ARTC

Melbourne–Brisbane Inland Rail Alignment Study

Final Report July 2010

Appendix K Operating Cost of Infrastructure

PARSONS BRINCKERHOFF

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1. Introduction

1.1 Background

The proposed alignment for the inland railway has been developed in accordance with the criteria documented in Appendix C (Design Standards) and includes:

- Geometry generally complies with 'normal limits' (i.e. horizontal curve radii greater than 1,000 m and grades flatter than 1 in 100) which represents preferred practice and is not exceeded where possible. Occasionally, 'minimum and maximum limits' (i.e. curve radii as tight as 800 m and grades as steep as 1 in 80) are proposed in order to reduce costs. In 'normal terrain', the limits enable a maximum design speed of 115 km/h to be maintained
- Where a constraint leads to lower speeds, such as in mountainous terrain, sections of alignments have been optimised for speeds less than 115 km/h including gradients as steep as 1 in 50 and curves as tight as 400 m radius on new and existing track.
- The reference train for the inland railway has three 3,220 kW AC drive locomotives hauling 73 wagons made up of a mixture of bogie container flat wagons and bogie container well wagons. The reference train is 1,800 m long, 40% double stacked, and capable of 115 km/h on 21 tonne (21 t) axle load track. The reference trains are called superfreighters in the rail industry.

The proposed alignment is a combination of lengths of existing track or upgraded track and sections of greenfield construction. Upgraded track is either standard-gauge track upgraded to Class 1, or narrow gauge track upgraded to dual gauge. Upgrading of track would comprise complete reconstruction of the track structure and hence it would be of a quality similar to greenfield construction.

Forecast freight for a notional commencement date of 2020 is two reference trains operating each direction per day on the inland railway. This would increase to eight trains each way per day as demand increases. The inland railway would also be used for grain traffic and, more significantly, the haulage of coal particularly in Queensland. Existing traffic would use sections of the inland railway. Maintenance costs identified in this appendix relate to the inland railway from Illabo to Kagaru only, as the track from Melbourne to Illabo and Kagaru to Brisbane would continue to be maintained by ARTC.

1.2 Objectives

The objective of this appendix is to provide estimates of the below rail operation and maintenance costs applicable to the alignment. These costs contribute to the financial and economic analysis of the proposed inland railway.

1.3 Outline

This appendix describes activities and costs associated with operating and maintaining infrastructure on the inland railway. It identifies the costs which are most significant to the financial and economic assessment of the project, rather than providing a complete breakdown of all the costs associated with operating and maintaining a railway.

The capital or leasing costs of providing the depots and maintenance facilities required to operate the inland railway are not covered because the method and parties involved in the operation of inland railway will be determined at a later time.

Operating costs have been estimated using assumed staffing levels. The cost estimates cover train planning, train control, incident response and safety inspections. An allowance for some overheads has been made; however overheads relating to corporate governance have not been included because the corporate arrangements for the inland railway have not been determined.

Maintenance costs have been estimated for new, upgraded and existing track based on desk-top reviews and estimates for plant, labour and materials requirements. Upper and lower values are suggested, with likely values being allocated to each section of track.

Information from desk-top reviews of operating and maintenance costs is included in this appendix and provides context to the estimates.

This appendix includes infrastructure operating costs only. Above rail operating costs are discussed in Appendix G.

2. Below rail operating costs

2.1 Literature review

Previous research and analysis has been undertaken by ARTC and others into the costs associated with the operation of freight railways in Australia. The following documents were reviewed in the course of preparing section 2 of this appendix:

- *Review of ARTC Operations and Maintenance Costs and Cost Allocation Method*, PricewaterhouseCoopers, April 2008
- *Rail Salary Survey, Kinetic Recruitment, 2009.*

It has been reported by PricewaterhouseCoopers (PwC) that:

- ARTC proposed an annual operating expenditure of approximately $91 million over the 2002 to 2012 Access Undertaking, with a forecast average of $5,795 per track km between 2002 and 2007
- A review of WestNet Rail's Forrestfield - Kalgoorlie line showed an operating cost per track km of $13,932
- The Westnet Rail operating cost figure contains the operations and overhead costs which include labour costs related to signal maintenance, accounting, corporate services, human resources, IT, infrastructure management, standards and compliance, projects, signals and communication, network access management, train control, regional perway management, and head office infrastructure management. The divisions appear to be equivalent to the divisions related to operating costs for ARTC
- The increased scale and scope of ARTC's network compared to the WestNet network results in a considerable average cost saving
- It is difficult to make meaningful comparisons of operating costs across track owners/managers given the diverse nature of individual operations, the technologies employed, and the differing cost bases of individual operators
- The average cost of ARTC's network has increased 133% from the allowances made in the previous access period ($6,073) to the forecast cost of $14,133. The ARTC explain the increased costs by the increase of employees from about 89 in 2002 to 720 maintenance infrastructure workers plus 620 direct employees in 2007-08. Of the direct employees, 180 carry out network control functions, the remaining 440 essentially take on executive roles associated with managing the infrastructure maintenance contracts and workforce, the network control workforce in NSW, the infrastructure investment program, the NSW Country Regional Network, and other support and management functions
- ARTC's average operating expenditure of the non-NSW network over the undertaking is $7,773 per track km which is approximately 44% lower than the WestNet Rail reference point. Meanwhile, the operating expenditure on the NSW segments is $19,697 per track km over the ten year period of the undertaking.
- In 2002, ACCC approved an Access Undertaking relating to the Interstate Rail Network between Kalgoorlie (WA), Tarcoola (SA), Broken Hill (NSW), Melbourne (Vic) and Wodonga (Vic). Costs assumed to comprise operating costs were allocated by train km. Historical operating expenditure reference points for ARTC operations between 2001 and 2006 ranged between $1.42 and $1.59 per train km.
- Subsequent to the 2002 Undertaking, the inclusion of NSW assets has necessitated a more complex and sophisticated cost allocation process. Indirect costs (typically operating costs) are allocated through a complex process which recognises the type

of cost, the driver of the cost and the allocation of the segment. Costs are allocated by a process called LOREN.

2.2 Approach to operating costs for the inland railway

Whilst the reviews by PwC and current approach by ARTC are interesting and relevant to any future implementation of the inland railway, ARTC's LOREN approach is not proposed for the estimation of operating costs of inland railway in this study. This is because:

- Substantial detailed assessment would be required
- The track owners/managers of inland railway have not been decided
- ARTC's approach includes some divisions in the allocation of costs (such as finance) which are considered separately as part of the project's financial and economic model.

The most significant costs associated with train planning, train control, incident response and safety inspections have therefore been estimated by considering theoretical roles, staff numbers, accommodation and transport needs. An allowance for overheads has been made.

Costs are estimated at 2010 prices and are based on the assumption that 8 trains each way per day are operating between Melbourne and Brisbane on the inland railway. Small cost savings may be available for periods in which lower traffic volumes are forecast, such as two trains each way per day as the initial operation of the inland railway. However, any savings are expected to be insignificant in the context of the total study.

The capital or leasing costs of providing and maintaining the depots and facilities required to operate the inland railway are not included because the method and parties involved in the operation of inland railway will be determined at a later time. The most significant facilities cost is expected to be the train controller's accommodation which is not known because the planned Advanced Train Management System (ATMS) signalling system will be used when the inland railway is operational but is still in 'Proof of Concept' phase. ATMS is communication based, and does not require lineside signals.

Operating costs of water treatment facilities and power required to operate mechanical and electrical plant have not been studied but an allowance has been made in the cost estimate.

2.3 Operations planning

It is assumed that the management and planning of railway operations for the inland railway will take place in existing headquarters buildings using existing management structures. A new Operations Manager and an administrative assistant (or equivalent resources) may be required. A wage cost of $250,000 per year is assumed for this workload. An estimate of two additional train planning positions is made to allow for the additional clerical work created by the operation of the inland railway. The wage cost of the train planners is estimated to be $110,000 per person per year.

An additional 20% of wage costs is added to cover the corporate overhead costs of these posts.

Staff costs for Operations Management and Planning are therefore estimated at $564,000 per year.

2.4 Train control

Train control for the inland railway will take place in existing train control centres using existing management. The introduction of ATMS is expected to alter the type of equipment and workload of train controllers considerably compared to the present, and therefore no estimate of the cost of office space is attempted. Two additional train controllers are expected to work continuously to cover the operation of the inland railway. Ten additional employees are required to cover the shifts necessary for 24 hour operation. $125,000 per person per year is assumed for train controller wage costs. An additional 20% is added to cover the corporate overhead costs of these posts.

Train controller costs are estimated at $1.5 million per year.

2.5 Transit management

Incident response, accident investigation and safety inspections over and above those required by maintenance requirements, is carried out either by maintenance staff, specialist staff or a combination of both. For the inland railway it is assumed that in rural areas incident response would be supervised by one dedicated person with a dedicated vehicle, working alone when carrying out inspections, but being assisted by staff from maintenance depots in the event of a major incident.

It is assumed that existing depots and staff between Melbourne and Narromine, and between Toowoomba and Brisbane in Queensland, will be able to cover the additional traffic generated by the inland railway. Between Narromine and Toowoomba two additional incident response staff members are assumed at a wage cost of $125,000 per person. With an additional 50% to cover overtime and corporate overhead costs, the wage bill is estimated to be $375,000 per year. A vehicle, costing approximately $50,000 per year to lease, operate and maintain could also be attributed to the annual cost of each staff member.

Transit management costs are estimated to be $475,000 per year.

2.6 Power supply

The proposed inland railway will require operating costs for power supply, most notably for three significant new tunnels. The tunnels will require forced ventilation due to the need for fresh air for the train crew, locomotives and during egress and incident response. Extra power will be required for lighting and other equipment. The other equipment may include requirements for water pumping and treatment facilities.

An allowance of $750,000 has been made for power consumption for the electrical equipment of the inland railway.

2.7 Analysis of below rail operating costs

Based on the use at no cost of existing management, buildings and the assistance of staff from existing maintenance depots, an allowance for the below rail operating costs is assumed to be $3.3 million per year. An additional capital cost of $500,000 should be allowed in the first year to mobilise staff.

Compared to some of the industry reference points for operating costs, it is apparent that the assumed costs for the inland railway are lower. The lower rates are explained by:

- The assumed operating costs for inland rail are the additional costs incurred (such as specific staff, vehicles and power) if the inland railway was added to an existing operating network. Existing management, buildings and assistance of staff from existing maintenance depots is assumed to be available free of charge

- The industry reference points include for items such as corporate governance, finance, depreciation.

3. Below rail maintenance costs

3.1 Below rail maintenance

Below rail maintenance is generally considered to be the maintenance of infrastructure assets comprising track, turnouts, crossings, signalling and communications, structures (bridges, culverts and retaining walls), formation, slopes and soft landscaping, fences, drainage, pavements and yards. The maintenance is divided into Routine Maintenance and Major Periodic Maintenance.

Routine Maintenance includes frequent and seasonal activities that are required to ensure the general condition and functionality of the assets. It includes manual activities, inspections and small works.

Major Periodic Maintenance requires specialist machinery and includes:

- Programmed replacements of sleepers, surfacing and rails
- Rail grinding
- Ballast distribution, removal and replacement
- Major bridge repairs
- Repairs to surfaced level crossings.

Replacement of concrete sleepers and rails on lightly trafficked tracks is typically programmed at intervals of several decades.

Inspections would be visual and would use Hi-Rail vehicles. The AK Car would be used to record track geometry. Ultrasonic testing will investigate rail flaws. Track faults will be recorded, graded according to their severity and included in the ongoing program of maintenance works. For faults of a potentially critical nature, reactive maintenance will be undertaken to rectify the fault as soon as possible.

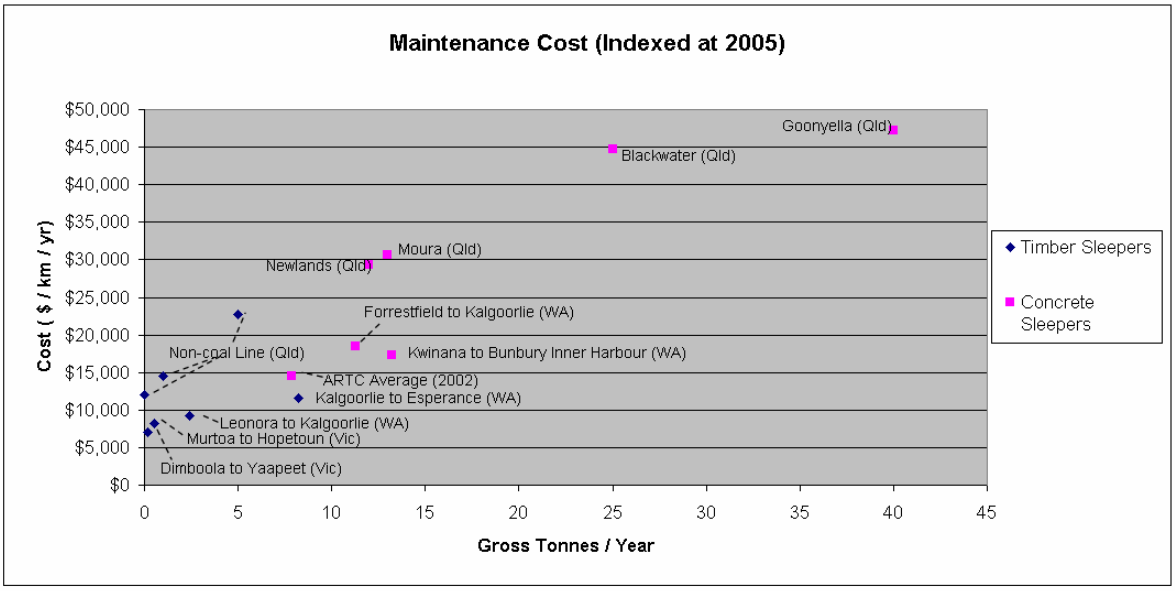
3.2 Literature review

Previous research and analysis has been undertaken by ARTC and others on the costs associated with the maintenance and renewal of freight railways in Australia. In producing this section of the appendix, the following documents have been reviewed and considered:

- *Maintenance Cost Benchmarking for the Victorian Freight Network*, WorleyParsons, January 2006
- *An Assessment of ARTC Maintenance Cost Relative To Efficient Industry Practice*, ARTC, June 2007
- *Review of ARTC Operations and Maintenance Costs and Cost Allocation Method*, PricewaterhouseCoopers, April 2008
- *Rail Salary Survey, Kinetic Recruitment, 2009*
- *Hunter Valley Access Undertaking 2009: Explanatory Guide Supplementary Information, ARTC, October 2009*
- *QR Network's Draft Amending Access Undertaking West Blackwaters Reference Tariff, Queensland Competition Authority, March 2009.*

Maintenance cost benchmarking for the Victorian freight railways, WorleyParsons, January 2006

The report provides benchmarks from regulatory regimes in Australia. The information is presented in Figure 3-1 to show maintenance cost against gross tonnage, and highlight which tracks have concrete and timber sleepers.



Note: Information taken from the "Maintenance Cost Benchmarking for the Victorian Freight Network", Worley Parsons 2006

Note: ARTC Average has a large proportion of concrete

Figure 3-1 Variation of benchmark maintenance costs with traffic volume

The report comments:

- In regard to Queensland, there is a fixed component of rail infrastructure cost where lines carrying very little tonnage require a minimum expenditure which is still at least half of more densely used lines
- Queensland costs were actual costs whereas Western Australia is based on a theoretical construct
- Queensland's coal systems have concrete sleepers and therefore compare with Regional Fast Railways (RFR) in Victoria. The higher tonnage lines have a maintenance profile influenced more heavily by component replacement due to wear while the lightly used lines, being constructed with timber sleepers and requiring regular inspections have their maintenance dictated by time effects. The legacy of timber sleepers and their inevitable short term life is a major component of the maintenance cost
- Queensland's topography and soils are different to Victoria's but there is a large range from the tropical mountainous areas to the dry inland, both sandy soils and expansive black clays. ARTC's network comprises a mixture of topography and soil type with the Nullarbor Plain being dominant in track length but in Victoria and SA there are regions of severe curvature and black soil clay
- The two Victorian, standard gauge, grain lines are on clay and loam soils in an arid environment and probably represent the lower limit of the maintenance costs for a Victorian Class 4/5 region

- ARTC's 2001-2002 costs (which includes routine maintenance, MPM and incident costs) on balance, probably represent the position of Victoria's Class 2 lines. ARTC has fewer level crossings, flatter terrain, more moderate climate and simpler signalling systems than WNR, hence lower maintenance costs for ARTC is expected. This observation is also true for Victoria.

The report proposes maintenance cost benchmarks as summarised in Table 3-1.

Table 3-1 Summary of maintenance costs benchmarks (WorleyParsons 2006)

Region	Traffic details	Assumed traffic level cost drivers	WorleyParsons benchmarks (per km per year)			Other benchmarks (per km per year)	
			Bench-mark	RM	MPM	higher	lower
Regional Fast Rail network	160kmph passenger railcar, freight at 80 km/h, 19t axle load	Regional Fast Rail operation	$21,400	$10,361	$11,039	Moura $29,350	Kwinana to Bunbury $17,292
Residual passenger network	115kmph loco hauled passenger, freight at 80km/h, 19t axle load	Residual passenger, suburban, or freight greater than 5 MGT	$18,412	$5,746	$12,666	Qld Major trunk $22,750	ARTC $14,582
Class 2 & 3 freight only lines	freight at 80 km/h, 19t axle load	freight rail 0.5 to 5 MGT	$15,815	$5,337	$10,478	Qld Major trunk $22,750	Leonora to Kalgoorlie $9,274
Class 4 & 5 freight only lines	freight at 50 km/h, 19t axle load	freight rail less than 0.5 MGT	$9,894	$2,735	$7,159	Qld 'fringe' grain lines $12,000	Yaapeet $7,013

Source: *Maintenance Cost Benchmarking for the Victorian Freight Network*, WorleyParsons, Jan 2006

The cost drivers identified in the report include traffic type (associated with safety requirements for passenger operations or freight), line speed, scale and efficiency of operation, and type of infrastructure (particularly sleeper type and signalling), and to a smaller extent, physical environment and regulatory settings. The report notes the higher cost of maintaining Residual Passenger Lines compared with Regional Fast Rail Lines is entirely due to the need to replace timber sleepers.

The report is based on the assumption that assets will be maintained on a strictly like for like basis and that all non-timber structures will never be replaced except for components worn by the rail traffic.

The report provides analysis of the increase in costs attributable to mixed traffic when compared with what would be required if only passenger or freight traffic were to use various lines.

The report clarifies that the suggested benchmarks (Table 3-2) were derived from an average of:

- 85% of maintenance costs estimated by Worley Parsons using an assessment of materials, plant and labour

- Lower benchmarks from industry data
- Higher benchmarks from industry data.

An assessment of ARTC maintenance cost relative to efficient industry practice, ARTC, June 2007

The report comments:

- A NSW Auditor-General's report to Parliament reported $268 million of maintenance backlog relating to rail lines leased to ARTC. When a short time period is considered, maintenance costs could vary from a life cycle average;
- the WorleyParsons efficient cost benchmarks are predicated on ARTC's network asset configuration in 2006-07. ARTC maintenance forecasts complete changes to the network. The most significant impact on ARTC maintenance scope and cost over the term of the undertaking results from the concrete resleepering program on the north-south ARTC interstate corridor in 2007-2009
- ARTC adjusted the WorleyParsons modelling on the north-south ARTC interstate corridor to create full concrete sleepering and derive efficient cost benchmarks adjusted for this effect. Reported benchmarks are summarised in Table 3-2 in $ per track km (rounded to $500). Benchmarks in GTK are reported by ARTC but not repeated in this appendix.

Table 3-2 Summary of maintenance costs benchmarks (ARTC 2007)

Region	WorleyParsons existing configuration ($ per km)	WorleyParsons Concrete configuration ($ per km)	ARTC 2007-09 Average ($ per km)	ARTC 2009-12 Average ($ per km)
ARTC East-West Interstate Network	$ 16,500	N/A	$12,500	$12,000
ARTC North-South Interstate Network	$ 27,500	$ 16,500	$20,500	$13,500

Source: *An Assessment of ARTC Maintenance Cost Relative To Efficient Industry Practice*, ARTC, 2007

- WorleyParsons has assumed unit labour rates which are lower than ARTC's experience and could add 15-30% to the Total Remuneration Cost
- WorleyParsons has applied 20% for overheads which is similar to ARTC experience for maintenance contracts. However this leads to an underestimate of costs for network governance functions of a company such as ARTC
- ARTC would expect a favourable cost outcome on the east-west network given the track condition generally, with concrete sleepers, steady state maintenance requirements and benign terrain
- ARTC's maintenance costs on the north-south network are expected to fall substantially (30%) from 2007 to 2012 in line with changing track configuration (a benefit associated with the concrete sleeper investment by ARTC)
- ARTC would expect maintenance expenditure to track closer to Worley Parsons efficient benchmarks over time. This is because ARTC's maintenance scope in the first few years relates to a newer and improved asset following concrete resleepering and other rehabilitation works. This would be below the scope reflecting long term steady state requirements, and is not suitable beyond the short term.

Review of ARTC operation and maintenance costs and cost allocation method, PricewaterhouseCoopers, April 2008

The report provides maintenance expenditure reference points (in 2006/7 dollars) as follows:

- Actual ARTC Undertaking 2002-2007 (as reported by annual KPIs) have an average of $14,994 per track km or a $1.79 per GTK(000) in 2002/3 reducing to 1.51 in 2005/06
- Essential Services Commission (Vic), Pacific National Freight 2006 includes $22,162 per track km for Regional Fast Rail, $28,849 per track km for other passenger and $15,081 per track km for freight
- Economic Regulation Authority (WA) 2007 has $18,784 per track km for WestNet (Forrestfield to Kalgoorlie, excluding MPM costs)
- Queensland Competition Authority has $8,920 to 12,870 per track km for QR Network based on average maintenance costs on 19/21tal lines where annual tonnage is 3 to 6MGT.

The report also comments:

- If passenger networks are excluded from the analysis, the top of the reference point range reduces from $29,000 to below $19,000 per track km
- The average cost of maintenance for ARTC over the upcoming regulation period is expected to be $12,360
- ARTC's average cost of $12,360 over the regulatory period is in the middle of the QR reference points which are exclusive of MPM. Once a similar adjustment has been made to ARTC's maintenance figures the average maintenance costs is relatively similar
- ARTC has a complicated structure in terms of the ownership and operation of particular line segments which includes outright ownership, leased ownership or management contracts. The complexity of its operations, legislative requirements in NSW and constraints on its ability to outsource contracts impact costs and economies on various parts of the network.

Hunter Valley Access Undertaking 2009: Explanatory Guide Supplementary Information, ARTC, October 2009

The guide provides costs per thousand gross tonne kilometres (kgtkm) in three zones with similar track characteristics (25 to 30tal, 60 – 80 km/h): 'Non-TOP' rates of $0.36 to $0.721 and 'TOP' rates of $5.049 to $6.012 are quoted.

Maintenance expenditure includes major periodic maintenance (MPM) and reactive corrective routine maintenance (RCRM).

Forecasts for the network for 2010 include:

- Nett tonnes = 125.8m
- Coal GTK = 29.25 billion
- Variable maintenance = $18.85 m
- Fixed maintenance = $18.75 m
- Non-segment specific costs = $33.57 m
- Total operating costs = $71.17 m

The report states that on a cost per GTK basis, overall maintenance unit cost (including allocated overheads) has decreased by around 30% from 0.19c/GTK to 0.13c/GTK over a 2.5 year period. It is observed that $37.6m (variable and fixed maintenance cost) divided by 29.25 billion GTK equates to $1.28 per GTK (000) i.e. 0.128c/GTK

3.3 Categorisation of track

The design, construction and maintenance of railways in Australia are documented in standards that generally cover individual states or apply network-wide. Different principles are adopted in the various locations, although a national code of practice is expected to be in place by the time the inland railway is in operation.

For the purposes of this appendix, the use of track categories (Class 1 and Class 2) has been adopted for the specification of standards for the construction and maintenance of the proposed and existing alignments.

The reference train for the study is assumed to be capable of 115 km/h on 21 tal track. It is similar to the characteristics of Express Freight and Superfreighter (Intermodal) services for which paths are sold by ARTC. However, the categories in existing standards do not include the requirements of these services.

Bearing in mind the specifications of the reference train and the likely level of traffic demand, the minimum construction standard for the 'newly constructed' and 'upgraded' track on the inland railway is as follows:

- Rails — Continuously welded 60 kg
- Fastenings — Pandrol resilient fastening
- Sleepers — Concrete @ 660 mm spacing
- Ballast depth — 300 mm nominal depth.

3.4 Approach to maintenance costs of the inland railway

The proposed inland railway has been considered from a maintenance perspective and costs have been estimated according to the principal cost drivers, being track configuration, freight volume and time. It is recognised that the type of traffic using a line (passenger and/or freight) influences maintenance. However, WorleyParsons has reported that the impact is less than 10% for the Victorian Residual Passenger Network on a cost per GTK basis. Because the inland railway is reasonably similar to RPN in terms of maximum traffic speed and axle load, the type of traffic has not been specifically used in the analysis of maintenance costs in this report. However the work by WorleyParsons is noted and, along with the many other factors, included in the assessment of costs.

The track configuration has been defined as:

- Existing Class 1 track, suitable for use by the inland railway over the longer term
- New track structure – either Class 1 greenfield construction or upgraded track, to be reconstructed to Class 1 standard before services commence on the inland railway
- Existing Class 2 track, suitable for use on the inland railway over the shorter term but to be upgraded in the medium term.

The freight volume has been estimated according to the traffic that is likely at the time of initial operation of inland railway and later when eight intermodal trains are expected to run each way each day on the line. Each section of the inland railway has been allocated one of the following categories of annual railway tonnage:

- Below 10 mtpa
- 10 to 30 mtpa
- More than 30 mtpa.

It has been assumed that existing Class 1 and Class 2 tracks will be maintained on a steady state basis; that is the maintenance effort would be constant with time. The new track structure on greenfield or upgraded tracks is expected to have a small increase in cost from initial construction through to a steady state condition. For new track structure, different costs have been estimated for the two time categories of before and after 15 years of service.

For each of the categories, maintenance costs per track kilometre have been estimated. The estimates have been based on desk-top reviews of previous studies, comments and inputs from ARTC and an independent validation exercise (comprising a build-up of costs from estimates of plant, labour and materials). Costs have been estimated at 2010 rates.

Whilst three primary cost drivers have been chosen for the analysis in this study, a large number of smaller factors will affect the actual maintenance of the railway. Likely cost rates and upper and lower bound values have therefore been suggested.

Some of the factors having a smaller impact on the maintenance costs include:

- Frequency of structures – this affects in particular the scale of inspections
- Terrain (potentially resulting in low radius curves and steep gradients on the railway alignment) – the proposed inland railway alignment generally has few sharp curves or steep gradients
- Access - the distance of infrastructure from maintenance depots will have impact but is not possible to assess at this stage in the project;
- Sleepers – whilst new construction will have concrete sleepers, the proportion of timber sleepers in existing tracks will affect the maintenance cost. Any existing Class 1 track with timber sleepers will not be upgraded except as a possible separate program of works after the commencement of inland railway services.
- Rollingstock characteristics – The reference train for this study is assumed to be capable of 115 km/hr on 21 tal track. This compares with 115 km/h on 19 tal track for the Victorian Residual Passenger Network (WorleyParsons, 2006) and is different from many of the other benchmarks. Other rollingstock characteristics such as wagon stiffness have not been considered in the estimation of maintenance costs in this report
- Condition and life span – the condition and remaining life span of existing assets will impact the maintenance cost of existing track
- Tunnel equipment – tunnels would require forced ventilation because of the need for fresh air for the train crew and locomotives, and during egress and incident response. Power will be required for lighting and other equipment such as remotely operated draught doors. Water entering the tunnels, such as ground-water, may require pumping and treatment. The mechanical and electrical equipment will require maintenance and eventually replacement
- Signalling system – lineside equipment required for the inland railway will be maintained and the quantum compared with that in existing benchmark operations will affect the accuracy of estimates in this report.

An allowance for maintenance and corporate overheads is included in estimates to cover planning, supervision and mobilisation of maintenance resources, a share of corporate functions such as finance and accounting, information technology and human resources.

Allowance for headquarters overheads and network governance is not included in the assessment of maintenance costs in this report.

3.5 Signalling system

The signalling system is assumed to be the Advanced Train Management System (ATMS) which is currently at 'Proof of Concept' phase. This is a transmission based system, requiring no lineside signals. There will be train borne elements, and line-side systems that monitor lineside devices.

In 2006 a study for ARTC estimated high level maintenance costs for the entire 10,000 km network of $23 million per year, and it is assumed that this is the price of maintaining and replacing the additional hardware associated with ATMS. As a conservative estimate for this study, it may be assumed that the $23 million at 2006 prices is now $25 million in 2010. This cost is for the entire 10,000 km ARTC network, and so $2.5 million could be apportioned to an inland railway. This cost can be added to the existing maintenance cost. Whilst ATMS has no lineside signals, lineside control equipment will remain, and there will be additional satellite communications equipment.

3.6 Estimated maintenance cost rates

The estimates of maintenance cost rates for various track categories are presented in Table 3-3.

Table 3-3 Estimated maintenance cost rates

Traffic volume	Bound estimate	New and upgraded track		Existing track	
		0-15yrs	15+yrs	Class 1	Class 2
Between1and 10 million tonnes per year	Lower bound	$8,000	$9,000	$10,000	$10,000
	Most likely	$12,000	$17,500	$20,000	$21,000
	Upper bound	$19,000	$22,100	$27,500	$30,000
Between 10 and 30 million tonnes per year	Lower bound	$9,600	$16,500	$17,900	N/A
	Most likely	$22,000	$25,000	$25,000	N/A
	Upper bound	$40,000	$45,000	$45,000	N/A
Greater than 30 million tonnes per year	Lower bound	$20,000	$25,000	$25,000	N/A
	Most likely	$30,000	$35,000	$35,000	N/A
	Upper bound	$40,000	$50,000	$50,000	N/A

3.7 Estimate of maintenance cost of infrastructure for inland railway

The maintenance costs for the inland railway is estimated in Table 3-4 for 2020 demand forecasts, and in Table 3-5 for the case when eight trains each way per day are operating (assumed to be 2050).

The sections from Melbourne to Illabo and from Kagaru to Acacia Ridge have been excluded from the estimate because these sections will be managed as part of the network controlled by ARTC and the financial and economic model for the inland railway does not include revenue from these sections.

Table 3-4 Estimate of maintenance cost at 2020

Alignment section	Track configuration	Traffic volume (gtpa)	Mainten-ance cost rate ($)	Track length (km)	Mainten-ance cost ($m)
Illabo to Parkes	Existing Class 1	1m to 10m	20,000	242	4.84
Parkes to Narromine	Existing Class 2	1m to 10m	21,000	106	2.23
Narromine to Narrabri (nth)	New Class 1	1m to 10m	12,000	307	3.68
Narrabri (nth) to Moree	Existing Class 2	1m to 10m	21,000	106	2.23
Moree to Yelarbon	New Class 1	1m to 10m	12,000	143	1.72
Yelarbon to Inglewood	New dual gauge	1m to 10m	12,000	34	0.41
Inglewood to Millmerran	New Class 1	1m to 10m	12,000	71	0.85
Millmerran to Brookstead	New dual gauge	1m to 10m	12,000	20	0.24
Brookstead to Oakey	New Class 1	1m to 10m	12,000	53	0.64
Oakey to Kagaru	New dual gauge	10m to 30m	22,000	148	3.26
Total maintenance cost per year ($m in 2010 prices)					**20.08**

Table 3-5 Estimation of maintenance cost at 2050

Alignment section	Track configuration	Traffic volume (gtpa)	Mainten-ance cost rate ($)	Track length (km)	Mainten-ance cost ($)
Illabo to Stockinbingal	New Class 1	10m to 30m	22,000	37	0.81
Stockinbingal to Parkes	Existing Class 1	10m to 30m	25,000	174	4.35
Parkes to Narromine	New Class 1	10m to 30m	22,000	106	2.33
Narromine to Narrabri (north)	Class 1 (15+yrs)	10m to 30m	25,000	307	7.67
Narrabri (north) to Moree	New Class 1	10m to 30m	22,000	106	2.33
Moree to Oakey	Class 1 (15+yrs)	10m to 30m	25,000	321	8.03
Oakey to Kagaru	Class 1 (15+yrs)	More than 30m	35,000	148	5.18
Total maintenance cost per year ($m in 2010 prices)					**30.71**

3.8 Analysis of maintenance costs

The maintenance of the inland railway alignment between Illabo and Kagaru is estimated to cost $20 million per year in 2020 (notionally) when two trains per day each way would be expected to run, increasing to $31 million per year in 2050 when eight trains each way per day are forecast. An additional allowance of $2.5 million per year is made for maintenance of ATMS.

The maintenance cost equates to an average of $16,260 per track km in 2020 (notional), rising to an average of $25,650 per track km in 2050.

In terms of cost per GTK:

- In 2020, assuming 9000t between Illabo and Oakey and 19000t between Oakey and Kagaru, the maintenance cost equates to an average of $1.59 per GTK(000)
- In 2050, assuming 25,000t between Illabo and Oakey and 35,000t between Oakey and Kagaru, the maintenance cost equates to an average of $0.98 per GTK(000).

These figures compare with:

- those reported by PricewaterhouseCoopers for ARTC's Undertaking 2002-2007 (as reported by annual KPIs) of an average of $14,994 per track km or a $1.79 per GTK(000) in 2002/3 reducing to $1.51 in 2005/06.
- Those reported by ARTC for the Hunter Valley of $1.30 per GTK(000).

4. Summary of operation and maintenance costs for inland railway

Operating costs

Based on the use (at no cost) of existing management, buildings and the assistance of staff from existing maintenance depots, an allowance for the below rail operating costs is assumed to be $3.3 million per year. An additional capital cost of $500,000 should be allowed in the first year to mobilise staff.

Maintenance costs

The maintenance of the inland railway alignment between Illabo and Kagaru is estimated to cost $20.1 million per year in 2020 (notionally) when two trains per day each way would be expected to run, rising to $30.7 million per year in 2050 when eight trains each way per day are forecast. An additional allowance of $2.5 million per year is made for maintenance of ATMS.

Table 4-1 Total infrastructure cost per year (2010 dollars)

Infrastructure costs	Estimated cost (millions)	
	2020	2050
Operating costs	$3.3	$3.3
ATMS costs	$2.5	$2.5
Maintenance costs	$20.1	$30.7
Total	**$25.9**	**$36.5**