-	66	66	48
2045	-	18	18	-	66	66	48
2046	-	18	18	522	66	66	570
Total	755	446	1,201	522	1,620	1,620	940
PV total	566	103	669	46	358	358	- 265
						NPV ($mn)	**- 265**
						BCR	**0.60**
						IRR (%)	**4%**
						NPV/I	**-0.5**

Appendix D – Evaluation Modelling Results – 50 year evaluation period

Table D.1: Economic Evaluation Results at 7% Real Discount Rate – 50 year evaluation

	Stage 1 (incremental to base case)
Total Undiscounted Capital Costs ($ mn)	755
Project Costs (present value (PV) $ mn):	
Capital Costs	566
Maintenance costs	120
Total Project Costs	686
Freight Benefits (PV $ mn)	
Transit time savings	8
Operating cost savings	1,585
Road freight decongestion	24
Customer reliability benefits	125
Externality cost savings	203
Crash cost savings	243
Residual value	8
Total benefits	2,196
Summary excluding WEBS	
NPV ($ mn)	1,510
NPV/I	2.7
BCR (ratio)	3.2
IRR (%)	15%
BCR (including WEBS)	3.4

Note: figures may not sum due to rounding

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