Applicable Railway Infrastructure DORC

Final Report

Arc Infrastructure Pty Ltd

06 June 2025

→ **The Power of Commitment**

Project name	Arc Infrastructure Advice
Document title	Applicable Railway Infrastructure DORC | Final Report
Project number	12620198
File name	12620198 – REP – 005 – DORC Report

GHD Pty Ltd | ABN 39 008 488 373

The Power of Commitment

Executive Summary

This report outlines the methodology used to calculate the depreciated optimised replacement cost (DORC) value of Railway Infrastructure controlled and managed by Arc Infrastructure (Arc) in Western Australia, in compliance with requirements of the “Railways (Access) Code 2000” (The Code) and Arc’s Costing Principles.

This DORC follows regulatory principles and precedent and is based on efficient replacement costs for Modern Equivalent assets in an optimised configuration, where the MEA:

1. meets the closest comparable service standard to the existing
2. comprises the assets and form of construction which would be designed and constructed at the valuation date, using modern design techniques, constructed from modern materials using modern methods, and in compliance with prevailing legislation and prevailing standards

and the optimised asset configuration has the capacity to meet the actual and reasonably projected demand, within the physical constraints of the existing railway corridor, that can be constructed at least cost, where the level of service associated with the actual and reasonably project demand is defined in terms of:

– maximum axle loads;
– maximum train speeds; and
– maximum train lengths.

The DORC includes provisions for design development, planning and approval costs, material costs, construction costs, project and construction management costs and funding costs, and adjustments for contributed assets and operating cost differences between the existing assets and the modern equivalents.

Two alternative signalling systems have been considered to address the above requirements. These are discussed in detail in the report and presented throughout as ‘Alternative A’ and ‘Alternative B’.

The total **DORC with OpEx Adjustments value for the Arc Network is estimated to be for:**

– Alternative Signalling A: $15,262.8million
– Alternative Signalling B: $14,440.8million

as at 31 December 2024, calculated as follows:

Table 0-1 Calculation Item Descriptions

Calculation Item	Description	Value ($CY24 million)
Alternative A		
Network replacement cost	Replacement costs for track, signalling and control systems, right of way, civil structures, buildings, track structures, miscellaneous.	19,876.5
Asset optimisation	Removal of redundant assets, adjustment for optimised configuration for minimum service levels.	(158.1)
Construction Cost Savings from Alternative Procurement		(2,650.3)
Asset development costs	Design, planning and development, project and construction management, funding costs.	12,985.7
Depreciation	Adjustment to reflect remaining useful life.	(14,760.8)
Operating Cost Adjustments		(30.2)
TOTAL DORC WITH OPEX ADJUSTMENTS		**15,262.8**
Alternative B		
Network replacement cost	Replacement costs for track, signalling and control systems, right of way, civil structures, buildings, track structures, miscellaneous.	19,876.5
Asset optimisation	Removal of redundant assets, adjustment for optimised configuration for minimum service levels.	(1,442.3)
Construction Cost Savings from Alternative Procurement		(2,650.3)
Asset development costs	Design, planning and development, project and construction management, funding costs.	12,141.9
Depreciation	Adjustment to reflect remaining useful life.	(13,248.8)
Operating Cost Adjustments		(236.2)
TOTAL DORC WITH OPEX ADJUSTMENTS		**14,440.8**

The calculations are presented graphically in 0-1.

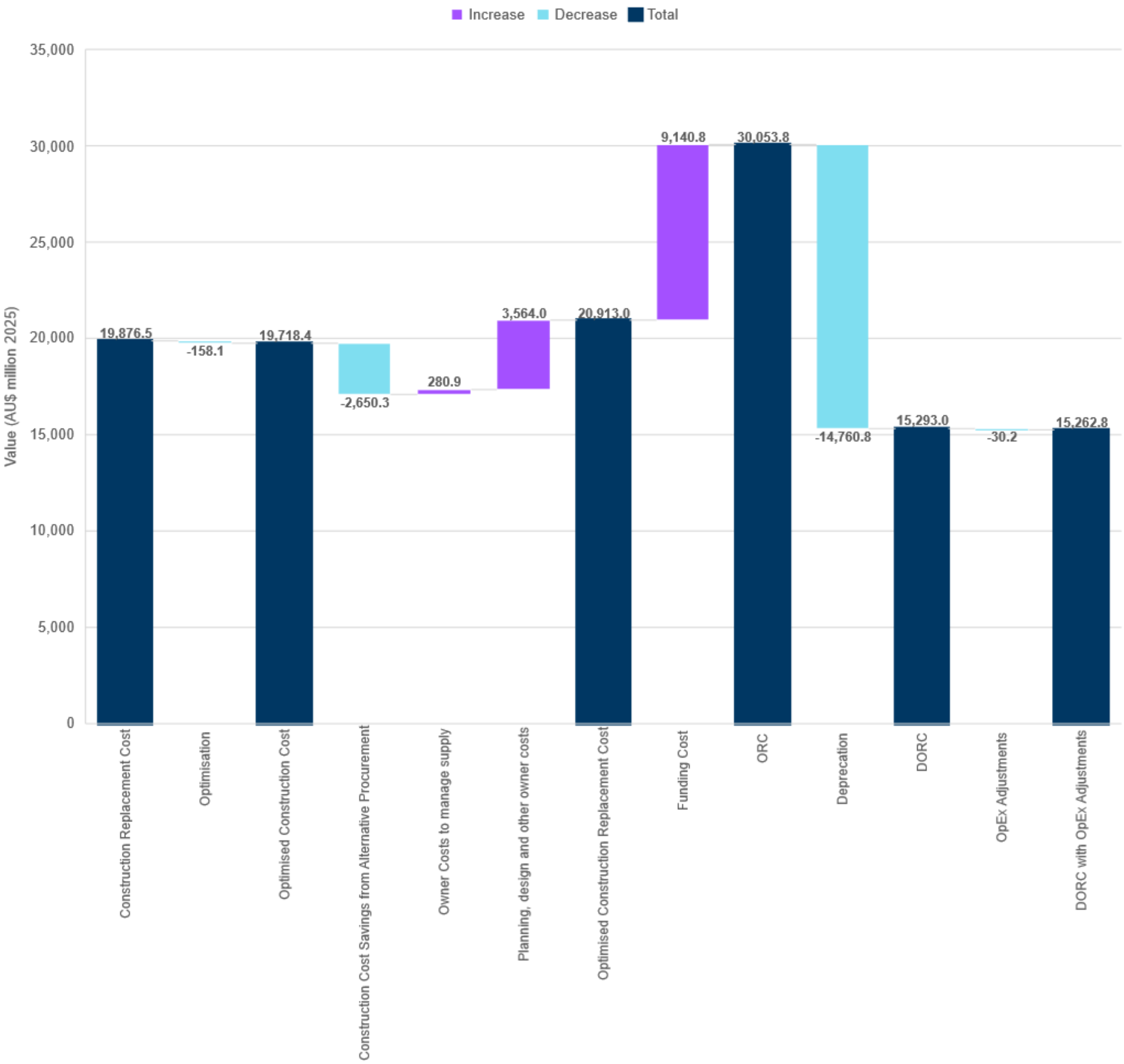


Figure 0-1   ***DORC Calculations***

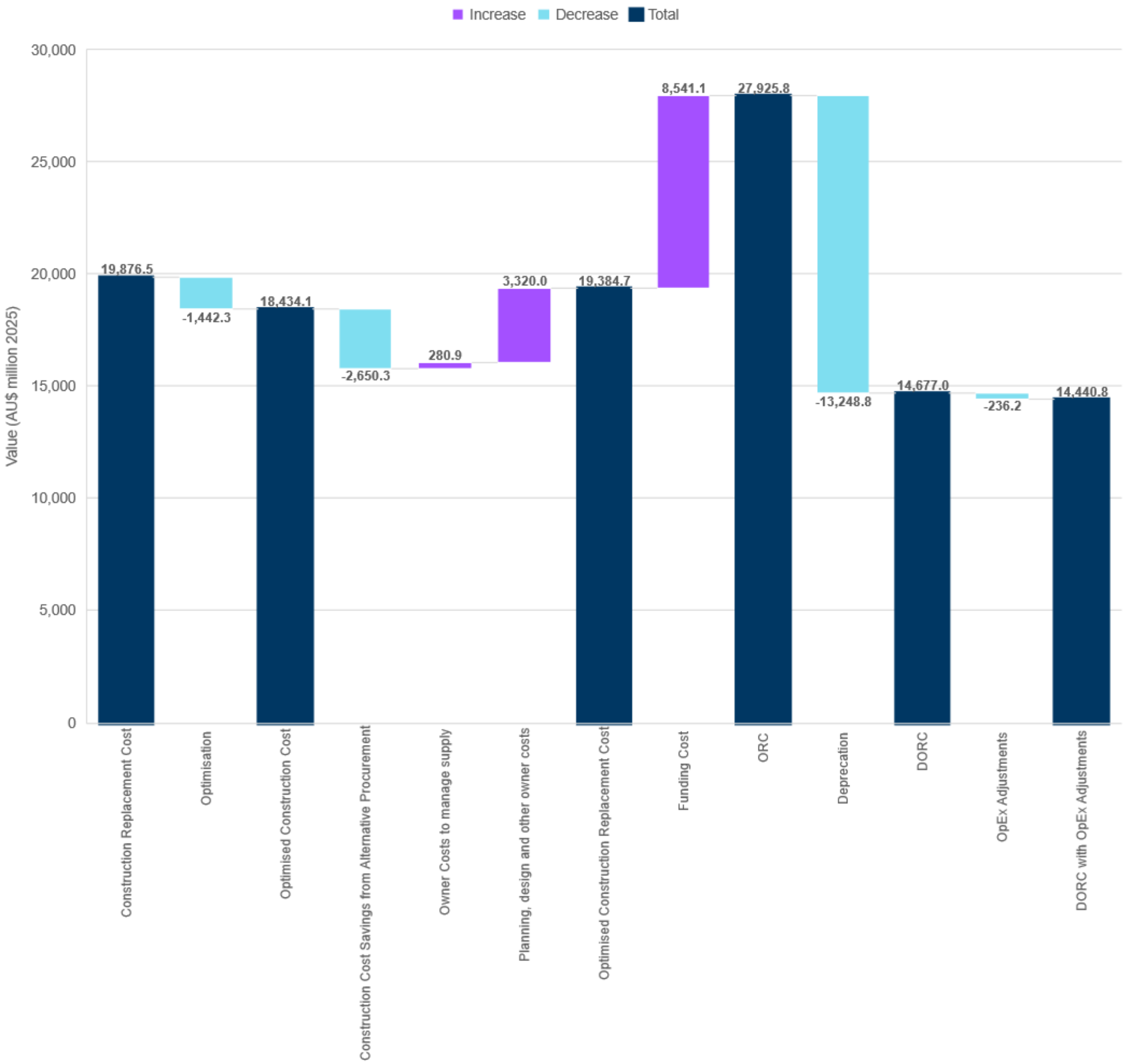


Figure 0-2 Development of the DORC for the Arc Rail Network Alternative A and B

Figure 0-3, Figure 0-4, Figure 0-5, and Figure 0-6 show the build-up of the DORC by Route Section for Alternative Signalling A.

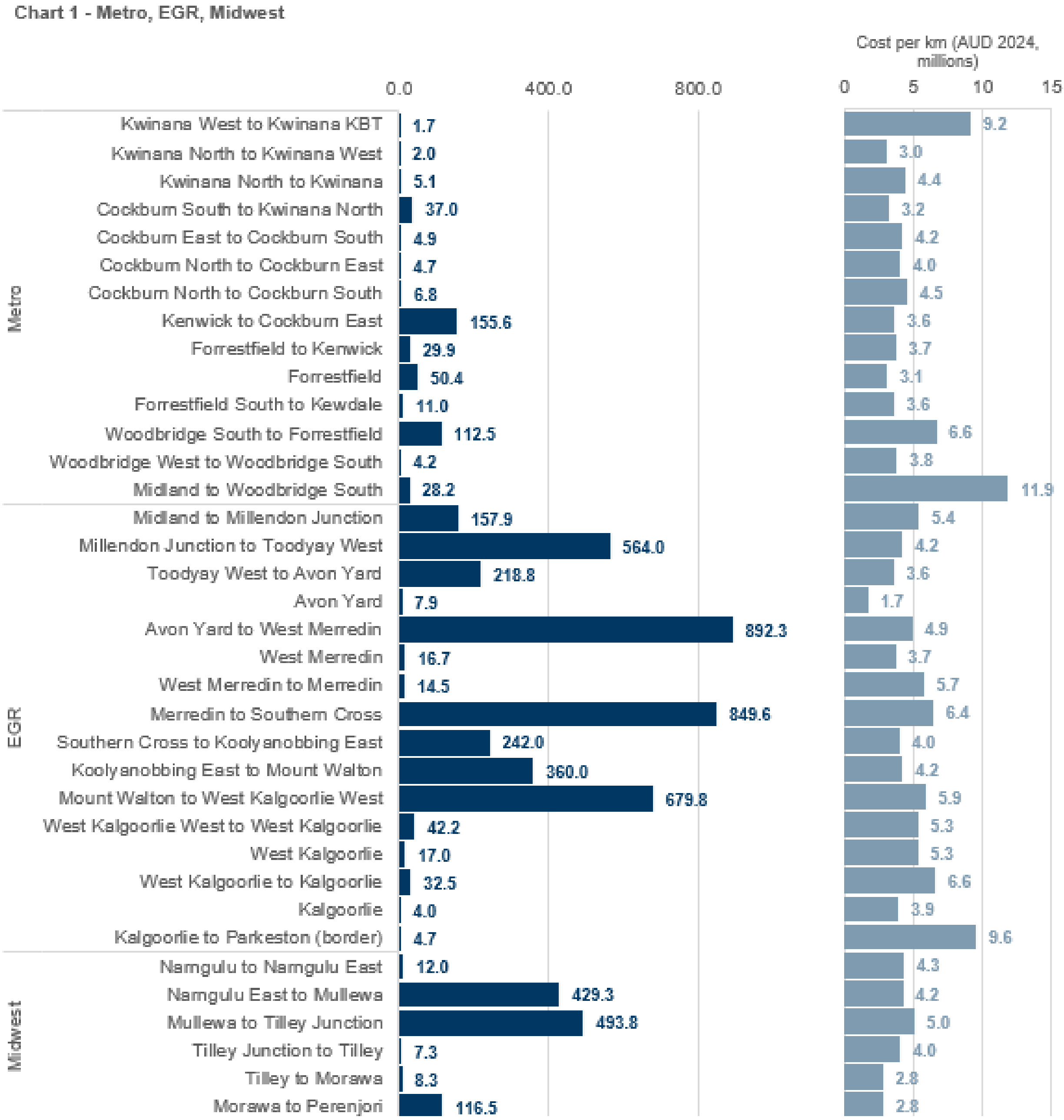


Figure 0-3 *DORC Alternative A by Route Section - 1*

Chart 2 - LBL, EBL, SWM, Collie

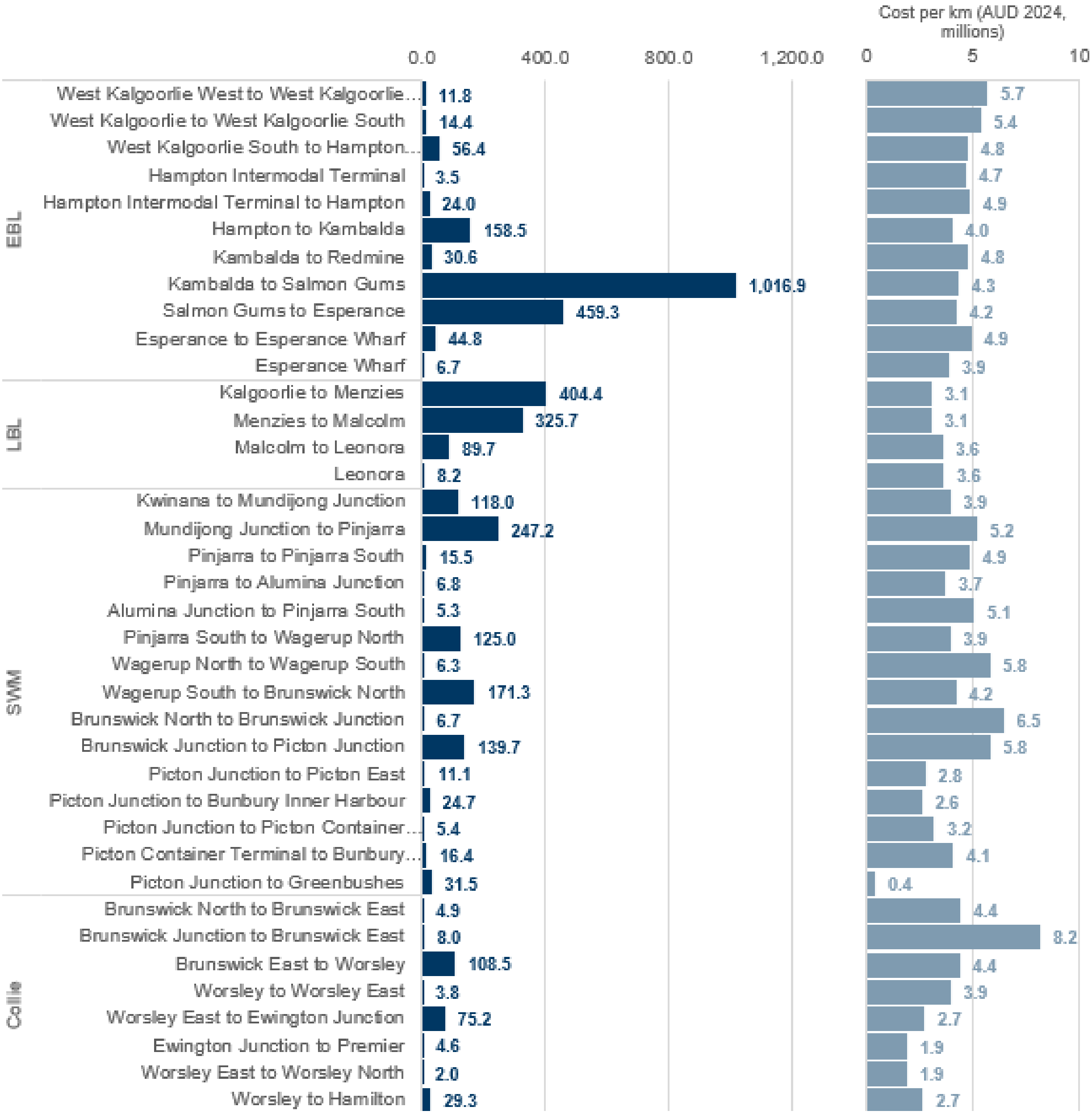


Figure 0-4 DORC Alternative A by Route Section - 2

Chart 3 - MR, Central, GSR, Lakes

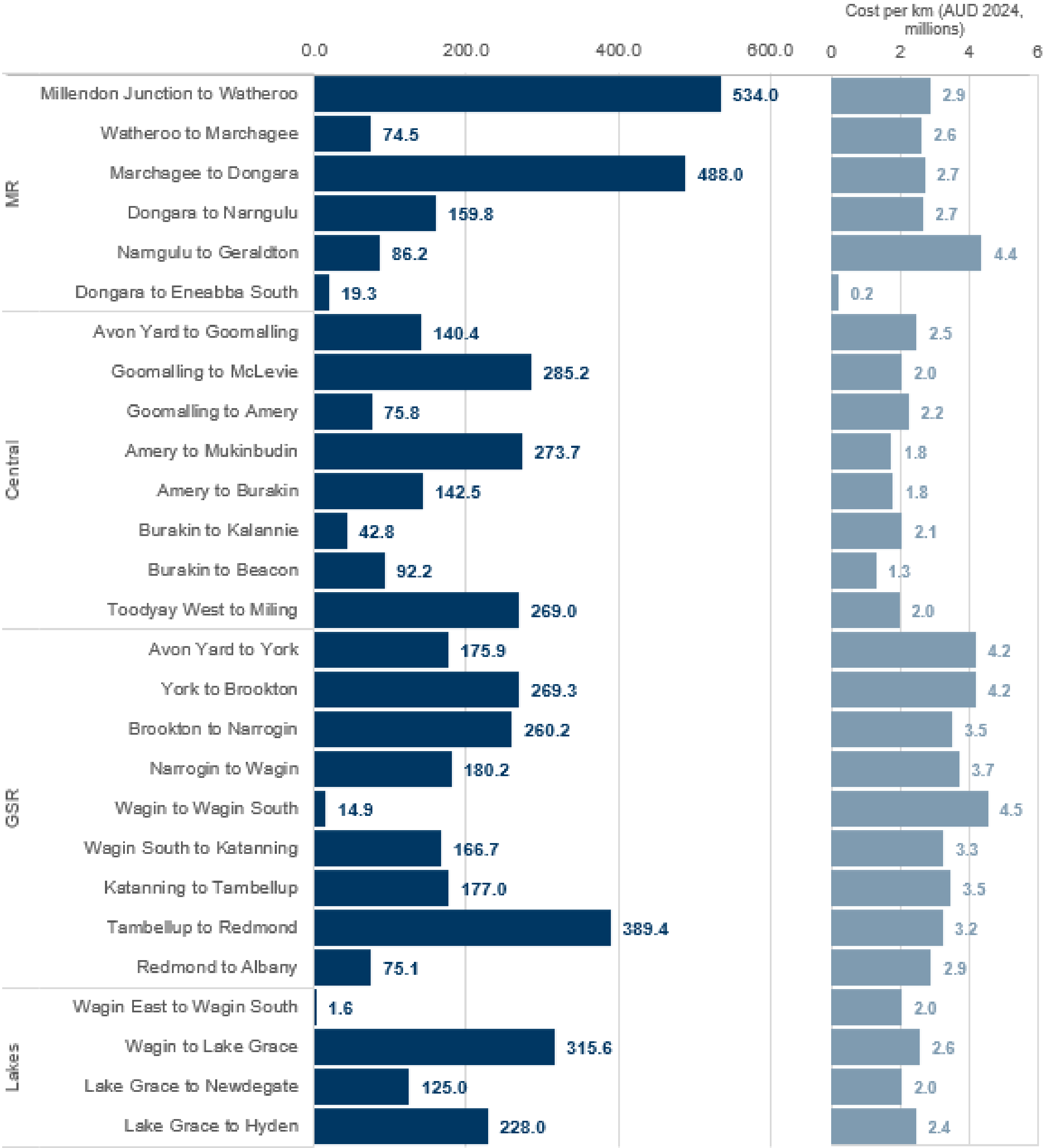


Figure 0-5 DORC Alternative A by Route Section - 3

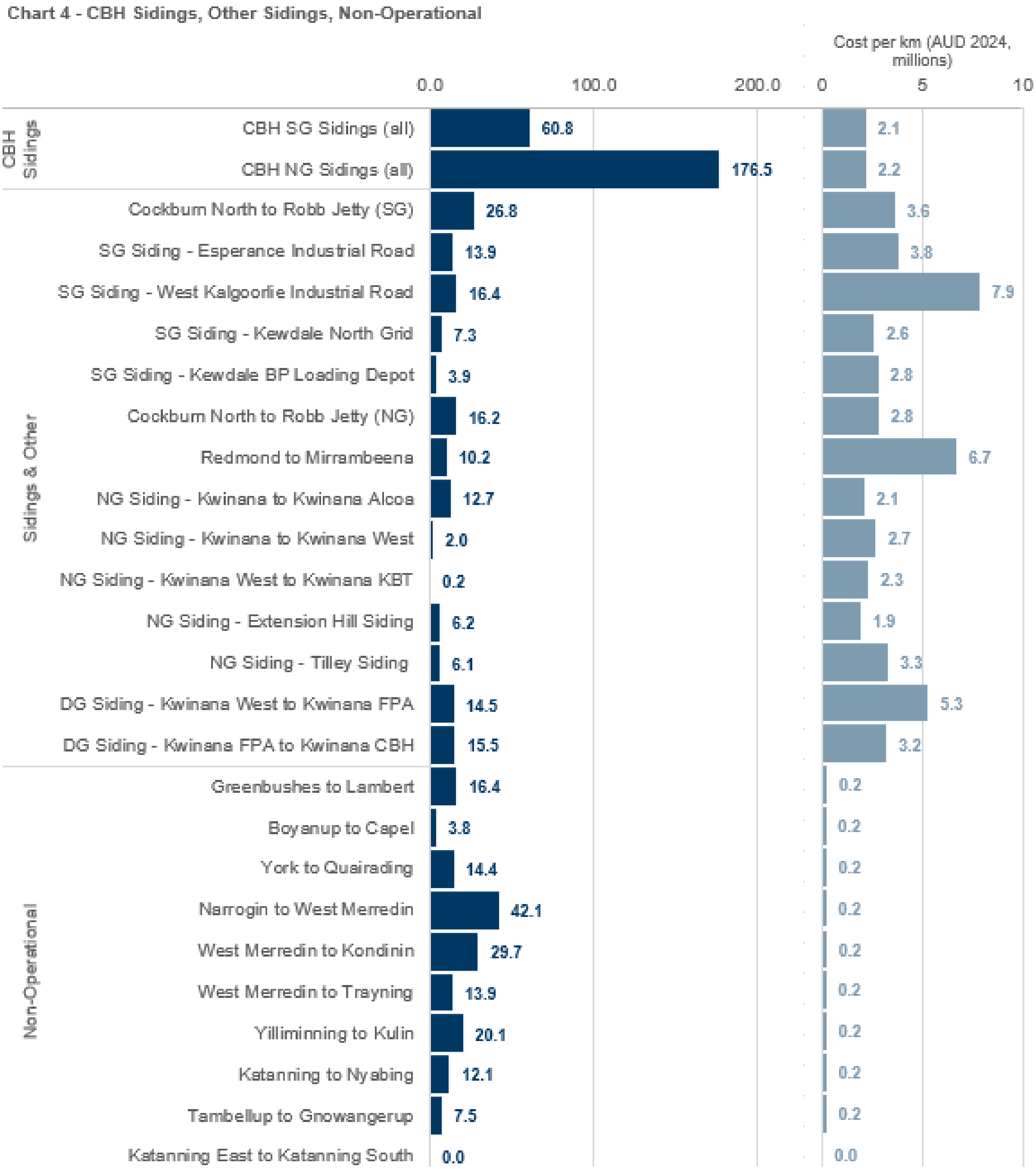


Figure 0-6 DORC Alternative A by Route Section - 4

Figure 0-7, Figure 0-8, Figure 0-9, and Figure 0-10 show the build-up of the DORC by Route Section for Alternative Signalling B.

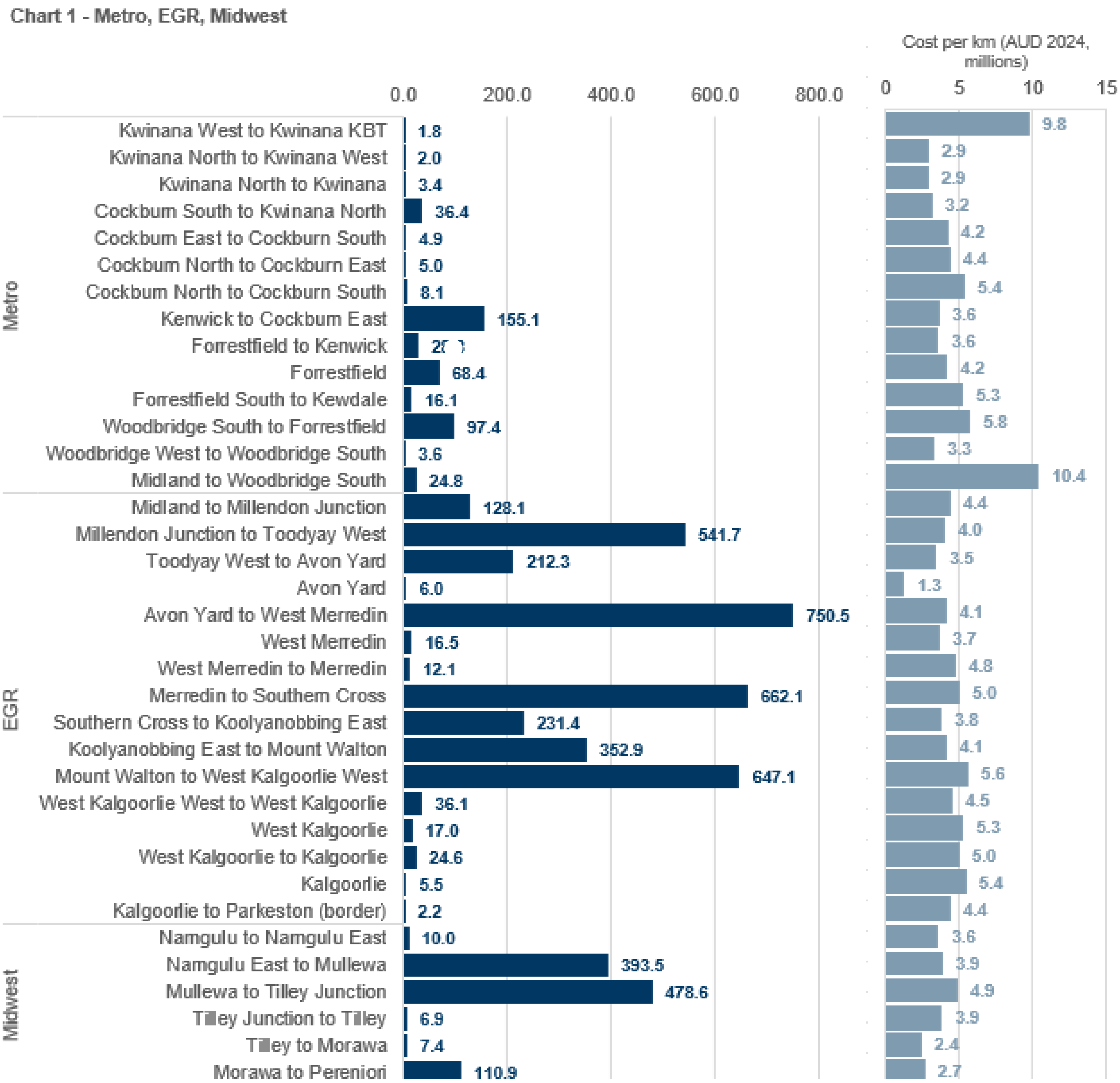


Figure 0-7 DORC Alternative B by Route Section

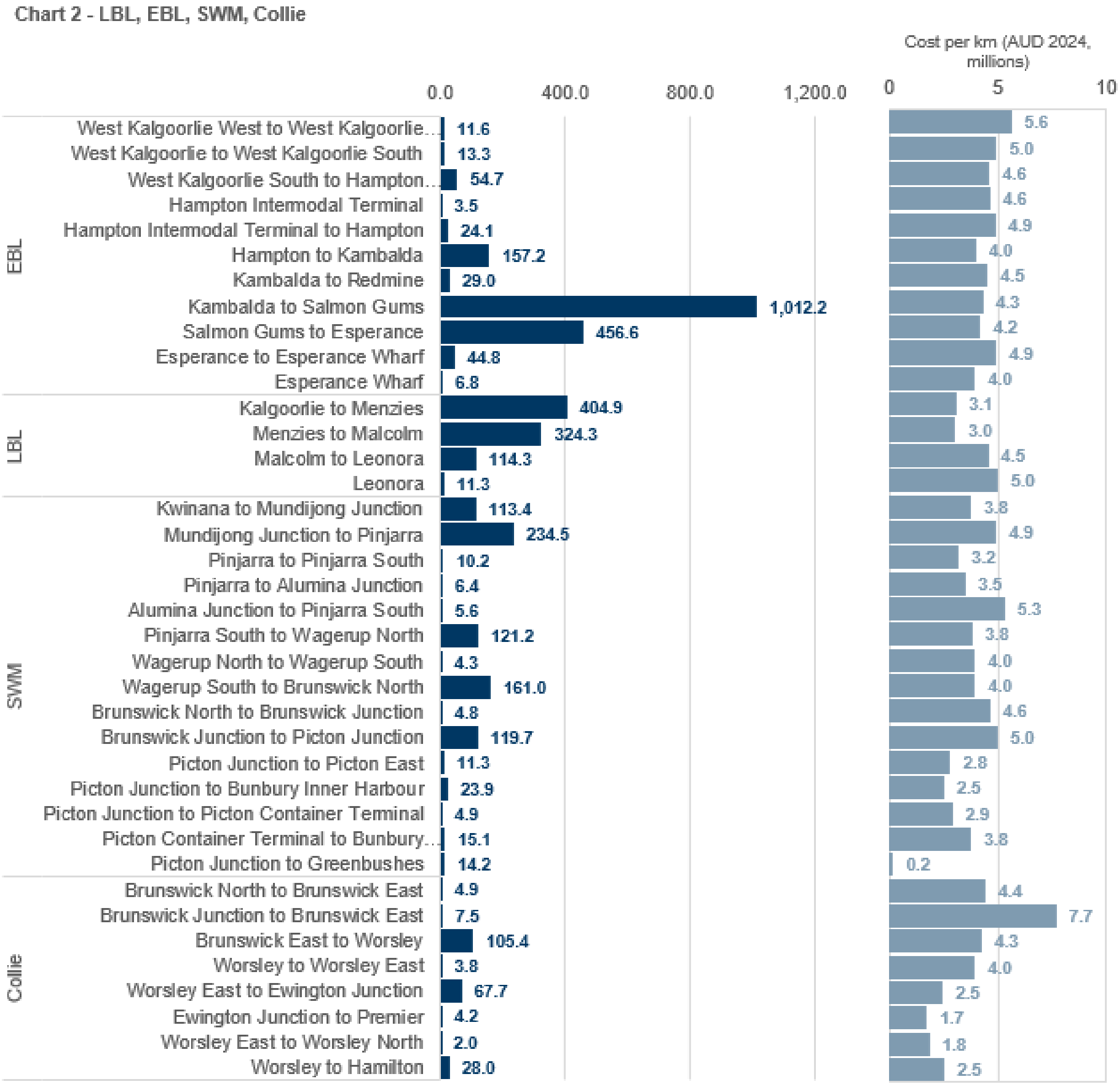


Figure 0-8 DORC Alternative B by Route Section - 2

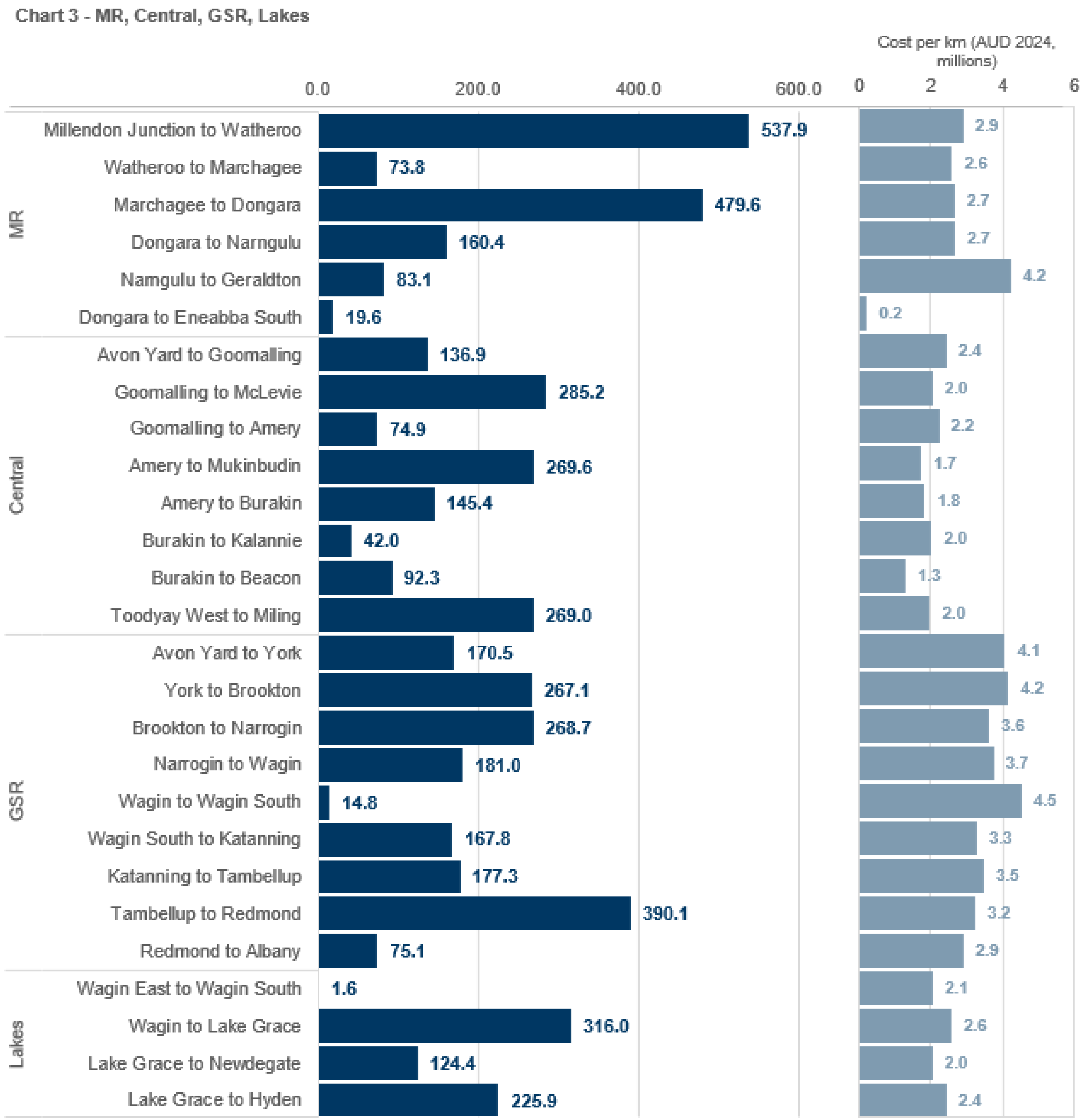


Figure 0-9 DORC Alternative B by Route Section - 3

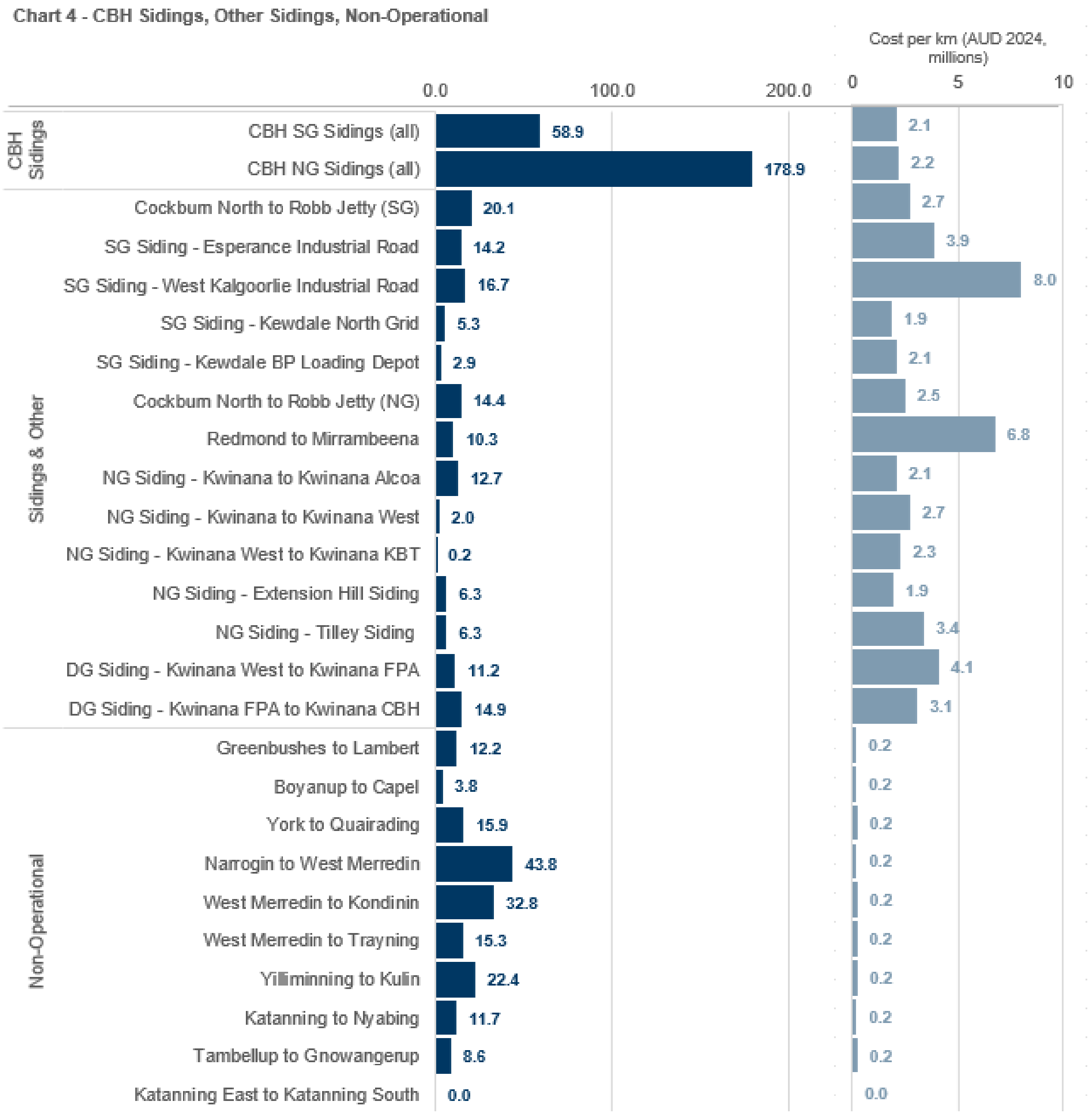


Figure 0-10 DORC Alternative B by Route Section - 4

Contents

Table index

Figure index

Abbreviations

Term	Definition
AACE	Association for the Advancement of Cost Engineering
AS	Australian Standard
CapEx	Capital Expenditure
CBI	Computer-based interlocking
CBTC	Communication Based Train Control
CTC	Centralised Train Control
DMI	driver machine interface
DORC	Depreciated Optimised Replacement Cost
EPBC Act	Environment Protection and Biodiversity Act 1999
EPCM	Engineering, Procurement, Construction and Management
ETCS	European Train Control System
ICE	Interactive Connectivity establishment
IDC	Interest During Construction
km	kilometre
m	metre
m^3	Metre cubed
MEA	Modern Equivalent Asset
mm	millimetre
OpEx	Operating Expenditure (Costs)
ORC	Optimised Replacement Cost
NPV	Net Present Value
PCBC	Precast Box Culvert
PSC	Pre-stressed Concrete
PTA	Public Transport Authority
RAB	Regulatory Asset Base
RBTC	Radio Based Train Control
RC	Replacement Cost
TAL	Tonne axle load
WA	Western Australia
WACC	Weighted Average Cost of Capital

1. Introduction

1.1 The DORC Valuation Method

The DORC approach is used to estimate the value of infrastructure assets because of their unique configuration, where there is typically no market data on sales of such 'specialised' assets[1]. The approach is consistent with the requirements under the "Railways (Access) Code 2000" (the Code).

This DORC valuation estimates the realistic least cost that would be incurred in replacing the Railway Infrastructure, being the facilities necessary for the operation of a railway, including[2]:

– railway track, associated track structures, over or under track structures, supports (including supports for equipment or items associated with the use of a railway);
– tunnels and bridges;
– stations;
– train control systems, signalling systems and communication systems;
– electric traction infrastructure;
– buildings and workshops; and
– associated plant machinery and equipment,

but not including —

– sidings or spur lines that are excluded by the "Railways (Access) Act 1998" from being Railway Infrastructure; and
– rolling stock, rolling stock maintenance facilities, office buildings, housing, freight centres, and terminal yards and depots.

with assets that:

– have the capacity to provide the level of service that meets the actual and reasonably projected demand; and
– are modern equivalent assets (MEA);

less appropriate adjustments for optimisation, depreciation and maintenance liabilities.[3]

The level of service is defined in terms of:[4]

– Maximum axle loads;
– Maximum train speeds, and
– Maximum train lengths.

The appropriate MEA is specified having regard to:[5]

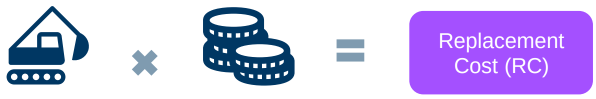
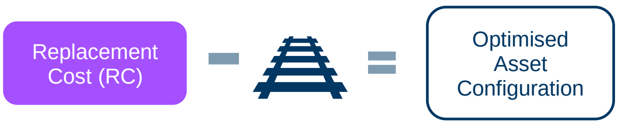
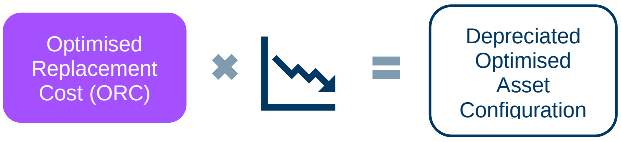
– the required operating standards (axle load, maximum speed, maximum train length);
– the population of supporting infrastructure (bridges, culverts); and
– the topography of route (gradient and track curvature).

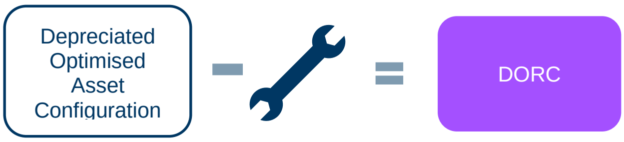
The 'valuation date' for this DORC assessment is 31 December 2024. On this basis, the output reflects the market-based valuation for the existing asset as 31 December 2024.[6] Indexation of the DORC with OpEx Adjustment is then to be based on the Australian Bureau of Statistics Eight Capital Cities All Groups CPI.

The approach used to determine the DORC is shown below.

[1] International Valuation Standards Committee, International Valuation Guidance Note No. 8 Depreciated Replacement Cost International Valuation Standards 6th Edition, 2003, available at: **http://www.romacor.ro/legislatie/22-gn8.pdf**
[2] Railways (Access) Code Section 3
[3] Railways (Access) Code 2000, Part 1
[4] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[5] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[6] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.2.

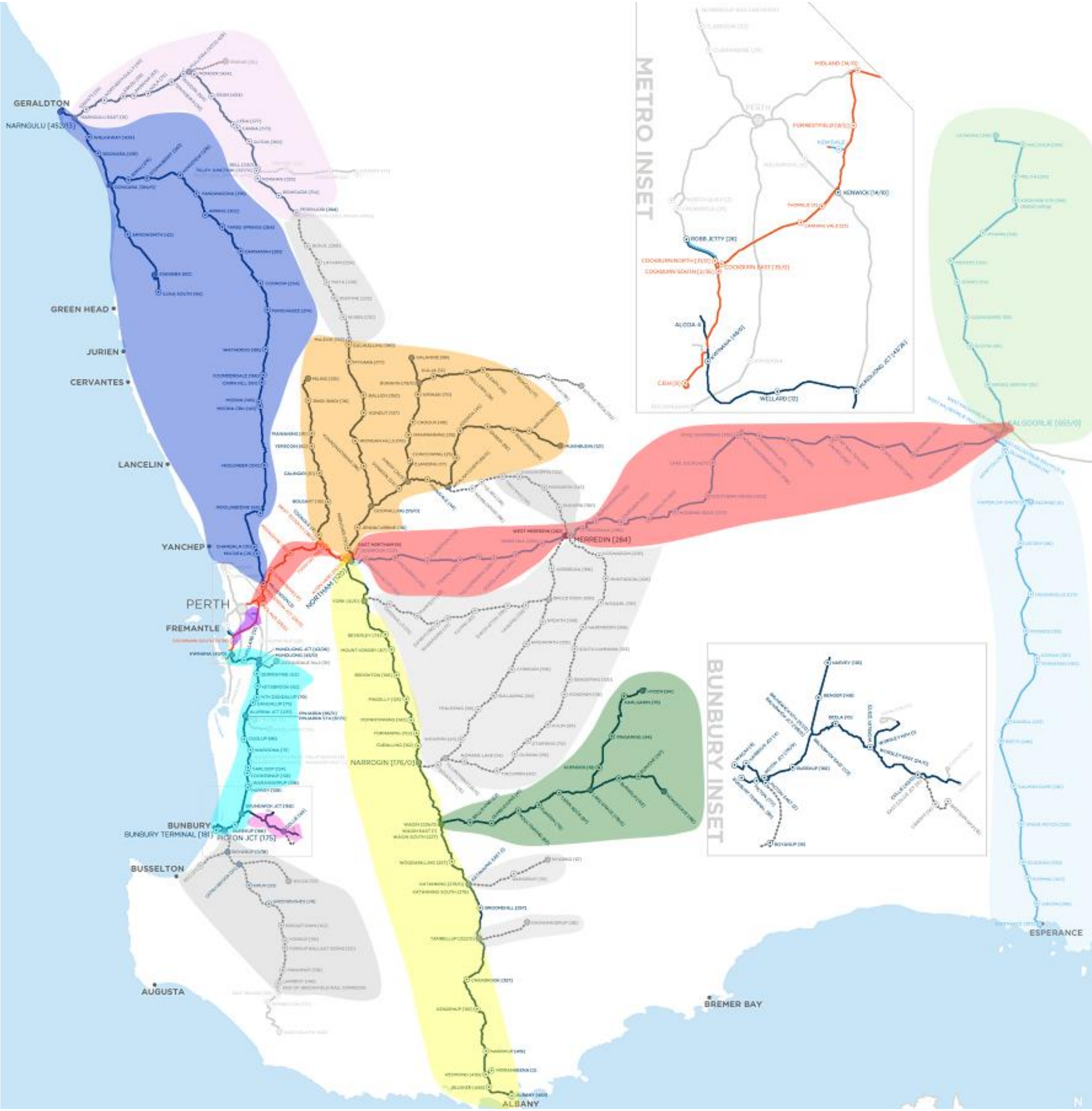
Table 1-1 DORC Methodology Approach

1	**Establish Assumptions** 	– Set out the underlying principles and assumptions on which the DORC will be developed.	Section 2
2	**Confirm Assets** 	– Review the asset registers – Establish the assets within and outside of scope – Establish the asset classes	Section 3
3	**Develop Construction Replacement Cost** 	– Establish the form of the modern equivalent assets. – Establish appropriate market rates for direct and indirect costs. – Extend by the quantity to determine construction replacement cost for the included assets.	Section 4
4	**Develop Optimised Asset Configuration** 	– Identify the minimum asset characteristics that are required to provide the level of service – Develop the optimised asset configuration that would deliver the closest comparable service standard to the existing asset	Section 5.1
5	**Include project development costs** 	– Determine the up-front design, development and approval costs that would be incurred to construct the optimised asset configuration. – Develop a realistic project development schedule and determine the funding costs (cost of capital) that would be incurred to construct the assets. – Deduct the proportion of the asset value that was contributed by other parties.	Sections 5.10 and 5.11
6	**Reduce ORC by asset life remaining** 	– Review condition and maintenance data to estimate the proportion of asset lives that remain at the valuation date. – Reduce the ORC in proportion to the remaining lives to represent that the existing assets are not new.	Section 6

7	**DORC adjustments** 	– Deduct the NPV of any operating costs savings over the remaining life of the assets as a consequence of using the MEA over the existing.	Section 7

1.2 Arc Infrastructure Network

Arc manages and controls the freight rail network in the south-west region of Western Australia (Railway Network) as indicated below, for ease of reference broken down into Network Groups according to Arc’s guidance. The Railway Network facilitates the movement of bulk commodities and freight to ports in Geraldton, Kwinana, Albany, Bunbury, Fremantle and Esperance, and connects Western Australia to the Eastern States via ARTC’s railway network, in addition to some passenger services.



Network Group	Colour Legend	Network Group	Colour Legend	Network Group	Colour Legend
Metro		LBL		Central	
EGR		SWM		GSR	
Midwest		Collie		Lakes	
EBL		MR		Non-operational	

Figure 1-6 Map of the Arc Network (source: Arc_Map_Network (arcinfra.com))

1.3 Purpose of this report

GHD Pty Ltd has been engaged by Arc to prepare a DORC estimate for network assets controlled and managed by Arc in Western Australia, following typical approaches and regulatory precedent, and in compliance with requirements of the Code.

This report outlines the methodology used to calculate the DORC value of these rail network assets

1.4 Limitations

This report: has been prepared by GHD for Arc Infrastructure Pty Ltd and may only be used and relied on by Arc Infrastructure Pty Ltd for the purpose agreed between GHD and Arc Infrastructure Pty Ltd as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Arc Infrastructure Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 2 and throughout the report). GHD disclaims liability arising from any of the assumptions being incorrect.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

Supplied Documentation

GHD has prepared this report on the basis of information provided by Arc Infrastructure Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Preparation of the DORC Model

GHD has prepared the DORC ("Model") for, and for the benefit and sole use of, Arc Infrastructure Pty Ltd to support the calculation of the Depreciated Optimised Replacement Cost (DORC) and the initial opening Regulatory Asset Base (RAB) and must not be used for any other purpose or by any other person.

The Model is a representation only and does not reflect reality in every aspect. The Model contains simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Model. Accordingly, the outputs of the Model cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.

The information, data and assumptions ("Inputs") used as inputs into the Model are from publicly available sources or provided by or on behalf of the Arc Infrastructure Pty Ltd, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Model as further Inputs become available.

The Model is limited by the mathematical rules and assumptions that are set out in the Report or included in the Model and by the software environment in which the Model is developed.

The summation of each asset type's replacement cost may be different to the sum of the values in the tables for each MEA due to number rounding.

The Model is a customised model and not intended to be amended in any form or extracted to other software for amending. Any change made to the Model, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Model including any outputs.

2. Key Assumptions

Key assumptions that underpin the DORC valuation are presented in Table 2-1. The application of these assumptions to the DORC is discussed in more detail in the body of this report.

Table 2-1 Key Assumptions for the DORC

Parameter	Assumption	Basis
Valuation Date	31 December 2024	Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.2.
Currency	Australian dollars, real at December 2024.	As valuation date.
Level of Service	The level of service for the Arc network associated with the actual and reasonably project demand is defined in terms of: – maximum axle loads; – maximum train speeds; and – maximum train lengths. See Appendix A-2 for Arc's Level of Service schedule.	Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4.
Accuracy	As is typical for valuations of this type, the accuracy is constrained by the estimating methodology rather than the definition of the works. Overall, the DORC assessment most closely aligns to an AACE Class 5 estimate with an accuracy in the range of -20% to -30% on the low side, to +30% to +50% on the high side.	GHD derived based on estimation methods.
Brownfield Development	The asset replacement cost is based on the cost of developing and constructing an asset on a brownfield basis. A brownfield valuation in this context assumes that the assets to be valued are essentially at the same location and of broadly similar configuration as the existing asset, but on an undeveloped site, and that all supporting infrastructure outside of the site limits (e.g., access roads, service provisions, earthworks etc.) exist as they are at the valuation date. Regulatory precedent is for a DORC to be undertaken on a brownfield basis because it more appropriately reflects the costs to replace the assets which are delivering the service. The Code does not permit costs related to cuttings and embankments that were completed prior to the effective date of the Code to be included. In this DORC assessment, the costs associated with these activities have therefore been set to zero.	Regulatory precedent[7]
Replacement Cost	MEAs are selected on the basis that they meet the closest comparable service standard to the existing asset (at the valuation date) and are designed and constructed using modern methods and materials, use proven technology and subject to prevailing legislation. MEAs have been selected that use established and proven technology that a contractor with experience in constructing similar assets would employ. MEAs may differ from existing assets because: – The form of construction of the existing asset is no longer the least cost method due to advances in plant and materials capabilities. – Changes in technology and/or product development. – Changes dictated by legislation (e.g., health and safety legislation) and/ or current standards. The asset is obsolete. This usually arises where technical advancements result in a type or style of in-situ asset being no longer available.	Costing Principles Section 2.3

[7] Statement of Principles for the Regulation of Transmission Revenues, (Draft), ACCC, 27 May 1999, p. 44, available at: **https://www.accc.gov.au/system/files/128%20ACCC%20Draft%20Principles%20Electricity%20Transm%20Revenues%205-99.pdf** Subsequently adopted and developed by the AER into the Statement of Regulatory Principles, 2004.

Parameter	Assumption	Basis
Optimised Replacement Cost	The optimised asset configuration is defined as that which has the capacity to meet the actual and reasonably projected demand, based on a ten-year forecast, within the physical constraints of the existing railway corridor, that can be constructed at least cost. The level of service associated with the actual and reasonably projected demand is defined in terms of[8]: – maximum axle loads; – maximum train speeds; and – maximum train lengths. Any redundant assets identified as a result of applying the above requirements are to be removed (optimised) from the asset base, where redundancy is defined as Railway Infrastructure that is no longer required to be used due to replacement with other Railway Infrastructure, changes in standards or advancements in technology or due to it not being relevant to providing the level of service demand forecast. Railway infrastructure that is either disposed of or stranded is not included in the definition of optimisation.[9]	Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4 Costing Principles, Arc Infrastructure, 30 May 2024, Section 3.6
Right of Way	Only capital costs associated with land acquisitions after the commencements of the Code can be included. There have been no relevant material land acquisitions since 2000.	Arc advice
Planning and approval requirements	Development consent would be granted. Pre-construction costs including securing the necessary planning, heritage and environmental approvals, completing design development and likely environmental offsets and construction monitoring are in accordance with the requirements of legislation current at the valuation date. A single planning application process for the entire development would be completed.	GHD project experience.
Construction costs	Based on the construction of MEAs. Construction rates are assumed to be those secured through competitive tendering at the valuation date, with no additional provision for escalation, and under terms where risk is efficiently allocated. Where markets experience significant temporal variability due to external factors (such as where construction rates depend on global demand), mid-market rates are assumed where the market is neither unduly strong nor unduly weak.	GHD experience.
Construction costs allowances and inclusions	Included are reasonable allowances that an efficient and experienced contractor would include as well as asset owner costs for programme management and supervision.	GHD experience.
Construction staging and scheduling	Works would proceed simultaneously on multiple fronts, dictated by availability of resources at efficient costs.	GHD experience.
Funding costs	An assessment of funding costs has been included, based on a real pre-tax WACC of 7.46% as indicated by the Economic Regulation Authority.[10]	As published by the ERA.

[8] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[9] Costing Principles, Arc Infrastructure, 30 May 2024, Section 3.6
[10] Determination on the 2024 weighted average cost of capital for the freight and urban railway networks, and for Pilbara railways, ERA, 19 August 2024

3. Asset Inclusions and Groupings

3.1 Asset Categories

The assets have been classified and grouped as shown in Table 3-1.The structure of this report follows these asset categories, which are also used in the summary tables.

Table 3-1 Asset Categories

Asset Category	Asset Collection	Included Extent	Basis
Right of Way	Land	None	No relevant land has been purchased by Arc since 2000.
	Formation	– Where it exists on Arc's network. – Where high levels of reliability are required, such as on frequently travelled lines. – Where high axle loads are run.	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles.
	Cuttings	– Construction cost of cuttings are included where the cuttings were formed after 2000.	As required by the Code. The only cuttings included in this basis are on the Midwest Network Group.
	Embankments	– Embankment costs are included where the embankments were formed after 2000.	As required by the Code. The only embankments included in this basis are a small amount on the Midwest Network Group.
	Access Roads	Along all track kilometres, on one side of the track only.	Vehicular access is required to all sections of track.
Civil Structures	Bridges	As existing.	The existing alignment is determined from the basis of a brownfield development.
	Tunnels	As existing.	The existing alignment is determined from the basis of a brownfield development.
	Culverts	As existing.	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles.
Associated Track Structures	Pedestrian Level Crossings	As existing network. Note that motor vehicle crossings are not included as these are not owned by Arc.	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles. Note that motor vehicle crossings are not included as these are not owned by Arc.
Track	Rail	As existing network.	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles.
	Sleepers	As existing network.	
	Ballast	As existing network.	
	Turnouts	As existing network.	
Signalling and Control Systems	Signalling	As required to provide the level of service across the network.	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles.
	Communication Systems		

Buildings	Control Centres	As existing network.	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles.
	Depots	As existing network.	
Miscellaneous	Plant, machinery and equipment	As existing network.	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles.
	Walkways	Shunt walkways on embankments	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles
	Signage	As existing network	To meet the closest comparable service standard to the existing asset, as required by the Costing Principles.

3.2 Route Section Groupings

For ease of reference and presentation in this report, the route sections have been collated into Network Groups as presented in Table .

Table 3-2 Network Group to Route Section mapping

Network Group	Route Section
Metro	Kwinana West to Kwinana KBT
	Kwinana North to Kwinana West
	Kwinana North to Kwinana
	Cockburn South to Kwinana North
	Cockburn East to Cockburn South
	Cockburn North to Cockburn East
	Cockburn North to Cockburn South
	Kenwick to Cockburn East
	Forrestfield to Kenwick
	Forrestfield
	Forrestfield South to Kewdale
	Woodbridge South to Forrestfield
	Woodbridge West to Woodbridge South
	Midland to Woodbridge South
EGR	Midland to Millendon Junction
	Millendon Junction to Toodyay West
	Toodyay West to Avon Yard
	Avon Yard
	Avon Yard to West Merredin
	West Merredin
	West Merredin to Merredin
	Merredin to Southern Cross
	Southern Cross to Koolyanobbing East

Network Group	Route Section
	Koolyanobbing East to Mount Walton
	Mount Walton to West Kalgoorlie West
	West Kalgoorlie West to West Kalgoorlie
	West Kalgoorlie
	West Kalgoorlie to Kalgoorlie
	Kalgoorlie
	Kalgoorlie to Parkeston (border)
Midwest	Narngulu to Narngulu East
	Narngulu East to Mullewa
	Mullewa to Tilley Junction
	Tilley Junction to Tilley
	Tilley to Morawa
	Morawa to Perenjori
	Perenjori to Maya
EBL	West Kalgoorlie West to West Kalgoorlie South
	West Kalgoorlie to West Kalgoorlie South
	West Kalgoorlie South to Hampton Intermodal Terminal
	Hampton Intermodal Terminal
	Hampton Intermodal Terminal to Hampton
	Hampton to Kambalda
	Kambalda to Redmine
	Kambalda to Salmon Gums
	Salmon Gums to Esperance
	Esperance to Esperance Wharf
	Esperance Wharf
LBL	Kalgoorlie to Menzies
	Menzies to Malcolm
	Malcolm to Leonora
	Leonora
SWM	Kwinana to Mundijong Junction
	Mundijong Junction to Pinjarra
	Pinjarra to Pinjarra South
	Pinjarra to Alumina Junction
	Alumina Junction to Pinjarra South
	Pinjarra South to Wagerup North
	Wagerup North to Wagerup South
	Wagerup South to Brunswick North
	Brunswick North to Brunswick Junction
	Brunswick Junction to Picton Junction
	Picton Junction to Picton East
	Picton Junction to Bunbury Inner Harbour

Network Group	Route Section
	Picton Junction to Picton Container Terminal
	Picton Container Terminal to Bunbury Terminal
	Picton Junction to Greenbushes
Collie	Brunswick North to Brunswick East
	Brunswick Junction to Brunswick East
	Brunswick East to Worsley
	Worsley to Worsley East
	Worsley East to Ewington Junction
	Ewington Junction to Premier
	Worsley East to Worsley North
	Worsley to Hamilton
MR	Millendon Junction to Watheroo
	Watheroo to Marchagee
	Marchagee to Dongara
	Dongara to Narngulu
	Narngulu to Geraldton
	Dongara to Eneabba South
Central	Avon Yard to Goomalling
	Goomalling to McLevie
	Goomalling to Amery
	Amery to Mukinbudin
	Amery to Burakin
	Burakin to Kalannie
	Burakin to Beacon
	Toodyay West to Miling
GSR	Avon Yard to York
	York to Brookton
	Brookton to Narrogin
	Narrogin to Wagin
	Wagin to Wagin South
	Wagin South to Katanning
	Katanning to Tambellup
	Tambellup to Redmond
	Redmond to Albany
Lakes	Wagin East to Wagin South
	Wagin to Lake Grace
	Lake Grace to Newdegate
	Lake Grace to Hyden
CBH Sidings	CBH SG Sidings (all)
	CBH NG Sidings (all)
Sidings & Other	Cockburn North to Robb Jetty (SG)

Network Group	Route Section
	Esperance Industrial Road
	West Kalgoorlie Industrial Road
	Kewdale North Grid
	Kewdale BP Loading Depot
	Cockburn North to Robb Jetty (NG)
	Redmond to Mirrambeena
	NG Siding - Kwinana to Kwinana Alcoa
	NG Siding - Kwinana to Kwinana West
	NG Siding - Kwinana West to Kwinana KBT
	NG Siding - Extension Hill Siding
	NG Siding - Tilley Siding
	Kwinana West to Kwinana FPA
	Kwinana FPA to Kwinana CBH
Non-Operational	Greenbushes to Lambert
	Boyanup to Capel
	York to Quairading
	Narrogin to West Merredin
	West Merredin to Kondinin
	West Merredin to Trayning
	Yilliminning to Kulin
	Katanning to Nyabing
	Tambellup to Gnowangerup
	Katanning East to Katanning South

4. Construction Replacement Cost (RC)

4.1 Construction Replacement Cost Approach

This Construction Replacement Cost (RC) valuation assumes design and construction of infrastructure using Modern Equivalent Assets (MEAs). The MEAs are those which would be typically designed and constructed at the valuation date to meet the closest comparable service standard to the existing assets.[11] MEAs therefore use modern design techniques, are constructed from modern materials using modern methods, and in compliance with prevailing legislation at the valuation date.

MEAs have been selected which:

– Use proven technologies. New or unproven technologies or methods are not used as this could reduce the viability of the MEA being able to provide the level of service of the existing assets and increase project risk;
– Align with how the asset would be constructed today, given modern technology and construction methods, including prevalence of use of that item in industry (e.g. commercially available assets);
– Are appropriate for the level of foreseeable demand on each route section.

[11] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.6

MEAs may differ from existing assets because:

- There is likely to be variability in the actual assets because most infrastructure is developed in stages over time and may have been designed to provide a different level of service to that which is now required. The MEA is likely to be more consistent across assets that are required to provide a similar level of service.
- Changes in technology and/or product development.
- Changes dictated by legislation (e.g., health and safety legislation) and/or current standards.
- The asset is obsolete. This usually arises where technical advancements result in a type or style of in-situ asset no longer being available.

The MEAs selected and the basis for selection are described by asset category in the following sections.

The MEA for each asset component has been established and the unit construction rate presented as the sum of the contractor's direct and indirect cost components, as shown in Figure 4-1, in accordance with appropriate industry guidance.[12]

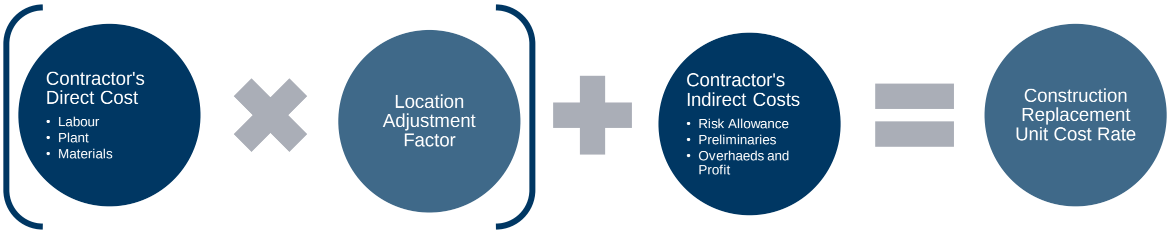


Figure 4-1 Development of the Construction Replacement Cost

The replacement cost estimates are intended to be the least-cost to re-construct the existing assets with MEAs at the valuation date. Least-cost are the costs incurred when delivery is undertaken by an experienced and responsible, competitive industry service provider using the most efficient means in a brownfield environment. To achieve this, rates and prices have been independently established having regard to the unique characteristic of Arc's vast and geographically spread rail network, with established rates then benchmarked (where appropriate) and adjusted to account for dissimilarities on recent and relevant projects including but not limited to:

- Armadale Line Upgrade;
- Bayswater Station;
- Great Eastern Highway Bypass Interchange;
- High-Capacity Signalling;
- Kenwick Rail Freight Facility;
- Morley – Ellenbrook Line;
- Radio Systems Replacement;
- Rail Revitalisation Program;
- Thornlie – Cockburn Link; and
- Yanchep Rail Extension.

The direct replacement costs have been prepared on the basis of normal economic and industry circumstances.

The direct replacement cost estimate assumes the availability of critical labour, plant and/or material resources required to perform the works. Any change in market pressures could impact the reasonableness of the costs presented.

[12] Guidance Note 2 – Base cost estimation, Department of Infrastructure, Transport, Regional Development, Communication and the Arts, Australian Government, Version 2, November 2023

The assumptions and exclusions discussed here are intended to apply holistically across the overall direct replacement costs in general. Any asset specific assumptions or considerations are documented in the asset category discussion later in this report.

4.2 Contractor's Direct Cost

For each MEA the contractor's direct cost was determined by establishing unit rates for each item. These unit rates cover:

Cost of labour	This is the 'raw' salary costs to the contractor which include payroll, burden[13] and taxes.
Cost of materials	This is the cost of the bulk materials required for the construction. These are typically expressed in \$/hour terms (plant and equipment) or in \$/m^3 (bulk materials) or \$/item terms (plant and equipment).

These unit rates represent the direct cost of constructing the works. The rates are then multiplied by the quantity of units in the MEA to estimate the direct replacement cost.

The direct replacement costs seek to reflect the current cost of replacing the existing assets with MEAs and reflect the cost of assets constructed by a competitive industry service provider using the most efficient means in a brownfield environment.[14]

Three standard estimating methodologies have been applied to develop the direct replacement cost for each asset. The selection of method depended upon the level of information available for each asset, summarised as follows:

Analogous Estimating	Analogous estimating is a top-down estimation technique for estimating the cost, resources and durations of projects, typically used for an **order of magnitude** (or an initial) cost estimate. This basis of estimating applies knowledge from previous projects to determine either updated unit rates or an overall cost for scope elements. This method relies heavily on one or more projects being very similar to the project being estimated. The reference (analogous or similar) project is typically one previously finished, is currently under execution, is in tender for construction, or has a completed final design level estimate. Items, quantities and unit costs from the similar project are used as a basis for estimating the current project. Similar costs from the reference project can be used to estimate other groups, categories, elements, and items of total project cost.
Parametric Estimating	Parametric estimating is a quantitative approach to determine the expected cost based on historic or market data. The basis of parametric estimating is applying known or accurate unit rates to known quantities to arrive at a figure for elements of scope. This method is primarily used to support development of scoping or early design estimates where very little project definition is available. Major project parameters are identified as are relationships and ratios between historical data and other parameters are used to calculate the cost of various items of work.
Analytical Estimating	Analytical estimating is a method of determining project costs or timelines by breaking down tasks into smaller components and calculating detailed first principle estimates. This estimating technique is the most accurate estimating technique, but most time consuming.

The application of these methods to each asset category is discussed in each of the respective asset category sections of this report.

Cost categories have been established to build up the construction replacement costs for the asset categories shown in Table 3-1.

[13] Where burden refers to indirect costs that cannot be attributed to a specific member of staff. Such costs include leave allowances, super contributions, workers compensation insurance .
[14] Note that the replacement cost is based on the MEA, which may not be the same form of construction as the existing asset.

4.3 Location Adjustment Factor

Location adjustment factors based on geographical regions have been developed and applied to the direct construction costs. These factors are to account for the variation in construction costs between different locations (typically the further the location is from an urban centre, the more costly construction activities are).

The location adjustment factor is a percentage uplift relative to the costs of construction in the Perth area and reflect GHD’s experience of relative construction costs in these regions. The factor takes into account the variation in the costs of the plant, material and labour and is displayed spatially in Figure 4-2.

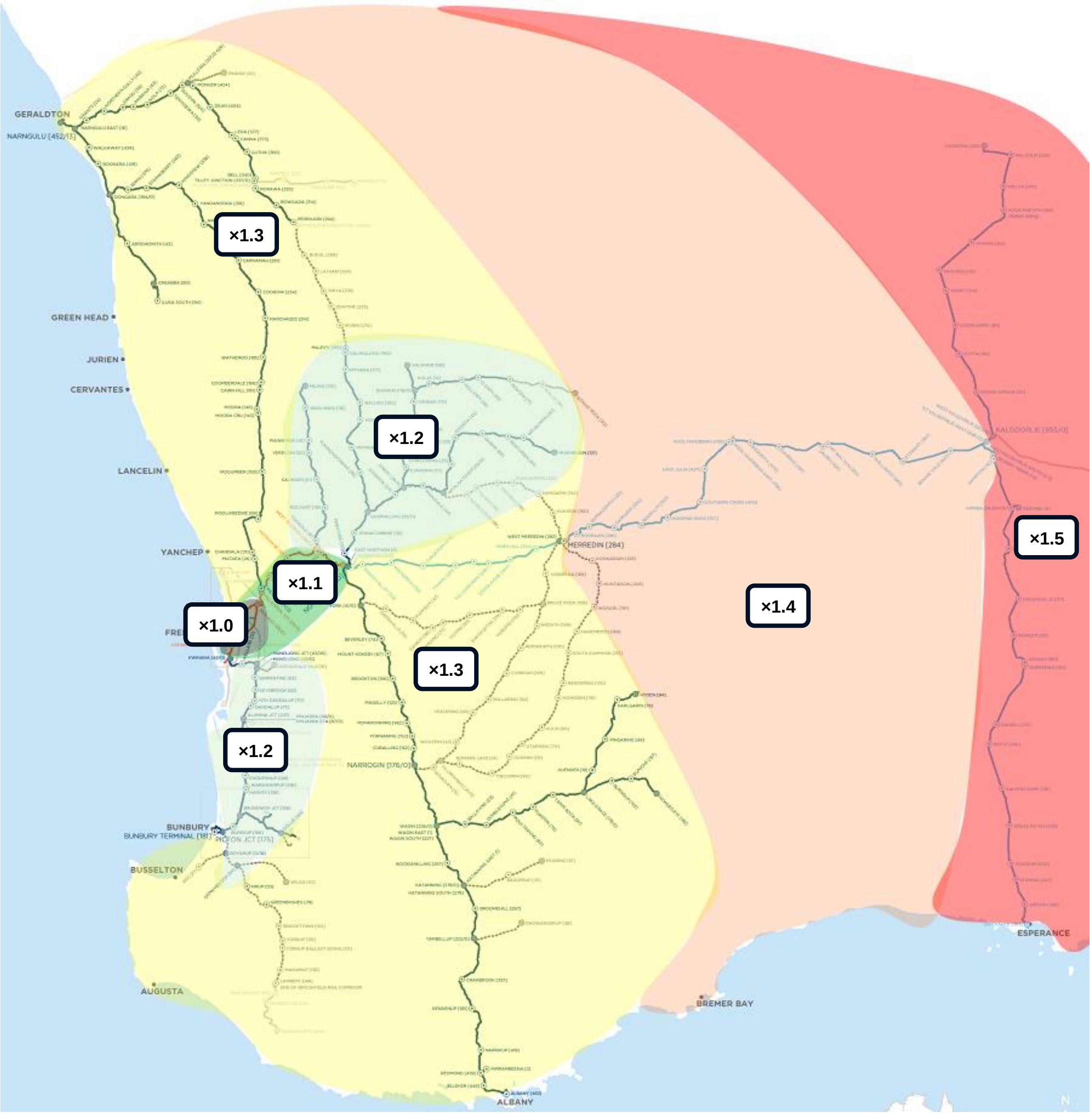


Figure 4-2 Location Factor Mapping

4.4 Contractor’s Indirect Costs

Indirect costs represent the contractor’s costs of doing business and when combined with the direct costs, indicate the construction replacement cost. These are shown in Figure 4-3.

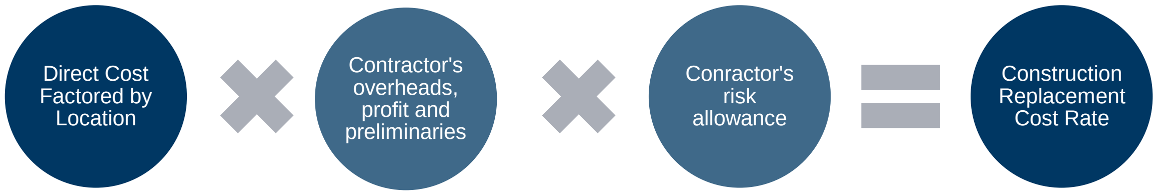


Figure 4-3 Allowance for Contractor’s Indirect Costs

Indirect costs include:

Overheads, profits, and preliminaries These costs represent the cost of doing business for the contractor, which is recovered in addition to the capital works. These cover the contractor’s supervision, maintenance and support, construction equipment and vehicles, cranage, temporary facilities, services and utilities, operating expenses, office-running costs, small tools, overheads and fees.

This would also cover costs associated with temporary laydown areas and access, temporary facilities, site security and support services, warehousing, site survey/set out, induction costs, freight and local accommodation costs

Contractor’s risk allowance This is to cover the risk premium that an experienced contractor would include in developing their tender price, to allow for unexpected, exogenous and non-insurable events that may occur during construction and could impact construction cost. This might include flooding of excavations or equipment breakdowns for example.

This follows regulatory precedent that an ‘allowance for contractors’ construction risk should reasonably be included’.[15]

No form of contingency is included.

The indirect costs are expressed as percentage uplifts. They have been based on recently tendered similar works in WA, adjusted as appropriate to account for any change(s) in circumstances, and are therefore reflective of the current market at the valuation date.

The Contractor’s indirect costs are calculated as compounding percentages of direct costs factored by location (shown in Figure 4-3). The percentages applied are as follows:

- Risk allowance: 5%
- Contractor’s preliminaries 30%
- Contractor’s Overheads and Profit 9.5%

These percentages are based on professional judgement of a qualified cost estimator based on recently tendered similar works and intended to be representative of realistic construction costs for an experienced and responsible contractor.

[15] Australian Competition and Consumer Commission, Final determination: Statement of reasons – access dispute between Glencore Coal Assets Australia Pty Ltd and Port of Newcastle Operations Pty Ltd, 2018, page 92, available at: **https://www.accc.gov.au/system/files/public-registers/other/Glencore%20PNO%20access%20dispute%20-%20Final%20Determination%20-%20Statement%20of%20Reasons%20-%2018%20September%202018%20%28Public%20version%29.pdf**

4.5 Right of Way

Based on the Costing Principles the asset replacement cost used in this DORC with OpEx Adjustment is the lowest current cost to replace the Railway Infrastructure based on MEAs. The MEA scope is defined on the basis that it meets the closest comparable service standard to the existing asset as outlined in Section 4.1. [16]

The actually and reasonably projected level of service as defined in Table 2-1 has been determined by Arc and provided to GHD as the relevant basis for costing. GHD has referred to this required level of service and has made no assessment of its own in this regard. Arc's level of service statement can be found in Appendix A-2.

As well as constructing from a virgin site in a brownfield environment, a DORC framework would also need to allow for the construction of assets not owned by the asset owner, but are necessary to enable construction of assets owned by the asset owner that are required for the service.[17] Applying this principle to the Right-of-Way assets for Arc's network means that:

- costs of developing the site from a virgin site include the acquisition of the land corridor, the clearing and grubbing of the site and the creation of cuttings and embankments. In compliance with the Railway Code applicable to these assets, the costs of land purchase and the costs of cuttings and embankments made prior to the commencement of the Code are not included in the asset replacement cost used in the DORC. Expenditure since the commencement of the Code to create capacity, or expand the network, or improve standards or efficiency, are included;
- infrastructure is costed as though it were constructed without existing traffic on the rail; and
- planning and development costs to the extent that they are required to integrate with existing infrastructure are included.

The discrete construction tasks underpinning the Right of Way replacement cost are discussed below.

4.5.1 Land acquisition

There has been no land acquired since 2000. No costs are therefore included.

4.5.2 Clearing and Grubbing

As an undeveloped site, the corridor would need to be prepared for bulk earthworks. This includes:

- Clearing and grubbing (removal of vegetation to expose topsoil) and carting to stockpile; and
- Stripping topsoil layer to remove the soft top layer and associated organics unsuitable for railway subgrade. This is likely to vary in depth across the network, but based on GHD's experience of similar work in WA, we have assumed an average 0.5 metre depth across the network.

This would be undertaken across the network, the extent being:

Cuttings and embankments	The land area at the base of the embankment or at top of a cutting. Area has been calculated from railway corridor dimensions across the entire network provided by Arc, and is discussed in 4.5.1.
Other sections – where formation is present	The land area at the base of the formation layer to allow for compaction and formation placement. The area has been based on standard assumptions about formation shoulder widths and depths, and is discussed in 4.5.4.
Other sections – where no formation is present	The land area at the base of the ballast layer to allow for compaction and ballast placement.

[16] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3
[17] Australian Competition and Consumer Commission, Final determination: Statement of reasons – access dispute between Glencore Coal Assets Australia Pty Ltd and Port of Newcastle Operations Pty Ltd, 2018, page 105.

As required by the Code, only costs associated with earthworks completed since 2000 can be included. As clearing and grubbing is and earthworks activity, only clearing and grubbing for earthworks since 2000 have been included.

These minimum land areas were assumed as this amounts to the lowest cost; in practice a larger area would need to be cleared to allow for construction tolerances and working areas. Direct costs have been developed using the Parametric Estimating methodology.

The construction replacement cost for clearing and grubbing is shown in Table 4-1. The variation on cost rates reflects the location of the site.

Table 4-1 Clearing and Grubbing Construction Replacement Cost

Network Group	Area to be cleared and grubbed (m^2)	Rate ($/$m^2$)	Construction Replacement Cost ($ millions)
Metro			-
EGR			-
Midwest	8,636,530	0.12	67.1
EBL			-
LBL			-
SWM			-
Collie			-
MR			-
Central			-
GSR			-
Lakes			-
CBH Sidings			-
Sidings & Other			-
Non-Operational			-
TOTAL			**67.1**

4.5.3 Cuttings and Embankments

As required by the Code, only costs associated with earthworks completed since 2000 have been included.

The only earthworks that have been undertaken since 2000 is the upgrade of the line from Geraldton to Tilley. The capacity of the section of track from Mullewa to Tilley – a length of about 100 km - was upgraded from 16TAL to the current 21TAL capable track in 2011-2012. The works included the construction of the new track and associated earthworks. The relevant sections are shown in Table where the volume of earthworks (both excavation of cuttings referred to as 'cut' and placement of fill in embankments referred to as 'fill') was based on data provided by Arc. For cut and fill volume calculations, data of batter slope and height, and of the slope crest and toe from the rail centreline at intervals along the track were analysed.

The output of the cut and fill volume calculations along the section is shown in Table . It shows that the volume of material needed for embankments is more than the material won from cuttings.

On the basis that an efficient contractor would look to optimise cut to fill balances to reuse material won from cutting excavation where possible to minimise the cost of importing fill, the cut/fill balance and associated costs in Table assumes:

– All cut material would be suitable for use as fill;

– All cut material would be hauled to stockpile within the site, then hauled from stockpile to fill; and

– Cut material would have a net bulking factor of 1.2 when compacted and used in embankments. This is based on GHD's experience of realistically achievable net bulking for similar works in the region. In effect, this means that every cubic metre of excavated material can provide 1.2 cubic metres of fill.

This analysis shows a shortfall of 241,761 m^3 of fill material. Fill would be most efficiently sourced from an external quarry. These volumes are combined with unit rates to give the earthworks replacement cost shown in Table 4-2.

Table 4-2 Earthwork Volumes for Cuttings and Embankments

Description of Earthworks	Unit	Quantity	Rate ($/$m^3$)	Direct Cost ($millions)	Construction Replacement Cost ($ million)[18]
Placed embankment material	m^3	323,395	15.00	1.22	2.4
Cut material excl. bulking	m^3	(68,028)	10.00	0.68	1.3
Net bulked cut material available as fill	m^3	(81,634)	-	-	-
Shortfall – sourced from imported fill	m^3	241,761	31.00	7.49	14.6
TOTAL				**9.40**	**18.3**

[18] Includes Direct Cost adjusted for location factors, and with the addition of contractors risk allowance, preliminaries, overheads and profit.

4.5.4 Formation

Formation is material that is placed on top of the ground along the rail corridor to provide a stable foundation for the track, and to distribute operating (axle) loads to the subgrade soil beneath.

As the costing principles require that the replacement cost be based on the level of service for the Arc network associated with the actual and reasonably projected demand, where demand is defined in terms of maximum axle loads (as well as train length and speed)[19], we have included formation:

- Where it exists on Arc's network (in practice, parts of the network were not originally created with formation and some sections remain without it today);
- Where high levels of reliability are required, such as on frequently travelled lines. In effect, all twin track sections, the sections from Bunbury to Perth and Perth to Kalgoorlie, and lines to the ports; and
- Where relatively high axle loads are run. Typically for iron ore, which would include the line from Tilley to Geraldton.

Along these sections of track, the modern equivalent formation replacement would need to be in accordance with current construction standards. This requires that formation achieves a California Bearing Ratio (CBR)[20] of 20. Based on recent project experience, 300mm formation thickness is likely to be required. For the purposes of this assessment, and to achieve the least practicable cost, the replacement cost assumes an average 230mm (at a minimum) thickness would be sufficient. Standard construction detailing also requires formation extend 3.5 metres either side of the track centre line. This equates to 1.6 cubic metres of formation per linear metre of track.

Any earthworks required to get to subgrade level are included in sections 4.5.2 and 4.5.3. Construction of formation would then require:

- Excavation to a depth of 230mm;
- Disposal of excavated material off-site;
- Trimming and compaction of subgrade;
- Filling to subgrade with 230mm thick limestone foundation; and
- Trimming and compaction to limestone formation level.

For all other sections of track (i.e. those not captured by the above three level of service requirements) we have assumed that there is no formation and the subgrade has been sufficiently compacted to provide adequate support for the required level of service through years of train movements.

If the network were to be replaced today, it would need to comply with current standards, which require a formation layer. Nevertheless, in accordance with the requirement of the costing principles that the MEA shall provide the closest comparable service standard to the existing asset,[21] no cost for the construction of formation in these sections of track has been included. To provide the closest comparable service standard to the existing asset on these sections (where level of service is defined in terms of axle loads), the modern equivalent replacement would need to compact the subgrade – effectively replicating the compaction that years of train movements has achieved. The construction tasks on these track sections would be:

- Clear and grub;
- Strip topsoil layer; and
- Proof-roll the subgrade to compact.

The cost rates for this activity are built up from rates seen in the current market for projects including similar infrastructure in Western Australia, and include the allowances for site location, contractor overheads, profits, preliminaries and risk as discussed in section 4.1.

Formation has been priced using the Parametric Estimating methodology to determine appropriate Direct Unit Costs. The replacement costs for formation are shown in Table 4-3.

[19] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[20] CBR is a measure of the strength of the subgrade
[21] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

Table 4-3 Formation Construction Replacement Cost

Network Group	Formation Construction			Proof-rolled Sections			Total
	km	Rate ($ million/km)	Construction Replacement Cost ($ millions)	km	Rate ($ million/km)	Construction Replacement Cost ($ millions)	($ million)
Metro	107.9	0.38	41.5	-	-!	-	41.5
EGR	829.8	0.55	460.5	-	-!	-	460.5
Midwest	204	0.45	91.7	99.3	0.11	10.8	102.5
EBL	422.4	0.68	286.3	-	-!	-	286.3
LBL	-	-	-	265.7	0.13	33.4	33.4
SWM	199.7	0.54	108.3	80.1	0.10	8.0	116.3
Collie	-	-	-	69.8	0.10	7.0	7.0
MR	-	-	-	569.3	0.11	61.9	61.9
Central	-	-	-	694.4	0.10	69.7	69.7
GSR	480.7	0.59	282.4	-	-!	-	282.4
Lakes	-	-	-	277.8	0.11	30.2	30.2
CBH Sidings	-	-	-	109.8	0.11	11.7	11.7
Sidings & Other	-	-	-	44.3	0.10	4.2	4.2
Non-Operational	-	-	-	814.4	0.11	87.2	87.2
TOTAL	**2,244.5**	**0.57**	**1,270.7**	**3,024.9**	**0.11**	**324.3**	**1,595.0**

4.5.5 Access Roads

Applying the principles described in Section 4.1, the MEA access roads have been selected to provide a comparable level of service to the existing assets. On this basis, access roads across the network are assumed to be cleared and improved unsealed dirt tracks 3.5m wide (sufficient for single lane access), along one side of the track only, as this is least cost.

The rate applied to construct the access roads includes:

– Vegetation clearing;
– Topsoil removal;
– Subgrade improvement; and
– Subgrade preparation.

The rates are based on recently tendered rates for similar tasks in Western Australia and include the allowances discussed in 4.1.

The replacement cost for access roads is shown in Table 4-4. The variation in rate is because of the difference in location factor between Network Groups.

Table 4-4 Access Roads Replacement Cost

Network Group	Length (km)	Rate ($ million/km)	Construction Replacement Cost ($ million)
Metro	108	0.09	9.6
EGR	830	0.12	95.5
Midwest	304	0.14	35.1
EBL	422	0.13	56.3
LBL	266	0.13	35.4
SWM	280	0.15	29.9
Collie	70	0.11	7.4
MR	569	0.12	65.8
Central	694	0.11	74.1
GSR	481	0.12	55.6
Lakes	278	0.12	32.1
CBH Sidings	110	0.11	12.4
Sidings & Other	44	0.10	4.5
Non-Operational	814	0.10	92.7
TOTAL	**5,270**	**0.12**	**606.5**

4.5.6 Summary Replacement Cost

Replacement Cost is shown by Network Group in Table 4-5Table , with average rates per track kilometre shown below.

Table 4-5 Right of Way Construction Replacement Cost

Network Group	Clearing and grubbing ($ million)	Cuttings and Embankments ($ million)	Formation ($ million)	Access Roads ($ million)	Total ($ million)
Metro	-	-	41.5	9.6	51.1
EGR	-	-	460.5	95.5	556.1
Midwest	67.1	18.3	102.5	35.1	223.0
EBL	-	-	286.3	56.3	342.7
LBL	-	-	33.4	35.4	68.8
SWM	-	-	116.3	29.9	146.2
Collie	-	-	7.0	7.4	14.5
MR	-	-	61.9	65.8	127.8
Central	-	-	69.7	74.1	143.9
GSR	-	-	282.4	55.6	337.9
Lakes	-	-	30.2	32.1	62.3
CBH Sidings	-	-	11.7	12.4	24.2
Sidings & Other	-	-	4.2	4.5	8.7
Non-Operational	-	-	87.2	92.7	179.9
TOTAL	**67.1**	**18.3**	**1,595.0**	**606.5**	**2,286.9**

Table 4-6 ***Right of Way Average Construction Replacement Cost Rates per Track Kilometre***

Network Group	Clearing and grubbing ($ million/km)	Cuttings ($ million/km)	Formation ($ million/km)	Access Roads ($ million/km)
Metro	-	-	0.38	0.09
EGR	-	-	0.55	0.12
Midwest	4.5	0.06	0.34	0.12
EBL	-	-	0.68	0.13
LBL	-	-	0.13	0.13
SWM	-	-	0.42	0.11
Collie	-	-	0.10	0.11
MR	-	-	0.11	0.12
Central	-	-	0.10	0.11
GSR	-	-	0.59	0.12
Lakes	-	--	0.11	0.12
CBH Sidings	-	-	0.11	0.11
Sidings & Other	-	-	0.10	0.10
Non-Operational	-	-	0.11	0.11
AVERAGE	**4.5**	**0.06**	**0.30**	**0.12**

4.6 Civil Structures

The Costing Principles require that the asset replacement cost used in the DORC with OpEx Adjustments must be the lowest current cost to replace the Railway Infrastructure based on Modern Equivalent Assets. The MEA scope is defined on the basis that it meets the closest comparable service standard to the existing asset. [22]

The MEA for Civil Structures follows the same approach as Right of Way is described in Section 4.5.

The Railway Infrastructure is defined to include associated track structures, over or under track structures, tunnels and bridges[23]. The Costing Principles also confirm that the definition of associated infrastructure includes culverts.

Consequently, this Civil Structures section includes bridges, tunnels and culverts.[24]

4.6.1 Bridges

The selection of the modern equivalent asset for the bridges was based on consideration of:

– Function of the existing structure type, required loading and span;
– Site location, ease of transportation and cranage requirements; and
– Ongoing maintenance requirements over structure life.

Arc's data for the 229 bridges within Arc's network included the following parameters:

– Bridge length;
– Bridge height;
– Bridge width; and
– Number of spans and span length;

[22] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3
[23] Costing Principles, Arc Infrastructure, 30 May 2024, Section 1.4
[24] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

– Year of installation (where known).

The bridge length and width data for all bridges in both Arc's operational and non-operational network were individually verified through satellite imagery.

In accordance with the definition, the MEA scope is to meet the closest comparable service standard to the existing asset, [25] and therefore the spans of the proposed bridge replacement types are based on replicating both the structural depth where feasible and the existing span depths. Thus, the bridge type MEA allocation is based on essentially providing as close as possible a direct replacement to current standards.

A 24-tonne load rating was assumed for all bridges based on typical maximum axle loads on the network as provided by Arc and unrestricted operating speed.

Five alternative modern structural forms (Table) were developed to retain the same service level as the existing assets. The structural forms were selected according to the principles shown in Table . The structural forms reflect common rail type structures used in WA, either by the PTA or mining corporations. Due allowance has been made in adjustments for the assumed Arc loading compared to that required by these other rail operators. All structure types are based on ballasted sections.

The applicable span ranges shown in Table are based on typical application in GHD's experience and are the range within which each MEA type is likely to be the least cost and most efficient alternative.

Table 4-7 Bridge Structure Alternative MEA Forms

Type	Name	Description	Span Range (m)
Type 1	Precast box culvert	A rectangular, reinforced concrete structure manufactured off-site. Typically used for short spans, for road or river crossings, and utility tunnels. Ideal where spans are short, and a pre-cast yard can be established close by.	≤ 3.7
Type 2a	Plank composite deck	Longitudinal reinforced concrete beams, topped with reinforced concrete deck slab.	3.7 ≤ 9.7
Type 2b	Teeroff composite deck	Single or twin reinforced concrete 'T' section longitudinal beams, topped with reinforced concrete deck slab. High mass sections so require intense cranage effort. Not well suited to remote locations.	9.7 ≤ 18.0
Type 3	Steel composite deck	Longitudinal steel universal beams with steel universal cross beams. Cast-in-situ reinforced concrete deck over permanent forms with shear connections to steel beams. Lighter weight than concrete sections, so requires less cranage and better suited to more remote locations.	18.0 ≤ 21.9
Type 4	Long span steel composite deck	Deep section fabricated steel girders running longitudinally on each side of the structure. Steel universal beam cross-girders with cast-in-situ reinforced concrete deck over permanent forms	21.9 ≤ 30.5

Each of the bridges in the network was assigned one of the five MEA structural forms based on span, location and the ease with which maintenance could be implemented given the asset's location.

The total number of each MEA bridge type and the corresponding deck area by Network Group is shown in Table with the corresponding deck area (as the basis of the replacement costing) in Table 4-8.

[25] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

Table 4-8 Number of Bridges of Each MEA by Network Group

Network Group	MEA Type					
	Type 1 - PCBC	Type 2a - PSC Plank	Type 2b - PSC Teeroff	Type 3 - Steel Composite	Type 4 - Steel Composite	Total
Metro	0	0	1	4	1	**6**
EGR	0	0	2	2	3	**7**
Midwest	6	4	1	0	0	**11**
EBL	0	1	0	0	0	**1**
LBL	0	7	0	0	0	**7**
SWM	1	27	6	6	0	**40**
Collie	0	2	2	2	0	**6**
MR	0	19	1	4	0	**24**
Central	4	19	0	0	1	**24**
GSR	3	34	2	1	2	**42**
Lakes	1	2	0	0	0	**3**
CBH Sidings	0	0	0	0	0	**0**
Sidings & Other	0	0	2	0	0	**2**
Non-Operational	7	43	2	3	1	**56**
TOTAL	**22**	**158**	**19**	**22**	**8**	**229**

Table 4-9 Total Bridge Deck area (m^2) for Each MEA Type by Network Group

Network Group	Total deck area (m^2) of each MEA Bridge Type					
	Type 1 - PCBC	Type 2a - PSC Plank	Type 2b - PSC Teeroff	Type 3 - Steel Composite	Type 4 - Steel Composite	Total
Metro	-	-	-	1,814.1	1,442.0	**3,256.1**
EGR	-	-	703.1	264.3	1,952.3	**2,919.7**
Midwest	270.5	135.2	-	-	-	**405.6**
EBL	-	27.8	-	-	-	**27.8**
LBL	-	763.0	-	-	-	**763.0**
SWM	45.8	2,065.2	695.0	1,645.0	-	**4,451.0**
Collie	-	211.5	202.8	420.9	-	**835.1**
MR	-	968.9	105.5	1,539.7	-	**2,614.0**
Central	70.2	1,460.7	-	-	638.3	**2,169.2**
GSR	91.3	2,107.0	683.0	452.6	856.1	**4,190.0**
Lakes	37.8	143.9	-	-	-	**181.7**
CBH Sidings	-	-	-	-	-	**-**
Sidings & Other	-	-	634.8	-	-	**634.8**
Non-Operational	149.5	2,549.4	-	70.0	533.4	**3,302.3**
TOTAL	**554.8**	**10,432.5**	**3,024.2**	**6,206.5**	**5,422.1**	**25,750.3**

The construction replacement cost for the bridges has been priced using the Parametric Estimating methodology to determine appropriate direct unit costs for each MEA bridge type. The average rate per square metre is shown in Table . As with other asset types, the variation in rate between locations reflects the increase in construction cost with remoteness. This is extended by the deck area to estimate the replacement cost in Table 4-10.

Table 4-10 Bridge Construction Replacement Cost Rate ($ per square metre of deck area)

Network Group	Average construction replacement cost rate ($/m^2) for each MEA Bridge Type				
	Type 1 - PCBC	Type 2a – Plank Composite Deck	Type 2b – Teeroff Composite Deck	Type 3 - Steel Composite	Type 4 – Long Span Steel Composite
Metro				13,452	12,705
EGR			15,596	41,853	13,975
Midwest	11,352	14,549			
EBL		19,057			
LBL		19,057			
SWM	185,201	19,535	16,142	16,142	
Collie		15,246	16,142	16,142	
MR		16,516	17,488	17,488	
Central	0	15,246			15,246
GSR	56,301	16,516	17,488	17,488	16,516
Lakes	0	16,516			
CBH Sidings					
Sidings & Other			13,452		
Non-Operational	42,347	17,821		17,488	15,246

Table 4-11 Bridge Construction Replacement Cost ($ million)

Network Group	Construction replacement cost ($ millions) for each MEA Bridge Type					
	Type 1 - PCBC	Type 2a – Plank Composite Deck	Type 2b – Teeroff Composite Deck	Type 3 - Steel Composite	Type 4 – Long Span Steel Composite	Construction Replacement Cost ($ million)
Metro	-	-	9.7	24.4	18.3	52.4
EGR	-	-	11.0	11.1	27.3	49.3
Midwest	36.4	2.0	-	-	-	38.4
EBL	-	0.5	-	-	-	0.5
LBL	-	14.5	-	-	-	14.5
SWM	8.5	40.3	11.2	26.6	-	86.6
Collie	-	3.2	3.3	6.8	-	13.3
MR	-	16.0	1.8	26.9	-	44.8
Central	-	22.3	-	-	9.7	32.0
GSR	5.1	34.8	11.9	7.9	14.1	73.9
Lakes	-	2.4	-	-	-	2.4
CBH Sidings	-	-	-	-	-	0.0
Sidings & Other	-	-	8.5	-	-	8.5
Non-Operational	6.3	45.4	8.0	1.2	8.1	69.1
TOTAL	**56.3**	**181.5**	**65.4**	**104.9**	**77.6**	**485.8**

4.6.2 Tunnels

Four tunnels have been identified across the network as shown in Table 4-12. On the basis that the MEA is to be defined to meet the closest comparable service standard to the existing asset,[26] we have assumed that the dimensions of the replacement tunnel assets would be the same as the existing.

Table 4-12 Tunnel Assets

Network Group	Length (m)	Width	MEA
Metro	114.8	Dual track	Cut and Cover
EBL	161.8	Single track	Cut and Cover
MR	152.0	Dual track	Cut and Cover
MR	27.9	Single track	Cut and Cover

All tunnel assets are to provide grade separation to allow road assets (owned by others) to pass over the rail.

The relatively shallow excavation depth means that the least cost modern equivalent method of construction for tunnels of this type is most likely cut-and-cover. This method of construction involves excavating the trench, constructing the tunnel within the trench, then reinstating the surface above.

In a brownfield setting, where the tunnels would be constructed under operating roads, it is likely that a contractor would construct these tunnels from the surface downwards. In this method, the side walls are constructed first, possibly as bored piles or slurry walls. The surface is then excavated and the roof slab constructed. Top side infrastructure can then be reinstated whilst excavation of the tunnel and base slab construction continues from below. This minimises the duration of any traffic diversions.

[26] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

Table 4-13 Tunnel Assets Construction Replacement Cost

Network Group	Tunnel length (m)	Tunnel width (No of tracks)	Construction Replacement Cost Rate ($million per metre length)	Construction Replacement Cost ($million)
Metro	114.8	Dual	0.07	16.3
EGR	-	-		-
Midwest	-	-		-
EBL	161.8	Single	0.11	17.2
LBL	-	-		-
SWM	-	-		-
Collie	-	-		-
MR	152.0 27.9	Dual Single	0.09	30.6
Central	-	-		-
GSR	-	-		-
Lakes	-	-		-
CBH Sidings	-	-		-
Sidings & Other	-	-		-
Non-Operational	-	-		-
TOTAL	**723.4**	**-**	**0.09**	**64.2**

4.6.3 Culverts

There are 6,614 culverts totalling over 114 km in length across the Arc network. All have been reviewed and an MEA selected on the following basis:

- All would be reinforced concrete pipes as these are the least cost option that is readily available and provide the same level of service as the existing assets;
- A minimum of 600mm diameter standard culvert sizing has been applied throughout. Smaller diameter culverts are available, but would result in a greater whole-of-life cost because of the increased maintenance commitment (smaller culverts are more prone to blockages, thus resulting in extra maintenance effort); and
- Where no culvert length is known, the average length of all culverts across the network was used.
- The number of each MEA types for culverts are shown below and the lengths of the culverts across the network is shown below.

The average construction replacement cost and total replacement cost by Network Group is shown below.

Table 4-14 Number of Culverts Across the Network

Network group	Number of MEA Culverts by diameter (mm)								Total
	600	900	1200	1500	1800	2400	3000	3600	
Metro	35	-	2	3	1	3	1	-	45
EGR	388	3	32	35	120	192	34	13	817
Midwest	306	7	12	14	4	4	1	-	348
EBL	455	74	5	13	35	8	5	2	597
LBL	471	13	18	31	4	15	40	9	601
SWM	329	-	2	2	2	2	6	-	343
Collie	205	5	7	1	1	4	1	-	224
MR	595	28	21	10	6	5	6	1	672
Central	1,090	223	57	59	14	4	10	1	1,458
GSR	643	100	54	33	23	4	1	1	859
Lakes	503	108	4	14	3	1	2	-	635
CBH Sidings	6	1	-	-	-	-	-	-	7
Sidings & Other	7	-	-	1	-	-	-	-	8
Non-Operational	-	-	-	-	-	-	-	-	-
TOTAL	**5,033**	**562**	**214**	**216**	**213**	**242**	**107**	**27**	**6,614**

Table 4-15 Length of Culverts Across the Network (km)

Network group	Total length of MEA Culvert (km) by diameter (mm)								Total
	600	900	1200	1500	1800	2400	3000	3600	
Metro	0.43	-	0.03	0.04	0.01	0.03	0.01	-	0.55
EGR	7.13	0.03	0.19	0.25	0.91	1.39	16.16	0.08	26.14
Midwest	11.03	0.08	0.16	0.16	0.07	0.02	0.00	-	11.51
EBL	3.61	0.43	0.04	0.07	0.25	0.06	0.02	0.02	4.50
LBL	5.76	0.05	0.06	0.12	0.02	0.05	0.15	0.04	6.26
SWM	3.27	-	0.02	0.01	0.01	0.01	0.04	-	3.36
Collie	2.03	0.06	0.09	0.01	0.01	0.09	0.00	-	2.30
MR	4.47	0.22	0.13	0.06	0.02	0.03	0.02	0.01	4.96
Central	15.25	1.68	10.15	0.21	8.62	0.02	0.04	0.00	35.99
GSR	5.22	9.34	0.46	0.23	0.20	0.02	0.00	0.00	15.48
Lakes	3.06	0.42	0.02	0.03	0.01	0.00	0.01	-	3.56
CBH Sidings	0.04	0.00	-	-	-	-	-	-	0.05
Sidings & Other	0.03	-	-	0.01	-	-	-	-	0.04
Non-Operational	-	-	-	-	-	-	-	-	-
TOTAL	**61.32**	**12.32**	**11.35**	**1.20**	**10.16**	**1.72**	**16.47**	**0.16**	**114.69**

Table 4-16 Culvert Construction Replacement Cost Rate ($'000s per metre)

Network Group	MEA Average Culvert Construction Replacement Cost Rate ($'000s/m) by diameter (mm)							
	600	900	1200	1500	1800	2400	3000	3600
Metro	12.4		1.8	2.2	2.7	3.6	4.5	
EGR	2.1	1.7	2.3	3.0	6.8	5.1	0.1	8.0
Midwest	1.5	1.7	13.9	2.9	3.5	4.7	5.8	
EBL	2.2	5.7	2.7	3.4	4.0	5.4	6.7	8.1
LBL	1.5	2.0	36.1	3.2	4.0	86.9	76.4	8.1
SWM	4.1		2.2	2.7	3.2	4.3	5.4	
Collie	23.0	21.9	20.0	2.7	3.2	4.3	5.4	
MR	1.7	7.7	2.1	2.9	3.5	3.6	5.8	7.0
Central	0.6	1.6	2.2	22.2	3.2	4.3	5.4	6.5
GSR	3.2	1.7	2.3	2.9	3.5	4.7	5.8	7.0
Lakes	1.8	14.7	2.3	2.9	3.5	4.7	5.8	
CBH Sidings	1.1	1.7						
Sidings & Other	157.7			2.2				
Non-Operational								

Table 4-17 Culvert Replacement Cost ($ million)

Network Group	MEA Culvert Replacement Cost ($million) by diameter (mm)								
	600	900	1200	1500	1800	2400	3000	3600	Total
Metro	5.3	-	0.1	0.1	0.0	0.1	0.1	-	5.6
EGR	14.6	0.1	0.4	0.8	6.2	7.1	1.8	0.6	31.7
Midwest	16.2	0.1	2.2	0.5	0.2	0.1	0.0	-	19.3
EBL	7.9	2.4	0.1	0.2	1.0	0.3	0.2	0.2	12.4
LBL	8.8	0.1	2.3	0.4	0.1	4.5	11.5	0.3	27.9
SWM	13.5	-	0.0	0.0	0.0	0.1	0.2	-	13.9
Collie	46.7	1.4	1.9	0.0	0.0	0.4	0.0	-	50.4
MR	7.7	1.7	0.3	0.2	0.1	0.1	0.1	0.0	10.2
Central	8.9	2.7	21.8	4.8	27.8	0.1	0.2	0.0	66.4
GSR	16.9	16.3	1.1	0.7	0.7	0.1	0.0	0.0	35.9
Lakes	5.4	6.2	0.1	0.1	0.0	0.0	0.0	-	11.9
CBH Sidings	0.0	0.0	-	-	-	-	-	-	0.1
Sidings & Other	4.6	-	-	0.0	-	-	-	-	4.6
Non-Operational	-	-	-	-	-	-	-	-	-
TOTAL	**156.7**	**31.0**	**30.2**	**7.7**	**36.4**	**12.8**	**14.2**	**1.2**	**290.2**

4.6.4 Summary Replacement Cost

The replacement cost for Civil Structures is shown in Table 4-18.

Table 4-18 Civil Structures Construction Replacement Cost ($ million)

Network Group	Bridges	Tunnels	Culverts	Total ($ million)
Metro	52.4	16.3	5.6	**74.4**
EGR	49.3	-	31.7	**81.0**
Midwest	38.4	-	19.3	**57.7**
EBL	0.5	17.2	12.4	**30.1**
LBL	14.5	-	27.9	**42.4**
SWM	86.6	-	13.9	**100.5**
Collie	13.3	-	50.4	**63.7**
MR	44.8	30.6	10.2	**85.7**
Central	32.0	-	66.4	**98.4**
GSR	73.9	-	35.9	**109.8**
Lakes	2.4	-	11.9	**14.2**
CBH Sidings	-	-	0.1	**0.1**
Sidings & Other	8.5	-	4.6	**13.1**
Non-Operational	69.1	-	-	**69.1**
TOTAL	**485.8**	**64.2**	**290.2**	**840.2**

4.7 Track

Based on the Costing Principles asset replacement cost used in this DORC with OpEx Adjustment is the lowest current cost to replace the Railway Infrastructure based on Modern Equivalent Assets. The MEA scope is defined on the basis that it meets the closest comparable level of service to the existing asset [27] (level of service is defined in Table 2-1).

Railway Infrastructure is defined as including railway track, associated track structures, over or under track structures, supports (including supports for equipment or items associated with the use of a railway).[28]

This section reports on the railway track which includes:

– Rail;
– Sleepers;
– Ballast; and
– Turnouts.

Track has been priced using Analytical Estimating methodology as, of all of the assets, it is the least influenced by external factors. The cost rates established by this first principles estimate have been benchmarked against the outturn rates of projects listed earlier (refer to Section 2, Key Assumptions), in addition to the Public Transport Authority's (PTA) recently completed Rail Revitalisation Project[29], part of a multi-year track operating maintenance capital investment program.

[27] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3
[28] Costing Principles, Arc Infrastructure, 30 May 2024, Section 1.4
[29] (**https://www.pta.wa.gov.au/projects/current-projects/rail-revitalisation-program**

4.7.1 Rail

The MEA for rail assets was selected on the following basis:

– A minimum track weight of 41kg per metre was used as this is readily obtained by Arc despite it not being the industry standard product. This has been used on sections of track where this is closest to the existing rail weight. Otherwise, a minimum of 50kg track has been used. For context, the Public Transport Authority (PTA) currently use of 50kg/m on ballasted track for all replacement rail projects and 60kg/m in turnouts and concrete slab track[30].

– All existing rail with weight between 51 and 60 kg per metre was replaced with 60kg per metre as this is the next readily available rail weight (and therefore least cost) with the closest comparable service standard to the existing asset.

– All 50 kg head hardened and 60 kg head hardened rail remains as is, as the use of this type of rail is assumed to be related to tight radius curves. High lateral loads at curves with a tight radius result in significant grinding of the rail. The use of hardened steel minimises the wear and therefore results in lower whole-of-life costs. Although head-hardened rail costs more than standard rail, for the purposes of this assessment, the same (lower) rate has been used for head hardened rail because it makes up just 3% of the network and would therefore not have a material cost impact.

The length of rail MEA is shown in Table 4-19. This includes the length of track and length of rail (i.e. length of rail is two times the track length for single track, and three times track length for dual gauge single track).

This is extended by the supply and install rate, which varies because of the remoteness of the location, to the total construction replacement cost.

Table 4-19 Rail MEA Construction Replacement Costs

Network Group	Track Length (km)	Rail Length (km)			Supply Rate ($m/km)			Install Rate ($m/km)	Total ($ million)
		41kg/m rail	50kg/m rail	60 kg/m rail	41kg/m rail	50kg/m rail	60 kg/m rail		
Metro	108	0	280	32	-	0.34	0.37	0.19	**165.5**
EGR	830	21	1,678	171	0.38	0.43	0.45	0.24	**1,264.1**
Midwest	304	234	101	272	0.43	0.44	0.48	0.25	**426.7**
EBL	422	0	740	105	-	0.51	0.56	0.29	**674.9**
LBL	266	2	530	0	0.50	0.51	-	0.29	**421.1**
SWM	280	129	382	49	0.40	0.41	0.45	0.23	**355.6**
Collie	70	0	136	4	-	0.41	0.45	0.23	**88.7**
MR	569	188	945	5	0.43	0.44	0.48	0.25	**780.3**
Central	694	388	761	240	0.40	0.41	0.45	0.23	**886.6**
GSR	481	2	799	160	0.43	0.44	0.48	0.25	**667.3**
Lakes	278	163	392	0	0.43	0.44	-	0.25	**379.9**
CBH Sidings	110	61	139	20	0.41	0.44	0.47	0.24	**148.6**
Sidings & Other	44	9	69	19	0.43	0.38	0.39	0.21	**58.2**
Non-Operational	814	1585	43	1	0.43	0.44	0.45	0.24	**1,084.9**
TOTAL	**5,270**	**2,782**	**6,994**	**1,077**					**7,402.4**

[30] Public Transport Authority (2023) Narrow Gauge Main Line Track and Civil Infrastructure Code of Practice

4.7.2 Sleepers

The existing network contains concrete, steel and timber sleepers. 73 percent of the existing sleepers are installed at a density of between 1,250 and 1,500 per track kilometre. 25 percent are installed at more than 1,500 per track kilometre and a minority (2 percent) at less than 1,250 per track kilometre. If the network were to be replaced today, it would need to comply with current standards which typically require sleeper density of 1,500 per track kilometre. This would mean 5 percent more sleepers than exist on the network.

The costing principles require that the MEA shall provide the closest comparable service standard to the existing asset where level of service is defined in terms of: [31]

– maximum axle loads;
– maximum train speeds; and
– maximum train lengths.

Sleeper spacing, when combined with ballast depth and formation stiffness, impacts the maximum axle loads the network can accommodate. Consequently, because the replacement cost is to be based on the closest comparable level of service to the existing network, the replacement cost is based on replicating the existing sleeper spacing.

Neither timber nor steel sleepers are readily available in mass quantities in the current market. The closest comparable alternative available at least cost in the current market are concrete sleepers. These sleepers are the standard product in use today and have therefore been selected as the most efficient asset with the closest comparable service standard to the existing.[32]

Sleeper MEA and construction replacement costs are shown in Table 4-20Table .

Table 4-20 Sleeper MEA Construction Replacement Costs

Network Group	Track Length (km)	Number of Sleepers	Sleeper Supply Rate ($m per km)	Install Rate ($m/km)	Total ($ million)
Metro	108	143,792	0.37	0.05	**45.1**
EGR	830	1,233,215	0.53	0.07	**501.4**
Midwest	304	454,995	0.54	0.07	**185.7**
EBL	422	629,896	0.62	0.08	**296.6**
LBL	266	400,865	0.63	0.08	**188.7**
SWM	280	303,378	0.36	0.05	**114.3**
Collie	70	93,700	0.45	0.06	**35.3**
MR	569	752,250	0.48	0.06	**307.0**
Central	694	935,151	0.45	0.06	**352.2**
GSR	481	630,536	0.47	0.06	**257.3**
Lakes	278	366,513	0.47	0.06	**149.6**
CBH Sidings	110	139,213	0.45	0.06	**56.1**
Sidings & Other	44	55,932	0.40	0.05	**20.1**
Non-Operational	814	950,134	0.42	0.06	**384.5**
TOTAL	**5,270**	**7,089,570**	**6.62**	**0.90**	**2,893.9**

[31] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3
[32] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

4.7.3 Ballast

Ballast, when combined with sleeper spacing and formation stiffness, impacts the maximum axle loads the network can accommodate. As the replacement cost is to be based on the closest comparable level of service to the existing network, and the definition of level or service includes maximum axle loads, the replacement cost is based on all track being ballasted to the same depth as is currently in place (typically 250-300mm on all Arc standard gauge network) and at least the minimum standard set by the Australian standard AS7630 (2017). Ballast material is assumed to be an 'aggregate and rock for engineering purposes' as per AS 2758 Part 7.

For the purposes of this assessment and in the absence of ballast depth data, the replacement cost has been based on achieving and average installed ballast density of 1.7 tonnes per cubic metre, using material sourced within 1.5 hours of the installation location. The construction replacement cost for ballast is presented in Table 4-21.

Table 4-21 Ballast MEA Construction Replacement Costs

Network Group	Track Length (km)	Supply and Cart Rate ($/m^3)	Distribute, Shape and Profile Rate ($/m^3)	Total ($ million)
Metro	108	14.9	6.5	**21.4**
EGR	830	148.5	64.2	**212.8**
Midwest	304	54.6	23.6	**78.2**
EBL	422	87.6	37.9	**125.5**
LBL	266	55.1	23.8	**78.9**
SWM	280	46.4	20.1	**66.5**
Collie	70	11.6	5.0	**16.6**
MR	569	102.3	44.2	**146.6**
Central	694	115.2	49.8	**165.0**
GSR	481	86.4	37.4	**123.7**
Lakes	278	49.9	21.6	**71.5**
CBH Sidings	110	19.4	8.4	**27.8**
Sidings & Other	44	7.0	3.0	**10.0**
Non-Operational	814	144.0	62.3	**206.3**
TOTAL	**5,270**	**942.9**	**407.8**	**1,350.7**

4.7.4 Turnouts

To replicate the level of service provided by the existing turnouts on the network at least cost, the MEA for turnouts has been based on the following assumptions:

– Any existing non-standard turnouts have been replaced with standard turnouts[33]. Standard turnouts are 'off-the-shelf' configurations, with defined crossing angle, switch geometry, rail weight and crossing assembly, laid on straight mainline track with no customised geometry. These are most cost efficient to install and to maintain as spare parts can be easily sourced;

– All turnouts have been replaced with 60kg per metre rail weight turnouts because this is the industry standard and therefore the least cost asset. Based on variability that Arc experience in practice, turn outs costs were estimated based on rail gauge;

– All sleepers in the turnouts are assumed to be concrete;

[33] Standard turnouts as defined by **Better Rail Code of Practice (**BRCoP) Table 3.16

– Where no specific turnout data is available, these have been assumed to be 1:10 standard turnout with 60kg/m rail on concrete sleepers, as the most efficient and least cost configuration that would be used today.

The MEA turnouts assets and the construction replacement cost is shown below.

Table 4-22 Turnout MEA Construction Replacement Costs ($ million)

Network Group	Number of Turnouts	Construct and Install Rate ($ million ea.)	Total Construction Replacement Cost ($ million)
Metro	89	0.07	**44.8**
EGR	224	0.06	**95.8**
Midwest	58	0.05	**18.5**
EBL	66	0.06	**27.6**
LBL	39	0.04	**11.3**
SWM	115	0.04	**32.9**
Collie	19	0.05	**6.2**
MR	76	0.04	**23.5**
Central	95	0.05	**30.6**
GSR	86	0.05	**27.0**
Lakes	39	0.05	**13.2**
CBH Sidings	187	0.05	**60.6**
Sidings & Other	68	0.05	**23.9**
Non-Operational	119	0.05	**39.7**
TOTAL	**1,280**		**455.5**

4.7.5 Summary Replacement Cost

The replacement cost and average unit rates for Track installation are shown in Table 4-23.

Table 4-23 Track assets Construction Replacement Costs ($ million)

Network Group	Track length (km)	Rail ($ millions)	Sleepers ($ millions)	Ballast ($ millions)	Turnouts ($ millions)	Total Construction replacement cost ($ million)	Average Construction Rate ($ million per km)
Metro	108	165.5	45.1	21.4	44.8	**276.8**	2.6
EGR	830	1,264.1	501.4	212.8	95.8	**2,074.0**	2.5
Midwest	304	426.7	185.7	78.2	18.5	**709.1**	2.3
EBL	422	674.9	296.6	125.5	27.6	**1,124.5**	2.7
LBL	266	421.1	188.7	78.9	11.3	**700.0**	2.6
SWM	280	355.6	114.3	66.5	32.9	**569.2**	2.0
Collie	70	88.7	35.3	16.6	6.2	**146.8**	2.1
MR	569	780.3	307.0	146.6	23.5	**1,257.3**	2.2
Central	694	886.6	352.2	165.0	30.6	**1,434.4**	2.1
GSR	481	667.3	257.3	123.7	27.0	**1,075.4**	2.2
Lakes	278	379.9	149.6	71.5	13.2	**614.1**	2.2
CBH Sidings	110	148.6	56.1	27.8	60.6	**293.1**	2.7
Sidings & Other	44	58.2	20.1	10.0	23.9	**112.2**	2.6
Non-Operational	814	1,084.9	384.5	206.3	39.7	**1,715.5**	2.1
TOTAL	**5,270**	**7,402.4**	**2,893.9**	**1,350.7**	**455.5**	**12,102.5**	**2.3**

4.8 Signalling and Communications/Control Systems

Signalling and communication assets and control systems play a crucial role in the operation of Arc's network by:

– controlling train movements to minimise safety risks – vital to prevent accidents and protect network users;
– managing traffic movements to achieve planned capacity, minimising congestion and enabling efficient movement of trains.

The signalling and control systems include assets on trains and across the network, managed through control centres.

MEAs for the signalling and communication infrastructure were assigned based on the existing asset inventory provided by Arc and GHD's assessment of current levels of service. GHD completed a review of modern equivalent alternative signalling and communications products that could be constructed at the valuation date to meet the closest comparable service standard to the existing assets.[34].

The outcomes of the signalling and communications technology review are described in the following sections, which also summarise their existing application on the Arc network. Subsequently, this information underpins the selection of MEA which is discussed in the following sections.

The Costing Principles require that the asset replacement cost used in the DORC with OpEx Adjustment must be the lowest current cost to replace the Railway Infrastructure based on Modern Equivalent Assets that present the

[34] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.6

closest comparable level of service to the existing.[35] This means that the replacement should assume the same control systems as existing, but using modern equipment and materials.

The service standard provided by the existing signalling and communications infrastructure is dependent on the control systems deployed across the Arc network. There are two signalling and communications systems in use by Arc on the existing network. These are:

– Train Order Working; and
– Centralised Train Control.

These systems are discussed in Table 4-24.

Table 4-24 Train Control Systems in use Across the Arc Network

System	Description	Current Application
Train Order Working	Train Order Working is a legacy system where the train is given authority to move along a limited track section, typically one length of single track, between two passing loops. In practice, this is typically communicated and confirmed verbally between train controller and driver. This authority enables the train to keep moving to the end of the section, when the process repeats to update the authority. There is generally no need for a train detection system, as the train's position is reported by the driver at each stop by train radio, or by phone.	This system is primarily used on relatively low traffic, and/or geographically remote parts of a railway network. Arc operate this system on several lines including the Esperance to Hampton line, West Kalgoorlie to Leonora, Avon Yard to Albany and associated branch lines.
Centralised Train Control (CTC) with Computer Based Interlockings (CBI)	In this system the train operates from lineside signals, and the driver reacts to the signal in front of the train (as would a road user). The signals are controlled from a central train control centre. This is called pure CTC. If the system also includes rail vehicle detection, it is called RVD. RVD is most common, and is usually achieved by: – Track circuits (the train completes an electric circuit as it travels on the rail – which is displayed on a screen at the CTC); – By axle counter (a device between tracks that counts each axle as it goes past, to determine speed and position of the train and relay the information to the CTC). Both systems require a communications backbone to support the relay of information to the central train control. In a modern installation this would typically be fibre optic which extends for the length of the corridor. Routes are set automatically by the central train control system. Commands are sent to lineside equipment rooms, which control all required local functionality through a system of interlocked equipment (the interlocking). Interlocking ensures only safe routes can be set (i.e. route options are interlocked to work together). The interlocking can be computer based using software such as Microlok, or relay (solid state) based.	Arc currently operate RVD from Bunbury Port through to Perth, and Perth to Kalgoorlie (though the Kalgoorlie line relies on legacy copper communication lines and not fibre optic). The Arc CTC systems are currently mostly Microlok computer based interlockings, with the rail vehicle detection being provided by track circuits.

The distribution of these systems across the network is shown in Figure 4-4 and in more detail in Table

[35] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

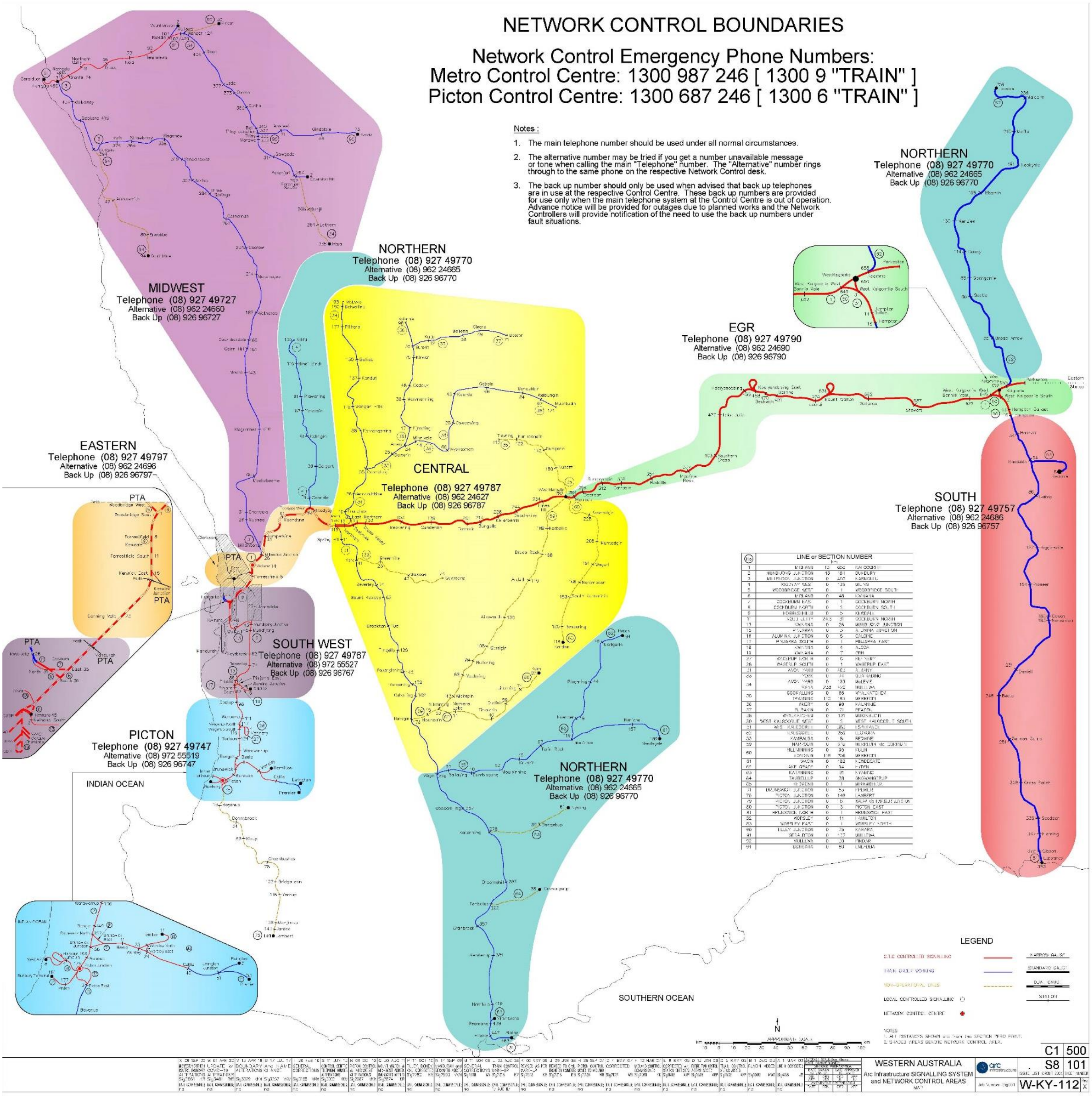

NETWORK CONTROL BOUNDARIES
Network Control Emergency Phone Numbers:
Metro Control Centre: 1300 987 246 [1300 9 "TRAIN"]
Picton Control Centre: 1300 687 246 [1300 6 "TRAIN"]
Notes :
1. The main telephone number should be used under all normal circumstances.
2. The alternative number may be tried if you get a number unavailable message or tone when calling the main "Telephone" number. The "Alternative" number rings through to the same phone on the respective Network Control desk.
3. The back up number should only be used when advised that back up telephones are in use at the respective Control Centre. These back up numbers are provided for use only when the main telephone system at the Control Centre is out of operation. Advance notice will be provided for outages due to planned works and the Network Controllers will provide notification of the need to use the back up numbers under fault situations.
MIDWEST
Telephone (08) 927 49727
Alternative (08) 962 24660
Back Up (08) 926 96727
NORTHERN
Telephone (08) 927 49770
Alternative (08) 962 24665
Back Up (08) 926 96770
EGR
Telephone (08) 927 49790
Alternative (08) 962 24690
Back Up (08) 926 96790
EASTERN
Telephone (08) 927 49797
Alternative (08) 962 24696
Back Up (08) 926 96797
CENTRAL
Telephone (08) 927 49787
Alternative (08) 962 24627
Back Up (08) 926 96787
SOUTH
Telephone (08) 927 49757
Alternative (08) 962 24686
Back Up (08) 926 96757
SOUTH WEST
Telephone (08) 927 49767
Alternative (08) 972 55527
Back Up (08) 926 96767
PICTON
Telephone (08) 927 49747
Alternative (08) 972 55519
Back Up (08) 926 96747
PTA
INDIAN OCEAN
SOUTHERN OCEAN
LINE or SECTION NUMBER
LEGEND
WESTERN AUSTRALIA
Arc Infrastructure SIGNALLING SYSTEM and NETWORK CONTROL AREAS
C1 500
S8 101
W-KY-112

Figure 4-4 Use of Train Order Working and Centralised Train Control across the Arc network[36]

Table 4-25 Service Standard of Existing and Proposed MEA Signalling and Communications Infrastructure

Network Group	Route Section	Existing Control System	Proposed MEA Control System
Metro	All	Centralised Train Control (CTC)	As existing
EGR	West Merredin to Parkeston	Centralised Train Control (CTC), Rail Vehicle Detection	As existing
Midwest	Geraldton to Mullewa	Centralised Train Control (CTC)	As existing
	All other sections	Train Order Working	As existing
EBL	Kalgoorlie to Hampton	Centralised Train Control (CTC)	As existing
	Hampton to Esperance	Train Order Working	As existing
LBL	All	Train Order Working	As existing
SWM	All	Centralised Train Control (CTC)	As existing
Collie	Brunswick East to Collie	Centralised Train Control (CTC), Rail Vehicle Detection	As existing
	All other sections	Train Order Working,	As existing
MR	All	Train Order Working	As existing
Central	All	Train Order Working	As existing
GSR	All	Train Order Working	As existing
Lakes	All	Train Order Working	As existing
CBH Sidings	All	Train Order Working	As existing
Sidings & Other	All	Train Order Working	As existing
Non-Operational	All	Ex Train Order Working	As existing

The replacement cost is based on the provision of assets required to deliver a level of service equivalent to the train control systems and equipment as shown in Table , using modern equivalent alternatives. In practice this means that the MEA would include below ground fibre optic cabling, rather than the mixture of copper and fibre optic networks that currently exist, and all other assets would be replaced with like-for-like new alternatives.

Signalling and communications infrastructure are often proprietary products, supplied and installed by specialist contractors. The procurement model assumes that the specialist contractor for the signalling and communications assets would be engaged and managed by the Principal Contractor. The Principal Contractor's costs for the procurement and management of these works, as well as adjustments for location.

This assessment has been based on signalling inventory data provided by Arc, and is the sum of:

– Fibre optic communications network;
– Signalling and control system assets;
– Communications assets; and
– Radio Masts.

[36] https://www.arcinfra.com/ARCInfrastructure/media/documents/Network%20Specifications/Arc-Infrastructure-Network-Control-Boundaries.pdf

4.8.1 Fibre Optic Communications Network

We have assumed that a fibre optic cable would be installed along sections of the network that currently operate centralised train control as shown in Table , because this most closely replicates the service offered by the existing infrastructure.

Table 4-26 shows the length of fibre optic cabling within each signal and Network Group and the direct replacement costs. The supply and install rates vary by Network Group because of the location factor that reflects the remoteness of each group (See discussion in Section 4.3).

Table 4-26 Communications Backbone Replacement Cost

Network Group	Length of Fibre Optic Cabling (km)	Average Supply, test and commission rate ($ million per km)	Average Install Rate (million per km)	Total ($ million)
Metro	67.9	0.12	0.69	55.5
EGR	738.5	0.16	0.92	796.3
Midwest	-	-	-	-
EBL	422.4	0.18	1.04	517.2
LBL	-	-	-	-
SWM	199.7	0.15	0.83	195.6
Collie	-	-	-	-
MR	-	-	-	-
Central	-	-	-	-
GSR	-	-	-	-
Lakes	-	-	-	-
CBH Sidings	-	-	-	-
Sidings & Other	-	-	-	-
Non-Operational	-	-	-	-
TOTAL	**1,428.5**	**0.16**	**0.93**	**1,564.6**

4.8.2 Signalling and Control Systems Assets

The quantities of each modern equivalent signalling and control asset are summarised in Table , by Network Group. This also presents the direct unit cost rate (unfactored by location) for each item.

The total cost for each Network Group is then carried forward to Table and combined with the location factor to determine the construction replacement cost of all signalling and communications assets.

Table 4-27 Construction Replacement Cost of MEA Signalling and Control Assets by Network Group (excluding adjustments for location)

MEA	Unit	Metro	EGR	Midwest	EBL	LBL	SWM	Collie	MR	Central	GSR	Lakes	CBH Sidings	Sidings & Other	Non-Operational	Total Quantity	Unit Rate ($ unfactored by location)	Total Cost ($ million)
AC Supplies	No.	8	32	8	1		17	4	2					2		74	81,000	6.0
Boom barrier Level Crossing Protection	No.	8	36	7	3		41	3	9	4	9			6		126	1,109,972	139.9
Computer Based Interlockings	No.	18	93	39	11	1	18		8					5		193	243,000	46.9
DC Supplies	No.	6	91	26	13	1	8	1	5	1	5					157	24,300	3.8
Equipment Cabinet	No.	72	419	74	44	7	246	49	59	41	53	10	1	35	21	1,131	32,400	36.6
Equipment Room	No.	15	114	46	24	11	46	7	29	34	27	13		3	26	395	81,000	32.0
Flashlight Level Crossing Protection	No.	1	69	24	13	6	50	8	33	37	41	10	1	3	14	310	554,986	172.0
Indication Panels	No.		3				1									4	40,500	0.2
Miscellaneous Track Side Equipment	No.	4	11	43	37	4	11	4	25	12	23	2	2	9		187	8,100	1.5
Pedestrian Crossings	No.	4	3						4							11	277,493	3.1
Points Electric	No.	123	183	31	23		109	17	9	1	3			31		530	162,000	85.9
Points Mechanical	No.										4					4	40,500	0.2
Signalling Cables	km	58	348		13		221	26						21		687	48,600	33.4
Signalling Line Routes	km.		364			1										365	324,000	118.1
Signals	No.	129	371	52	9	1	231	36	18	2	2			32		883	64,800	57.2
Switchlocks	No.		44	4	5		4	4	5					2		68	8,100	0.6
TDM Systems	No.						7	4								11	162,000	1.8
Track Circuits - Audio Frequency Overlay	No.	1	63	19			26	3	4	1	1					118	12,960	1.5
Track Circuits - Coded	No.	7	198	48	9	1	61	16	10		2					352	12,960	4.6
Track Circuits - Predictors	No.	7	114	13	1	2	50	3	9		2			1		202	12,960	2.6
Track Circuits - Solid State Controlled	No.				41			4	5		4					54	12,960	0.7
Track Circuits DC	No.	211	384	134	83	7	263	77	134	108	174	18		53	4	1,650	12,960	21.4
Track Circuits Pulse	No.	5								3				24	1	33	12,960	0.4
Track Side Warning Systems	No.		8	3					1							12	162,000	1.9
Train Detection Systems	No.	13	29			3			3	20	2	16	3	17		106	24,300	2.6
TOTAL COST ($ MILLION)		**53.7**	**330.1**	**50.0**	**24.0**	**5.3**	**140.7**	**18.7**	**41.1**	**31.4**	**40.2**	**7.6**	**0.7**	**20.7**	**10.6**			**774.8**

Table 4-28 Signalling and Control systems assets Construction Replacement Cost ($ million)

Network Groups	Signalling and Control System Asset Costs ($ million)	Average Location Factor	Signalling and Control Systems Construction Replacement Cost ($ million)
Metro	53.7	1.00	53.7
EGR	330.8	1.30	431.8
Midwest	50.2	1.30	65.2
EBL	24.0	1.50	36.0
LBL	5.3	1.50	7.9
SWM	141.1	1.20	169.3
Collie	18.7	1.20	22.4
MR	41.1	1.30	53.4
Central	31.4	1.20	37.7
GSR	40.5	1.30	52.6
Lakes	7.6	1.30	9.8
CBH Sidings	0.7	1.20	0.8
Sidings & Other	20.7	1.01	20.9
Non-Operational	10.6	1.22	13.0
TOTAL	**776.2**	**1.26**	**974.5**

4.8.3 Control Centre Signal Assets

There are two control centres on Arc's network which contain signals assets. The cost for these assets has been distributed across the network where signalling assets exist. This is because the signals within this asset group service the whole network. Table 4-29 details the construction replacement cost for control centre signals.

Table 4-29 Control Centres Signals Assets Replacement Costs

Network Groups	Control Centre Asset Direct Costs ($ million)	Average Location Factor	Control Centre Asset Construction Replacement Cost ($ million)
Metro	5.8	1.00	5.8
EGR	50.9	1.30	66.9
Midwest	3.7	1.30	4.8
EBL	20.4	1.50	30.7
LBL	0.4	1.50	0.6
SWM	16.6	1.20	20.0
Collie	1.3	1.20	1.5
MR	2.9	1.30	3.7
Central	2.1	1.20	2.5
GSR	2.6	1.30	3.4
Lakes	0.5	1.30	0.6
CBH Sidings	0.8	1.20	1.0
Sidings & Other	1.1	1.01	1.1
Non-Operational	0.9	1.22	1.1
TOTAL	**110.0**	**1.26**	**143.8**

4.8.4 Communications Assets

Communications assets include equipment rooms, radio base stations (radio masts are identified separately), and associated signalling huts and cabins. The quantities of each modern equivalent communications asset are summarised in Table 4-30Table , by Network Group. This also presents the direct unit cost rate (unfactored by location) for each item.

The total cost for each Network Group is then carried forward to Table and combined with the location factor to determine the construction replacement cost of all signalling and communications assets. Note that the average location factors in this table will differ from those in the other assessments because of the geographical spread of the assets within a Network Group.

Table 4-30 Construction Replacement Cost of MEA Communications Assets by Network Group (excluding adjustments for location)

MEA	Unit	Metro	EGR	Midwest	EBL	LBL	SWM	Collie	MR	Central	GSR	Lakes	CBH Sidings	Sidings & Other	Non-Operational	Total Quantity	Unit Rate ($ unfactored by location)	Total Costs ($ million)
Equipment Room	No.	3	34	13	9		16	2	3				3			83	81,000	6.7
Radio Base Station	No.	1	13		2	2	1	1	4	3	5		3			35	97,248	3.4
Signalling Equipment Hut Including Interlocking	No.		1													1	486,000	0.5
Train Order Cabin	No.			17	17	8			12	18	18	7	34	2	29	162	162,000	26.2
TOTAL	**NO.**	**4**	**48**	**30**	**28**	**10**	**17**	**3**	**19**	**21**	**23**	**7**	**40**	**2**	**29**	**281**		**36.9**

Table 4-31 Communications Systems Assets Construction Replacement Cost ($ million)

Network Groups	Communication Asset Costs (not factored by location) ($ million)	Average Location Factor	Signalling and Control Systems Construction Replacement Cost ($ million)
Metro	0.3	1.00	0.3
EGR	4.5	1.30	5.9
Midwest	3.8	1.30	4.9
EBL	3.7	1.50	5.5
LBL	1.5	1.50	2.2
SWM	1.4	1.20	1.7
Collie	0.3	1.20	0.3
MR	2.6	1.30	3.3
Central	3.2	1.20	3.8
GSR	3.4	1.30	4.4
Lakes	1.1	1.30	1.5
CBH Sidings	6.0	1.28	7.7
Sidings & Other	0.3	1.00	0.3
Non-Operational	4.7	1.29	6.1
GRAND TOTAL	**36.9**	**1.30**	**48.1**

4.8.5 Radio Masts

As noted above, radio masts are identified separately to other signalling and communications assets. This is because radio masts may provide coverage over more than the route section in which they are located. To address this, GHD has considered that all radio masts provide coverage to all route sections to which they are proximate to. GHD has established this using two methods:

1. Where the named location of the radio mast matched the name of a route section, or part of the name of a route section, it was assumed to provide coverage over all those associated route sections. For example, the radio mast at Amery was assumed to provide a service to the following route sections:
   a. Amery to Burakin
   b. Amery to Mukinbudin
   c. Goomalling to Amery

   In these situations, the radio mast was assumed to provide a service to each route section in proportion to the total combined length of all route sections that it serves (in kilometres);
2. Where the named location of the radio mast did not match the name of a route section, it was assigned to the route section it is closest to by visual inspection of its location. The cost of that radio mast was then allocated to that route section.

As well as recognising that a radio mast may provide a service to more than one route section, this approach also recognised that a route section may receive a service from more than one radio mast. This was achieved by summing the total proportions of all radio masts that served each route section.

Using this approach enables the allocation of the 114 radio masts across the Arc network to each Network Group as shown in Table 4-32.

Note that the average location factors in this table will differ from those in the other assessments because of the geographical spread of the assets within a Network Group.

Table 4-32 Radio Mast Construction Replacement Cost ($ million)

Network Groups	Number of masts servicing each Network Group	Mast Replacement Cost Rate ($ million each)	Radio Mast Costs (not factored by location) ($ million)	Average Location Factor	Radio Mast Construction Replacement Cost ($ million)
Metro	1.2	1.4	1.7	1.00	1.7
EGR	22.3	1.4	30.4	1.32	40.2
Midwest	11.5	1.4	15.7	1.30	20.4
EBL	13.3	1.4	16.8	1.50	25.2
LBL	8.0	1.4	1.4	1.50	2.0
SWM	8.5	1.4	11.6	1.20	13.9
Collie	4.0	1.4	5.5	1.20	6.6
MR	17.8	1.4	10.6	1.30	13.8
Central	4.0	1.4	5.4	1.20	6.5
GSR	15.3	1.4	5.9	1.30	7.7
Lakes	-	1.4		-	-
CBH Sidings	6.1	1.4	8.2	1.27	10.5
Sidings & Other	0.3	1.4	0.3	1.14	0.4
Non-Operational	1.6	1.4	2.2	1.28	2.9
GRAND TOTAL	**114.0**		**115.8**	**1.31**	**151.8**

Table 4-33 Radio Mast Inventory

Radio Mast	Route Section	Route Section length (km)	Total track length served by radio mast (km)
Amery	Amery to Burakin	79.3	269.2
	Amery to Mukinbudin	156.1	
	Goomalling to Amery	33.8	
Avon Yard Radio	Avon Yard	13.0	13.0
Beela	Brunswick East to Worsley	24.8	24.8
Bonnievale	Mount Walton to West Kalgoorlie West	115.7	115.7
Bowgada	Morawa to Perenjori	41.8	41.8
Brunswick N	Brunswick North to Brunswick East	1.1	42.8
	Wagerup South to Brunswick North	40.7	
	Brunswick North to Brunswick Junction	1.0	
Bunbury Inner Harbour	Picton Junction to Bunbury Inner Harbour	9.5	13.5
	Picton Container Terminal to Bunbury Terminal	4.0	
Bungulla	Avon Yard to West Merredin	181.9	181.9
Burakin	Burakin to Beacon	71.7	171.9
	Burakin to Kalannie	20.8	
	Amery to Burakin	79.3	
Burracoppin	Merredin to Southern Cross	132.0	132.0
Cairn Hill	Millendon Junction to Watheroo	185.9	185.9

Radio Mast	Route Section	Route Section length (km)	Total track length served by radio mast (km)
Canna	Mullewa to Tilley Junction	98.1	98.1
Carrabin	Merredin to Southern Cross	132.0	132.0
Collie Radio	Worsley East to Ewington Junction	27.5	27.5
Cookernup	Wagerup South to Brunswick North	40.7	40.7
Coorow	Marchagee to Dongara	180.6	180.6
Cunderdin	Avon Yard to West Merredin	181.9	181.9
Daniell	Kambalda to Salmon Gums	235.0	235.0
Darrine	Koolyanobbing East to Mount Walton	85.4	85.4
Dean	Mullewa to Tilley Junction	98.1	98.1
Doodlakine	Avon Yard to West Merredin	181.9	181.9
Eneabba	Dongara to Eneabba South	94.4	94.4
Eradu	Esperance to Esperance Wharf	9.1	9.1
Esperance CER	Salmon Gums to Esperance	108.5	108.5
Esperance Hill	Salmon Gums to Esperance	108.5	108.5
F/Field Radio	Forrestfield	16.3	16.3
Geraldton Port	Narngulu to Geraldton	19.7	19.7
Gilingarra	Millendon Junction to Watheroo	185.9	185.9
Gingin	Millendon Junction to Watheroo	185.9	185.9
Goodia	Kambalda to Salmon Gums	235.0	235.0
Goomalling	Goomalling to Amery	33.8	173.7
	Goomalling to McLevie	140.0	
Grass Patch	Avon Yard to West Merredin	181.9	181.9
Hamilton	Worsley to Hamilton	11.0	11.0
Hampton Bam	Hampton Intermodal Terminal to Hampton	4.9	4.9
Higginsville	Kambalda to Salmon Gums	235.0	235.0
Jaurdi	Koolyanobbing East to Mount Walton	85.4	85.4
Jimperding	Millendon Junction to Toodyay West	71.4	71.4
Kalgoorlie Radio	Kalgoorlie	1.0	1.0
Kalgoorlie RSS	Kalgoorlie	1.0	1.0
Keysbrook	Brookton to Narrogin	74.2	74.2
Kojarena	Narngulu East to Mullewa	101.6	101.6
Kambalda	Kambalda to Salmon Gums	235.0	280.8
	Kambalda to Redmine	6.4	
	Hampton to Kambalda	39.4	
Kookynie	Kambalda to Salmon Gums	235.0	235.0
Koolyanobbing	Hampton to Kambalda	39.4	124.8
	Koolyanobbing East to Mount Walton	85.4	
Kwinana	Cockburn South to Kwinana North	11.5	58.1
	Kwinana FPA to Kwinana CBH	4.8	

Radio Mast	Route Section	Route Section length (km)	Total track length served by radio mast (km)
	Kwinana West to Kwinana FPA	2.8	
	Kwinana to Kwinana Alcoa	6.1	
	Kwinana to Kwinana West	0.7	
	Kwinana West to Kwinana KBT	0.3	
	Kwinana North to Kwinana West	0.7	
	Kwinana North to Kwinana	1.2	
	Kwinana to Mundijong Junction	30.0	
Lefroy	Kambalda to Salmon Gums	235.0	235.0
Leonora	Malcolm to Leonora	25.1	27.4
	Leonora	2.3	
Manmanning	Amery to Burakin	79.3	79.3
Meckering	Avon Yard to West Merredin	181.9	181.9
Meenaar	Avon Yard to West Merredin	181.9	181.9
Merredin Radio	Merredin to Southern Cross	132.0	132.0
Millendon Hill	Millendon Junction to Toodyay West	71.4	272.2
	Midland to Millendon Junction	14.9	
	Millendon Junction to Watheroo	185.9	
Millendon Relay Rm	Millendon Junction to Toodyay West	71.4	272.2
	Midland to Millendon Junction	14.9	
	Millendon Junction to Watheroo	185.9	
Moondyne	Millendon Junction to Toodyay West	71.4	71.4
Mt Bakewell	York	0.8	0.8
Mt Barrow (Mt Barker)	Tambellup to Redmond	120.7	120.7
Mt Fairlield (Katanning)	Katanning to Tambellup	51.1	103.3
	Wagin South to Katanning	51.1	
	Katanning	1.1	
Mt Latham (Wagin)	Wagin	1.1	1.1
Mt Melville	Albany	1.6	1.6
Mt Nardie	Toodyay West to Avon Yard	38.1	38.1
Morawa	Morawa	1.6	46.4
	Tilley to Morawa	3.0	
	Morawa to Perenjori	41.8	
Mullewa	Mullewa	1.3	201.1
	Narngulu East to Mullewa	101.6	
	Mullewa to Tilley Junction	98.1	
Mundijong	Kwinana to Mundijong Junction	30.0	77.6
	Mundijong Junction to Pinjarra	47.6	

Radio Mast	Route Section	Route Section length (km)	Total track length served by radio mast (km)
Narngulu	Dongara to Narngulu	60.2	184.3
	Narngulu to Geraldton	19.7	
	Narngulu to Narngulu East	2.8	
	Narngulu East to Mullewa	101.6	
Narrogin	Brookton to Narrogin	74.2	345.8
	Narrogin to West Merredin	223.2	
	Narrogin to Wagin	48.4	
Nola	Narngulu East to Mullewa	101.6	101.6
Norseman	Kambalda to Salmon Gums	235.0	235.0
Northam Radio	Avon Yard to West Merredin	181.9	181.9
Northern Gully	Narngulu East to Mullewa	101.6	101.6
Perenjori	Morawa to Perenjori	41.8	41.8
Picton	Picton Junction to Greenbushes	78.3	117.5
	Picton Junction to Bunbury Inner Harbour	9.5	
	Picton Junction to Picton Container Terminal	1.7	
	Brunswick Junction to Picton Junction	24.0	
	Picton Junction to Picton East	4.0	
Pingelly	Brookton to Narrogin	74.2	74.2
Pinjarra	Mundijong Junction to Pinjarra	47.6	85.4
	Alumina Junction to Pinjarra South	1.1	
	Pinjarra to Pinjarra South	3.2	
	Pinjarra to Alumina Junction	1.8	
	Pinjarra South to Wagerup North	31.8	
Pinjarra CER	Mundijong Junction to Pinjarra	47.6	85.4
	Alumina Junction to Pinjarra South	1.1	
	Pinjarra to Pinjarra South	3.2	
	Pinjarra to Alumina Junction	1.8	
	Pinjarra South to Wagerup North	31.8	
Pintharuka	Canna	3.0	3.0
Salmon Gums	Salmon Gums	1.5	1.5
Scaddan	Salmon Gums to Esperance	108.5	108.5
Southern Cross	Southern Cross	2.8	2.8
Stewart	Mount Walton to West Kalgoorlie West	115.7	115.7
Sukey Hill (Cranbrook)	Tambellup to Gnowangerup	38.6	38.6
Tardun	Mullewa to Tilley Junction	98.1	98.1
Tenindewa	Narngulu East to Mullewa	101.6	101.6
Wagerup	Wagerup South to Brunswick North	40.7	73.6
	Wagerup North to Wagerup South	1.1	

Radio Mast	Route Section	Route Section length (km)	Total track length served by radio mast (km)
	Pinjarra South to Wagerup North	31.8	
Wallaroo	Mount Walton to West Kalgoorlie West	115.7	115.7
Worsley	Worsley to Hamilton	11.0	36.7
	Brunswick East to Worsley	24.8	
	Worsley to Worsley East	1.0	

The construction replacement cost of each modern equivalent communications asset is summarised in table 4-34, by Network Group.

Table 4-34 Summary Signalling and Communications Replacement Cost ($ million)

Network Group	Fibre Optic Network ($ million)	Signalling and Control Assets ($ million)	Control Centre Signal Assets ($ million)	Communications Assets ($ million)	Radio Masts ($ millions)	Total Direct Costs ($ millions)
Metro	55.5	53.7	5.8	0.3	1.7	111.2
EGR	796.6	431.8	66.9	5.9	40.2	1,274.5
Midwest	0.0	65.2	4.8	4.9	20.4	90.6
EBL	517.2	36.0	30.7	5.5	25.2	583.9
LBL	0.0	7.9	0.6	2.2	2.0	12.2
SWM	195.6	169.3	20.0	1.7	13.9	380.4
Collie	0.0	22.4	1.5	0.3	6.6	29.3
MR	0.0	53.4	3.7	3.3	13.8	70.6
Central	0.0	37.7	2.5	3.8	6.5	48.1
GSR	0.0	52.6	3.4	4.4	7.7	64.7
Lakes	0.0	9.8	0.6	1.5	-	11.3
CBH Sidings	0.0	0.8	1.0	7.7	10.5	19.0
Sidings & Other	0.0	20.9	1.1	0.3	0.4	21.6
Non-Operational	0.0	13.0	1.1	6.1	2.9	21.9
TOTAL	**1,564.8**	**974.6**	**143.8**	**48.1**	**151.8**	**2,739.2**

4.8.6 Summary Replacement Cost

As discussed above, the signalling and communications works would be undertaken by a specialist contractor procured by the Principal Contractor as part of the overall network replacement task.

The Principal Contractor would incur additional costs to manage the signalling contract. The signalling and communications replacement cost is the summation of the construction costs (discussed in the preceding sections) and the additional costs incurred by the Principal Contractor. These are shown in the table below.

Table 4-35 Summary Signalling and Communications Replacement Cost ($ million)

Network Group	Total Direct Costs	Principal Contractor's Risk Allowance	Principal Contractor's Preliminaries	Principal Contractor's OH + Profit	Total Replacement Cost ($ millions)
Metro	111.2	11.7	36.9	15.2	174.9
EGR	1,274.5	134.0	422.5	173.9	2,005.0
Midwest	90.6	9.5	30.0	12.4	142.5
EBL	583.9	61.4	193.6	79.7	918.5
LBL	12.2	1.3	4.0	1.7	19.2
SWM	380.4	40.0	126.1	51.9	598.4
Collie	29.3	3.1	9.7	4.0	46.1
MR	70.6	7.4	23.4	9.6	111.1
Central	48.1	5.1	15.9	6.6	75.6
GSR	64.7	6.8	21.5	8.8	101.8
Lakes	11.3	1.2	3.7	1.5	17.8
CBH Sidings	19.0	2.0	6.3	2.6	30.0
Sidings & Other	21.6	2.3	7.2	2.9	33.9
Non-Operational	21.9	2.3	7.3	3.0	34.4
TOTAL	**2,739.2**	**288.0**	**908.2**	**373.9**	**4,309.2**

4.9 Buildings

4.9.1 Modern Equivalent Asset Selection

This asset class includes building structures owned and used by Arc for the operation and maintenance of the Railway Infrastructure. This includes control centres, and maintenance facilities. The MEA for the assets included are shown in Table 4-36.

Table 4-36 Building Assets

Building Assets	Asset Type	MEA Selection
Centralised Control Centres	Control centres at: – Avon – Canning Vale – Picton Arc operate a fourth Control Centre at Midland but this is a leased asset and is not therefore included in this valuation.	A standard 800m^2 building. Concrete block walls on slab-on-ground. Internal fit out to office standard.
Maintenance facilities	Arc own ten maintenance facilities across the network at: – Kalgoorlie – Katanning – Kewdale – Merredin – Midland	A steel-framed workshop building with associated office space, carparking and external laydown areas. The same size of facility was adopted at all ten locations, based on the average provision of the existing maintenance facilities.

Building Assets	Asset Type	MEA Selection
	– Narngulu – Narrogin – Northam – Picton – Pinjarra Each typically includes an office, workshop, external hardstand/laydown areas and carparking	
Depots and other facilities	Arc operate a number of other facilities including flashbutt welding facilities, depots, training centres, sheds/warehouses and residential properties. However, most are leased. With the exception of Kenwick Flashbutt Welding Facility, Kewdale training facility and Hampton Rail Siding, these facilities are non-rail specialised.	A steel-framed workshop building with associated office space, carparking and external laydown areas.

4.9.2 Summary Replacement Cost

The replacement cost has been based on unit rates benchmarked against relevant recent projects:

Centralised Control Centre	Benchmarked against PTA's Public Transport Operations Control Centre, adjusted to account for differences in scope of works and escalation between the date of Tender and the valuation date.
Maintenance Facilities	Benchmarked against numerous PTA depots, including (but not limited to) Bellevue Depot, Claisebrook Depot, Nowergup Depot and Welshpool Depot, adjusted to account for differences in scope of works and escalation between the date of Tender and the valuation date.
Depots	Benchmarked against PTA and other depots based on building and external area and facilities

The Construction Replacement Cost for buildings assets is shown below.

Table 4-37 Building Asset Construction Replacement Cost ($ million)

Building Type	Unit	Quantity	Rate ($ million per unit)	Amount
Centralised Control Centre	No.	3	8.2	24.7
Maintenance Facility	No.	10	12.4	123.7
Depot	m^2	60,427	228.4	13.8
TOTAL				**162.2**

The construction replacement cost by Network Group is shown in Table . The Centralised Control Centres and Maintenance Facilities provide services over multiple route sections. The cost of these assets has therefore been allocated to route sections based on the route kilometre within each route section. For control centres, only those routes with signalling have been included.

Table 4-38 Summary Building Asset Construction Replacement Cost ($ million)

Network Group	Centralised Control Centres	Maintenance Facilities	Depots	Total ($millions)
Metro	0.6	3.2	0.3	**4.1**
EGR	4.8	24.2	2.2	**31.3**
Midwest	1.5	7.3	0.8	**9.6**
EBL	2.5	12.4	1.1	**16.0**
LBL	1.6	7.8	0.7	**10.1**
SWM	1.2	5.8	0.7	**7.7**
Collie	0.4	2.1	0.2	**2.6**
MR	2.8	14.0	1.5	**18.3**
Central	4.1	20.4	1.8	**26.3**
GSR	2.8	14.1	1.3	**18.2**
Lakes	1.6	8.2	0.7	**10.5**
CBH Sidings	0.6	2.8	0.3	**3.7**
Sidings & Other	0.3	1.3	0.1	**1.7**
Non-Operational	-	0.0	2.1	**2.1**
TOTAL	**24.7**	**123.7**	**13.8**	**162.2**

4.10 Associated Track Structures

4.10.1 Pedestrian Crossings

This asset class includes pedestrian crossings. To achieve the lower current cost asset to provide the closest comparable service standard to the existing assets, five modern equivalent crossing types have been identified in Table :[37]

Table shows the number of each crossing type by Network Group.

Table 4-39 Associated Track Structure (level crossings) MEA types

Type	Name	Description
1	Active: Gated	Protected crossing with control systems, pedestrian mazes, self closing gates and lights, fenced, asphalt surfaces with signage and white lines.
2	Active: Signals	Protected crossing with control systems, pedestrian mazes, lights, fenced, asphalt surfaces with signage and white lines.
3	Passive: Maze	Un-protected crossing with pedestrian mazes, self-closing gates, lights, fenced, asphalt surfaces with signage and white lines.
4	Passive: Path Only	Un-protected crossing with pedestrian walkway and signage.
5	Unprotected	Un-protected asphalt paved crossing with signage.

[37] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

Table 4-40 Number of Associated Track Structures of Each MEA Type by Network Group

Network Group	MEA Type					
	Type 1 Active: Gated	Type 2 Active : Signalled	Type 3 Passive : Maze	Type 4 Passive : Path Only	Type 5 Unprotected	Total
Metro	0	3	14	0	1	18
EGR	8	3	25	4	7	47
Midwest	0	1	3	0	0	4
EBL	0	2	4	2	9	17
LBL	0	1	0	0	1	2
SWM	1	3	16	1	4	25
Collie	0	1	6	0	0	7
MR	3	2	14	1	1	21
Central	2	2	6	2	3	15
GSR	3	17	22	3	3	48
Lakes	0	1	0	0	0	1
CBH Sidings	0	0	1	0	0	1
Sidings & Other	1	7	4	1	1	14
Non-Operational	0	7	0	0	0	7
TOTAL	**18**	**50**	**115**	**14**	**30**	**227**

4.10.2 Summary Replacement Cost

The below is a summary of the construction replacement cost by Network Group.

Table 4-41 Construction Replacement Cost of Associated Track Structures of Each MEA Type by Network Group

Network Group	MEA Type					
	Type 1 Active: Gated	Type 2 Active : Signalled	Type 3 Passive : Maze	Type 4 Passive : Path Only	Type 5 Unprotected	Total
Metro	-	0.58	1.55	-	0.04	**2.2**
EGR	2.64	0.75	3.29	0.19	0.39	**7.3**
Midwest	-	0.25	0.43	-	-	**0.7**
EBL	-	0.58	0.66	0.13	0.57	**1.9**
LBL	-	0.29	-	-	0.06	**0.4**
SWM	0.31	0.70	2.12	0.05	0.20	**3.4**
Collie	-	0.23	0.80	-	-	**1.0**
MR	1.00	0.50	2.01	0.06	0.05	**3.6**
Central	0.61	0.46	0.80	0.10	0.15	**2.1**
GSR	1.00	4.27	3.16	0.17	0.16	**8.8**
Lakes	-	0.25	-	-	-	**0.3**
CBH Sidings	-	-	0.14	-	-	**0.1**
Sidings & Other	0.26	1.35	0.44	0.04	0.04	**2.1**
Non-Operational	-	1.74	-	-	-	**1.7**
TOTAL	**5.81**	**11.96**	**15.41**	**0.74**	**1.67**	**35.6**

4.11 Miscellaneous

4.11.1 Plant, Tools and Equipment

This asset class includes items of plant, tools and equipment owned and operated by Arc as part of operating and maintaining the Railway Infrastructure. There are several broad types of plant and equipment as shown in Table .

The closest comparable service standard to the existing assets have been selected as the MEAs:[38]

[38] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.3

Table 4-42 Plant, Machinery and Equipment MEAs

Asset Category	MEA for Asset Category	Reasoning for MEA Selection
Tampers	Robel 62.05 Vertical tamper	Currently used on Arc network
Light Vehicles	Ford Ranger PX MKII TOYOTA Landcruiser Prado GXL	Most common light vehicles used by Arc and readily available in Australia.
Heavy Vehicles	Isuzu F-series and N-series	
Trailers	Box trailer Flat top trailer Pig trailer Plant transport trailer	
Rail Vehicle moving and placing assets	RRV TOYOTA Landcruiser narrow gauge/standard gauge RRV Mitsubishi Canter narrow gauge	Most common RRVs used by Arc
Asset Monitoring Vehicle (AMV)	Arc's proprietary product, valuation includes provision for in house research and development	No equivalent replacement available on the market
Ballast Wagons	CH Wagon class	Current technology on the market
Sleeper Laying Machines	Liebherr A922 Octopus Sleeper Layer	Currently used by Arc and available in Australia.
Power tools	Geismar petrol rail grinder Drills, Post hole diggers, chainsaws, petrol wrenches, petrol bitumen cutters, welders	
Hand tools and protective equipment	Welding helmet Track Recorders Rail threading tongs	
Forklifts	3000kg gas forklift	
Generators	CAT C15 550 kVA Generator Set	
Elevated Work Platforms (EWP)	Nifty Lift EWP	
Asset Monitoring Vehicle	Custom product	

The Railway Owner would incur costs in procuring these assets. This is discussed in Section 5.10.

Except for the Asset Monitoring Vehicle, the plant and equipment assets are all proprietary products which would be purchased directly from distributors or manufacturers by the Railway Owner. They do not therefore attract any additional costs from the Principal Contractor (risk allowance, preliminaries, overheads or profit).

The asset monitoring vehicle is a custom gauge-convertible road-rail Mack Truck which has track geometry testing equipment mounted onboard. The asset would be purchased directly by the Railway Owner. The replacement cost for this custom asset was estimated based on Arc's advice and GHD's judgement, which considers significant Railway Owner research and development effort to create this asset and Railway Owner assembly effort.

Replacement costs for plant, machinery and equipment are presented in Table 4-43.

Table 4-43 Replacement Cost – Plant Machinery and Equipment ($ million)

Asset Type	Quantity	Total Replacement Cost ($million)
Light vehicles	153	7.6
Heavy vehicles	75	11.6
Trailers	47	2.5
RRV	107	17.3
Forklifts	14	0.3
Ballast wagons	33	5.3
Power tools	321	1.6
Tampers	40	0.6
Trolleys	11	0.06
Support equipment	120	4.7
Hand tools	7	0.007
Generators	1	0.15
Asset Monitoring Vehicle	1	10
TOTAL		**61.8**

4.11.2 Signage

This asset category includes signage owned by Arc as part of operating and maintaining the Railway Infrastructure. Signage inventory includes permanent signs such as speed restriction signs.

Table 4-44 Signage Replacement Cost ($ million)

Network Group	Total Replacement Cost ($millions)
Metro	0.1
EGR	1.7
Midwest	0.5
EBL	0.4
LBL	0.4
SWM	0.5
Collie	0.2
MR	1.1
Central	1.3
GSR	1.1
Lakes	0.7
CBH Sidings	0.0
Sidings & Other	0.1
Non-Operational	-
TOTAL	**8.1**

4.11.3 Walkways

Walkways are access paths for personnel. These are assumed to be present along the length of all embankments and cutting. Replacement costs are shown in Table 4-45.

Table 4-45 Walkways Replacement Cost ($ million)

Network Group	Total Replacement Cost ($millions)
Metro	1.0
EGR	32.8
Midwest	5.1
EBL	4.7
LBL	1.9
SWM	2.9
Collie	2.8
MR	5.0
Central	5.2
GSR	7.0
Lakes	1.1
CBH Sidings	0.0
Sidings & Other	0.4
Non-Operational	-
TOTAL	**70.1**

4.11.4 Fencing

Fencing exists around critical signalling and communications infrastructure, for example radio towers, signalling cases and huts, and communications towers. The fencing costs are shown in section 4.8 where Signalling and Communications are shown. There is no railway corridor fencing.

4.11.5 Summary Replacement Cost

Summary replacement cost by Network Group is shown in Table 4-46.

Table 4-46 Construction Replacement Cost of Miscellaneous Assets by Network Group

Network Group	Plant, Tools and Equipment	Signage	Walkways	Total
Metro	1.6	0.1	1.0	**2.8**
EGR	12.1	1.7	32.8	**46.6**
Midwest	3.7	0.5	5.1	**9.3**
EBL	6.2	0.4	4.7	**11.4**
LBL	3.9	0.4	1.9	**6.2**
SWM	2.9	0.5	2.9	**6.3**
Collie	1.0	0.2	2.8	**4.0**
MR	7.0	1.1	5.0	**13.1**
Central	10.2	1.3	5.2	**16.7**
GSR	7.0	1.1	7.0	**15.1**
Lakes	4.1	0.7	1.1	**5.8**
CBH Sidings	1.4	0.0	0.0	**1.5**
Sidings & Other	0.7	0.1	0.4	**1.1**
Non-Operational	0.0	0.0	0.0	**0.0**
TOTAL	**61.8**	**8.1**	**70.1**	**139.9**

4.12 Summary Construction Replacement Cost

The summary construction replacement cost by asset and Network Group is shown in Table 4-47.

Table 4-47 Summary Construction Replacement Cost ($ million)

Network Group	Right of Way	Civil Structures	Track	Signalling and Control Systems	Buildings	Associated Track Structures	Miscellaneous	Total
Metro	51.1	74.4	276.8	174.9	4.1	2.2	2.8	586.2
EGR	556.1	81.0	2,074.0	2,005.0	31.3	7.3	46.6	4,801.2
Midwest	223.0	57.7	709.1	142.5	9.6	0.7	9.3	1,151.8
EBL	342.7	30.1	1,124.5	918.5	16.0	1.9	11.4	2,445.2
LBL	68.8	42.4	700.0	19.2	10.1	0.4	6.2	847.1
SWM	146.2	100.5	569.2	598.4	7.7	3.4	6.3	1,431.7
Collie	14.5	63.7	146.8	46.1	2.6	1.0	4.0	278.7
MR	127.8	85.7	1,257.3	111.1	18.3	3.6	13.1	1,616.8
Central	143.9	98.4	1,434.4	75.6	26.3	2.1	16.7	1,797.4
GSR	337.9	109.8	1,075.4	101.8	18.2	8.8	15.1	1,667.1
Lakes	62.3	14.2	614.1	17.8	10.5	0.3	5.8	725.1
CBH Sidings	24.2	0.1	293.1	30.0	3.7	0.1	1.5	352.7
Sidings & Other	8.7	13.1	112.2	33.9	1.7	2.1	1.1	172.9
Non-Operational	179.9	69.1	1,715.5	34.4	2.1	1.7	0.0	2,002.7
TOTAL	**2,286.9**	**840.2**	**12,102.5**	**4,309.2**	**162.2**	**35.6**	**139.9**	**19,876.5**

5. Optimised Replacement Cost (ORC)

5.1 Optimised Replacement Cost Approach

The Optimised Replacement Cost consists of the summation of the components in Figure 5-1 which are discussed in the following sections.

Figure 5-1 Components of the Optimised Replacement Cost

Component	Inclusions	Discussed in
Optimised Construction Replacement Cost	The construction replacement cost for the optimised asset configuration.	Section 5.2 to 5.9
Railway Owner Project Costs	The costs that an efficient Railway Owner would incur to: – Develop the project and procure designs – Secure development approvals – Manage and supervise the necessary studies, design and construction contracts – Cover associated corporate overheads	Section 5.10
Railway Owner Funding Costs	The costs associated with securing the necessary funding to enable the project to be constructed. These include: – The costs of an efficient Railway Owner to secure debt and equity funding – The opportunity cost of the capital invested in the project	Section 5.11

5.1.1 Definition of Optimisation

The optimised asset configuration is defined as that which has the capacity to meet the actual and reasonably projected demand, within the physical constraints of the existing railway corridor, that can be constructed at least cost. In this application, the level of service associated with the actual and reasonably project demand is defined in terms of[39]:

- maximum axle loads;
- maximum train speeds; and
- maximum train lengths.

The level of service across the network, defined in accordance with the Costing Principles[40], is summarised in Appendix Level of Service.

5.1.2 Reasonable Future Levels of Service

The Costing Principles require that the optimised asset configuration be based on a ten year demand forecast developed from ten years of historical demand data.[41]

This demand forecast has been developed by Arc and included in the Level of Service Statement in Appendix A-2. This indicates no anticipated change to the level of service requirements over the forecast period.

[39] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[40] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[41] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4

5.1.3 Optimised Asset Configuration

The Optimised asset configuration represents the Railway Infrastructure that would be required to deliver the level of service associated with the actual and reasonably projected demand.

Applying the relevant principles in the Costing Principles to this assessment GHD has[42]:

– Reviewed the demand forecast and identified any required changes in service capacity of assets;
– Compared the capability of the MEA used as the basis for the Replacement Cost with the capacity of the existing assets and rectified any areas of unjustifiable inconsistency; and
– Identified and removed redundant assets.

  In this context, redundancy is defined as Railway Infrastructure that is no longer required to be used due to replacement with other Railway Infrastructure, changes in standards or advancements in technology or due to it not being relevant to providing the level of service demand forecast.

Note that Railway Infrastructure that is either disposed of or stranded is not included in the definition of optimisation, where[43]:

– Disposed assets are Railway Infrastructure which has been decommissioned and removed from the Railway Network, where the Railway Network means the Railway Infrastructure managed by Arc;44
– Stranded assets are Railway Infrastructure which have been taken out of service because of lack of demand.

The optimised asset configuration as a result of applying these three principles is summarised as follows:

Review of demand forecast	GHD has reviewed the Level of Service Statement provided by Arc and concluded future required capacity of the assets is not likely to be lower than that provided by the existing assets, where demand is defined in terms of:[45] – maximum axle loads; – maximum train speeds; and – maximum train lengths. On this basis, there is no scope for optimisation by applying this principle. Note that the review did not explore the need to increase the level of service beyond that offered by the existing Railway Infrastructure.
Comparison of MEA capability	GHD has reviewed the MEAs used as the basis for the replacement cost and has found no opportunity to reduce the replacement cost to resolve any inconsistences between the level of service provided by the MEA and the existing assets. GHD has identified instances of technical obsolescence that enable a lower cost alternative to the MEA replacement asset. This includes signalling where an alternative signalling system using lower cost technology has been considered. This is discussed in section 5.5.
Removal of redundant assets	The sections identified as redundant are shown in Table 5-1. This track is not currently in use and GHD has seen no evidence to suggest any realistic prospect that it may re-enter service in a reasonable time frame. This track can therefore be considered redundant in accordance with the definition in the Costing Principles, and the associated replacement costs removed.

42 Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
43 Costing Principles, Arc Infrastructure, 30 May 2024, Section 3.6
44 Costing Principles, Arc Infrastructure, 30 May 2024, Section 1.4
45 Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4

Reduction of loop lengths and removal of redundant loops

GHD has identified opportunities to optimise loops by either reducing their length or removing them entirely.

Loops that are more than 300 metres shorter than the maximum train length have been removed, as they are insufficient to service the maximum train length.

Additionally, loops that exceed the maximum train length have been shortened to match. This ensures that these loops continue to provide the same level of service on their respective route sections while optimising their length for cost efficiency. A breakdown of loop name and their optimised length is shown in Table 5-2. In total this method has reduced the total loop length by 33,597m.

Table 5-1 Redundant Route Sections

Route Section	Length (km)
Mollerin Loop (CBH Siding)	0.295
Mollerin Loop	0.357
Mollerin Siding 1	0.307
Kulja CBH Siding	0.308
Manmanning Loop	0.748
Manmanning CBH Siding	0.774
Manmanning Crossover	0.049
TOTAL	**2.838**

Table 5-2 Loop Optimisation

Loop Name	Original Loop Length (m)	Optimised Length (m)	Amount Reduction (m)
Avon Yard Loop	2079	1800	279
Beacon Loop	596	0	596
Beckwith Loop	1850	1800	50
Beela Loop	1284	700	584
Bell Loop	1379	1100	279
Bencubbin Loop	373	0	373
Benger Loop	646	600	46
Bodallin Loop	1909	1800	109
Bonnie Vale Loop	1850	1800	50
Booraan Loop	1453	0	1453
Brookton Loop	428	0	428
Broomehill Loop	462	0	462
Broomehill South Loop	462	0	462
Brunswick Loop	803	700	103
Bullaring Loop	578	500	78
Bungulla Loop	1847	1800	47
Burakin Loop	550	0	550
Burracoppin Loop	1856	1800	56
Carrabin Loop	1870	1800	70
Collie Loop	937	500	437

Loop Name	Original Loop Length (m)	Optimised Length (m)	Amount Reduction (m)
Coolup Loop	742	600	142
Cowan Loop	1908	1800	108
Cuballing Loop	500	0	500
Cunderdin Loop	1957	1800	157
Dandalup Loop	924	900	24
Daniell Loop	1898	1800	98
Darrine Loop	1858	1800	58
Dean Loop	1430	1100	330
Doodlakine Loop	1857	1800	57
Dudinin CBH Loop	672	500	172
Eneabba Loop	598	0	598
Eradu Loop	1460	1100	360
Esperance Loop	1440	0	1440
Gabbin Loop	372	0	372
Gibson Loop	1850	1800	50
Goomalling Loop	481	0	481
Goomalling Loop (Water Road)	481	0	481
Grants Loop	1266	1100	166
Grass Valley Loop	1843	1800	43
Greenbushes Loop	672	500	172
Hampton Loop (Nickel)	1831	1800	31
Higginsville Loop	1858	1800	58
Hines Hill Loop	2303	1800	503
Jaurdi Loop	1856	1800	56
Jennacubbine Loop	693	0	693
Jitarning Loop	635	500	135
Kambalda Loop	1975	1800	175
Katanning Loop	672	0	672
Kellerberrin Loop	1852	1800	52
Kendenup Loop	550	0	550
Keysbrook Loop	980	900	80
Kirup Loop	630	500	130
Koolyanobbing Loop	2215	1800	415
Koonadgin Loop	630	500	130
Koorda Small Loop	357	0	357
Kukerin Loop	410	0	410
Kununoppin Loop (Closed Section)	623	600	23
Kwinana Loop	1314	900	414
Kwinana Loop - Start of Section 13	1314	900	414
Kwinana Loop (Crossover)	1314	900	414

Loop Name	Original Loop Length (m)	Optimised Length (m)	Amount Reduction (m)
Lake Grace Loop	655	0	655
Lake Julia Loop	1845	1800	45
Latham Loop (No. 1 Road)	696	500	196
Leda Loop	1330	1100	230
Lefroy Loop	1854	1800	54
Leonora Loop	431	0	431
Mawson CBH Loop	517	500	17
Meckering Loop	1826	1800	26
Merredin Loop	555	0	555
Monger Loop	1389	1100	289
Mooliabeenie Loop	586	0	586
Moorine Rock Loop	2121	1800	321
Morawa Loop	428	0	428
Mukinbudin Loop	391	0	391
Mundijong Loop	1109	900	209
Narngulu Aurizon East Balloon Loop Connection	1329	1100	229
Narrikup Loop	502	0	502
Narrogin Loop	736	0	736
Nola Loop	1300	1100	200
Nomans Lake Loop	1300	500	800
Norseman Loop	670	0	670
Northern Gully Loop	1262	1100	162
Perenjori Loop	730	0	730
Salmon Gums Loop	1856	1800	56
Scadden Loop	1856	1800	56
Southern Cross Loop	1877	1800	77
Stewart Loop	1857	1800	57
Tambellup Loop	522	0	522
Tammin Loop	2100	1800	300
Tenindewa Loop	1270	1100	170
Three Springs Loop	515	0	515
Wagerup South - Yarloop Main	1536	600	936
Wagin Loop	498	0	498
Walkaway Loop	529	0	529
Wallaroo Loop	1856	1800	56
Waroona Loop	764	600	164
Warwarrup Loop	718	600	118
Wellard Loop	1117	900	217
West Kalgoorlie Loop	2020	1800	220

Loop Name	Original Loop Length (m)	Optimised Length (m)	Amount Reduction (m)
West Merredin Loop	2159	1800	359
Woodanilling Loop	556	0	556
Worsley Loop	1057	700	357
Yarloop Loop	609	600	9
Yarloop Loop (Crossover)	609	600	9
Yarloop South Connection to Heritage Siding	609	600	9
Yearling Loop	585	500	85
York Loop	577	0	577
TOTAL			**-33,597**

The effect of these on each of the asset category and the resulting optimised construction replacement cost is discussed in the following sections.

5.2 Right of Way

The optimisation of the Right of Way has been based on the same principles:[46]

– Any areas where the MEA capability differs from the existing asset capacity;
– Any required changes in service capacity of assets;
– Any assets that are redundant; and
– Reduction of loop lengths and removal of redundant loops.

As discussed in section 4.6, the MEAs have been selected to most closely match the level of service provided by the existing assets (and typically to provide the same level of service as the existing assets).

GHD has reviewed the Level of Service Statement provided by Arc and concluded future required capacity of the assets is not likely to be lower than that provided by the existing assets.

The costs removed as a result of the above principles are shown in Table 5-3.

Table 5-3 Right-of-Way Optimised Construction Replacement Cost

Network group	RC	Clearing and Grubbing ($ million)	Cuttings and Embankments ($ million)	Formation ($ million)	Access Roads ($ million)	Subtotal	OCRC
RC		**67.1**	**18.3**	**1,595.0**	**606.5**	**2,286.9**	
Metro	51.1	-	-	-	-	-	51.1
EGR	556.1	-	-	- 3.7	-0.7	-4.4	551.6
Midwest	223.0	-	-	- 1.4	-0.3	-1.7	221.3
EBL	342.7	-	-	- 0.4	-0.1	-0.5	342.2
LBL	68.8	-	-	- 0.3	-0.3	-0.6	68.1
SWM	146.2	-	-	- 1.7	-0.4	-2.1	144.1
Collie	14.5	-	-	- 0.0	-0.0	0	14.4
MR	127.8	-	-	- 0.1	-0.1	-0.2	127.5
Central	143.9	-	-	- 0.2	-0.2	-0.4	143.5

[46] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4

Network group	RC	Clearing and Grubbing ($ million)	Cuttings and Embankments ($ million)	Formation ($ million)	Access Roads ($ million)	Subtotal	OCRC
GSR	337.9	-	-	- 1.5	-0.3	-1.8	336.1
Lakes	62.3	-	-	- 0.1	-0.1	0	62.2
CBH Sidings	24.2	-	-	- 0.9	-1.0	-2	22.3
Sidings & Other	8.7	-	-	- 0.2	-0.2	-0.4	8.3
Non-Operational	179.9	-	-	- 0.4	-0.4	-0.8	179.0
Subtotal	2,286.9	-	-	- 11.1	-4.2	-15.3	**2,271.6**
TOTAL		**67.1**	**18.3**	**1,583.9**	**602.3**	**2,271.6**	

5.3 Civil Structures

The optimisation of the Civil Structures has been based on the same principles:[47]

– Any areas where the MEA capability differs from the existing asset capacity;
– Any required changes in service capacity of assets;
– Any assets that are redundant; and
– Reduction of loop lengths and removal of redundant loops.

As discussed in section 4.6, the MEAs have been selected to most closely match the level of service provided by the existing assets (and typically to provide the same level of service as the existing assets).

GHD has reviewed the Level of Service Statement provided by Arc and concluded future required capacity of the assets is not likely to be lower than that provided by the existing assets, where demand is defined in terms of[48]:

– maximum axle loads;
– maximum train speeds; and
– maximum train lengths.

On this basis, there is no scope for optimisation by applying principles above, therefore the ORC is unchanged from the replacement cost.

5.4 Track

The optimisation of the Track assets has been based on the same principles as Right-of-Way:[49]

– Any areas where the MEA capability differs from the existing asset capacity;
– Any required changes in service capacity of assets;
– Any assets that are redundant; and
– Reduction of loop lengths and removal of redundant loops.

As discussed in section 4.6, the MEAs have been selected to most closely match the level of service provided by the existing assets (and typically to provide the same level of service as the existing assets).

[47] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[48] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4
[49] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4

GHD has reviewed the Level of Service Statement provided by Arc and concluded future required capacity of the assets is not likely to be lower than that provided by the existing assets.

The application of these principles to Track assets is shown in Table 5-4.

Table 5-4 Track Assets Optimised Construction Replacement Cost

Track Optimisation							
Network Group	**RC**	**Rail**	**Sleepers**	**Ballast**	**Turnouts**	**Subtotal**	**OCRC**
RC		**7,402.4**	**2,893.9**	**1,350.7**	**455.5**	**12,102.5**	
Metro	276.8	-35.1	-12.7	-4.9	0.0	-52.8	**224.0**
EGR	2,074.0	-273.6	-157.4	-50.2	-2.0	-483.3	**1,590.7**
Midwest	709.1	-93.9	-59.4	-18.5	-0.4	-172.2	**536.8**
EBL	1,124.5	-144.0	-114.8	-29.1	-0.5	-288.4	**836.1**
LBL	700.0	-92.2	-63.9	-18.8	-3.4	-178.4	**521.7**
SWM	569.2	-78.8	-36.6	-16.0	-2.8	-134.1	**435.0**
Collie	146.8	-19.2	-9.2	-3.9	0.0	-32.3	**114.4**
MR	1,257.3	-166.1	-70.5	-34.1	-0.7	-271.4	**985.9**
Central	1,434.4	-190.0	-80.9	-38.5	-1.0	-310.4	**1,124.0**
GSR	1,075.4	-144.8	-56.9	-29.1	-0.4	-231.2	**844.2**
Lakes	614.1	-80.8	-33.3	-16.7	-0.4	-131.1	**483.0**
CBH Sidings	293.1	-40.0	-17.1	-8.0	-4.4	-69.5	**223.6**
Sidings & Other	112.2	-14.8	-6.6	-2.7	-0.8	-24.9	**87.3**
Non-Operational	1,715.5	-231.6	-85.8	-48.4	-3.4	-369.3	**1,346.2**
Subtotal		-1,605.1	-805.3	-319.0	-20.1	-2,749.4	**9,353.0**
TOTAL	**12,102.5**					**9,353.0**	

5.5 Signalling and Communications

In developing an optimised signalling and communications system, GHD has considered solutions that address the requirements of the Costing Principles:

– The MEA scope will be defined on the basis that it meets the closest comparable service standard to the existing asset' (as required by Clause 2.3 of the Costing Principles);

– MEAs comprise the assets and form of construction which would be designed and constructed at the valuation date, using modern design techniques, constructed from modern materials using modern methods, and in compliance with prevailing legislation and prevailing standards; and

– The optimised asset configuration will be the asset configuration which has the capacity to meet the actual and reasonably projected demand, within the physical constraints of the existing railway corridor, that can be constructed at least cost (as required by Clause 2.4 of the Costing Principles).

The level of 'service' is associated with the actual or projected demand (as defined in Table 2-1).

GHD has identified two signalling and communications systems that broadly meet these requirements:

Alternative A:	**Conventional Signalling and Communications system using MEA equipment** This alternative most closely aligns with the first requirement above as it is a direct replication of the current assets. GHD's view is that it only partially complies with the second requirement because of the safety risks associated with lack of certainty over train location in areas of dark territory (noting that Arc's MicroLok system provides SIL 4 compliance where installed).
Alternative B:	**Radio Based Train Control (RBTC)** This solution provides a lower cost below rail solution to Alternative A, and therefore most closely aligns with the third requirement above. This includes Radio Based Train Control over those parts of the network that currently operate centralised train control and overlaid over the existing infrastructure in the Metro areas, and replicates this in the existing areas of dark territory. Whilst it provides for the same (and in some location improved) service standard as the existing assets, it is not a direct replication of the existing assets and is less aligned with the first requirement than Alternative A. It follows industry good practice, in that some form of communications-based system is under active development across most Australian rail networks. This alternative therefore closely aligns with the second requirement. Its compliance with the second requirement above is similar to Alternative A.

Given the materiality of this component, GHD has undertaken parallel assessments of both alternatives, which are discussed in the following sections.

5.5.1 Alternative A: Conventional Signalling and Communications system using MEA equipment

This approach would replicate Arc's existing signalling system like-for-like across the entire network.

In compliance with the Costing Principles, optimisation of the signalling assets has been undertaken to identify a solution that has the capacity to meet the actual and reasonably projected demand, within the physical constraints of the existing railway corridor, that can be constructed at least cost.

Optimisation involved removing any lines currently not in use.

As noted above, this most closely aligns with the requirements of the Costing Principles at clause 2.3.

5.5.2 Alternative B: Radio Communications based Train Control (RBTC)

This alternative has the capacity to meet the actual and reasonably projected demand, within the physical constraints of the existing railway corridor, that can be constructed at least cost. This alternative therefore most closely aligns with the Costing Principles at Clause 2.4.

There are three distinct parts to the application (Figure 5-2):

Metro areas	A communications based train control system like ETCS, combined with a like-for-like replacement of existing signalling infrastructure, resulting in a system like ETCS level 2 Overlay, but without the onboard vital computer, so there is no ATP function. Lineside signals are still in use along with Axle counters and CBI's.
Non-metro areas that operate centralised train control	A radio-based train control system, using in-cab signalling (via the ICE box). The vital communication network is replicated in areas where it is present today (EGR, Kalgoorlie to Esperance, Geraldton to Mullewa, etc). Axle counters are used mid block in single track areas, at each level crossing (to replicate predictors), and at each loop. Turnouts are controlled by CBI's and object controllers. There are no lineside signals and related

infrastructure. Movement authority is granted via the secure private radio network to the ICE box.

Dark territory

As existing. Radio communication to communicate movement authorities, but no train detection or lineside assets (no CBIs). Points are operated manually as they are today, and the train location is detected by the communication system only.

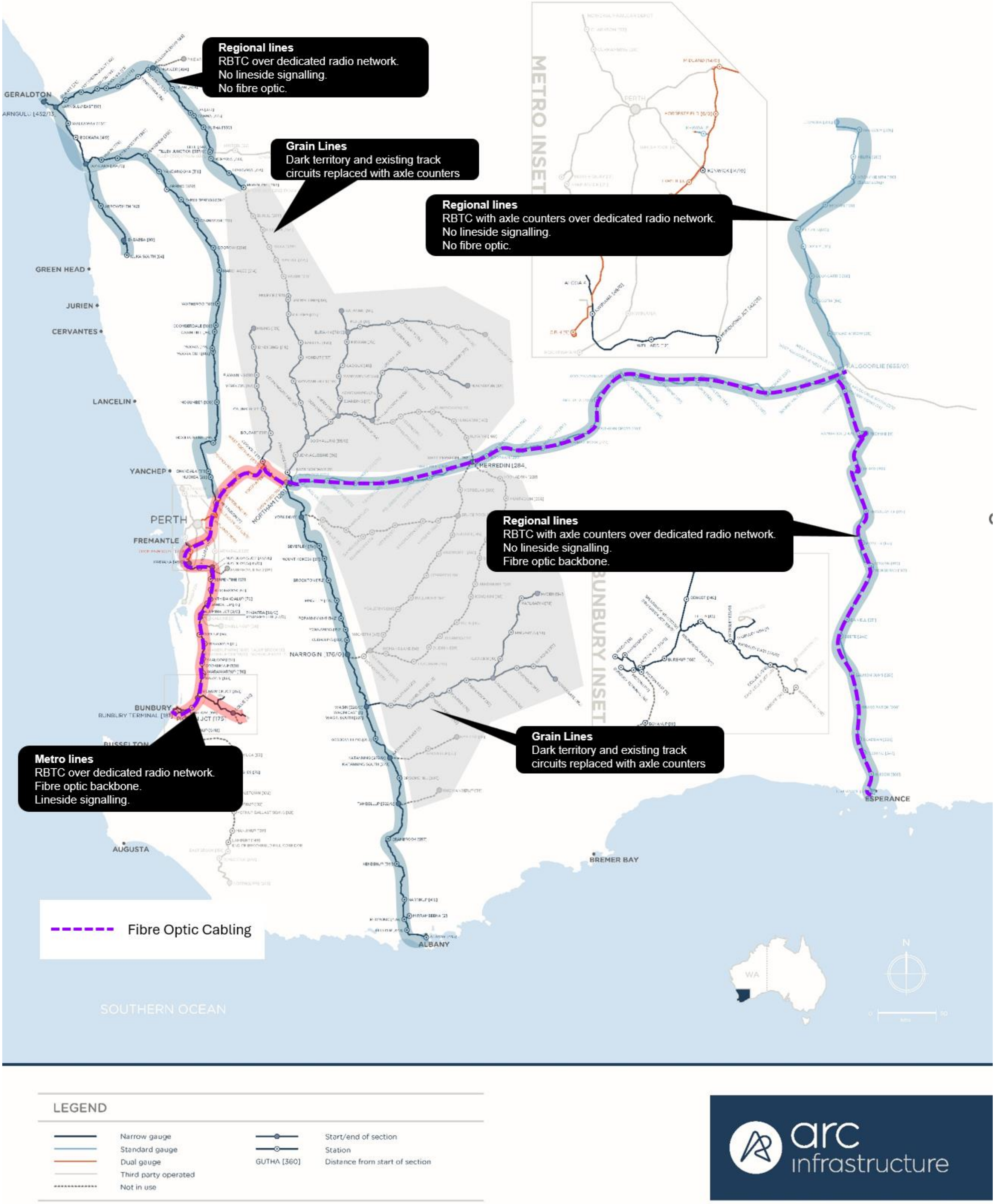


Figure 5-2 Signalling Strategy Diagram

The overall intent was to minimise lineside assets to reduce overall construction and maintenance costs, by using the internet of things approach to tie assets to a secure radio network. This approach is in line with current developments in Australia and globally.

Australia has been undergoing modernisation of its rail signalling and control systems. Federal freight networks have moved away from the CTC and Train Order Working (the systems currently in use by Arc) and instead operate some form of communications-based (Radio based) train control system.

For the purposes of this exercise, the proposed system for Arc's network is referred to as Radio-Based Train Control (RBTC) to distinguish it from the more infrastructure intensive communications-based system in use in Sydney and Melbourne metropolitan areas, commonly referred to as CBTC.

Globally, European Train Control System (ETCS) level 2 is the most widely adopted communications-based train control technology, and it is the best supported. It is currently in use throughout Europe, with a cut down version for freight used in Netherlands, Sweden, Germany, and being trialled in Italy. This system relies on 4G/GPS/Satellite communication.

In ETCS level 2 there are typically four key onboard parts:

– The driver machine interface (DMI);
– Radio antenna;
– The ETCS Vital computer; and
– And the Odometer system.

The vital computer and odometer fitted to trains would not be required for the RBTC envisioned as Arc's MEA because they are mostly used in the ATP supervision, and are required to accurately fix the train position in a high density network. RBTC was envisaged to require only an in-cab unit in each locomotive, given the 15 minute headways. Many locomotives already have a unit installed, but for those that do not, an ICE box leveraging a 4G mobile card and GPS antenna to continuously locate the train would be installed. The cost of this fit out is estimated as $200,000 - $300,000 per locomotive. This mirrors the functionality of the TMACS enhanced train order working system used in Country New South Wales.

5.5.2.1 Overview of Radio Based Train Control Adoption in Australian Rail Networks

Below is a summary of evidence base illustrating the status of communications based technology in rail networks in Australia.

Table 5-5 Case Studies on Radio Based Technology in Australia

Application	System	Comparison with Arc Alternative B
Rio Tinto (WA)	**Autohaul** Rio Tinto operates the world's first fully autonomous heavy-haul rail network using ATO with ETCS Level 2 and LTE radio communication. Trains are monitored remotely from a central control centre in Perth. Key features include, 50 radio towers for continuous LTE coverage and retained lineside signalling for driver fallback (Level 2 overlay), connected via Microlok interlockings over a fibre optic network. Supervisory speed monitoring is through ETCS.	Alternative B is much lower level of service (and less infrastructure intensive because it does not provide for: – Full autonomy – Continuous coverage – Microlok interlockings – Speed monitoring
Aurizon (QLD)	**ETCS Level 2 with TETRA (TrainGuard Project)** Aurizon, Australia’s largest rail freight operator, is implementing ETCS Level 2 as an overlay to its existing train control systems under the TrainGuard Project, developed in partnership with Siemens. This rollout applies to the Central Queensland Coal Network (CQCN) and is designed to enhance operational safety, particularly in the areas of speed supervision and prevention of signals passed at danger (SPADs). The key features of this project include ETCS Level 2 overlay, functionality to supervise train speed and designed to reduce risk of SPADs. Currently, the implementation is complete from Goonyella to Abbot Point, the full network rollout is due for completion by the end of FY2025.	Alternative B is lower level of service (and less infrastructure intensive because it does not provide for: – Continuous coverage – Microlok interlockings – Speed monitoring
Queensland Rail (QLD)	**ETCS Level 2 (Brisbane) and ETCS Level 1 (North Coast)** The Brisbane network adopts ETCS Level 2 overlay using TETRA radio, maintaining existing lineside signalling. The North Coast Line (Brisbane to Cairns) implementation of ETCS Level 1 is underway with Automatic Train Protection supported by Westlok and Microlok systems from Brisbane to Gympie (with level 2 to follow after the metro area rollout has concluded). Queensland Rail Plans and has funded the level through to Cairns.	Alternative B is lower level of service (and less infrastructure intensive because it does not provide for: – Continuous coverage – Microlok interlockings – Speed monitoring
ARTC	**ATMS system** ARTC has developed a CBTC system (ATMS) to replace traditional paper-based train order systems. The train has a box onboard with GPS and 4G mobile communication. This system was in use over a short section of their network but it no longer supported by the OEM.	Alternative B provides a comparable level of service

5.5.2.2 Basis for Radio-Based Train Control (RBTC) as a Modern Equivalent Asset

Where a radio-based train control (RBTC) system is proposed to be applied to the Arc network, it would transmit the location and communicate with the train across mobile networks and/or digital radio, with the mobile provider guaranteeing the Safety Integrity Level (SIL) of the communication system.

Advances in mobile communications technology and the Internet of Things (IoT) have enabled reliable control networks with adequate levels of reliability and safety using this type of infrastructure.

In these systems, movement authorities are automatically issued to the train by section through an onboard control system, where the train control sets the route. The driver confirms authority by pressing a button.

These systems require minimal lineside equipment, other than at the beginning and end of sections and do not require continuous interlockings along the route. Interlockings are only required for route setting over turnouts. Radio towers are required for communicating with the driver and axle counters are used at loops to positively identify which track the train has entered. The standard configuration would be two axle counters on approach, separated by an overlap length, with axle counters at each end of each loop road (loop / main). This would allow positive discrimination on arrival and entry into each loop, plus clearance for route setting behind.

A radio based train control system would meet (and exceed) the level of service requirements of the CTC system currently in use by Arc because it provides:

– continuous communication between the train and control centre which ensures that the train's movements, route information, and movement authority are continuously monitored;
– the reliance on fixed trackside signals can be relaxed in low headway areas, improving safety by reducing the risk of signal errors;
– reliability and flexibility for use across a broad network where there are passing loops, junctions and yards and;
– A Safety Integrity Level (SIL)[50] in compliance with current regulations.

Although the RBTC system proposed in low-headway areas would exceed the level of service provided by the existing assets (because it would enable continuous communication), it would be a lower cost below rail alternative to the existing CBC system because it does not require a fibre-optic backbone and has reduced track-side infrastructure compared to CTC.

This reduces both the initial investment and ongoing maintenance costs. This communications-based enhanced train order working system is the least cost modern alternative system with the capacity to meet the actual and reasonably projected demand and would be installed at sections of Arc's network that currently operate CTC. There would be no change to sections to the areas of dark territory. These assumptions remove the need for a full optic fibre network throughout the corridor, which significantly reduces the replacement cost.

The principles of an enhanced train order working system applied to Arc's network is assumed to include:

Centralised Train Control buildings	One primary in Perth and a backup in Picton. This replicates the existing Arc operation.
Telecoms systems:	**Fibre optic cabling:** Full communications based train control, overlayed on a vital fibre optic cable back bone with lineside signalling on the following sections: – Metro – Kwinana to Midland; – EGR – Midland to Avon Yard, to Kalgoorlie; – SWM – Kwinana to Bunbury Terminal; – EBL – Kalgoorlie to Esperance. **Communications based using national telecoms network:** All other sections of the network would operate an Enhanced Train Order Working with modern equivalent communications technology, using a private radio communication network which includes: – A radio mast, router, signalling location case and base station every 30km to communicate with the train and the national telecoms network; – A location case at each end and connected to a local radio tower and base station via a vital Wi-Fi router link; – A 10m x 10m (on average) fenced enclosure around each base station.
Passing Loops:	All passing loops on the network would be standalone asset sets, communicating with the national network via radio tower and would include:

[50] *SIL is defined as the relative level of risk-reduction provided by a Safety Instrumented Function (SIF), i.e. the measurement of the performance required of the SIF. In the functional safety standards based on the IEC 61508 standard, four SILs are defined, with SIL4 being the most dependable and SIL1 the least. There are several quantitative and qualitive factors that determine the applicable SIL, such as risk assessments and safety lifecycle management. If the network were to be replaced today, regulations stipulate that a SIL3 and SIL4 (e.g. at public active (boom gate) level crossings)50 level of safety is required to ensure adequate level of protection. Arc's existing system provides this level of safety with MicroLok interlockings. This communications-based system would also comply, but without the need for interlockings.*

– A home and distant axle counter, at each end, and balises at each end of the loop, in both the main and passing loop roads;
– Two signs and two speedboards on each road.

Junctions:	Similarly, all junctions on the network would be standalone asset sets, communicating with the national network via radio tower and would include: – One axle counter of each leg; – One signal equipment hut with interlocking if the junction has a two or more turnouts; – A minor signal hut with interlocking if the junction has a single turnout.
Pedestrian Crossings:	All pedestrian crossings would also have the following: – Predictors either side of each crossing (for the purposes of this assessment, axle counters have been used as a proxy).
Control Centre Signalling Assets	For control centres on the network there associated signalling assets. There are currently two control centres owned by Arc, therefore two control centres are assumed for the optimised signalling asset. The direct cost for one control centre's signalling asset is $15 million. The cost for this has been spread over the network in proportion to where other signalling assets exist.
Signals	There are 154 signals over the Perth Central Freight Network. For the optimised replacement cost, these 154 signals are included to provide the current level of service.

The detailed component breakdown by application for the optimised asset configuration is discussed as follows.

5.5.2.3 Telecoms System

The build-up of the direct costs (i.e. those excluding Principal Contractor allowances) for the optimised asset configuration is shown below.

5.5.2.4 Passing Loops

Passing loops have been based on an assessment of the infrastructure that would be required for each loop– which varies by loop length. This is based on an assessment of the number and total length of loops within each route section. Where a loop is within more than one route section, the cost has been allocated in equal proportion to each route section.[51]

The build-up of the direct costs (i.e. those excluding Principal Contractor allowances) for the optimised asset configuration is shown below.

5.5.2.5 Junctions

Junctions have been based on an assessment of the infrastructure that would be required for each. This is based on an assessment of the number of legs at each junction. Where a junction is within more than one route section, the cost has been allocated in proportion to the number of junction legs within each route section.[52]

The build up of the direct costs (i.e. those excluding Principal Contractor allowances) for the optimised asset configuration is shown in below.

5.5.2.6 Pedestrian Crossings

For pedestrian crossings in each case, a crossing would require an axle counter system.

Each crossing would require access to the communications network via radio tower. We have assumed that the radio towers provided under the general telecoms provision, would provide sufficient coverage.

[51] This only happens on two occasions.
1. Narrogin Loop is in both Narrogin and Brookton to Narrogin sections. Each gets allocated 50% of the loop cost and
2. Three Springs Loop is within the Three Springs and the Marchargee to Dongarta route section. Each gets 50% of the loop cost.
[52] This only happens on two occasions.
1. Narrogin Loop is in both Narrogin and Brookton to Narrogin sections. Each gets allocated 50% of the loop cost and
2. Three Springs Loop is within the Three Springs and the Marchargee to Dongarta route section. Each gets 50% of the loop cost.

The build up of the direct costs (i.e. those excluding Principal Contractor allowances) for the optimised asset configuration is shown below.

5.5.2.7 Control Centre Signals

A build up of the costs associated with control centre signals is shown below.

5.5.3 Signalling and Communications Optimised Replacement Cost

5.5.3.1 Alternative A

Table 5-6 Alternative A Optimised Replacement Cost

	RC ($ million)	Optimisation ($ million)	ORC ($ million)
Metro	174.9	0.0	174.9
EGR	2,005.0	-11.6	1,993.3
Midwest	142.5	-0.6	141.9
EBL	918.5	-1.2	917.3
LBL	19.2	-1.2	18.0
SWM	598.4	-5.7	592.8
Collie	46.1	-0.1	45.9
MR	111.1	0.0	111.0
Central	75.6	-0.3	75.3
GSR	101.8	-0.1	101.8
Lakes	17.8	0.0	17.8
CBH Sidings	30.0	-3.7	26.3
Sidings & Other	33.9	0.0	33.9
NON-OPERATIONAL	34.4	-1.7	32.7
TOTAL	**4,309.2**	**-26.3**	**4,282.9**

5.5.3.2 Alternative B

Table 5-7 Optimised Telecoms System Direct Replacement Cost

	Optic Fibre	Radio Tower	Signalling Location Case Double Width	Router	Radio Base Station	Fencing	OCRC
Unit	**km**	**No.**	**No.**	**No.**	**No.**	**m**	
Rate ($ million)	**0.82**	**1.36**	**0.0567**	**0.0567**	**0.010**	**138**	
Logic		*Every 30km plus 10%*	*1 per radio mast*	*1 per radio tower* *1 per sig loc case*	*1 per radio tower*	*10x10m enclosure around each base station*	
Metro	55.5	1.7	0.1	0.1	0.1	0.0	57.4
EGR	795.5	40.0	1.7	1.7	2.9	0.2	841.8
Midwest	-	20.4	0.8	0.8	1.5	0.1	23.6
EBL	517.2	27.2	1.1	1.1	1.9	0.1	548.7
LBL	-	16.3	0.7	0.7	1.2	0.1	18.9
SWM	195.6	13.9	0.6	0.6	1.0	0.1	211.6
Collie	-	6.6	0.3	0.3	0.5	0.0	7.6
MR	-	31.5	1.3	1.3	2.3	0.1	36.5
Central	-	6.5	0.3	0.3	0.5	0.0	7.6
GSR	-	27.2	1.1	1.1	1.9	0.1	31.5
Lakes	-	-	-	-	-	-	-
CBH Sidings	-	11.1	0.5	0.5	0.8	0.0	12.9
Sidings & Other	-	0.4	0.0	0.0	0.0	0.0	0.4
Non-Operational	-	2.9	0.1	0.1	0.2	0.0	3.4
TOTAL ($ MILLION)	**1,563.7**	**205.7**	**8.6**	**8.6**	**14.7**	**0.8**	**1,802.0**

Table 5-8 Optimised Passing Loops Direct Replacement Cost

	No. of Passing Loops	Axle Counter System (1 Evaluator, 4 Heads)	Balises	Signalling Location case	Speedboards	Total
Unit	**No.**	**No.**	**No.**	**No.**	**No.**	**$ million**
Rate ($ million)		0.024	0.024	0.032	0.005	
Logic		*1 each side of a turnout - 3 per turnout, 2 turnouts per loop (total 6)*	*2 on each approach road -2 roads per loop (total 4)*	*1 case at each end of each loop (total 2)*	*8 per asset*	
Metro	0	-	-	-	-	-
EGR	30	7.7	3.9	2.6	0.2	14.3
Midwest	13	3.3	1.6	1.1	0.1	6.1
EBL	11	3.2	1.6	1.1	0.1	5.9
LBL	3	0.9	0.4	0.3	0.0	1.6
SWM	19	4.4	2.2	1.5	0.1	8.2
Collie	3	0.7	0.3	0.2	0.0	1.3
MR	6	1.4	0.7	0.5	0.0	2.6
Central	11	2.6	1.3	0.9	0.1	4.8
GSR	12	2.9	1.5	1.0	0.1	5.4
Lakes	3	0.8	0.4	0.3	0.0	1.4
CBH Sidings	5	1.2	0.6	0.4	0.0	2.2
Sidings & Other	0	-	-	-	-	-
NON-OPERATIONAL	17	4.2	2.1	1.4	0.1	7.9
TOTAL	**132**	**33.3**	**16.6**	**11.1**	**0.7**	**61.7**

Table 5-9 Optimised Junction Direct Replacement Cost

	Number of junctions	Number of legs	Axle Counter System	Signalling Equipment Hut	Signalling Equipment Hut (minor)	Total
Unit	**No.**	**No.**	**No.**	**No.**	**No.**	**$ million**
Rate ($ million)			0.024	0.49	0.24	
Logic			*1 on each approach*	*1 for each junction with 2 or more turnouts*	*1 for each junction that is a single turnout.*	
Metro	1.0	1.0	0.0	-	0.2	**0.3**
EGR	0.7	6.0	0.2	0.4	-	**0.5**
Midwest	-	-	-	-	-	**-**
EBL	-	-	-	-	-	**-**
LBL	-	-	-	-	-	**-**
SWM	3.7	21.0	0.6	1.7	0.3	**2.6**
Collie	1.3	3.0	0.1	0.7	-	**0.8**
MR	0.3	3.0	0.1	0.2	-	**0.3**
Central	-	-	-	-	-	**-**
GSR	-	-	-	-	-	**-**
Lakes	-	-	-	-	-	**-**
CBH Sidings	-	-	-	-	-	**-**
Sidings & Other	4.0	11.0	0.3	2.0	-	**2.3**
Non-Operational	-	-	-	-	-	**-**
TOTAL	**11.0**	**45.0**	**1.3**	**4.9**	**0.5**	**6.7**

Table 5-10 Optimised Crossing Direct Replacement Cost

	Pedestrian Crossings	Axle Counter System (1 Evaluator, 4 Heads)	Total ($ million)
Unit	**No.**	**No.**	
Rate ($ million)		.0243	
Logic		*2 axle counters either side of each crossing (proxy for predictors)*	
Metro	4	0.4	0.4
EGR	3	0.3	0.3
Midwest		-	-
EBL		-	-
LBL		-	-
SWM		-	-
Collie		-	-
MR	4	0.5	0.5
Central		-	-
GSR		-	-
Lakes		-	-
CBH Sidings		-	-
Sidings & Other		-	-
NON-OPERATIONAL		-	-
TOTAL	**11**	**1.2**	**1.2**

Table 5-11 Control Centre Signals and Signals Direct Replacement Cost

	Control Centre Signals	Signals	Total ($ million)
Unit	**No.**	**No.**	
Rate ($ million)	55.	.0648	
Logic	*2 control centres on Arc's network. Cost distributed across network*	*154 across the Perth Central Freight Lines*	
Metro	2.3	4.3	6.6
EGR	24.7	-	24.7
Midwest	9.1	-	9.1
EBL	14.0	-	14.0
LBL	5.5	-	5.5
SWM	7.8	0.6	8.4
Collie	1.9	-	1.9
MR	16.3	-	16.3
Central	19.3	-	19.3
GSR	13.7	-	13.7
Lakes	6.5	-	6.5
CBH Sidings	0.5	-	0.5
Sidings & Other	0.4	5.2	5.6
NON-OPERATIONAL	20.2	-	20.2
TOTAL	**142.1**	**10.1**	**152.2**

Table 5-12 shows the direct replacement cost for the optimised signalling and communications assets. This reflects the costs of the specialist signalling and communications contractor and excludes the allowances for the remoteness of the works (i.e. the location factor) and the additional costs that the Principal Contractor would incur to manage this contract and the associated works. These costs are added in Table 5-13 which shows the Optimised Replacement Cost for signalling and communications assets.

Table 5-12 Optimised Direct Replacement Cost

Network Group	Telecoms System ($ million)	Passing Loops ($ million)	Junction ($ million)	Pedestrian Crossings ($ million)	Signals and Control Centre Signals ($ million)	Total ($ million)
Metro	57.4	-	0.3	0.4	6.6	**64.7**
EGR	841.8	14.3	0.5	0.3	24.7	**881.6**
Midwest	23.6	6.1	-	-	9.1	**38.8**
EBL	548.7	5.9	-	-	14.0	**568.7**
LBL	18.9	1.6	-	-	5.5	**26.1**
SWM	211.6	8.2	2.6	-	8.4	**230.8**
Collie	7.6	1.3	0.8	-	1.9	**11.6**
MR	36.5	2.6	0.3	0.5	16.3	**56.2**
Central	7.6	4.8	-	-	19.3	**31.6**
GSR	31.5	5.4	-	-	13.7	**50.5**

Network Group	Telecoms System ($ million)	Passing Loops ($ million)	Junction ($ million)	Pedestrian Crossings ($ million)	Signals and Control Centre Signals ($ million)	Total ($ million)
Lakes	-	1.4	-	-	6.5	**7.9**
CBH Sidings	12.9	2.2	-	-	0.5	**15.6**
Sidings & Other	0.4	-	2.3	-	5.6	**8.4**
Non-Operational	3.4	7.9	-	-	20.2	**31.5**
TOTAL	**1,802.0**	**61.7**	**6.7**	**1.2**	**152.2**	**2,023.8**

Table 5-13 Optimised Construction Replacement Cost

Network Group	RC	Build up from Direct Cost		Total ($ million)
		Principal Contractor Risk Allowance	Principal Contractor Preliminaries	
Metro	64.7	67.9	88.3	96.7
EGR	881.6	920.7	1,196.9	1,299.0
Midwest	38.8	40.7	53.0	57.4
EBL	568.7	597.1	776.2	848.7
LBL	26.1	27.4	35.6	37.8
SWM	230.8	242.3	315.0	339.3
Collie	11.6	12.2	15.8	17.2
MR	56.2	59.0	76.7	83.9
Central	31.6	33.2	43.1	46.9
GSR	50.5	53.1	69.0	75.5
Lakes	7.9	8.3	10.8	11.8
CBH Sidings	15.6	21.4	27.8	26.8
Sidings & Other	8.4	8.8	11.4	12.5
Non-Operational	31.5	33.0	43.0	45.3
TOTAL	**2,023.8**	**2,125.0**	**2,762.5**	**2,998.6**

5.5.4 Summary Signalling and Communications Optimised Replacement Cost

Table 5-14 summarises the total signalling optimised construction replacement cost for Alternatives A and B.

Table 5-14 Signalling Assets Optimised Construction Replacement Cost

Network Group	Alternative A			Alternative B		
	RC	Optimisation ($ million)	ORC ($ million)	RC	Optimisation ($ million)	ORC ($ million)
Metro	174.9	0.0	174.9	174.9	-78.2	96.7
EGR	2,005.0	-11.6	1993.3	2,005.0	-705.9	1,299.0
Midwest	142.5	-0.6	141.9	142.5	-85.1	57.4
EBL	918.5	-1.2	917.3	918.5	-69.8	848.7
LBL	19.2	-1.2	18.0	19.2	18.6	37.8
SWM	598.4	-5.7	592.8	598.4	-259.1	339.3
Collie	46.1	-0.1	45.9	46.1	-28.9	17.2
MR	111.1	0.0	111.0	111.1	-27.2	83.9
Central	75.6	-0.3	75.3	75.6	-28.7	46.9
GSR	101.8	-0.1	101.8	101.8	-26.4	75.5
Lakes	17.8	0.0	17.8	17.8	-6.0	11.8
CBH Sidings	30.0	-3.7	26.3	30.0	-3.2	26.8
Sidings & Other	33.9	0.0	33.9	33.9	-21.4	12.5
Non-Operational	34.4	-1.7	32.7	34.4	10.9	45.3
TOTAL	**4,309.2**	**-26.3**	**4,282.9**	**4,309.2**	**-1,310.6**	**2,998.6**

5.6 Buildings

The optimisation of the Building assets has been based on the principles in the Costing Principles[53] These are discussed as follows.

– Any areas where the MEA capability differs from the existing asset capacity;
– Any required changes in service capacity of assets;
– Any assets that are redundant; and
– Reduction of loop lengths and removal of redundant loops.

As discussed in section 4.6, the MEAs have been selected to most closely match the level of service provided by the existing assets (and typically to provide the same level of service as the existing assets).

GHD has reviewed the Level of Service Statement provided by Arc and concluded future required capacity of the assets is not likely to be lower than that provided by the existing assets.

A summary of how the optimisation principles apply to Buildings is summarised below.

[53] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4

Comparison of MEA capability

As discussed in section 4.10, the MEAs have been selected to most closely match the level of service provided by the existing assets at least cost. This means that standard products have been used wherever possible because these are the lowest cost modern alternative.

On this basis, there is no scope for optimisation by applying this principle.

Removal of redundant assets

Centralised Control Centres

The services that the Picton and Avon control centres provided are now undertaken from the Midland and Caning Vale centres. Picton and Avon are therefore redundant in accordance with the definition in the Costing Principles and can therefore be optimised out of the replacement cost.

Maintenance facilities

All of the current maintenance facilities are operational and have not been replaced by other assets. None therefore fit the definition of redundant under the Costing Principles and there is no scope of optimisation.

The resulting optimisation for Buildings is shown in Table 5-15.

Table 5-15 Building Optimised Construction Replacement Cost ($ million)

Building Optimisation by MEA Type ($ millions)

Network group	RC	Centralised Control Centres	Maintenance Facilities	Depots	Subtotal	OCRC
RC		**24.7**	**123.7**	**13.8**	**144.9**	
Metro	4.1	-0.4	0.0		-0.4	**3.7**
EGR	31.3	-3.2	-0.2		-3.4	**27.8**
Midwest	9.6	-1.0	-0.1		-1.1	**8.5**
EBL	16.0	-1.7	0.0		-1.9	**14.3**
LBL	10.1	-1.0	-0.1		-1.1	**9.0**
SWM	7.7	-0.8	-0.1		-0.9	**6.9**
Collie	2.6	-0.3	0.0		-0.3	**2.4**
MR	18.3	-1.9	0.0		-1.9	**16.4**
Central	26.3	-2.7	0.0		-2.7	**23.5**
GSR	18.2	-1.9	-0.1		-2.0	**16.2**
Lakes	10.5	-1.1	0.0		-1.1	**9.4**
CBH Sidings	3.7	-0.4	-0.2		-0.6	**3.1**
Sidings & Other	1.7	-0.2	-0.1		-0.3	**1.4**
Non-Operational	2.1	0.0	0.0		0.0	**2.1**
Subtotal		-16.4	-0.8		-17.3	**144.9**
TOTAL	**162.2**	**8.2**	**122.8**	**13.8**	**144.9**	

5.7 Associated Track Structures

The optimisation of the Associated Track Structures has been based on the same principles as Right-of-Way:[54] These are discussed as follows.

– Any areas where the MEA capability differs from the existing asset capacity;
– Any required changes in service capacity of assets;
– Any assets that are redundant; and
– Reduction of loop lengths and removal of redundant loops.

As discussed in section 4.6, the MEAs have been selected to most closely match the level of service provided by the existing assets (and typically to provide the same level of service as the existing assets).

GHD has reviewed the Level of Service Statement provided by Arc and concluded future required capacity of the assets is not likely to be lower than that provided by the existing assets.

On this basis, there is no scope for optimisation by applying principles above, therefore the ORC is unchanged from the replacement cost, this is summarised in Table 5-16.

Table 5-16 Associated Track Structures Optimised Construction Replacement Cost

Associated Track Structure Optimisation								
Network group	**RC**	**Type 1 Active: Gated**	Type 2 **Active : Signalled**	Type 3 **Passive : Maze**	Type 4 **Passive : Path Only**	**Type 5 Unprotected**	**Subtotal**	**OCRC**
RC		**5.8**	**12.0**	**15.4**	**0.7**	**1.7**	**35.6**	
Metro	2.2						-	**2.2**
EGR	7.3						-	**7.3**
Midwest	0.7						-	**0.7**
EBL	1.9						-	**1.9**
LBL	0.4						-	**0.4**
SWM	3.4						-	**3.4**
Collie	1.0						-	**1.0**
MR	3.6						-	**3.6**
Central	2.1						-	**2.1**
GSR	8.8						-	**8.8**
Lakes	0.3						-	**0.3**
CBH Sidings	0.1						-	**0.1**
Sidings & Other	2.1						-	**2.1**
Non-Operational	1.7						-	**1.7**
Subtotal								**35.6**
TOTAL	**35.6**	**5.8**	**12.0**	**15.4**	**0.7**	**1.7**	**35.6**	

[54] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4

5.8 Miscellaneous

As discussed in section 4.6, the MEAs have been selected to most closely match the level of service provided by the existing assets (and typically to provide the same level of service as the existing assets).

The optimisation of the Miscellaneous assets has been undertaken based on the Costing Principles[55] as follows:

– Any areas where the MEA capability differs from the existing asset capacity;

– Any required changes in service capacity of assets;

– Any assets that are redundant; and

– Reduction of loop lengths and removal of redundant loops.

GHD has reviewed the Level of Service Statement provided by Arc and concluded future required capacity of the assets is not likely to be lower than that provided by the existing assets.

The application of these principles to Miscellaneous assets therefore means the Optimised Construction Replacement cost is equal to the Construction Replacement Cost.

5.9 Summary Optimised Construction Replacement Cost

The below table shows the effect of optimisation on the Construction Replacement Cost and the Optimised Construction Replacement Cost.

RC		2,286.9	840.2	35.6	12,102.5	4,309.2	162.2	139.9	**19,876.5**	
Metro	586.2	-	-	-	-52.8	-	-0.4	-	-53.2	**533.0**
EGR	4,801.2	-4.4	-	-	-483.3	-11.6	-3.4	-	-503.2	**4,298.0**
Midwest	1,151.8	-1.7	-	-	-172.2	-0.6	-1.1	-	-175.5	**976.3**
EBL	2,445.2	-0.5	-	-	-288.4	-1.2	-1.9	-	-291.8	**2,153.4**
LBL	847.1	-0.6	-	-	-178.4	-1.2	-1.1	-	-181.3	**665.8**
SWM	1,431.7	-2.1	-	-	-134.1	-5.7	-0.9	-	-142.8	**1,288.9**
Collie	278.7	0	-	-	-32.3	-0.1	-0.3	-	-32.9	**245.8**
MR	1,616.8	-0.2	-	-	-271.4	-0.0	-1.9	-	-273.6	**1,343.2**
Central	1,797.4	-0.4	-	-	-310.4	-0.3	-2.7	-	-313.9	**1,483.5**
GSR	1,667.1	-1.8	-	-	-231.2	-0.1	-2.0	-	-235.1	**1,432.0**
Lakes	725.1	0	-	-	-131.1	-	-1.1	-	-132.4	**592.8**
CBH Sidings	352.7	-2	-	-	-69.5	-3.7	-0.6	-	-76.4	**276.3**
Sidings & Other	172.9	-0.4	-	-	-24.9	-0.0	-0.3	-	-25.6	**147.3**
Non-Operational	2,002.7	-0.8	-	-	-369.3	-1.7	0.0	-	-371.9	**1,630.8**
Subtotal	19,876.5	-14.9	-	-	-2,749.4	-26.3	-17.3	-	-2,809.5	**17,067.0**
TOTAL		**2,271.6**	**840.2**	**35.6**	**9,353.0**	**4,282.9**	**144.9**	**139.9**	**17,067.0**	

Table 5-18

[55] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.4

Table 5-17 Alternative A Optimisation of the Construction Replacement Cost by Network Group ($ million)

Optimisation by Asset Category ($million)

Network Group	RC	Right of Way	Civil Structures	Associated Track Structures	Track	Signalling and Communications	Buildings	Miscellaneous	Subtotal	OCRC
RC		2,286.9	840.2	35.6	12,102.5	4,309.2	162.2	139.9	**19,876.5**	
Metro	586.2	-	-	-	-52.8	-	-0.4	-	-53.2	**533.0**
EGR	4,801.2	-4.4	-	-	-483.3	-11.6	-3.4	-	-503.2	**4,298.0**
Midwest	1,151.8	-1.7	-	-	-172.2	-0.6	-1.1	-	-175.5	**976.3**
EBL	2,445.2	-0.5	-	-	-288.4	-1.2	-1.9	-	-291.8	**2,153.4**
LBL	847.1	-0.6	-	-	-178.4	-1.2	-1.1	-	-181.3	**665.8**
SWM	1,431.7	-2.1	-	-	-134.1	-5.7	-0.9	-	-142.8	**1,288.9**
Collie	278.7	0	-	-	-32.3	-0.1	-0.3	-	-32.9	**245.8**
MR	1,616.8	-0.2	-	-	-271.4	-0.0	-1.9	-	-273.6	**1,343.2**
Central	1,797.4	-0.4	-	-	-310.4	-0.3	-2.7	-	-313.9	**1,483.5**
GSR	1,667.1	-1.8	-	-	-231.2	-0.1	-2.0	-	-235.1	**1,432.0**
Lakes	725.1	0	-	-	-131.1	-	-1.1	-	-132.4	**592.8**
CBH Sidings	352.7	-2	-	-	-69.5	-3.7	-0.6	-	-76.4	**276.3**
Sidings & Other	172.9	-0.4	-	-	-24.9	-0.0	-0.3	-	-25.6	**147.3**
Non-Operational	2,002.7	-0.8	-	-	-369.3	-1.7	0.0	-	-371.9	**1,630.8**
Subtotal	19,876.5	-14.9	-	-	-2,749.4	-26.3	-17.3	-	-2,809.5	**17,067.0**
TOTAL		**2,271.6**	**840.2**	**35.6**	**9,353.0**	**4,282.9**	**144.9**	**139.9**	**17,067.0**	

Table 5-18 Alternative B Optimisation of the Construction Replacement Cost by Network Group ($ million)

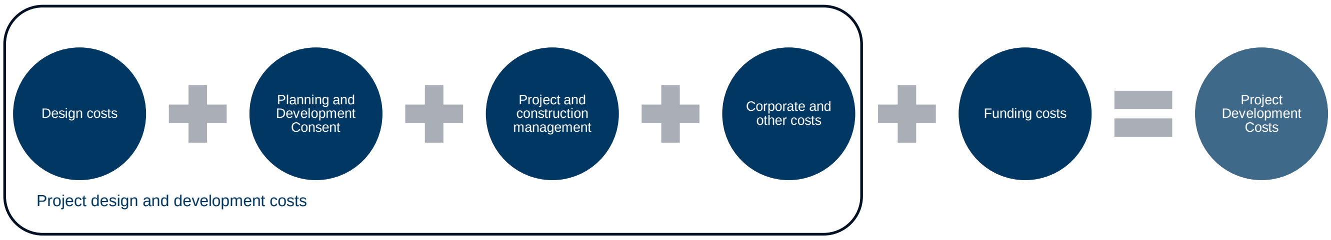
		Optimisation by Asset Category ($million)								
Network Group	**RC**	**Right of Way**	**Civil Structures**	**Associated Track Structures**	**Track**	**Signalling and Communications**	**Buildings**	**Miscellaneous**	**Subtotal**	**OCRC**
RC		2,286.9	840.2	35.6	12,102.5	4,309.2	162.2	139.9	19,744.3	
Metro	586.2	-	-	-	-52.76	-78.2	-0.4	-	-131.4	454.8
EGR	4,801.2	-4.4	-	-	-498.26	-705.9	-3.4	-	-1,197.5	3,603.6
Midwest	1,151.8	-1.7	-	-	-173.39	-85.1	-1.1	-	-260.0	891.8
EBL	2,445.2	-0.5	-	-	-300.85	-69.8	-1.9	-	-360.4	2,084.8
LBL	847.1	-0.6	-	-	-178.36	18.6	-1.1	-	-161.5	685.6
SWM	1,431.7	-2.1	-	-	-134.45	-259.1	-0.9	-	-396.3	1,035.4
Collie	278.7	0	-	-	-32.19	-28.9	-0.3	-	-61.6	217.1
MR	1,616.8	-0.2	-	-	-271.41	-27.2	-1.9	-	-300.7	1,316.1
Central	1,797.4	-0.4	-	-	-310.43	-28.7	-2.7	-	-342.3	1,455.1
GSR	1,667.1	-1.8	-	-	-231.23	-26.4	-2.0	-	-261.4	1,405.7
Lakes	725.1	0	-	-	-130.09	-6.0	-1.1	-	-138.3	586.8
CBH Sidings	352.7	-2	-	-	-71.69	-3.2	-0.6	-	-75.9	276.7
Sidings & Other	172.9	-0.4	-	-	-24.89	-21.4	-0.3	-	-47.0	125.9
Non-Operational	2,002.7	-0.8	-	-	-368.99	10.9	0.0	-	-359.3	1,643.4
Subtotal	19,876.5	-15.3	0.0	0.0	-2,779.0	-1,310.6	-17.3	0.0	-4,093.7	15,782.7
TOTAL		**2,271.6**	**840.2**	**35.6**	**9,351.9**	**2,998.6**	**144.9**	**139.9**	**15,782.7**	

5.10 Railway Owner Project Costs

The Railway Owner would incur costs in developing the project and constructing the infrastructure. These are in addition to the Principal Contractor construction costs discussed above.

The Railway Owner costs are incurred for the design, development, management and funding of the infrastructure construction that would be reasonably incurred by an efficient entity to construct the assets. This is summarised in Figure 5-3. A description of each of these costs follows as well as the rationale for its inclusion in the DORC.

Figure 5-3 Project Development Costs



Additionally, an efficient entity would investigate alternative procurement models to take advantage of potential economies of scale, coordination and minimisation of third party margin, to reduce cost. This is explored below, prior to the steps outlined in the figure above, to determine the least cost Optimised Construction Cost (OCC) on which the project development costs will apply.

5.10.1 Project Procurement Models

Provision of infrastructure would contemplate the most effective means of procurement and one which is to result in least cost overall. For a project of this scale, costs on a per unit basis will be lowest if the procurement is organised at a whole of project level rather than on a work package level. The sections below outline the approaches and the resultant cost savings to be incorporated into the ORC.

5.10.1.1 Conventional Procurement Scenario

The typical approach for assets of this type is to procure a Principal Contractor (Contractor), where a Contractor is engaged to deliver a scope of services for a fixed lump sum price. The Contractor assumes the responsibility to supply and deliver all equipment, labour, materials, and plant necessary to deliver the works in their entirety, with an option remaining to include or exclude design responsibilities. Given the overall extent and geographical spread of the works, it is likely that the works themselves would be packaged into several smaller packages of work, most likely by route or line distance.

This was the approach adopted by ARTC on the Inland Rail project, with overall construction of the 1,600km route divided into 13 projects, each of varying degrees of length and scope. It is understood that these packages of work have been procured on a Head Contractor basis.

The adoption of a Principal Contractor procurement model does not preclude the introduction of other forms of procurement, such as Early Contractor Involvement, Public Private Partnerships (PPP) or hybrid procurement models, which are not uncommon if these are expected to deliver the optimal outcomes (noting that the optimal outcome may not be mean least cost).

Procurement models such as Alliancing and Engineering Procurement Construction Management (EPCM) have been considered but discounted based on cost certainty and the transfer of risk that would be unlikely to result in a least overall cost outcome in the context of this DORC.

5.10.1.2 Alternative Lower-Cost Procurement Scenario

The Railway Owner's costs for project and construction management are likely to vary depending on the procurement model adopted. With the objective to reduce costs, GHD has considered alternative procurement strategies for a project of this scale that could offer a lower cost outcome. Procurement strategies that have been adopted on other similar projects were applied where relevant.

For a project of this scale, GHD expects an efficient Railway Owner to take the opportunity to direct supply materials for the works resulting in a lower overall project cost because of centralised procurement, improved procurement lead times and the removal of Principal Contractor margin. This approach also allows the Railway Owner to manage the efficient deployment of materials between work fronts to maintain schedule.

It was assumed that the Railway Owner would undertake direct supply for:

- Ballast;
- Sleepers;
- Rail; and
- Turnouts.

As discussed above, and as is typical for estimates of this type, the Railway Owner's project and construction management costs are assumed to be a fixed percentage of the value of the construction contract. This removal of Principal Contractor margin means that magnitude of the Railway Owner's costs to manage the construction contract will also reduce.

This reduction would be partially offset by the Railway Owner's additional costs to manage the direct procurement of these materials. We have added this cost by applying the same percentage allowances for construction and project management to the cost of the direct supply items, still resulting in an overall net reduction in project costs.

Typically, sleepers, rail, ballast as well as plant and equipment are Railway Owner supplied as these are off the shelf items and procurement does not require specialist input. A net saving of $2.5billion was calculated as a result of direct procurement of these items. The calculation removed the mark ups for contractor risk allowance, preliminaries and overheads on these direct supply items and instead added a 5% allowance to cover the Railway Owner direct supply management.

Table 5-19 and Table 5-20 shows the reduction in construction cost as a result of the Railway Owner opting to direct supply the items listed above.

Table 5-19 Alternative A Procurement Cost Reduction Attributable to Alternative Procurement Method ($ million)

Alternative A			
Asset Category	**Optimised Construction Cost (OCC) conventional procurement**	**OCC Savings from Direct Supply**	**Alternative Procurement OCC**
Right of Way	2,703.2	0.0	2,271.6
Civil Structures	999.8	0.0	840.2
Associated track structures	42.4	0.0	35.6
Track	14,283.9	2,562.6	9,353.0
Signalling and Control Systems	0.0	0.0	4,282.9
Buildings	172.4	0.0	144.9
Miscellaneous	166.5	0.0	139.9
TOTAL	**18,368.2**	**2,562.6**	**17,068.1**

Table 5-20 Alternative B Procurement Cost Reduction Attributable to Alternative Procurement Method ($ million)

Alternative B			
Asset Category	**Optimised Construction Cost (OCC) conventional procurement**	**OCC Savings from Direct Supply**	**Alternative Procurement OCC**
Right of Way	2,703.2	-	2,271.6
Civil Structures	999.8	-	840.2
Associated track structures	42.4	-	35.6
Track	14,283.9	2,562.6	9,353.0
Signalling and Control Systems	-	-	2,998.6
Buildings	172.4	-	144.9
Miscellaneous	166.5	-	139.9
TOTAL	**18,368.2**	**2,562.6**	**15,783.8**

5.10.2 Project Design and Development Costs

5.10.2.1 Design costs

Design costs include all design related activities from initial feasibility studies, concept development and screening, supporting development approvals, to detailed design sufficient for construction.

Feasibility studies would typically be required by an efficient Railway Owner to support investment decisions. These include the economic, technical, legal and scheduling considerations of the proposed development.

Concept design follows feasibility and typically outlines project requirements and specifications, planning strategies, business cases, programme and phasing strategies and construction logistics.

Once a preferred option has been identified, detailed design is required to develop the concept designs to a level of detail sufficient for construction. This includes detailed materials and workmanship specifications and for-construction drawings.

This DORC assessment assumes that the optimised asset configuration would be constructed, and that an efficient Railway Owner would undertake design studies for the entire optimised network as a single campaign, as this is likely to be least cost overall. The contractual relationship between the Railway Owner and the designer would depend on the procurement model, but the cost for the design would ultimately be borne by the Railway Owner, either directly or through an intermediary entity (e.g. a managing contractor). Consequently, for the purposes of this assessment the design costs have been applied to the Optimised Construction Replacement Cost.

Based on GHD's experience in design studies for rail sector infrastructure, it was considered that the costs for such a task would be of the order of 4-6% of the capital costs for the assets. On the basis that the design would be delivered efficiently at least cost, a 4% provision has been allowed for design activities.

5.10.2.2 Planning and development consent costs

Prior to commencing construction, the required planning and development consents would need to be secured, in accordance with current planning legislation. There would also be significant planning and environmental approvals and permits required to ensure appropriate development controls are in place for the development of this scale and location.

A detailed bottom-up build-up of the surveys, studies and consultation activities that would be required to construct the asset today has been developed, for each of the following development stages:

– **Feasibility and preliminary design**: to assess the factors that may influence design and/or lead to the initial advice statement
– **Design development and planning approval**: the specific studies required for the adopted design and advancement of the approvals and licensing process, by both Commonwealth and State governments.
– **Construction support**: compliance monitoring with the environmental and heritage requirements for construction (landscaping and remediation controls, as well as offsets) and the implementation requirements of the approvals.

A cost and indicative duration has been assigned to each of the individual activities that we anticipate would be required, based on the following key assumptions:

– The legislative framework at the valuation date applies;
– The development would be granted consent;
– The corridor is virgin and with minimal contamination;
– The development application would be for the entire project in a single application
– The Railway Owner would cover environmental offset costs associated with the developed area.

The cost summary is shown below. An itemised breakdown of each stage of development is included in A-3.

The durations for each individual activity were used to build up an estimate of the construction duration, noting that to be most efficient, some have been assumed to be undertaken concurrently. These durations are used in the development of the construction schedule discussed in Section 5.11.2.

Table 5-21 Planning and Development Approval Costs

Development and Planning Activity	Cost ($ million 2024)
Feasibility and input to preliminary design	14.25
Design Development and Planning Approval	185.95
Subtotal	**200.20**
Construction Support	37.49
TOTAL	**237.69**

5.10.2.3 Project and construction management costs

Project and construction management costs are costs the Railway Owner would incur to manage the network construction activities. This includes overall management of all design and construction activities from project inception through to commissioning, up to the time when the asset can earn revenue. The activities covered and the provisions made are discussed below:

Project and Contract Management

The cost of the Railway Owner project team to manage the design and construction process. This includes provision for the following activities related to construction of the optimised asset base.

– Project management and non-technical support;
– Project Controls;
– Procurement and Contracts;
– Finance & Accounting; and
– Document Control.

For a typical Principal Contractor procurement, GHD would expect a provision of about 5% of the Optimised Construction Replacement Cost.

Construction supervision

The cost of the supervision and inspection of the construction works. The party that undertakes this activity would depend on the procurement model adopted, but for the purposes of this assessment, provision of 7% of the Optimised Construction Replacement Cost has been made to cover these costs, evenly spread throughout the construction duration.

5.10.3 Corporate and Other Costs

Corporate and other costs cover other Railway Owner overhead costs such as finance, accounting, human resources, employee related costs (e.g. mobilisation and demobilisation, R&R), employment relations, as well as costs for project related office space, information technology setup, hardware and software, taxes and insurances.

A provision of 3% of the Optimised Construction Replacement Cost has been made to cover these costs.

5.10.4 Summary of Railway Owner Project Costs

Table 5-22 summarises the Project Design and Development Costs, and incorporates the net change to management costs from the application of the alternative procurement model.

Table 5-22 Summary Optimised Replacement Cost Build Up, Including Design and Development Costs ($ million)

Asset Category	OCC Alternative Procurement	Planning and Design Costs	Planning and Development Costs	Project and Construction Management Costs	Corporate and Other Costs	Total Project Development Costs	ORC including Design and Development Costs ($ million)
Alternative A							
Right of Way	2,271.6	90.9	28.1	272.6	68.1	463.2	2,734.9
Civil Structures	840.2	33.6	10.4	100.8	25.2	171.3	1,011.5
Associated Track Structures	35.6	1.4	0.4	4.3	1.1	7.3	42.9
Track	9,353.0	480.1	115.6	1,307.9	360.1	2,278.2	11,631.4
Signalling and Control Systems	4,309.2	171.3	79.6	513.9	128.5	873.4	5,156.3
Buildings	144.9	5.8	1.8	17.3	4.3	29.3	174.4
Miscellaneous	139.9	3.1	1.7	12.5	4.2	21.5	161.7
TOTAL	**17,094.4**	**786.3**	**237.7**	**2,229.4**	**591.6**	**3,844.9**	**20,913.0**
Alternative B							
Right of Way	2,271.6	90.9	34.2	272.6	68.1	465.8	2,737.4
Civil Structures	840.2	33.6	12.7	100.8	25.2	172.3	1,012.5
Associated Track Structures	35.6	1.4	0.5	4.3	1.1	7.3	42.9
Track	9,353.0	480.1	140.8	1,307.9	360.1	2,289.0	11,642.0
Signalling and Control Systems	2,998.6	119.9	45.2	359.8	90.0	614.9	3,613.5
Buildings	144.9	5.8	2.2	17.4	4.3	29.7	174.6
Miscellaneous	139.9	3.1	2.1	12.5	4.2	21.9	161.8
TOTAL	**15,783.8**	**734.9**	**237.7**	**2,075.3**	**553.0**	**3,600.9**	**19,384.7**

5.11 Railway Owner Funding costs

5.11.1 Funding Costs in DORC Valuations

Funding costs are included in DORC valuations because they reflect the costs incurred by the Railway Owner to fund the development and represent the opportunity cost of the capital required. This funding cost assessment is not a cashflow assessment that would be used to support or confirm the financial viability of the project. It is an estimation of the minimum reasonable amount of compensation for the opportunity cost of capital involved with constructing the asset.

For the Railway Owner to fund the replacement of the assets, it would need to secure funding from the market. That funding would be a combination of debt and equity and would be required to provide a market reflective return (otherwise investors would invest elsewhere). The cost of securing funding from the market, at an appropriate gearing and subject to appropriate returns, is represented by an industry specific Weighted Average Cost of Capital (WACC). The applicable weighted average cost of capital for Arc's assets is published by the Economic Regulatory Authority (ERA).

The construction costs should be incurred based on a construction schedule for the assets which the ACCC advise should represent a reasonable (and neither an unduly rushed nor delayed) construction process.[56]

The WACC is applied to the Optimised Replacement Cost over the entire project development, construction and commissioning period, up to the point when the assets can generate revenue. This conforms to regulatory precedent. In similar settings, the ACCC has confirmed that a DORC framework would need to consider a construction program that allowed for the construction of assets not owned by the Railway Owner if they are necessary to enable construction of assets owned by the Railway Owner that are required for the service, and that the Railway Owner can be assumed to earn revenue from its assets at the end of the assumed construction period.[57]

A project development schedule has been prepared to support this task. The project development schedule is discussed in Section 5.11.2.

5.11.2 Project Development Schedule

5.11.2.1 Broad assumptions

The development schedule has been built up to reflect the scheduling dependencies for the entire network being costed, based on the following broad assumptions:

1. The works would be completed by an experienced contractor who would make a reasonable assessment of the required effort and risks.
2. There are sufficient skilled construction resources to undertake the work in a reasonable time.
3. Much of the interior of Western Australia is extremely remote, and in the absence of rail, access would be restricted to roads only. In accordance with the brownfields approach, we have assumed that access roads that exist outside the rail corridor would be available to enable construction. In remote areas these roads are often located along the rail corridor.
4. There is sufficient temporary infrastructure to support the construction of labour camps and support the movement of labour around the country over the period to enable construction.
5. Weather conditions are not extreme and do not disrupt the continuity of safe and efficient work.
6. Materials and products (e.g. ballast, sleepers, track, services, and comms cabling etc.) can be sourced, manufactured, and delivered to site at the rate required to support the construction.

[56] Australian Competition and Consumer Commission, Final determination: Statement of reasons – access dispute between Glencore Coal Assets Australia Pty Ltd and Port of Newcastle Operations Pty Ltd, 2018, page 35.
[57] Australian Competition and Consumer Commission, Final determination: Statement of reasons – access dispute between Glencore Coal Assets Australia Pty Ltd and Port of Newcastle Operations Pty Ltd, 2018, page 105.

5.11.2.2 Scheduling principles

The development schedule has been built up in line with the following principles:

1. The development program is intended to minimise overall project development costs – not necessarily to develop the project in the shortest possible time.
2. The schedule is neither unduly rushed or unduly delayed[58] and represents the realistic minimum duration that we anticipate an experienced contractor would achieve in practice, to meet appropriate standards of construction, using modern plant, equipment and methods.
3. Activities that do not lie on the critical path, and do not therefore affect the overall construction duration, have been assumed to start as late as possible, reducing any programme float to zero. Delaying the tasks as far as possible back-loads the cash flow and reduces the magnitude of the funding costs. In practice, it is likely that these tasks would be initiated while some float remains, to minimise the risk of overall schedule impacts.
4. For a development of this scale and complexity, it's probable that some contractors would enter a partnering arrangement. Existing locally operating tier one civil contractors would engage smaller companies as subcontractors. While international entrants would be interested in the size and scale of this type of program, they would not be able to import significant labour resources in a short period due to visa restrictions. The program would therefore have to draw resources from the Australian east coast, while competing with the mining industry. Consequently, GHD has assumed that if a concerted program to recruit labour started when the business case was completed and procurement was starting, that it would be reasonable to assume there was sufficient labour to support a total of 10 concurrent work fronts concurrently.

5.11.2.3 Pre-construction planning design and approvals

Pre-construction planning tasks assume that:

– A Business Case would be undertaken for the entire programme of works;
– Development approvals would be secured for the entire network;
– The construction project would be an overall programme of works comprised of numerous individual projects built in sectors, but design and procurement of sections would happen concurrently; and
– Approvals from landholders and permitting is completed in a reasonable time.

5.11.2.4 Construction task considerations

Construction tasks consider that:

– Enabling works including access roads, precasting yards, water treatment plants, site establishment, accommodation camps etc. would need to be underway before construction could commence. 12 months has been allowed for the completion of enabling works for the initial sections, prior to construction. Enabling works for subsequent sections would be undertaken concurrently with construction of the initial sections.
– Construction of the network would be undertaken in a series of projects of a scale typical of major rail infrastructure developments. Recent precedent indicates that the line length of a typical major rail infrastructure project is around 200-300 km per sector. On this basis, the 5,560km of corridor in the network being costed would represent about 22 projects.
– Much of inland Western Australia is dry, and access to water is through boreholes which produce brackish water that requires treatment prior to its use in construction. This is impacting construction durations in projects in Western Australia and has been factored into the assumed construction rates for the network being costed.
– Much of the geology of the interior does not suit sourcing of either high grade capping or ballast material. While general fill can be found along the route and is assumed to be found locally, the higher-grade materials required will require substantial time and effort to identify and to produce.
– The duration to form the earthworks along the rail corridor is included in the construction schedule because this DORC valuation starts from an undeveloped site, and these earthworks would be necessary to enable the construction of assets required for the service. As noted above, the ACCC has confirmed that a DORC

[58] Australian Competition and Consumer Commission, Final determination: Statement of reasons – access dispute between Glencore Coal Assets Australia Pty Ltd and Port of Newcastle Operations Pty Ltd, 2018, page 92.

framework should include the construction of assets not owned by the Railway Owner if they are required to enable construction of assets that are required for the service.[59] In accordance with the Code, costs associated with any earthworks completed prior to 2000 have been excluded.

5.11.2.5 Scheduling logic and construction logistics

The scheduling logic has been built up in line with the following principles:

1. An efficient entity would not be able to rely on rail for logistical support for this project because there are no other proximate freight railways. There would be a need to open staging yards, and batching/precast plants at each extremity of the network (particularly, Geraldton, Kwinana, Bunbury, Albany, and Esperance Ports) to stage the works with construction progressing inwards towards the centre of the network. It is assumed that the national freight network would be present up to Kalgoorlie, allowing material to be transported via rail in from South Australia. The core part of the network (from all the ports inward and including Perth to Kalgoorlie) would be built first, to enable access by rail to the inland sections.
2. Each major section would be fed from a port, or from Kalgoorlie, working linearly inwards to lay the track.
3. Earthworks will commence first and will be on the critical path because of the relatively slow production rate.
4. Major structures (i.e. bridges, tunnels) are built concurrently with the earthworks.
5. Ballast, sleepers and rail would be constructed after formation, with a three-month lag between each, and commenced as late as practicable in the schedule, so as the complete construction coincident with the completion of earthworks.
6. Signalling installation would overlap earthworks and be concurrent with rail.
7. Operation begins on completion of commissioning. It is assumed rolling stock is imported from other localities and is placed on rail at the various ports to be ready for operation once commissioning is complete.

5.11.2.6 Construction duration benchmarking

Durations of major construction tasks are based on production rates that have been achieved in practice on recent projects for similar assets in Western Australia. These therefore represent realistic construction rates using modern plant, equipment and methods.

Preconstruction planning, design, approvals and enabling works	Typical pre-construction activities for a project of this scale, based on benchmarks from comparable linear infrastructure projects would be about five years. This is based on: - A detailed bottom up build up of studies on the physical environment, ecological and social setting, which each study between 6-12 months (some of which will need to capture seasonal variabilities). - This would be followed by constraints mapping and option development, and corridor studies and concept design (12-14 months). - A business case for a project of this scale and complexity, which based on experience of recent large infrastructure projects would require 12 months to complete. - A detailed EIS (Environmental Impact Statement) would be required, which for a project of this scale, we have assumed could take two years. - Once EIS was complete, detailed design and enabling works in readiness for construction could commence (12 months).
Contractor mobilisation	We have assumed 12 months would be required for temporary works design, workshop drawings, establishment of site facilities, accommodation camps, services, site prep, haul roads, secure water resources etc.
Earthworks and formation	Based on recent linear infrastructure projects that GHD has been involved in, corridor construction rates of 4.4km per month are achievable in practice. Formation would follow earthworks and complete three months after earthworks completion. With 10 concurrent work fronts (see 5.11.2.1), 528km per year should be achievable.
Track laying	The Alice Springs to Darwin line achieved track laying rates of 1.6km of track per day (and produced 4000 sleepers daily).

[59] The ACCC has noted that extent that the '*construction period should take into account all assets that are necessary to provide the Service to the point that revenue can be generated from the Service*' and that '*this would necessarily involve taking into account the time taken to construct assets that are neither owned nor leased* [by the Railway Owner], Final Determination: Statement of Reasons - Access dispute between Glencore Coal Assets Australia Pty Ltd and Port of Newcastle Operations Pty Ltd, ACCC, 18th September 2018

	This equates to 460km per year factoring in non-working days. With 10 fronts progressing concurrently, that amounts to 4,600 km per year.
Signalling	We have assumed three years would be required to install the signalling assets across the network and that this would b appropriate for Alternative A or Alternative B.
Commissioning	Based on recent experience, we have allowed 12 months for commissioning of each section.

5.11.2.7 Project Duration

Task scheduling has been undertaken in accordance with the principles, schedule logic and dependencies outlined above. Key schedule activities and durations are shown in Table .

Note that durations for sub-tasks sum to more than the overall duration because of scheduling overlaps. A Gantt chart of the overall development duration is presented in Figure 5-4.

The network to be costed consists of 5,560km of rail corridor. Availability of labour will limit the number of concurrent work fronts to 10, as discussed above, leading to the assumed overall project development duration of 18.1 years from initial option development to commissioning.

This is made up of 4.8 years of planning, design development and approvals, followed by 13.3 years of construction and commissioning.

Table 5-23 Summary Project Development Schedule

Activity	Quantity	Rate	Duration (years)
Preconstruction planning, design, approvals and enabling works			4.8
Option development and business case	*Based on experience of large-scale linear infrastructure developments.*		0.8
Environmental Constraints analysis and option shortlisting			0.3
Corridor studies, critical surveys and concept design			0.8
Environmental scoping, EIS, consultation, consideration and planning approval			2.0
Detailed design completion and enabling contracts			1.0
Construction works	5,560 km		13.3
Contractors mobilisation			1.0
Right of Way	5,560 km		11.8
Prepare borrow pits and stockpile areas	-	-	*0.6*
Cuttings and embankments (starts 3 months after start of previous task)	*5,560 km*	*528 km/yr*[60]	*10.5*
Formation (completes 12 months after earthworks for the final section)			
Access Roads (commences with borrow pits to provide access for earthworks)	*Determined by RoW tasks.*		*8.6*
Track			1.67
Ballast (follows formation, and completes 6 months after formation)	*5,560 km*	*4,600 km/yr*	*1.2*
Sleepers (follows ballast and completes 3 months after ballast)	*5,560 km*	*4,600 km/yr*	*1.2*
Rail (follows rail and completes 3 months after sleepers)	*5,560 km*	*4,600 km/yr*	*1.2*
Turnouts (constructed and completed with rail)	-	-	*1.2*
Associated Track Structures			5.5
Level crossings (completes 3 months after track laying)			*3.0*
Signalling			3.5
Signalling and communications (follows and completes 6 months after completion of track laying)			*3.5*
Civil structures			11.2
Bridges (as late as possible but completes 3 months before track laying complete to enable track to be overlaid on bridges)	*Not critical.*		*5.6*
Tunnels (finishes 1 month before track laying)	*Not critical.*		*5.75*
Culverts (constructed with bulk earthworks)	*Not critical*		*9.5*
Buildings			*4.0*
Control centres (completes 6 months after signalling, and 6 months before commissioning concludes)	*Not critical.*		*3.0*
Depots and workshops (completes 6 months before plant and equipment concludes)	*Not critical.*		*3.0*
Platforms (delayed to complete with commissioning)	*Not critical.*		*4.0*
Miscellaneous			*1.0*
Plant and equipment (concludes on completion of commissioning)	*Not critical*		*1.0*
Commissioning			1.0
Section commissioning (concludes 6 months after completion of all other tasks)	*Based on reasonable expectation of time to commission last section.*		*1.0*

[60] Alice Springs to Darwin Link constructed from 2001 – 2004 is the only recent example of a similar scale project. Only the Parkes to Narromine section has been constructed, commissioned and operational. The route length of this section is 106km and was constructed over 2 years. That amounts to an overall construction rate of 52km per year.

	Task	Duration (months)
	Arc Infrastructure's Rail Network	**229**
0	**Project Management**	**229**
	Pre-construction planning, design and approvals	**58**
1	Option development and business case	10
2	Environmental Constraints analysis and option shortlisting	4
3	Corridor studies, critical surveys and concept design	10
4	Environmental scoping, EIS, consultation, consideration a	24
5	Detailed design completion and enabling contracts	12
6	**Post Approvals**	**10**
7	Prepare CEMPs, management plans and obtain secondar	6
8	Engage suppliers, set up monitoring sites	4
9	**Construction Monitoring**	**165**
10	Ongoing monitoring	165
11	Construction Supervision	165
12	**Construction Works**	**171**
13	**Contractors mobilisation**	**12**
14	Temporary works design, workshop drawings, establish site facilities, accomodation camps,	12
15	**Right of Way**	**141**
16	Prepare borrow pits and stockpile areas	6
17	Cuttings and embankments	126
18	Formation	92
19	Access Roads	103
21	**Track**	**20**
22	Ballast	14
23	Sleepers	14
24	Rail	14
25	Turnouts	14
26	**Associated Track Structures**	**66**
27	Level crossings	36
28	Roads and shunt pathways	63
29	**Signalling and control systems**	**42**
30	Signalling	42
31	Control and Communications	42
32	**Civil Structures**	**69**
33	Bridges	67
34	Tunnels	69
35	Culverts	69
36	**Buildings**	**48**
37	Control centres	36
38	Depots and Workshops	36
39	Platforms	48
40	**Miscellaneous assets**	**12**
41	Plant and equipment	12
42	Other	12
43	**Commissioning**	**12**
42	Commissioning	12

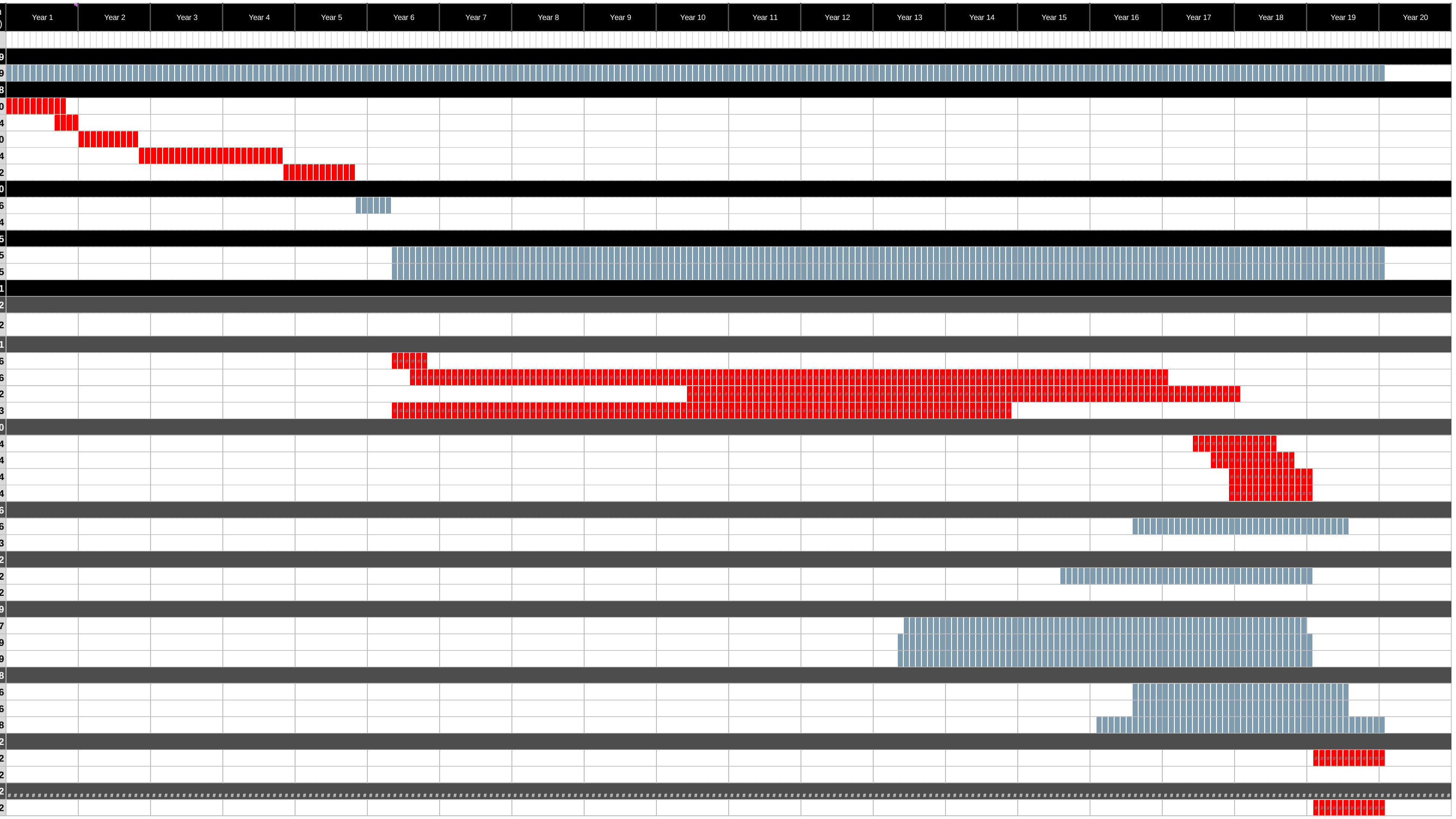


Figure 5-4 Construction Schedule (red colouring indicates critical pathway)

5.11.3 Calculation of the Funding Cost

The detailed construction schedule (shown in Figure 5-4) with tasks estimated to months, has been used to build up the interest during constriction (IDC) costs. This reflects the opportunity cost of the capital that would be invested in the construction of the network.

The ORC for each activity or asset type has been applied to the corresponding task in the construction schedule and costs distributed equally across all months of that task's duration. The equal distribution is appropriate because it is based on a consistent number of continuous work fronts and construction teams, and therefore consistent rate of expenditure for each activity over its duration.

These total monthly capital expenditures throughout the project development duration are as shown in Figure 5-5. This forms the basis for the IDC calculation.

Figure 5-5 shows the timing and expenditure of each of the project development tasks and asset category. The resulting capital expenditure commitment for the project development is back-loaded, with the most significant portion of investment only occurring in the final three years. This back-loading reduces the funding costs that the Railway Owner would incur on the project.

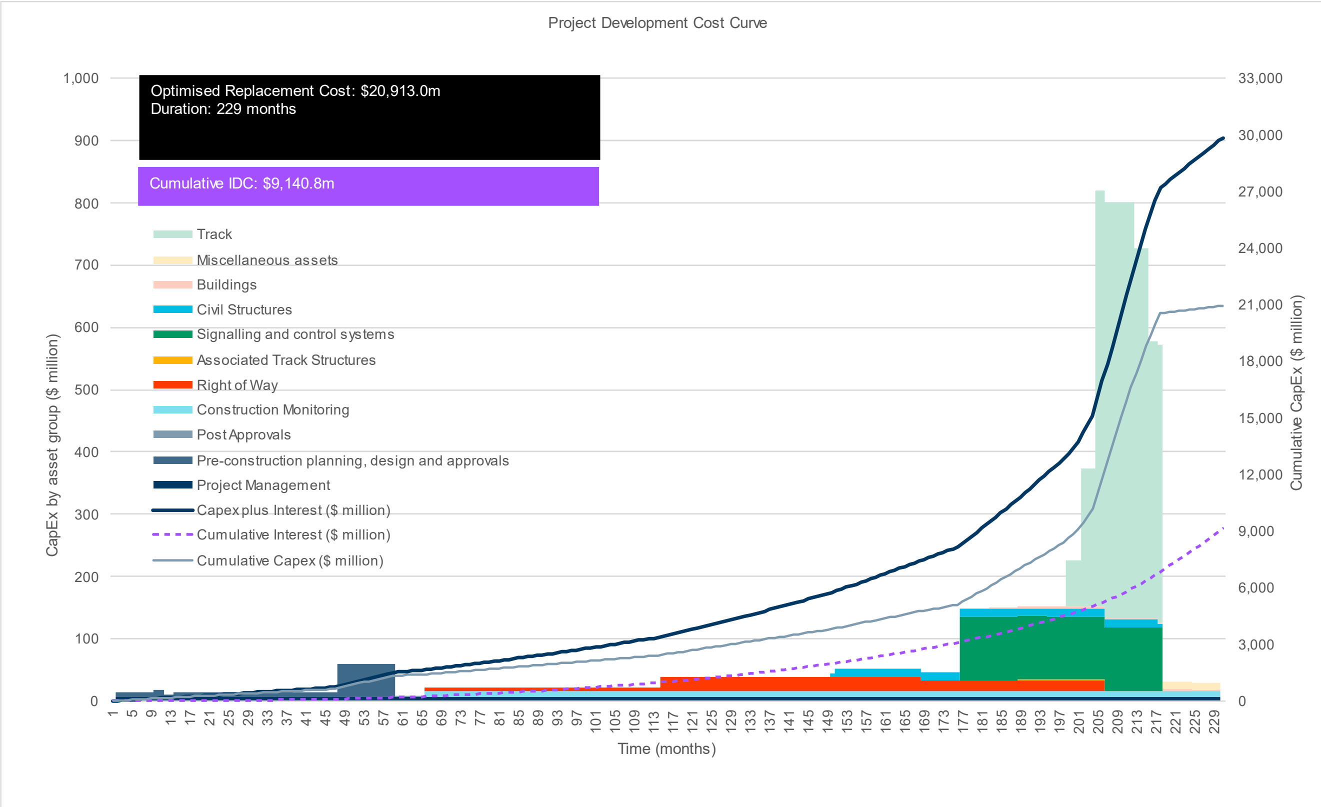
The WACC has then been applied to the monthly costs and compounded monthly to provide a detailed assessment of the IDC incurred during the project development duration. An annual real, pre-tax WACC rate of 7.46% as determined by the ERA[61] has been used.

Figure 5-5 shows the cost curve for the Optimised Replacement Cost, with a resulting funding cost of:

– $9,140.8 million (for signalling Alternative A); and
– $8,541.1 million (for signalling Alternative B).

[61] **Determination on the 2024 weighted average cost of capital for the freight and urban railway networks, and for Pilbara railways** (sourced from: www.erawa.com.au/cproot/24254/2/2024-Rail-WACC-Final-Determination-For-publication.pdf)

Alternative A:



Alternative B:

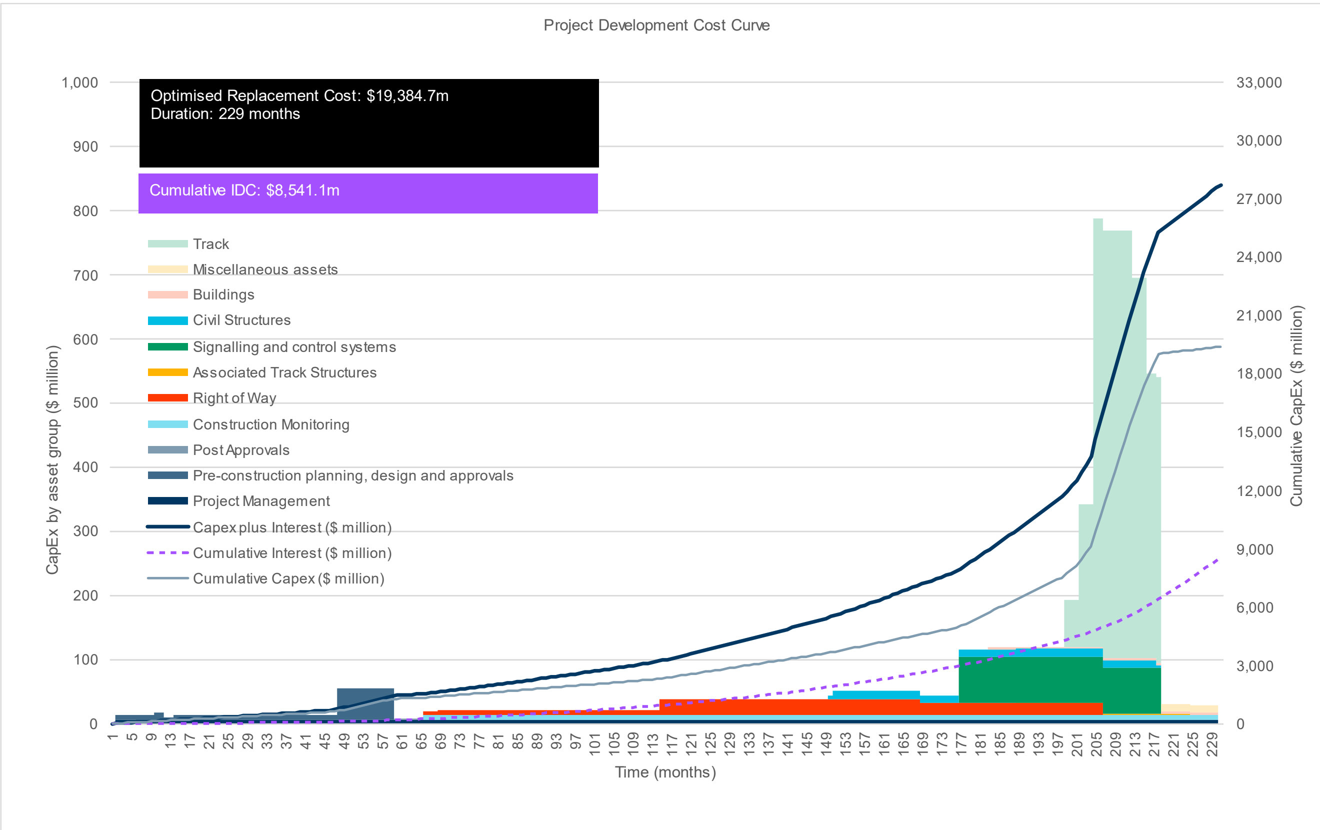


Figure 5-5 Project Development Capex commitment and funding cost

5.11.4 Summary of Funding Costs

Table 5-24 shows the ORC and the funding costs, by asset category. In accordance with regulatory precedent, the funding costs are allocated in proportion to the ORC (meaning that every $1 of ORC attracts a $ of IDC).

Table 5-24 Optimised Replacement Cost by Asset Category ($ million)

Asset Category	Optimised Replacement Cost Excluding funding cost	Funding Cost	Funding Cost Factor	Optimised Replacement Cost
Alternative A				
Right of Way	2,734.9	1,216.6	1.45	3,951.4
Civil Structures	1,011.5	450.0	1.45	1,461.5
Associated Track Structures	42.9	19.1	1.45	61.9
Track	11,631.4	5,009.0	1.44	16,640.4
Signalling and Control Systems	5,156.3	2,293.7	1.45	7,450.0
Buildings	174.4	77.6	1.45	252.0
Miscellaneous	161.7	74.9	1.43	236.6
TOTAL	**20,913.0**	**9,140.8**		**30,053.8**
Alternative B				
Right of Way	2,737.4	1,229.2	1.45	3,966.7
Civil Structures	1,012.5	454.7	1.45	1,467.1
Associated Track Structures	42.9	19.3	1.45	62.2
Track	11,642.0	5,061.2	1.44	16,703.2
Signalling and Control Systems	3,613.5	1,622.6	1.45	5,236.2
Buildings	174.6	78.4	1.45	252.9
Miscellaneous	161.8	75.7	1.43	237.5
TOTAL	**19,384.7**	**8,541.1**		**27,925.8**

5.12 ORC Summary

5.12.1 ORC Components by Network Group

Table 5-25 shows the Optimised Construction Replacement Cost components by Network Group, based on signalling Alternative A.

Table 5-25 Total Optimised Construction Replacement Cost by Network Group – Signalling Alternative A ($ million)

Network Group	OCC	Planning and Design Costs	Planning and Development Consent Costs	Project and Construction Management Costs	Corporate and Other Costs	Funding Cost	Optimised Replacement Cost
Alternative A							
Metro	533.0	23.4	7.4	67.6	17.6	285.4	934.4
EGR	4,298.0	190.1	59.9	548	143.0	2,302.0	7,541.0
Midwest	976.3	45.6	13.6	128.5	34.3	522.9	1,721.2
EBL	2,153.4	97.3	30.0	278.1	73.2	1,153.2	3,785.2
LBL	665.8	33.2	9.3	91.3	25.0	356.6	1,181.2
SWM	1,288.9	56.4	17.9	163.2	42.4	690.3	2,259.1
Collie	245.8	11.0	3.4	31.8	8.3	131.6	431.9
MR	1,343.2	64.2	18.7	179.5	48.3	719.3	2,373.2
Central	1,483.5	71.2	20.7	198.6	53.7	794.5	2,622.2
GSR	1,432.0	66.0	19.9	187.4	49.7	766.9	2,521.9
Lakes	592.8	28.7	8.3	79.8	21.7	317.4	1,048.7
CBH Sidings	276.3	12.9	3.9	37.1	9.7	148.3	488.2
Sidings & Other	147.3	6.6	2.1	18.9	5.0	78.9	258.8
Non-Operational	1,630.8	79.5	22.7	220.7	59.7	873.4	2,886.8
TOTAL	**17,067.0**	**786.3**	**237.7**	**2,230.4**	**591.6**	**9,140.8**	**30,053.8**

Table 5-27 shows the Optimised Construction Replacement Cost components by Network Group, based on signalling Alternative B.

Table 5-26 Total Optimised Construction Replacement Cost by Network Group – Signalling Alternative B ($ million)

Network Group	OCC	Planning and Design Costs	Planning and Development Consent Costs	Project and Construction Management Costs	Corporate and Other Costs	Funding Cost	Optimised Replacement Cost
Alternative B							
Metro	454.8	20.2	6.8	58.2	15.2	246.1	801.3
EGR	3,603.6	162.4	54.3	464.8	122.1	1,950.2	6,357.4
Midwest	891.8	42.2	13.4	118.4	31.8	482.6	1,580.2
EBL	2,084.8	94.6	31.4	269.9	71.1	1,128.1	3,679.9
LBL	685.6	34.0	10.3	93.8	25.6	371.0	1,220.3
SWM	1,035.4	46.3	15.6	132.7	34.8	560.3	1,825.1
Collie	217.1	9.9	3.3	28	7.5	117.5	383.3
MR	1,316.1	63.1	19.8	176.2	47.5	712.2	2,334.9
Central	1,455.1	70.0	21.9	195.4	52.8	787.4	2,582.6
GSR	1,405.7	65.0	21.2	184	49.0	760.7	2,485.6
Lakes	586.8	28.5	8.8	79.2	21.5	317.5	1,042.3
CBH Sidings	276.7	12.9	4.2	37.3	9.7	150.1	490.9
Sidings & Other	125.9	5.8	1.9	16.3	4.4	68.1	222.4
Non-Operational	1,643.4	80.0	24.7	222.3	60.0	889.3	2,919.7
TOTAL	**15,782.7**	**734.9**	**237.7**	**2,076.4**	**553.0**	**8,541.1**	**27,925.8**

5.12.2 ORC Asset Category Costs by Network Group

Table 5-27 shows the Optimised Construction Replacement Cost components by asset and Network groups, based on signalling Alternative A.

Table 5-27 Optimised Replacement Cost (including Railway Owner Costs) by Route – Signalling Alternative A ($ million)

Network group	Right of Way	Civil Structures	Associated Track Structures	Track	Signalling and Control Systems	Buildings	Miscellaneous	Total
Alternative A								
Metro	88.9	129.3	3.8	397.1	304.2	6.4	4.6	934.4
EGR	959.5	140.8	12.6	2,832.4	3,467.4	48.4	79.8	7,541.0
Midwest	385.0	100.4	1.2	957.2	246.8	14.9	15.7	1,721.2
EBL	595.3	52.4	3.4	1,494.5	1,595.6	24.9	19.1	3,785.2
LBL	118.5	73.8	0.6	931.0	31.3	15.6	10.4	1,181.2
SWM	250.6	174.8	5.9	774.1	1,031.1	11.9	10.7	2,259.1
Collie	25.0	110.8	1.8	203.5	79.9	4.1	6.9	431.9
MR	221.8	149.0	6.3	1,752.5	193.1	28.5	22.1	2,373.2
Central	249.5	171.2	3.7	1,998.0	131.0	41.0	27.9	2,622.2
GSR	584.7	191.0	15.2	1,500.1	177.0	28.2	25.5	2,521.9
Lakes	108.2	24.8	0.4	858.3	30.9	16.4	9.7	1,048.7
CBH Sidings	38.7	0.1	0.3	395.5	45.7	5.4	2.5	488.2
Sidings & Other	14.4	22.9	3.7	154.6	59.0	2.5	1.8	258.8
Non-Operational	311.3	120.2	3.0	2,391.7	56.9	3.7	0.0	2,886.8
TOTAL	**3,951.4**	**1,461.5**	**61.9**	**16,640.4**	**7,450.0**	**252.0**	**236.6**	**30,053.8**

Table 5-28 shows the Optimised Construction Replacement Cost components by asset and Network groups, based on signalling Alternative B.

Table 5-28 Optimised Replacement Cost (including Railway Owner Costs) by Route – Signalling Alternative B ($ million)

Network group	Right of Way	Civil Structures	Associated Track Structures	Track	Signalling and Control Systems	Buildings	Miscellaneous	Total
Alternative B								
Metro	89.2	129.8	3.8	398.6	168.8	6.4	4.7	801.3
EGR	963.2	141.4	12.7	2,843.1	2,268.3	48.6	80.1	6,357.4
Midwest	386.5	100.8	1.2	960.8	100.2	14.9	15.8	1,580.2
EBL	597.6	52.6	3.4	1,500.1	1,482.0	25.0	19.1	3,679.9
LBL	119.0	74.1	0.6	934.5	66.0	15.6	10.4	1,220.3
SWM	251.6	175.5	5.9	777.0	592.5	12.0	10.7	1,825.1
Collie	25.1	111.2	1.8	204.2	30.0	4.1	6.9	383.3
MR	222.6	149.6	6.3	1,759.1	146.5	28.6	22.2	2,334.9
Central	250.5	171.8	3.7	2,005.5	81.9	41.1	28.0	2,582.6
GSR	586.9	191.8	15.3	1,505.8	131.8	28.3	25.6	2,485.6
Lakes	108.6	24.9	0.4	861.6	20.6	16.5	9.7	1,042.3
CBH Sidings	38.9	0.1	0.3	397.0	46.7	5.5	2.5	490.9
Sidings & Other	14.4	22.9	3.7	155.2	21.8	2.5	1.8	222.4
Non-Operational	312.5	120.6	3.0	2,400.7	79.1	3.7	0.0	2,919.7
TOTAL	**3,966.7**	**1,467.1**	**62.2**	**16,703.2**	**5,236.2**	**252.9**	**237.5**	**27,925.8**

5.12.3 ORC Summary by Route Section – Alternative A

A detailed breakdown of ORC per Route Section is shown in figures below.

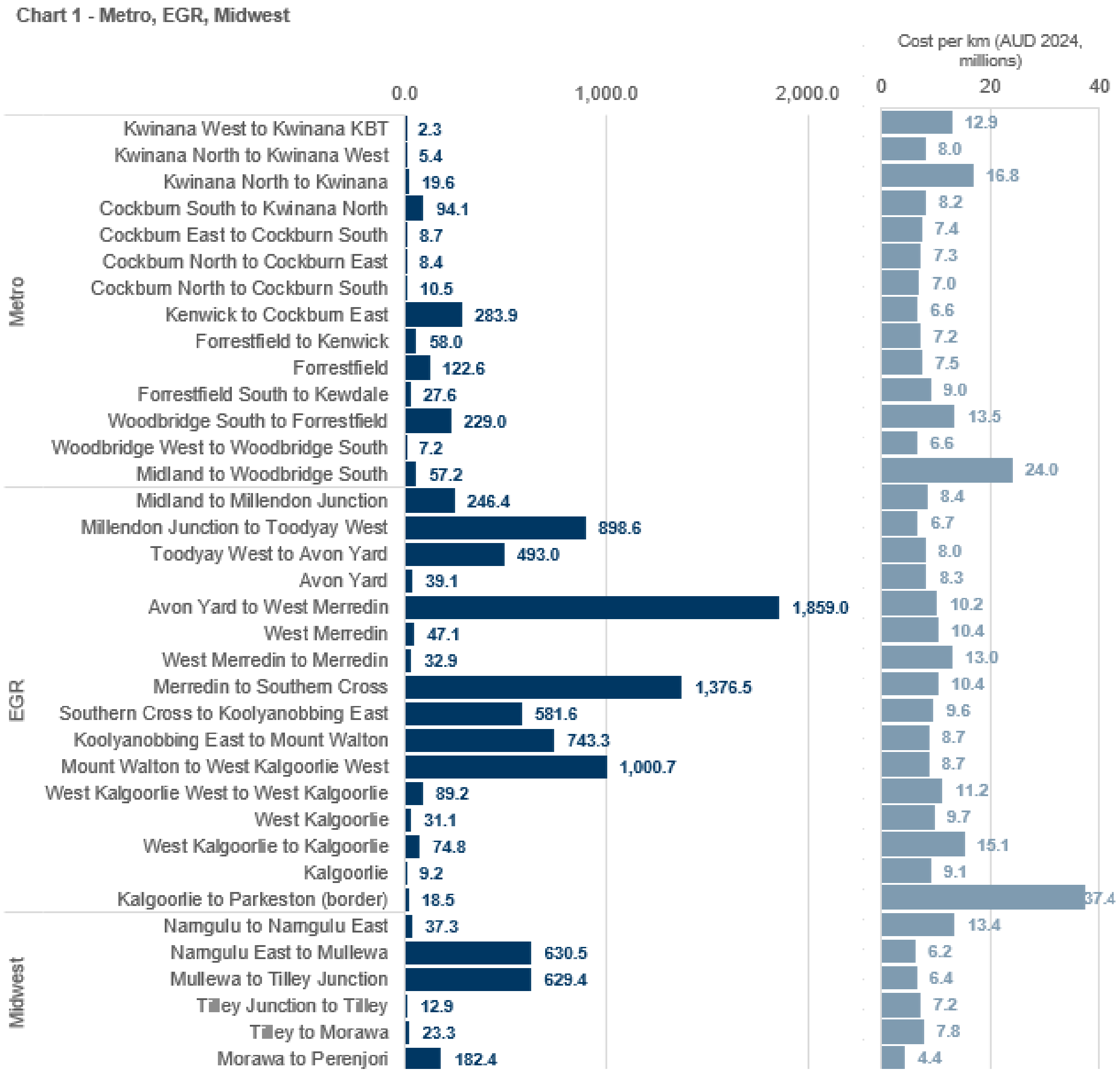


Figure 5-6 Chart 1 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route

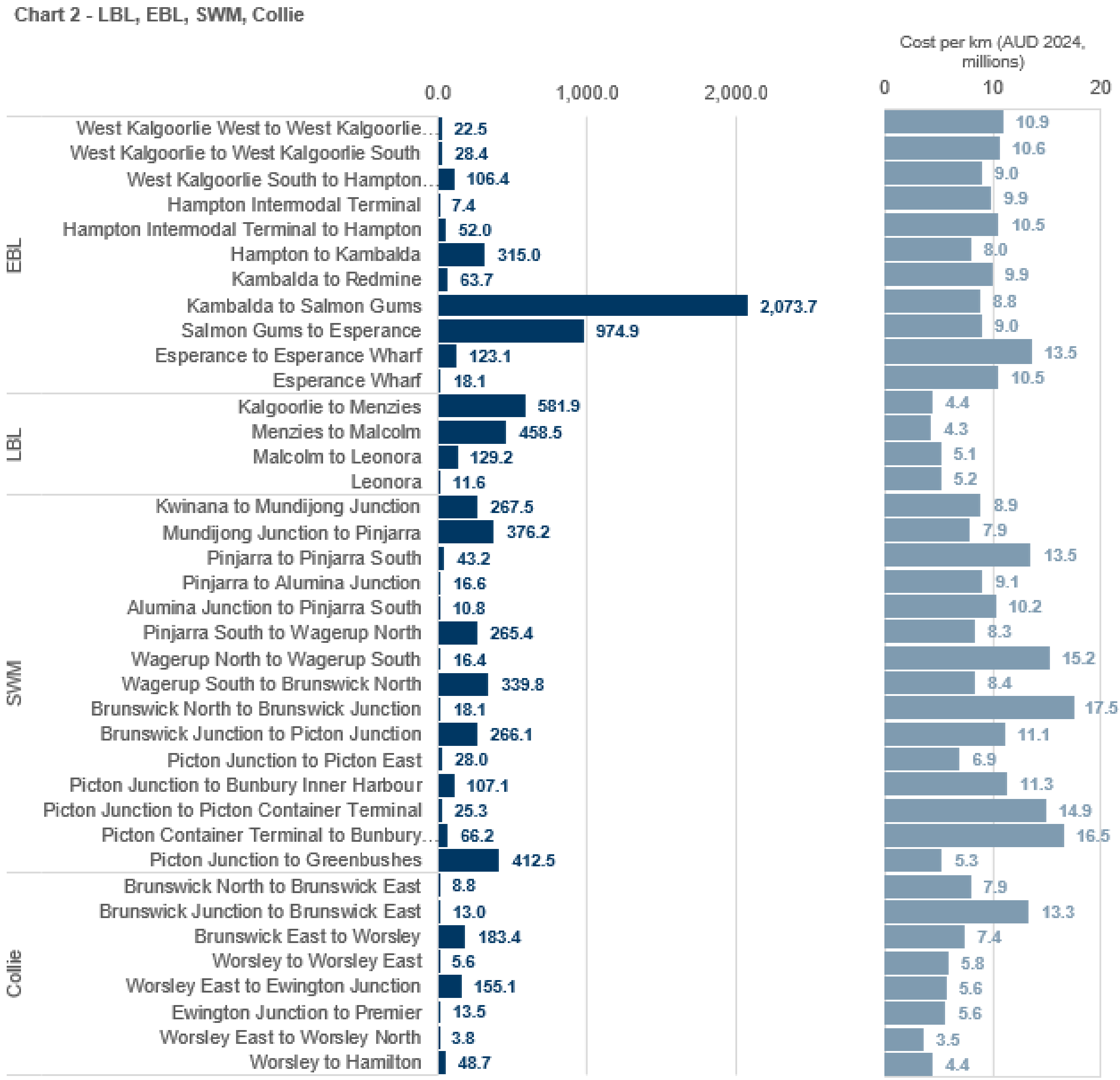


Figure 5-7 Chart 2 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route

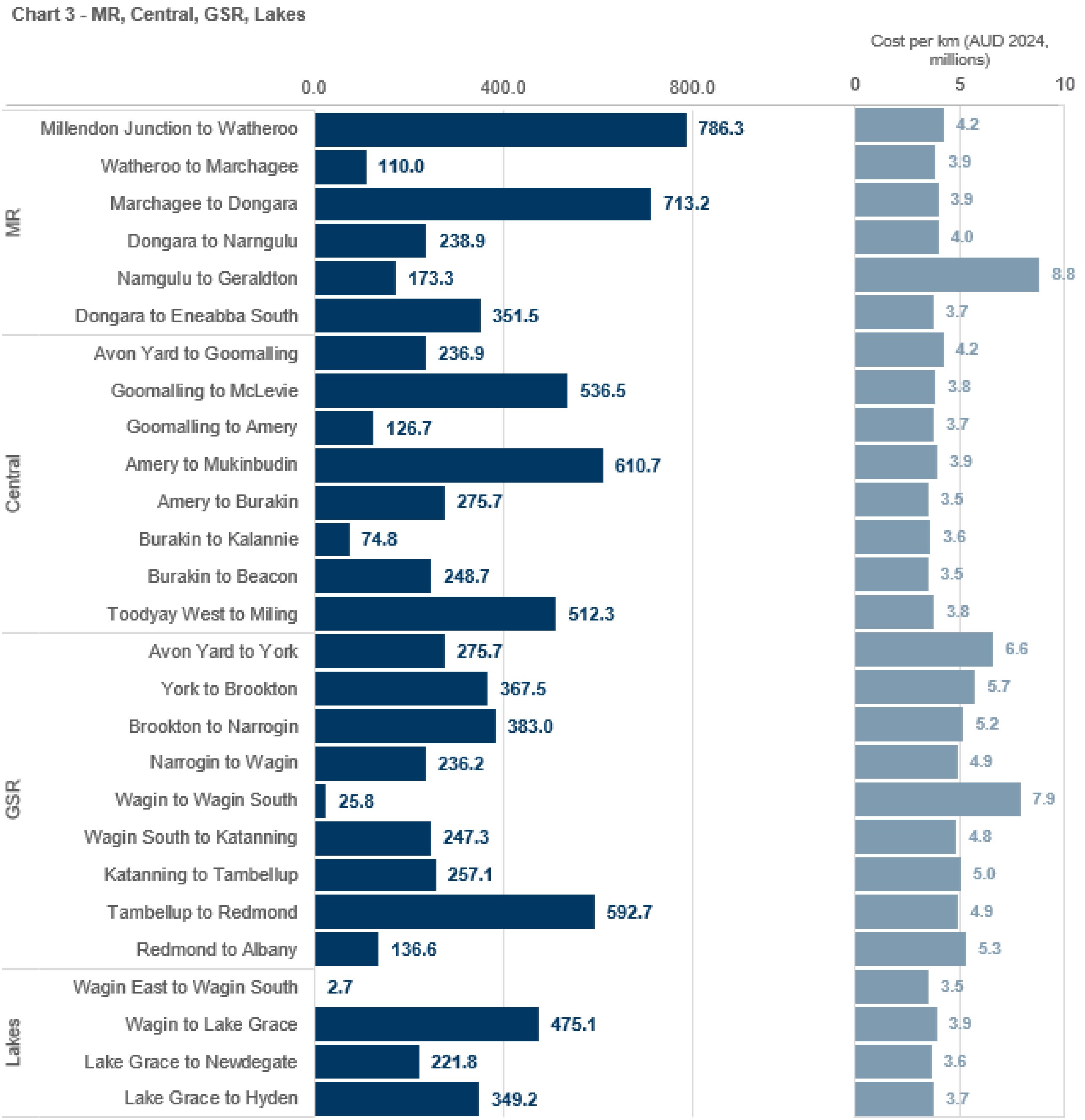


Figure 5-8 Chart 3 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route

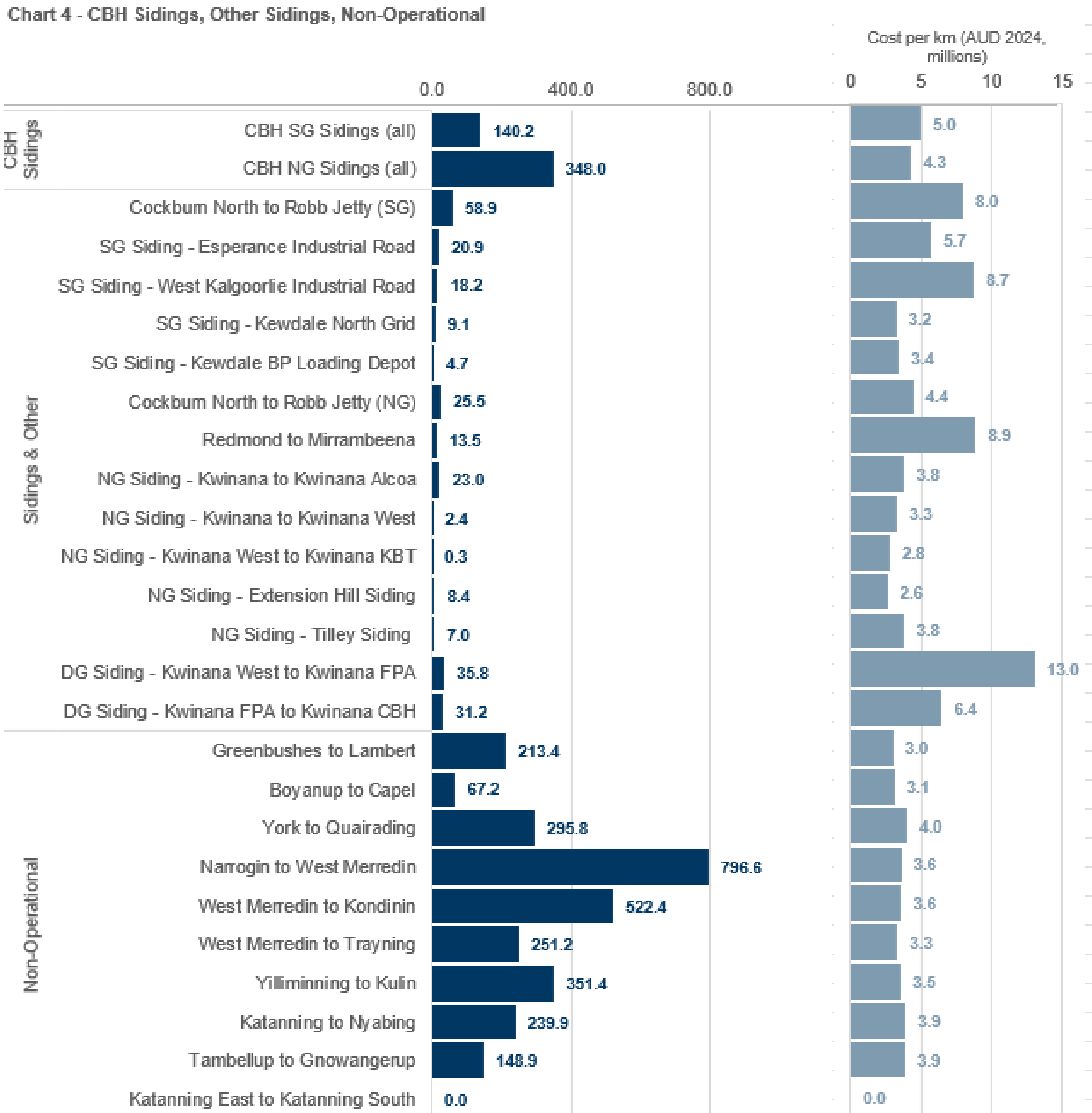


Figure 5-9 Chart 4 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route

5.12.4 ORC Summary by Route Section – Alternative B

A detailed breakdown of ORC per Route Section are shown below.

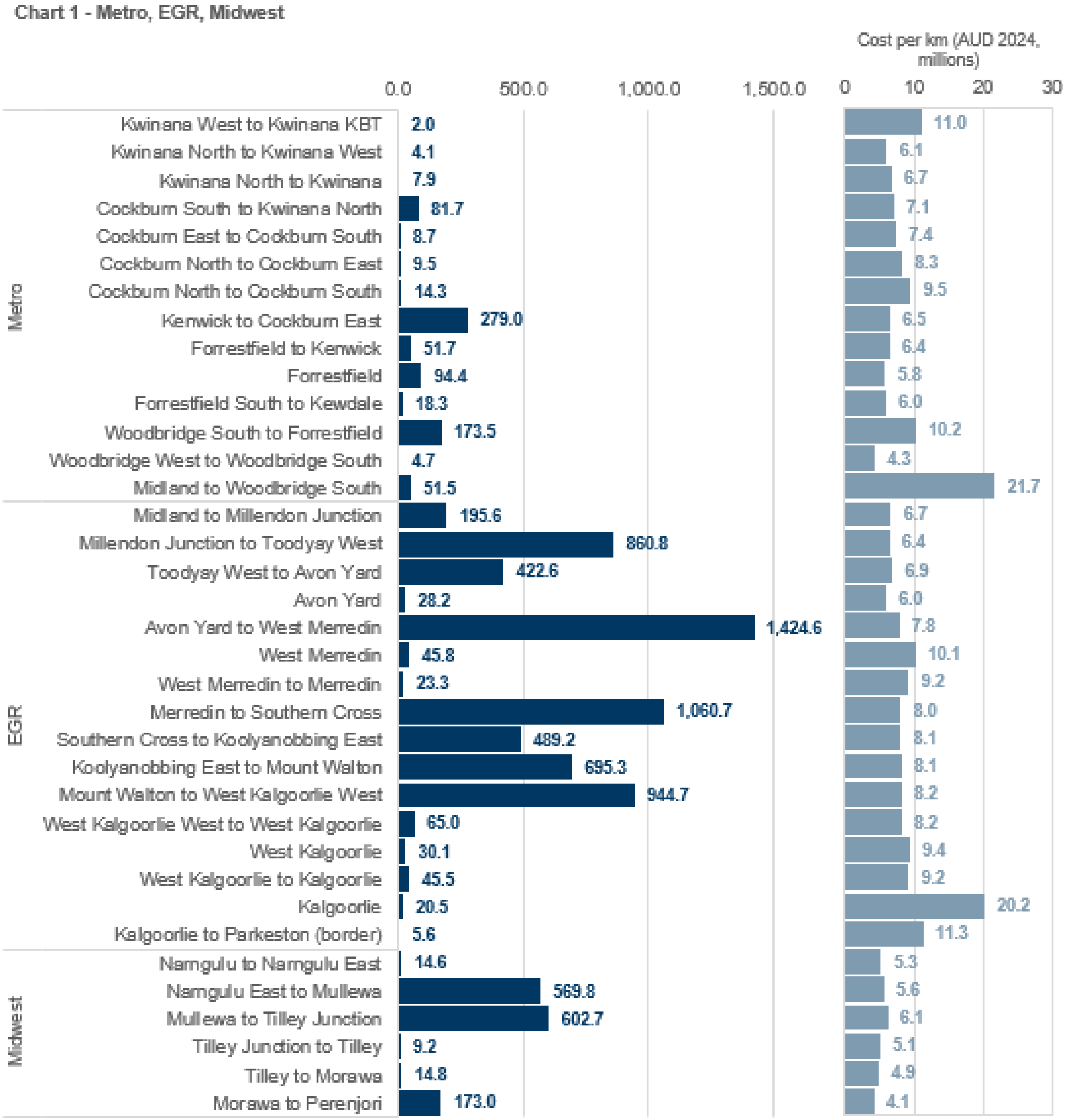


Figure 5-10   Chart 1 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route

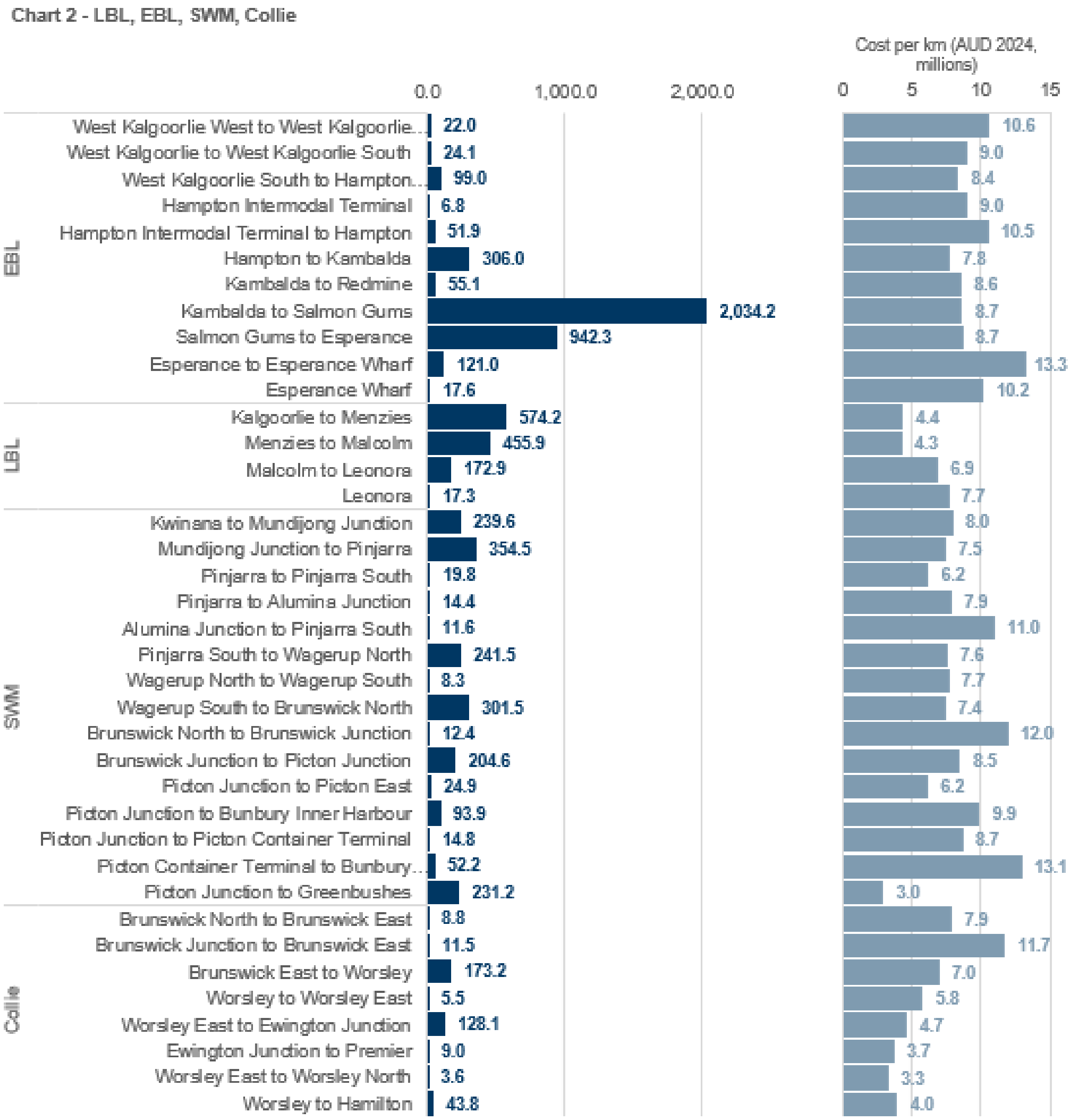


Figure 5-11 Chart 2 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route

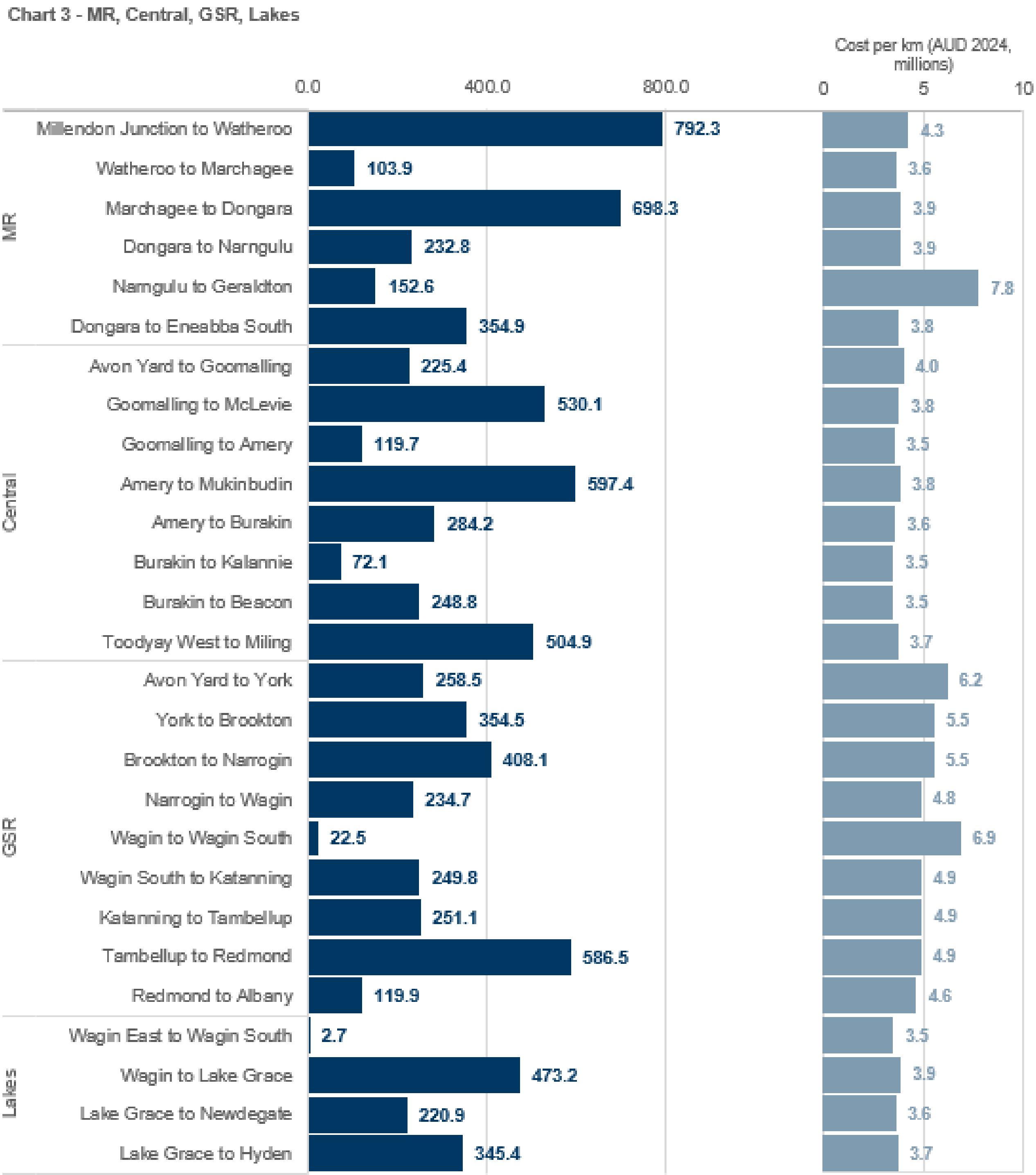


Figure 5-12 ***Chart 3 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route***

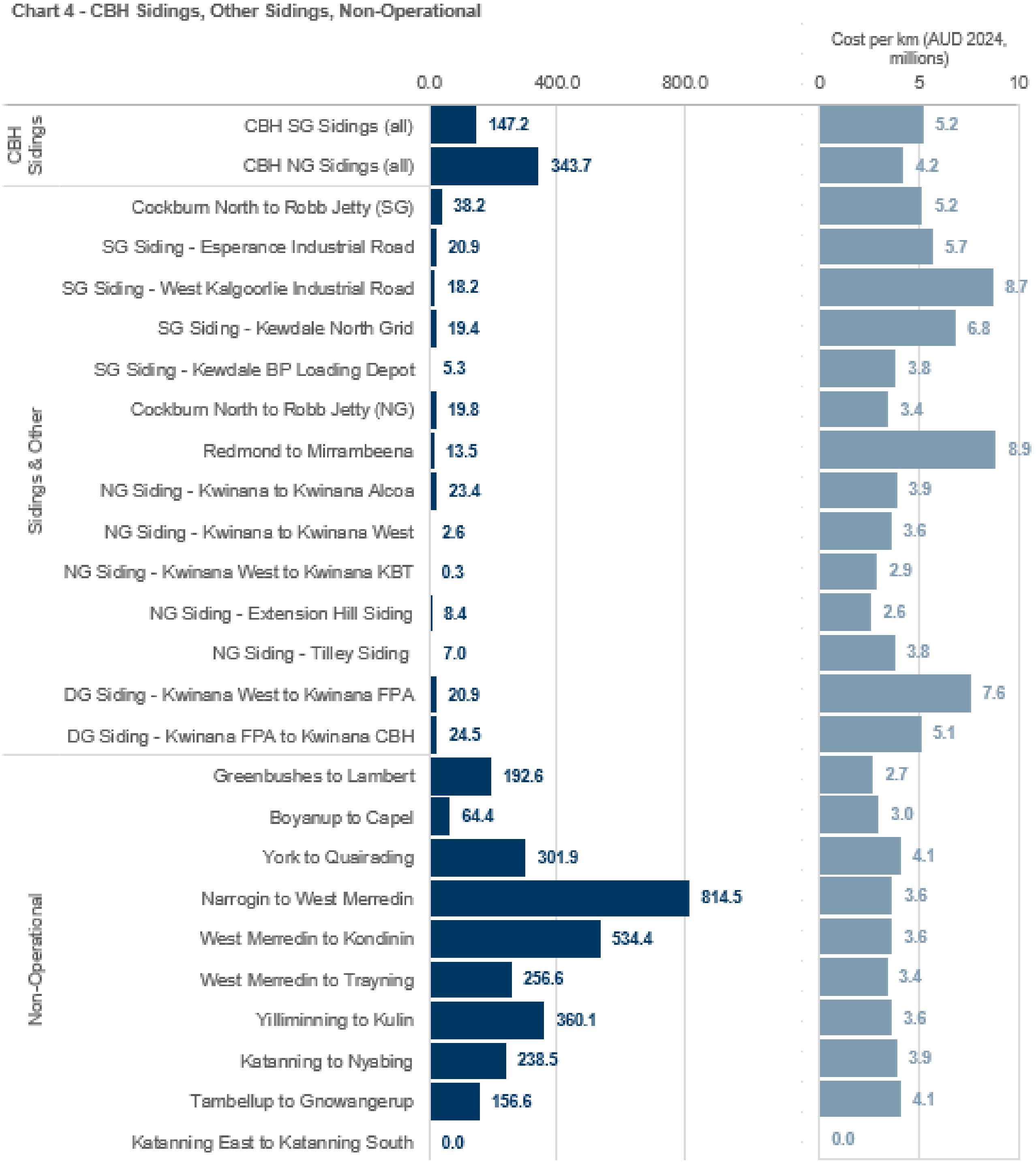


Figure 5-13 Chart 4 - Optimised Replacement Cost (including Railway Owner Costs) Summary by Route

6. Depreciated Optimised Replacement Cost

6.1 Approach to Depreciation

The purpose of depreciation is to recognise that the existing assets are not new, a proportion of the invested capital will already have been recovered and that they are likely to have reduced remaining service potential when compared to a new alternative replacement. This is distinct from financial depreciation because the assessment of depreciation for a DORC is based on remaining service potential of the existing assets at the valuation date. This is because depreciation adjustment also recognises that a proportion of any life-extending investments in the assets may also have been recovered.

As the alternative replacement represents the least cost approach to constructing an asset that provides the same (or comparable) level of service as the existing assets, the value of the remaining service potential of the existing assets is achieved by reducing the new replacement cost in proportion to the remaining Economic Life of the existing assets.[62]

Economic Life reflects the period of an asset's usefulness for its owner, or the period over which the Railway Owner intends to recover the investment. The assessment of Economic Life is to consider:[63]

– the current physical condition of the asset;
– the forecast rate at which the asset will be consumed; and
– the Economic Life of the asset based on the current physical condition of the asset and forecast rate of consumption.

The Economic Life is therefore the duration an asset is expected to generate revenue efficiently and reliably for the service it was designed for, assuming appropriate and industry good practice maintenance takes place.

6.1.1 Assessment of physical condition of the asset

Assessments of the physical condition of the asset determine the expected duration until an asset is replaced or until the next life-extending maintenance activity is expected to be required. This considers the asset's current condition assuming that reasonable regular maintenance is carried out and includes the cumulative value of any past investments which extended the life of the asset. The assessment of asset condition and likely time to next life extending maintenance followed the hierarchy of approaches depending on the level of data available as shown in Table 6-1Table .

[62] Costing Principles, Arc Infrastructure, 30 May 2024, 2.7
[63] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.7

Table 6-1 Remaining Life Assessment Hierarchy

Step	Basis of Remaining Life Assessment
If condition data exists:	Remaining life based on condition assessments derived from condition data.
If condition data does not exist, but commissioning date is known:	The time from commissioning was used, adjusted to reflect any deviation from industry normal deterioration rates evident from those assets where condition data is available. For assets in service, a minimum of 10% of Useful Life was applied to recognise the service provided by assets that are at the end of their lives. For most assets not in service, 0% of Useful Life has been applied on the basis that these assets are not currently able to deliver a services because of their condition.
If neither condition nor commissioning date is known:	For these assets there is no evidence to suggest a level of maintenance any different to the remainder of the Route Section. A Route Section weighted average deprecation rate will be applied to these assets, based on operating sections where condition data is known. The depreciation proportion is weighted by asset value. This will calculated as follows: $\text{Weighted Average Remaining Life}_R = \frac{\sum_{i=1}^{n}(\text{ORC}\times\text{Remaining Life})}{\sum_{i=1}^{n}\text{ORC}}$ Where: R = Route Section i = Asset ID within Route Section R n = the number of discrete asset IDs within Route Section R.

The reference in Table to depreciating to a minimum non-zero remaining life for assets in service aligns with DORC principles by recognising the value that the asset continues to provide.

A minimum of 10% life was selected as a reasonable minimum on the basis that for a typical major infrastructure asset with a 50 year design life, this represents five years, which is a reasonable duration for replacement. This therefore effectively assumes that asset replacement would be initiated at the valuation date.

The 10% minimum remaining life also follows regulatory precedent, including:

– 10% of the design life was used in the ACCC’s DORC for the ARTC network. A percentage was used because some of the assets in a rail network have shorter lives than the 50 years

– ARTC Standard Rail Network DORC, Booz Allen Hamilton, Feb 2001 used 10%: *‘In the event that a structure is in excess of 100 years old it is given a nominal remaining life of 10 years, i.e. 10% of its full life, to reflect the fact that it is still in service and therefore has some value.’*

– A minimum of 5 years remaining life was used in the valuation of assets for the Port of Newcastle declaration, in evidence before the ACCC and the Australian Competition Tribunal. As most assets had a useful life of 50 years, this equates to 10%.

– In its 2005 Ergon Energy Price review, the QCA adopted a minimum remaining service life of 3-5 years (depending on asset) to recognise the continued service beyond their standard life.

6.1.2 Rate of asset consumption

The replacement cost of the asset is reduced to reflect the accumulated depreciation up to the valuation date. The reduction was based on the Economic Life of the asset at the valuation date, relative to an assets Standard Design Life.

The assessment of the consumption of the asset refers to the duration over which there are likely to be demand for the service provided for the assets. The Costing Principles require that a proportional (straight line) depreciation is applied to represent the likely future rate of consumption.

In this application, a new asset’s Standard Design Life is the estimated life of the asset from its commissioning date to end of life, if only routine maintenance (i.e. maintenance that does not materially extend the asset’s life) is undertaken. Standard Design Lives have been taken from the Arc Costing Principles.[64] Where Standard Design Lives for specific asset types are not listed in the Costing Principles, national or international design standards or codes were used. Assets with the same form of MEA were assigned the same Standard Design Life.

This assessment of accumulated depreciation inherently includes the effect of any life-extending investments in the asset, asset commissioning date and asset condition (as per Section 2.7 of the Arc Costing Principles).

The Economic Life of the asset is then compared to the Standard Design Life and the optimised replacement cost for that asset reduced proportionally. This effectively assumes a linear reduction in asset service potential with time.

The demand for the assets is defined as:

- Maximum axle loads;
- Maximum train speeds; and
- Maximum train lengths.

GHD has seen no evidence to suggest that there will be a material change in these demand requirements that could indicate a deviation from the linear approach to depreciation prescribed in the Costing Principles is warranted.

The ability of some asset types to deliver the level of service does not deteriorate over time, providing appropriate routine (non-life extending) maintenance is undertaken. This would typically apply to land for example. This means that the Economic Life of these assets is equal to the Standard Design Life, which results in no depreciation. This is reasonable because there is no material degradation in service level over time.

There are also assets that may reach end of life because of technical obsolescence, rather than condition. This may apply to signalling for example.

The application of depreciation methods to each asset class is discussed in the following sections.

[64] Costing Principles, Arc Infrastructure, 30 May 2024, Appendix 2 – Standard Design Lives (referred to as Effective Life)

6.2 Right of Way

Right of Way includes:

- Clearing and grubbing;
- Cuttings and embankments;
- Formation; and
- Access Roads.

These considerations are discussed with respect to Right of Way are listed below.

Table 6-2 Application of Depreciation Approach to Right of Way

No.	Consideration	Application to Right of Way
1	Current physical condition	**Clearing and grubbing, cuttings, embankments and formation** Clearing and grubbing occurs prior to (and the area is then covered by) the construction of cuttings, embankments and/or formation. Regular maintenance (e.g. vegetation trimming and clearing of culverts and drainage paths) is undertaken so that the level of service provided by cuttings, embankments and formation does not reduce over time. This regular maintenance is operating costs and not included in this DORC. The physical condition (and therefore level of service) of these assets are therefore the same as new assets. **Access Roads** The condition of access roads is likely to reduce over time, in proportion to usage and maintenance activities. These assets are depreciated.
2	Rate at which the asset will be consumed.	**Clearing and grubbing, cuttings, embankments and formation** As the life of these assets does not reduce as a consequence of use, the rate at which the assets will be consumed over time is zero. **Access Roads** The rate at which the life of these assets reduce is discussed in 6.2.4.
3	The economic life	In principle, there is no constraint on the economic life of these assets (unless the track section that they relate to has a finite life).

6.2.1 Clearing and Grubbing

In determining the Economic Life of the asset, the Costing Principles require that the Economic Life of the asset be compared to the Standard Design Life and the optimised replacement cost reduced proportionally.[65] This reflects the accepted principle that a DORC is predicated on the basis that the value of the existing assets considers their remaining service potential, when compared to a new alternative.

As the condition and rate of consumption of the existing assets is the equal to the Standard Design Life[66], a 100-year Economic Life has therefore been applied.

[65] Costing Principles, Arc Infrastructure, 30 May 2024, Section 2.7
[66] Costing Principles, Arc Infrastructure, 30 May 2024, Appendix 2

6.2.2 Cuttings and Embankments

Cuttings and embankments do not physically deteriorate with time, provided adequate maintenance (e.g. drain clearance) is undertaken.

This reflects the accepted principle that a DORC is predicated on the basis that the value of the existing assets considers their remaining service potential, when compared to a new alternative. As the condition and rate of consumption of the existing assets is the equal to the Standard Design Life,[67] a 100-year Economic Life has therefore been applied.

6.2.3 Formation

Formation, as with cuttings and embankments, does not physically deteriorate with time, provided adequate maintenance (e.g. drain clearance) is undertaken.

This means the service life for the existing formation would be the same as the Standard Design Life[68]. An Economic Life of 100 years has therefore been applied.

6.2.4 Access Roads

Condition data was not available for these assets but as these assets are typically unsealed tracks with relatively short Economic Lives (probably of about 10 years), any condition data would be of limited value.

We have assumed that there is reasonable correlation between the weighted average economic life of the section and that of the access roads within it.[69] This is on the basis that those sections with a relatively long economic life would have been accessed relatively recently and/or frequently for maintenance or replacement purposes, so therefore the access roads would have been similarly recently maintained or replaced to support such activity.

Consequently, the weighted average depreciation by Route Section has been used as a proxy for the depreciation of the access tracks.

[67] Costing Principles, Arc Infrastructure, 30 May 2024, Appendix 2
[68] Costing Principles, Arc Infrastructure, 30 May 2024, Appendix 2
[69] The 'Weighted Average Remaining Life' of the Route Section means the average remaining life of just the assets where sufficient data is known to estimate remaining life, weighted by replacement cost.

6.2.5 Depreciated Optimised Replacement Cost – Right of Way

The depreciated optimised replacement cost for right-of-way assets is shown in Table 6-3.

Table 6-3 Depreciated Optimised Replacements Cost - Right of Way

Asset Class	Optimised Replacement Cost ($million)	Depreciation ($million)	Depreciated Optimised Replacement Cost ($million)
Alternative A			
Clearing and Grubbing	116.8	0.0	116.8
Cutting and Embankments	31.8	0.0	31.8
Formation	2,755.2	0.0	2,755.2
Access Roads	1,047.7	-538.8	508.9
TOTAL	**3,951.4**	**-538.8**	**3,412.6**
Alternative B			
Clearing and grubbing	117.2	0.0	117.2
Cutting and Embankments	31.9	0.0	31.9
Formation	2,765.8	0.0	2,765.8
Access Roads	1,051.8	-530.3	521.5
TOTAL	**3,966.7**	**-530.3**	**3,436.4**

Table 6-4 Right of Way Remaining Life (percent) and Depreciated Optimised Replacement Cost ($ million)

		Right of Way activity				
Network Group	ORC ($ million)	Clearing and Grubbing ($ million)	Cutting and Embankments ($ million)	Formation ($ million)	Access Roads ($ million)	DORC ($million)
Alternative A						
ORC		116.8	31.8	2,755.2	1,047.7	
Metro	88.9	100%	-	100%	40%	80.6
EGR	959.5	100%	-	100%	58%	895.3
Midwest	385.0	100%	100%	100%	56%	358.7
EBL	595.3	100%	-	100%	66%	545.4
LBL	118.5	100%	-	100%	71%	101.0
SWM	250.6	100%	-	100%	44%	219.3
Collie	25.0	100%	-	100%	55%	19.1
MR	221.8	100%	-	100%	57%	172.4
Central	249.5	100%	-	100%	50%	186.2
GSR	584.7	100%	-	100%	65%	554.7
Lakes	108.2	100%	-	100%	64%	88.3
CBH Sidings	38.7	100%	-	100%	47%	28.8
Sidings & Other	14.4	100%	-	100%	69%	11.8
Non-Operational	311.3	100%	-	100%	0%	151.0
TOTAL	3,951.4	**116.8**	**31.8**	**2,755.2**	**508.9**	**3,412.6**

Alternative B						
ORC		117.2	31.9	2,752.0	1,051.8	
Metro	89.2	100%	-	100%	40%	82.4
EGR	963.2	100%	-	100%	58%	901.7
Midwest	386.5	100%	100%	100%	56%	360.9
EBL	597.6	100%	-	100%	66%	548.6
LBL	119.0	100%	-	100%	71%	101.4
SWM	251.6	100%	-	100%	44%	221.2
Collie	25.1	100%	-	100%	55%	19.5
MR	222.6	100%	-	100%	57%	173.9
Central	250.5	100%	-	100%	50%	187.5
GSR	586.9	100%	-	100%	65%	558.0
Lakes	108.6	100%	-	100%	64%	88.7
CBH Sidings	38.9	100%	-	100%	47%	29.1
Sidings & Other	14.4	100%	-	100%	69%	11.8
Non-Operational	312.5	100%	-	100%	0%	151.5
TOTAL	**3,966.7**	**117.2**	**31.9**	**2,752.0**	**521.5**	**3,436.4**

6.3 Civil Structures

Civil structures are typically long-lived assets. The Costing Principles define the Standard Design Life of bridges and tunnels as 100 years. In practice, it is not uncommon for civil infrastructure to continue to provide a service after the Standard Design Life has expired, provided adequate routine maintenance is undertaken.

These considerations are discussed in this section with respect to individual civil structures.

6.3.1 Bridges

A hierarchy of approaches to determine the remaining life was applied to make best use of the data that was available, as summarised below.

Table 6-5 Bridge Depreciation Approach

Method No	Method	Basis	Percentage of ORC
1	Any bridges on non-operational routes were fully depreciated to zero.	Non-operational status of route reflects depreciated condition of assets.	22%
2	Where the date of installation is known, linear depreciation to the valuation date has been applied. If the date of installation is not known, method 3 was applied.	Bridges are long-lived assets and typically continue to provide a service through (and sometimes beyond) their design life with minimal life extending maintenance interventions.	21%
3	The average age of the bridges in the same Network Group was used, and linear depreciation to the valuation date applied. If there are no other bridges within the same Network Group, method 4 was used.	In the absence of asset specific age data, GHD has assumed that all bridges on the same Network Group are likely to be of a similar age or maintained such that they all have a similar proportion of life remaining.	47%
4	The average age of the bridges across the Arc network was used, and linear depreciation to the valuation date applied.	In the absence of asset or Network Group age data, GHD has assumed that the average of known data across the network is likely to be reasonable proxy for the age.	11%
Note	A minimum remaining life of 10% was assumed in methods 2-4 for any in-service assets that are at or beyond the end of their useful life.	Follows regulatory precedent by capturing the value of the ongoing service that life-expired assets continue to provide. See further discussion in section 6.1.	

The ORC was depreciated by the percentage life remaining for each asset to determine the DORC. The average life remaining percentage for each MEA type in each Network Group, and the resulting DORC are shown in Table 6-6.

Table 6-6 Bridges Average Remaining Life (percent) and Depreciated Optimised Replacement Cost ($ million)

		Bridge MEA					
Network Group	**ORC ($million)**	**Type 1 - PCBC**	**Type 2a - PSC Plank**	**Type 2b - PSC Teeroff**	**Type 3 - Steel Composite**	**Type 4 - Steel Composite**	**DORC ($million)**
Alternative A							
ORC		98.3	315.7	113.8	182.4	135.0	
Metro	91.2	-	-	46%	55%	64%	51.7
EGR	85.8	-	-	46%	69%	46%	44.5
Midwest	67.0	65%	43%	-	-	-	9.6
EBL	0.9	-	29%	-	-	-	0.3
LBL	25.3	-	44%	-	-	-	11.5
SWM	150.6	10%	25%	20%	35%	-	41.5
Collie	23.1	-	27%	11%	41%	-	7.0
MR	77.9	-	45%	24%	33%	-	29.3
Central	55.7	44%	48%	-	-	46%	26.4
GSR	128.6	47%	48%	47%	53%	46%	61.4
Lakes	4.1	43%	51%	-	-	-	2.1
CBH Sidings	-	-	-	-	-	-	-
Sidings & Other	14.9	-	-	46%	-	-	6.8
Non-Operational	120.2	-	-	-	-	-	-
TOTAL	**845.1**	**12.7**	**99.5**	**37.3**	**81.4**	**61.3**	**292.0**
Alternative B							
ORC		98.4	316.9	114.3	183.1	135.5	
Metro	91.5	-	-	46%	55%	64%	51.9
EGR	86.1	-	-	46%	69%	46%	44.7
Midwest	68.0	65%	43%	-	-	-	9.5
EBL	0.9	-	29%	-	-	-	0.3
LBL	25.4	-	44%	-	-	-	11.5
SWM	151.2	10%	25%	20%	35%	-	41.7
Collie	23.2	-	27%	11%	41%	-	7.1
MR	78.2	-	45%	24%	33%	-	29.4
Central	55.9	44%	48%	-	-	46%	26.5
GSR	129.1	47%	48%	47%	53%	46%	61.6
Lakes	4.1	43%	51%	-	-	-	2.1
CBH Sidings	-	-	-	-	-	-	-
Sidings & Other	14.9	-	-	46%	-	-	6.9
Non-Operational	120.6	-	-	-	-	-	-
TOTAL	**849.3**	**12.5**	**99.9**	**37.4**	**81.7**	**61.6**	**293.1**

6.3.2 Tunnels

In principle, the approach applied to bridges discussed above is equally applicable to tunnel assets.

GHD has not seen any data on the age or condition of the tunnel assets. As a proxy, GHD has applied the average Economic Life of the bridge assets on the same Network Group as the tunnel. This is on the basis that tunnel assets are likely to have been subject to similar life extending maintenance effort as bridges.

The percentage life remaining and depreciated optimised replacement cost of the tunnels is shown in Table 6-7.

Table 6-7 Tunnels Average Remaining Life (percent) and Depreciated Optimised Replacement Cost ($ million)

Network Group	ORC (million)	% Remaining Life	DORC (million)
Alternative A			
Metro	28.4	55%	**15.6**
EGR	-	-	**-**
Midwest	-	-	**-**
EBL	30.0	29%	**8.7**
LBL	-	-	**-**
SWM	-	-	**-**
Collie	-	-	**-**
MR	53.3	38%	**22.9**
Central	-	-	**-**
GSR	-	-	**-**
Lakes	-	-	**-**
CBH Sidings	-	-	**-**
Sidings & Other	-	-	**-**
Non-Operational	-	-	**-**
TOTAL	**111.6**	**42%**	**47.2**
Alternative B			
Metro	28.5	55%	15.7
EGR	-		-
Midwest	-		-
EBL	30.1	29%	8.7
LBL	-		-
SWM	-		-
Collie	-		-
MR	53.5	38%	23.0
Central	-		-
GSR	-		-
Lakes	-		-
CBH Sidings	-		-
Sidings & Other	-		-
Non-Operational	-		-
TOTAL	**112.1**	**42%**	**47.4**

6.3.3 Culverts

Culvert remaining life is based on the install year, against a Standard Design Life of 50 years (Table 6-8). Whilst maintenance is undertaken (e.g. culvert clearing), these activities are to maintain function, rather than extend life. On this basis, a linear depreciation from install date is appropriate.

Culverts would typically be installed as a route was constructed, similar to other civil structures on that route. The same steps as used for bridges has been applied, as summarised below.

Table 6-8 Culvert Depreciation Approach

Method No	Method	Basis	Percentage of ORC
1	Any culverts on non-operational routes were fully depreciated to zero.	Non-operational status of route reflects depreciated condition of assets.	1%
2	Where the date of installation is known, linear depreciation to the valuation date has been applied. If the date of installation is not known, method 3 was applied.	Linear depreciation assumes minimal life-extending interventions throughout the asset life, which is typical for culvert assets. Install date was known for a significant proportion of the culvert assets. See Table	92%
3	The average age of the culverts in the same Network Group was used, and linear depreciation to the valuation date applied. If there are no other culverts within the same Network Group, method 4 was used.	In the absence of asset specific age data, GHD has assumed that all culverts on the same Network Group are likely to be of a similar age or maintained such that they all have a similar proportion of life remaining.	3%
4	The average age of the culverts across the Arc network was used, and linear depreciation to the valuation date applied.	In the absence of asset or Network Group age data, GHD has assumed that the average of known data across the network is likely to be reasonable proxy for the age.	1%
Note	A minimum remaining life of 10% was assumed in methods 2 to 4 for any in-service assets that are at or beyond the end of their useful life.	Capturing the value of the service that is provided by the assets. See further discussion in 6.1.	3%

Table 6-9 Culverts Average Remaining Life (percent) and Depreciated Optimised Replacement Cost ($ million)

		Culvert Depreciation Optimised Replacement Cost ($ million) by diameter (mm)								
Network Group	**ORC ($ million)**	**600**	**900**	**1200**	**1500**	**1800**	**2400**	**3000**	**3600**	**DORC**
Alternative A										
ORC		272.5	54.0	52.5	13.4	63.2	22.3	24.7	2.2	
Metro	9.8	53%		52%	51%	49%	54%	52%		**4.7**
EGR	55.1	22%	38%	23%	38%	25%	12%	43%	47%	**12.1**
Midwest	33.6	55%	66%	65%	71%	71%	71%	71%		**19.3**
EBL	21.5	60%	59%	59%	47%	61%	64%	62%	66%	**13.1**
LBL	48.5	45%	50%	42%	46%	56%	43%	43%	47%	**23.2**
SWM	24.2	22%	0%	14%	35%	35%	23%	29%		**8.4**
Collie	87.6	69%	69%	69%	69%	69%	69%	24%		**60.5**
MR	17.8	29%	33%	33%	33%	34%	35%	29%	62%	**5.8**
Central	115.5	80%	80%	79%	78%	83%	51%	66%	80%	**102.6**
GSR	62.4	72%	72%	73%	71%	71%	72%	72%	72%	**49.8**
Lakes	20.6	56%	56%	66%	56%	56%	56%	17%		**12.5**
CBH Sidings	0.1	62%	62%							**0.1**
Sidings & Other	8.0	69%			54%					**6.0**
Non-Operational	-									**-**
TOTAL	**504.8**	**154.6**	**41.3**	**42.7**	**9.4**	**50.6**	**6.3**	**12.2**	**1.0**	**318.1**
Alternative B										
ORC		273.5	54.2	52.8	13.4	63.5	22.4	24.8	2.2	
Metro	9.8	58%		57%	57%	58%	56%	56%		**6.4**
EGR	55.3	22%	38%	23%	38%	25%	12%	43%	47%	**12.2**
Midwest	33.7	55%	66%	65%	71%	71%	71%	71%		**19.3**
EBL	21.6	60%	59%	59%	47%	61%	64%	62%	66%	**13.1**
LBL	48.7	45%	50%	42%	46%	56%	43%	43%	47%	**23.3**
SWM	24.3	22%	0%	14%	35%	35%	23%	29%		**8.4**
Collie	88.0	69%	69%	69%	69%	69%	69%	24%		**60.7**
MR	17.9	29%	33%	33%	33%	34%	35%	29%	62%	**5.9**
Central	115.9	80%	80%	79%	78%	83%	51%	66%	80%	**103.0**
GSR	62.7	72%	72%	73%	71%	71%	72%	72%	72%	**50.0**
Lakes	20.7	56%	56%	66%	56%	56%	56%	17%		**12.6**
CBH Sidings	0.1	64%	64%							**0.1**
Sidings & Other	8.0	71%			54%					**6.1**
Non-Operational	-									**-**
TOTAL	**506.7**	**156.9**	**41.5**	**42.9**	**9.4**	**50.8**	**6.3**	**12.2**	**1.0**	**321.1**

6.3.4 Depreciated Optimised Replacement Cost – Civil Structures

The depreciated optimised replacement cost for civil structures assets is shown in Table 6-10.

Table 6-10 Depreciated Optimised Replacement Cost – Civil Structures

Asset Class	Optimised Replacement Cost ($million)	Depreciation ($million)	Depreciated Optimised Replacement Cost ($million)
Alternative A			
Bridges	845.1	-553.1	292.0
Tunnels	111.6	-64.4	47.2
Culverts	504.8	-186.7	318.1
TOTAL	**1,461.5**	**-804.1**	**657.4**
Alternative B			
Bridges	848.3	-555.2	293.1
Tunnels	112.1	-64.6	47.4
Culverts	506.7	-185.7	321.1
TOTAL	**1,467.1**	**-805.5**	**661.6**

6.4 Track

Standard lives for rail, sleepers, ballast and turnouts are different and vary by application. Each is discussed in the following sections.

6.4.1 Rail

The Standard Design Life of track assets varies as a function of operational loads. The Costing Principles define the life of track assets as follows:

– 10 years for track on curves up to 400m radius;

– 15 years for track on curves between 400m and 800m radius; and

– 70 years for curves greater than 800m radius and tangents.

Remaining Life data was provided to GHD as percentages of Standard Design Life, which inherently included consideration of the variance in life with radius.

A hierarchy of approaches to determine the Economic Life was applied to make best use of the data that was available, as summarised below. The summary remaining life for rail assets is shown in Table 6-12.

Table 6-11 Rail Depreciation Approach

Method No	Method	Basis	Percentage of ORC
1	Any rail on non-operational routes were fully depreciated to zero.	Non-operational status of route reflects depreciated condition of assets.	20%
2	Where rail condition data at the valuation date is known, linear depreciation from the valuation date has been applied.	Remaining life estimates based on condition data was provided by Arc. The remaining rail life was determined by comparing the rail's current wear level to the threshold limits defined in the relevant code of practice, which sets maximum allowable wear for safe operation. The wear is typically measured in both vertical and lateral dimensions and provided as a percentage of rail head loss. As the	76%

Method No	Method	Basis	Percentage of ORC
	If condition data is not known, method 3 was applied.	rail approaches these limits, its remaining life decreases. Once the wear exceeds the threshold, the rail must be replaced to ensure safety and performance. This data categorised remaining life into four condition bands: – Less than 10 percent life remaining – 10 to 25 percent life remaining – 25 to 50 percent life remaining – More than 50 percent life remaining The total length of rail with condition data was calculated as follows: – We have assumed a normal distribution of rail condition within a remaining life range and have based the assessment on the mid-point of the range – Rail life was determined for lengths of individual rail, not by lengths of track.	
3	The average remaining life (weighted by ORC) of the assets in the same route section was used, and linear depreciation.	In the absence of rail specific age data, a weighted remaining life for the Route Section was applied to the rail lengths without condition data. This was assumed to be a reasonable proxy for rail condition on the basis that the maintenance effort applied is likely to be broadly consistent across all assets in the same Route Section.	4%
Note	A minimum remaining life of 10% was assumed for any in-service assets that are at or beyond the end of their useful life.	Follows regulatory precedent by capturing the value of the ongoing service that life-expired assets continue to provide. See further discussion in Section 6.1.	0%

Table 6-12 Rail Life Assessment

Rail Remaining Life Range	Percentage Life Remaining Assumed	Kilometres of Rail	Percentage of Rail kilometres
50% ≤ 100%	75.0%	317.2	3%
25% < 50%	37.5%	7,358.4	68%
10% < 25%	17.5%	653.7	6%
0 < 10%	10%	7.1	0%
No condition data		2,516.9	23%
TOTAL		**10,853.3**	**100%**

The distribution of track wear across the network is shown in Figure 6-1.

The rail length remaining life broken down by Network Group is shown below.

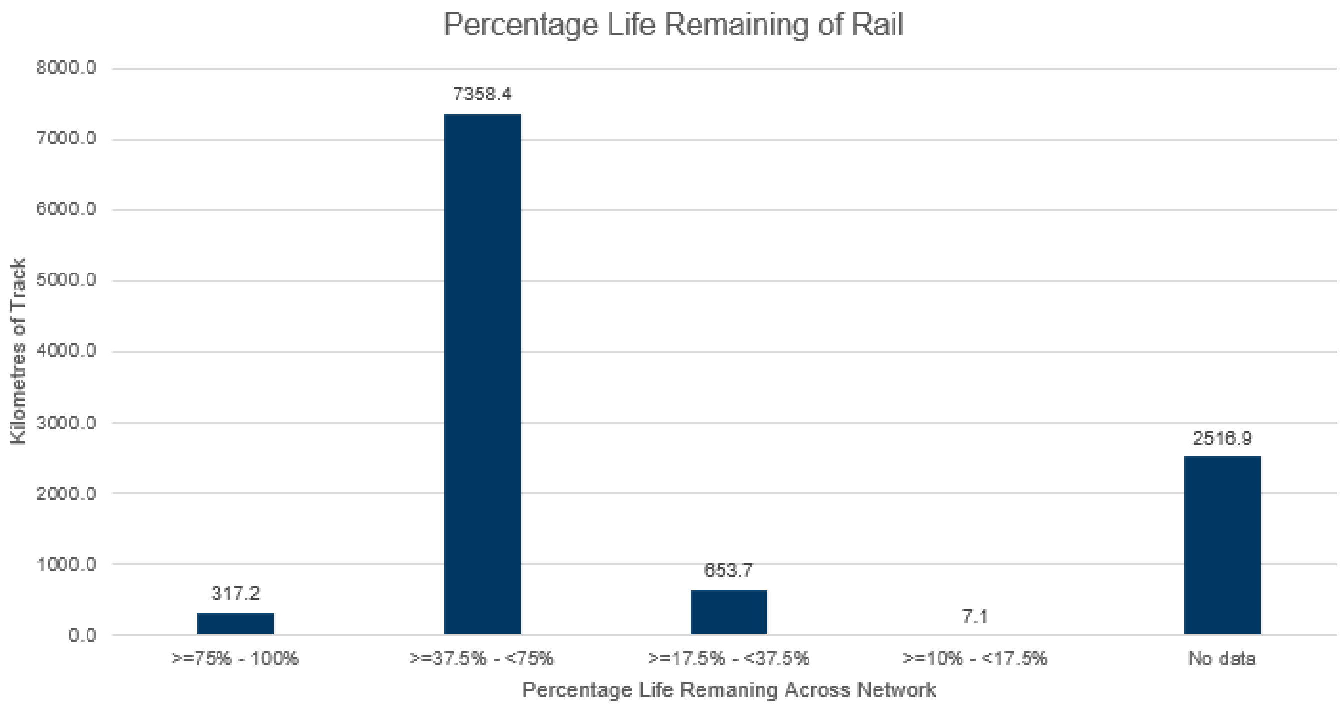


Figure 6-1 Rail Wear Distribution

Table 6-13 Rail Weighted Remaining Life

Network Group	Rail Length (km) by percentage Remaining Life					
	75.0%	37.5%	17.5%	10%	No data	Total
Metro	9.7	249.6	1.8	0.0	50.2	311.2
EGR	132.9	1,578.8	0.0	0.0	157.9	1,869.6
Midwest	51.6	489.4	0.0	0.0	66.3	607.3
EBL	25.7	799.0	2.9	0.0	17.2	844.8
LBL	5.9	520.8	0.0	0.0	4.6	531.3
SWM	32.1	352.6	1.7	0.0	173.1	559.6
Collie	0.3	138.3	0.0	0.0	1.0	139.6
MR	10.3	929.1	0.0	0.0	199.2	1,138.5
Central	7.6	751.6	623.6	3.0	3.0	1,388.8
GSR	9.0	927.7	9.5	0.0	15.2	961.3
Lakes	6.1	541.6	4.3	1.4	2.1	555.5
CBH Sidings	17.4	41.7	9.8	2.7	148.3	219.9
Sidings & Other	8.8	38.3	0.0	0.0	49.9	97.0
Non-Operational	0.0	0.0	0.0	0.0	1,628.9	1628.9
TOTAL	**317.2**	**7,358.4**	**653.7**	**7.1**	**2,516.9**	**10,853.3**

The depreciated optimised replacement cost for rail assets is shown in Table 6-14.

Table 6-14 Rail Assets Depreciated Optimised Replacement Cost

Network Group	ORC	Average Weighted Remaining Life	Depreciation ($million)	DORC ($million)
Alternative A				
Metro	231.7	52%	-86.6	**145.2**
EGR	1,760.0	58%	-607.4	**1,152.5**
Midwest	591.6	61%	-257.2	**334.4**
EBL	943.5	59%	-304.9	**638.5**
LBL	584.4	70%	-174.2	**410.2**
SWM	491.9	53%	-260.2	**231.7**
Collie	123.4	60%	-53.8	**69.6**
MR	1,091.5	63%	-491.5	**599.9**
Central	1,238.0	45%	-737.3	**500.6**
GSR	928.6	62%	-314.6	**614.0**
Lakes	531.4	59%	-196.6	**334.8**
CBH Sidings	192.8	49%	-97.9	**94.9**
Sidings & Other	77.1	74%	-24.9	**52.2**
Non-Operational	1,516.0	0%	-1,516.0	**-**
TOTAL	**10,301.9**		**-5,123.3**	**5,178.6**

Network Group	ORC	Average Weighted Remaining Life	Depreciation ($million)	DORC ($million)
Alternative B				
Metro	232.6	70%	-75.2	**157.4**
EGR	1,766.6	59%	-607.7	**1,159.0**
Midwest	593.8	62%	-258.1	**335.7**
EBL	947.0	59%	-305.8	**641.2**
LBL	586.6	69%	-174.9	**411.6**
SWM	493.7	55%	-260.0	**233.7**
Collie	123.9	60%	-54.0	**69.8**
MR	1,095.6	64%	-492.7	**602.9**
Central	1,242.6	45%	-740.1	**502.5**
GSR	932.1	63%	-315.6	**616.5**
Lakes	533.5	59%	-197.4	**336.1**
CBH Sidings	193.6	50%	-98.0	**95.6**
Sidings & Other	77.4	67%	-27.4	**50.0**
Non-Operational	1,521.8	0%	-1,521.8	**-**
TOTAL	**10,340.8**		**-5,128.6**	**5,212.1**

6.4.2 Sleepers

Sleeper remaining life is based on the type of sleeper and the install year, factored to account for sleeper pattern within each track section. The Standard Design Life of each sleeper type as per the Costing Principles is as shown in Table 6-15.

Table 6-15 Sleeper Useful Life

Timber type	Useful Life (years)
Timber	15
Concrete	50
Steel	40

The sleeper depreciation is based on the approach is shown below.

Table 6-16 Sleeper Depreciation Approach

Method No	Method	Basis	Percentage of ORC
1	Linear depreciation based on the year the sleeper was installed and the Standard Design Life.	Arc provided data on sleeper install year, length of track, sleeper type and sleeper pattern at a high level of track unit granularity. These were combined to determine the proportion of life remaining in each track unit by weighting sleeper age by pattern and track unit length.	46%
2	Where install year was not known, the weighted remaining life of the Route Section was used.	In the absence of specific age data, a weighted remaining life for the Route Section was applied to the sleepers without condition data. This was assumed to be a reasonable proxy for sleeper condition on the basis that the maintenance effort applied is likely to be broadly consistent across all assets in the same Route Section.	54%
Note	A minimum remaining life of 10% was assumed for any in-service assets that are at or beyond the end of their useful life.	Follows regulatory precedent by capturing the value of the ongoing service that life-expired assets continue to provide. See further discussion in Section 6-1.	0%

The distribution of sleeper remaining life is shown in Table 6-17. The life of fastenings has not been separately considered because we have assumed that fastenings would be replaced with sleepers.

Table 6-17 Sleeper Weighted Remaining Life

Network Group	Number of sleepers			Weighted Remaining Life (%)		
	Steel	Timber	Concrete	Steel	Timber	Concrete
Metro	2,247	6,004	135,541	74%	38%	34%
EGR	21,818	51,382	1,160,015	68%	69%	27%
Midwest	50,141	88,636	316,218	42%	42%	75%
EBL	255,899	319,409	54,588	39%	39%	38%
LBL	143,433	257,246	186	64%	64%	66%
SWM	11,168	32,519	259,691	18%	18%	63%
Collie	27,893	27,785	38,022	60%	60%	61%
MR	347,349	382,544	22,357	77%	77%	79%
Central	450,228	447,659	37,264	48%	47%	54%
GSR	289,003	324,591	16,942	40%	40%	41%
Lakes	180,069	185,366	1,078	50%	50%	50%
CBH Sidings	34,180	104,080	953	45%	45%	-
Sidings & Other	12,042	22,410	21,480	96%	96%	96%
Non-Operational	184,287	765,453	394	-	-	-
TOTAL	**2,009,757**	**3,015,084**	**2,064,729**			

Table 6-18 Sleeper Assets Depreciated Optimised Replacement Cost

Network Group	ORC	Weighted Remaining life	Depreciation (million)	DORC ($million)
Alternative A				
Metro	58.2	34%	-37.3	**20.9**
EGR	619.8	32%	-338.3	**281.5**
Midwest	227.8	67%	-99.1	**128.6**
EBL	332.2	40%	-191.1	**141.1**
LBL	225.9	64%	-73.2	**152.7**
SWM	140.0	62%	-61.1	**78.8**
Collie	46.6	61%	-21.2	**25.4**
MR	421.1	78%	-157.6	**263.5**
Central	483.1	48%	-256.3	**226.8**
GSR	356.4	40%	-170.3	**186.1**
Lakes	206.9	50%	-91.4	**115.4**
CBH Sidings	69.6	45%	-35.4	**34.3**
Sidings & Other	24.2	96%	-8.6	**15.7**
Non-Operational	531.3	-	-531.3	**-**
TOTAL	**3,743.1**		**-2,072.3**	**1,670.8**
Alternative B				
Metro	58.4	34%	-35.4	**23.0**
EGR	622.1	32%	-334.5	**287.6**
Midwest	228.6	67%	-99.3	**129.3**
EBL	333.4	40%	-190.5	**143.0**
LBL	226.7	64%	-73.9	**152.8**
SWM	140.5	62%	-58.9	**81.5**
Collie	46.8	61%	-21.2	**25.6**
MR	422.7	78%	-156.3	**266.4**
Central	484.9	48%	-256.8	**228.1**
GSR	357.8	40%	-167.7	**190.0**
Lakes	207.6	50%	-91.6	**116.0**
CBH Sidings	69.9	45%	-34.9	**35.0**
Sidings & Other	24.3	96%	-7.9	**16.4**
Non-Operational	533.3	-	-533.3	**-**
TOTAL	**3,757.1**		**-2,062.4**	**1,694.7**

6.4.3 Ballast

Ballast is subject to fouling and whilst this may be cleaned occasionally, ballast is not typically replaced. For the purposes of this assessment, it has been assumed that the cost of ballast de-fouling is captured as an operating cost and therefore not included in this assessment.

The ballast depreciation is calculated based on the information and assumptions shown in Table 6-19.

Arc has confirmed that it does not systematically undertake ballast replacement, but does typically complete about 6km of ballast replacement per year as part of other works (turnout replacement, culvert works etc).

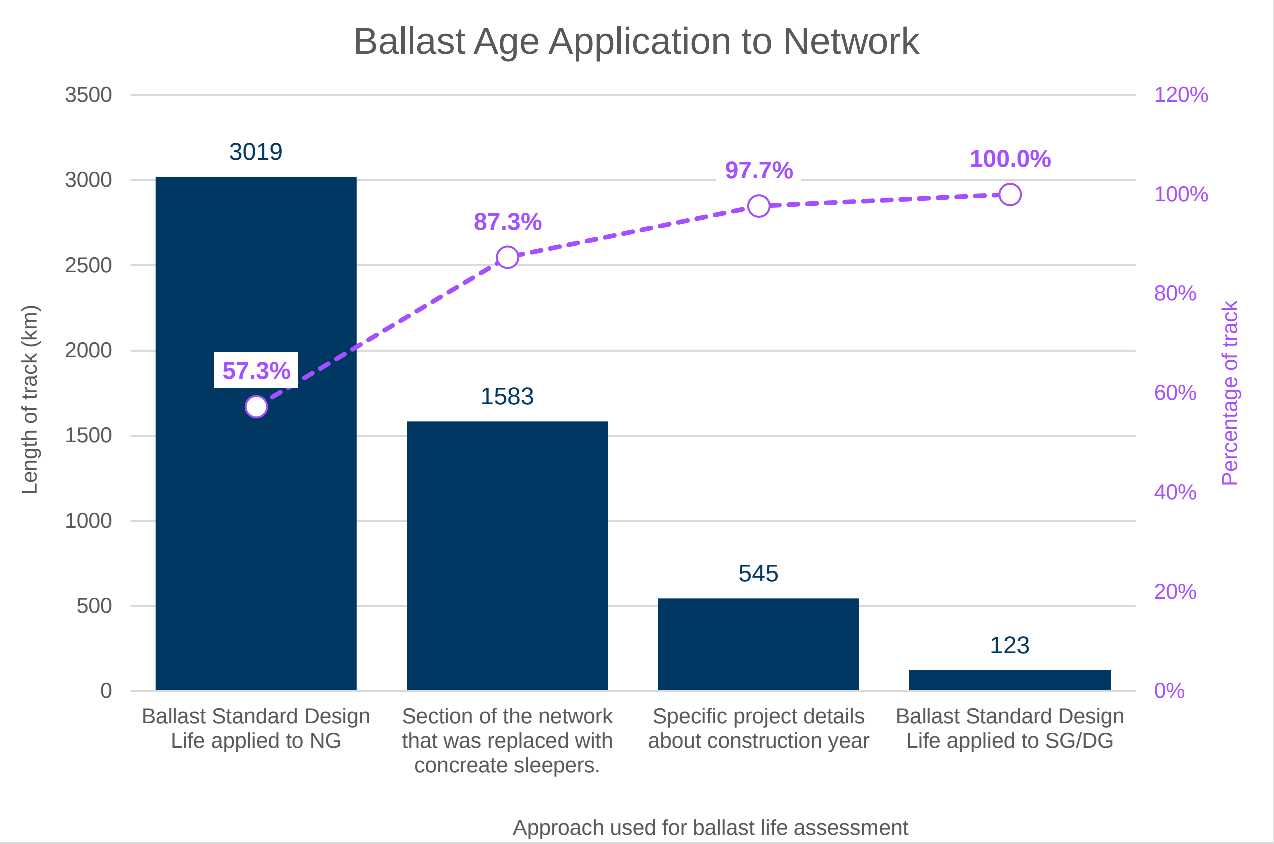
When applied across the network of about 5,270km of track, this means that in practice, ballast has an effective useful life of about 878 years.

Table 6-19 Ballast Depreciation Approach

Method No	Method	Basis	Percentage of ORC
1	For sections of the track where concrete sleepers have been installed, the ballast is assumed to be of the same age as the sleepers.	When sleepers have been replaced with concrete, it has been assumed that the ballast on these sections would also be replaced.	25.4%
2	Arc provided project details and dates of ballast replacement for specific sections of track.	Arc has identified specific projects where track/and or sleeper construction or replacements have been undertaken. It has been assumed that ballast would also have been constructed/replaced at the same time.	15%
3	Unless specific data has been provided by Arc, the age of the remaining ballast is assumed to match the age of the rail alignment.	That is, if the track is narrow gauge, we have assumed that the ballast has not been replaced since the track was originally constructed in the late 1800s – early 1900s. If the track is standard gauge, it has been assumed that the ballast dates from 1961 as this is the date when conversion to standard gauge commenced.[70] If the track is dual gauge, it has been assumed that the ballast dates from 1968 as this is when the dual gauge lines commenced.[71]	59.6%
Note	A minimum remaining life of 10% was assumed in all the three methods for any in-service assets that are at or beyond the end of their useful life.	Follows regulatory precedent by capturing the value of the ongoing service that life-expired assets continue to provide. See further discussion in Section 6-1.	0%

[70] Railways (Standard Gauge) Construction Act, 1961
[71] **WA SGR Nomination FINAL with Interp panel**

Figure 6-2 Ballast Age Application



This analysis gives the weighted average remaining life by Network Group in Table , and the corresponding DORC in Table 6-21.

Table 6-20 Application of ballast Age Criteria to Network Groups (km)

Network Group	Length of Ballast Construction (km) Linked to				Total
	With re-sleepering	Specific project	SG/DG conversion	NG construction	
Metro	86	1	21	0	108
EGR	704	64	52	9	830
Midwest	206	26	0	16	247
EBL	221	201	0	0	422
LBL	65	200	0	0	266
SWM	162	36	0	1	200
Collie	50	0	0	20	70
MR	13	0	0	556	569
Central	75	0	0	620	694
GSR	0	0	0	481	481
Lakes	0	0	0	278	278
CBH Sidings	0	8	25	77	110
Sidings & Other	1	9	24	11	44
Non-Operational	0	0	0	951	951
TOTAL	**1,583**	**545**	**123**	**3,019**	**5,270**

Table 6-21 Ballast Depreciated Optimised Replacement Cost

Network Group	ORC	Average Remaining Life	Depreciation ($millions)	DORC ($million)
Alternative A				
Metro	29.3	95%	-1.2	**28.1**
EGR	289.5	87%	-14.6	**274.9**
Midwest	106.2	82%	-21.1	**85.1**
EBL	171.7	94%	-6.3	**165.4**
LBL	107.1	93%	-6.6	**100.5**
SWM	90.0	78%	-28.9	**61.1**
Collie	22.6	90%	-1.2	**21.4**
MR	200.4	83%	-56.1	**144.2**
Central	225.5	85%	-28.7	**196.8**
GSR	168.6	85%	-24.1	**144.5**
Lakes	97.7	86%	-13.8	**83.9**
CBH Sidings	35.3	76%	-7.1	**28.2**
Sidings & Other	13.0	92%	-1.1	**11.8**
Non-Operational	281.3	0%	-281.3	**-**
TOTAL	**1,838.0**		**-492.2**	**1,345.8**

Network Group	ORC	Average Remaining Life	Depreciation ($millions)	DORC ($million)
Alternative B				
Metro	29.4	95%	-1.2	28.2
EGR	290.6	87%	-14.7	275.9
Midwest	106.6	82%	-21.2	85.4
EBL	172.3	94%	-6.3	166.0
LBL	107.5	93%	-6.6	100.9
SWM	90.3	78%	-29.0	61.3
Collie	22.7	90%	-1.2	21.5
MR	201.1	83%	-56.3	144.8
Central	226.3	85%	-28.8	197.5
GSR	169.3	85%	-24.2	145.1
Lakes	98.1	86%	-13.8	84.3
CBH Sidings	35.4	76%	-7.1	28.3
Sidings & Other	13.0	92%	-1.1	11.9
Non-Operational	282.3	0%	-282.3	-
TOTAL	**1,844.9**		**-494.0**	**1,350.9**

6.4.4 Turnouts

Turnouts deteriorate in a similar way to rail, but experience shorter lives because of the increased lateral loads. The Standard Design Life of a turnout is a function of the type of turnout and bearer as shown in Table 6-22Table .

Table 6-22 Turnout Standard Design Life as per the Costing Principles

Sleeper Type	Standard Design Life (years)
100% steel	40
1-2 Steel/Timber	15
1-3 Steel/Timber	15
1-4 Steel/Timber	15
Concrete	40
Timber	15
Timber/Steel Ad hoc	15
100% steel	40

The turnout remaining life distribution based on the approach in Table 6-23.

Table 6-23 Turnout Depreciation Approach

Method No	Method	Basis	Percentage of ORC
1	Any turnouts on non-operational routes were fully depreciated to zero.	Non-operational status of route reflects depreciated condition of assets.	12%
2	Linear depreciation from installation date.	Arc provided data on the date of installation of the turnout. In the absence of condition data, a linear reduction in remaining life was assumed based in the Standard Design Life for the turnout type.	26%
3	Where install year was not known, the weighted remaining life of the route section was used.	In the absence of specific age data, a weighted remaining life for the route section was applied to the turnouts. This was assumed to be a reasonable proxy for turnout condition on the basis that the maintenance effort applied is likely to be broadly consistent across all assets in the same route section.	59%
Note	A minimum remaining life of 10% was assumed in all the three methods for any in-service assets that are at or beyond the end of their useful life.	Follows regulatory precedent by capturing the value of the ongoing service that life-expired assets continue to provide. See further discussion in Section 6-1.	3%

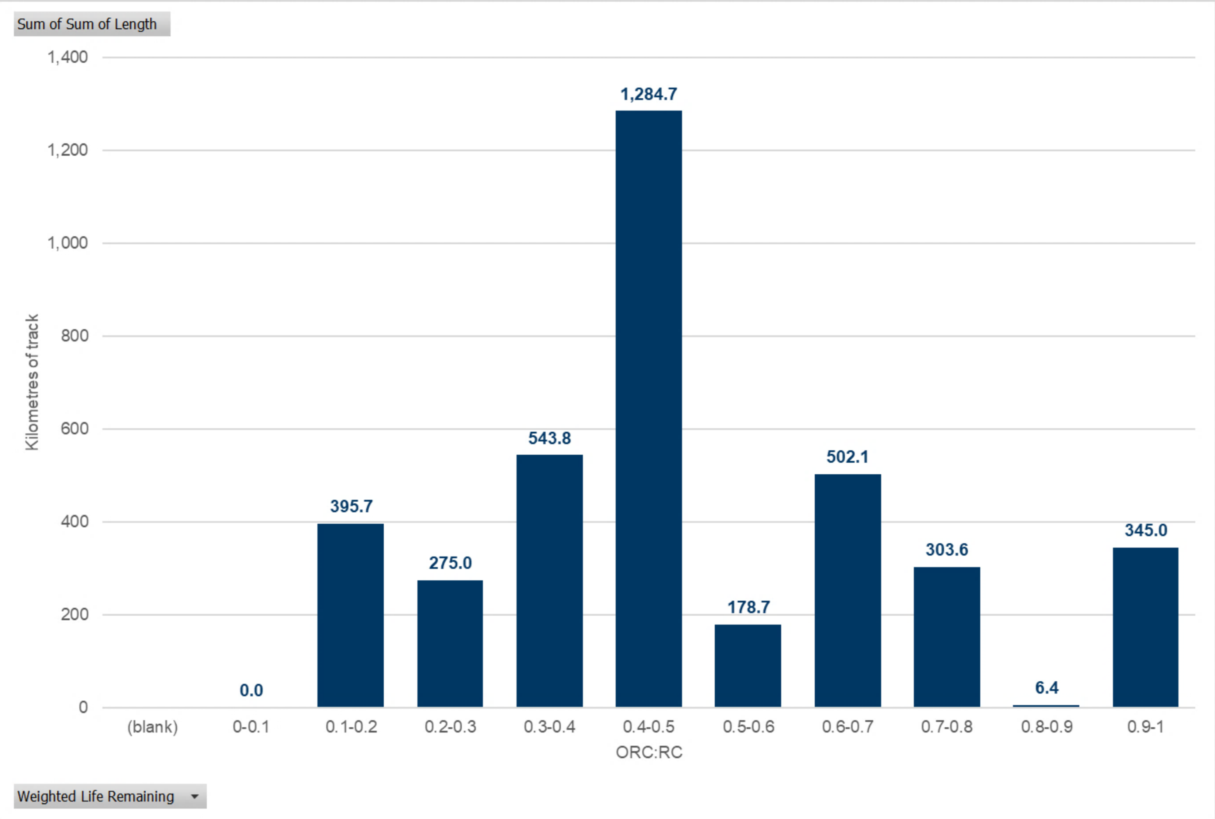


Figure 6-3 Turnout Age Distribution

This analysis gives the weighted average remaining life by Network Group in Table 6-24 and the corresponding DORC in Table 6-25.

Table 6-24 Application of Turnout Criteria to Network Groups (km)

Network Group	Average Remaining Life of Turnouts for Network Group
Metro	73%
EGR	52%
Midwest	56%
EBL	68%
LBL	72%
SWM	49%
Collie	61%
MR	66%
Central	50%
GSR	67%
Lakes	60%
CBH Sidings	43%
Sidings & Other	68%
Non-Operational	0%

Table 6-25 Turnout Depreciated Optimised Replacement Cost

Network Group	ORC	Average Remaining life	Depreciation ($millions)	DORC ($million)
Alternative A				
Metro	77.9	47%	-36.2	**41.7**
EGR	163.1	47%	-84.0	**79.1**
Midwest	31.6	55%	-14.3	**17.3**
EBL	47.1	66%	-20.2	**26.9**
LBL	13.7	71%	-3.9	**9.9**
SWM	52.3	48%	-26.4	**26.0**
Collie	10.9	60%	-4.3	**6.5**
MR	39.6	59%	-15.3	**24.3**
Central	51.4	49%	-25.9	**25.5**
GSR	46.4	62%	-16.6	**29.8**
Lakes	22.3	60%	-8.9	**13.4**
CBH Sidings	97.8	39%	-59.7	**38.0**
Sidings & Other	40.2	72%	-11.6	**28.6**
Non-Operational	63.0	0%	-63.0	**-**
TOTAL	**757.4**		**-390.4**	**367.0**
Alternative B				
Metro	78.2	73%	-22.5	**55.7**
EGR	163.7	52%	-82.9	**80.9**
Midwest	31.7	56%	-14.0	**17.7**
EBL	47.3	68%	-20.0	**27.3**
LBL	13.8	72%	-4.3	**9.5**
SWM	52.5	49%	-25.9	**26.6**
Collie	10.9	61%	-4.2	**6.7**
MR	39.8	66%	-14.1	**25.6**
Central	51.6	50%	-25.8	**25.8**
GSR	46.6	67%	-15.8	**30.8**
Lakes	22.4	60%	-8.9	**13.5**
CBH Sidings	98.1	43%	-58.4	**39.8**
Sidings & Other	40.4	68%	-12.4	**28.0**
Non-Operational	63.3	0%	-63.3	**-**
TOTAL	**760.3**		**-372.5**	**387.8**

6.4.5 Depreciated Optimised Replacement Cost

Table 6-26Table shows the Depreciated Optimised Replacement Cost for track assets.

Table 6-26 Track Assets Depreciated Optimised Replacement Cost ($millions)

Network Group	Rail	Sleepers	Ballast	Turnouts	DORC ($million)
Alternative A					
Metro	145.2	20.9	28.1	41.7	**235.8**
EGR	1,152.5	281.5	274.9	79.1	**1,788.0**
Midwest	334.4	128.6	85.1	17.3	**565.4**
EBL	638.5	141.1	165.4	26.9	**971.9**
LBL	410.2	152.7	100.5	9.9	**673.2**
SWM	231.7	78.8	61.1	26.0	**397.6**
Collie	69.6	25.4	21.4	6.5	**122.9**
MR	599.9	263.5	144.2	24.3	**1,032.0**
Central	500.6	226.8	196.8	25.5	**949.7**
GSR	614.0	186.1	144.5	29.8	**974.4**
Lakes	334.8	115.4	83.9	13.4	**547.6**
CBH Sidings	94.9	34.3	28.2	38.0	**195.4**
Sidings & Other	52.2	15.7	11.8	28.6	**108.3**
Non-Operational	-	-	-	-	**-**
TOTAL	**5,178.6**	**1,670.8**	**1,345.8**	**367.0**	**8,562.2**
Alternative B					
Metro	157.4	23.0	28.2	55.7	**264.3**
EGR	1,159.0	287.6	275.9	80.9	**1,803.4**
Midwest	335.7	129.3	85.4	17.7	**568.1**
EBL	641.2	143.0	166.0	27.3	**977.5**
LBL	411.6	152.8	100.9	9.5	**674.7**
SWM	233.7	81.5	61.3	26.6	**403.2**
Collie	69.8	25.6	21.5	6.7	**123.6**
MR	602.9	266.4	144.8	25.6	**1,039.7**
Central	502.5	228.1	197.5	25.8	**953.9**
GSR	616.5	190.0	145.1	30.8	**982.4**
Lakes	336.1	116.0	84.3	13.5	**549.8**
CBH Sidings	95.6	35.0	28.3	39.8	**198.7**
Sidings & Other	50.0	16.4	11.9	28.0	**106.3**
Non-Operational	-	-	-	-	**-**
TOTAL	**5,212.1**	**1,694.7**	**1,350.9**	**387.8**	**8,645.5**

6.5 Signalling and Control Systems

The depreciation of signalling and control system assets followed the same general approach as other asset classes, as shown below.

Table 6-27 Signalling Depreciation Approach

Method No	Method	Basis	Percentage of ORC
1	Assets on non-operational routes have been fully depreciated.	Non-operational status of route reflects depreciated condition of assets.	-
2	Where the date of installation is known, linear depreciation to the valuation date has been applied. If the date of installation is not known, method 3 was applied.	Signalling assets have been assumed to depreciate linearly from the install date.	81%
3	The average remaining life of the signalling assets across the network with known installation date was used, and linear depreciation to the valuation date applied. If there are no other bridges within the same Network Group, method 4 was used.	Signalling assets have a shorter life than other infrastructure assets and may reach end of life because of technical obsolescence rather than condition. It is therefore not appropriate to apply an average remaining life derived from infrastructure assets.	14%
Note	A minimum remaining life of 10% was assumed in all the three methods for any in-service assets that are at or beyond the end of their useful life.	Follows regulatory precedent by capturing the value of the ongoing service that life-expired assets continue to provide. See further discussion in section 6.1.	5%

Table 6-28 Signalling and Control Systems Assets Depreciated Optimised Replacement Cost ($ million)

Network Group	Optimised Replacement Cost	Average Percentage Life Remaining	Depreciation	DORC
Alternative A				
Metro	304.2	18%	-236.6	**67.6**
EGR	3,467.4	38%	-2,050.4	**1,417.0**
Midwest	246.8	48%	-124.9	**121.9**
EBL	1,595.6	18%	-1,295.3	**300.3**
LBL	31.3	47%	-21.3	**10.1**
SWM	1,031.1	27%	-753.2	**277.9**
Collie	79.9	32%	-56.3	**23.6**
MR	193.1	38%	-109.4	**83.7**
Central	131.0	28%	-95.9	**35.1**
GSR	177.0	25%	-135.4	**41.7**
Lakes	30.9	43%	-17.1	**13.9**
CBH Sidings	45.7	31%	-31.4	**14.4**
Sidings & Other	59.0	25%	-41.9	**17.1**
Non-Operational	56.9	22%	-45.6	**11.3**
TOTAL	**7,450.0**		**-5,014.7**	**2,435.3**
Alternative B				
Metro	168.8	18%	-131.8	36.9
EGR	2,268.3	38%	-1,333.1	935.2
Midwest	100.2	48%	-44.4	55.8
EBL	1,482.0	18%	-1,203.6	278.3
LBL	66.0	47%	-31.2	34.8
SWM	592.5	27%	-403.0	189.4
Collie	30.0	31%	-20.9	9.1
MR	146.5	38%	-80.1	66.4
Central	81.9	27%	-59.4	22.5
GSR	131.8	24%	-98.8	33.0
Lakes	20.6	43%	-11.9	8.7
CBH Sidings	46.7	31%	-35.4	11.3
Sidings & Other	21.8	24%	-17.0	4.7
Non-Operational	79.1	22%	-61.9	17.2
TOTAL	**5,236.2**	**31%**	**-3,532.6**	**1,703.6**

6.6 Buildings

6.6.1 Control Centres

Control centre remaining life is based on the install year, against a Standard Design Life of 50 years.[72] A linear depreciation from install date has been applied, using the average age of the Control Centres, as shown below.

Table 6-29 Control Centre Remaining Life

Control Centre	Year Constructed	Age (years)	Average Age	Percentage Remaining Life
Avon	2008	17	12.7	75%
Canning Vale	2022	3		
Picton	2007	18		

The data indicates that Picton control centre was commissioned in 2007, Canning Vale was commissioned in 2022, and Avon in 2008, giving an average remaining life of 75%. This was applied to all three control centres.

Table 6-30 Control Centres Average Remaining Life (percent) and Depreciated Optimised Replacement Cost (millions)

Network Group	ORC (million)	% Remaining Life	DORC (million)
Alternative A			
Metro	0.4	75%	**0.3**
EGR	2.8	69%	**2.1**
Midwest	0.8	66%	**0.6**
EBL	1.4	75%	**1.1**
LBL	0.9	75%	**0.7**
SWM	0.7	63%	**0.5**
Collie	0.2	75%	**0.2**
MR	1.6	71%	**1.2**
Central	2.4	73%	**1.8**
GSR	1.6	74%	**1.2**
Lakes	0.9	75%	**0.7**
CBH Sidings	0.3	64%	**0.2**
Sidings & Other	0.2	75%	**0.1**
Non-Operational	-	0%	**-**
TOTAL	**14.3**		**10.7**
Alternative B			
Metro	0.4	75%	**0.3**
EGR	2.8	69%	**2.1**
Midwest	0.9	66%	**0.6**
EBL	1.4	75%	**1.1**
LBL	0.9	75%	**0.7**
SWM	0.7	63%	**0.5**
Collie	0.2	75%	**0.2**

[72] **Arc Costings Principles** (2024)

Network Group	ORC (million)	% Remaining Life	DORC (million)
MR	1.6	71%	**1.2**
Central	2.4	73%	**1.8**
GSR	1.6	74%	**1.2**
Lakes	0.9	75%	**0.7**
CBH Sidings	0.3	64%	**0.2**
Sidings & Other	0.2	75%	**0.1**
Non-Operational	-	0%	**-**
TOTAL	**14.4**		**10.7**

6.6.2 Maintenance Facilities

Maintenance facility remaining life is based on the install year, against a Standard Design Life of 50 years.[73]The data provided to GHD indicates that all maintenance facilities were constructed in about 1991. A linear depreciation from this date has been applied to calculate the percentage remaining life, as shown in Table 6-31.

Table 6-31 Maintenance Facilities Remaining Life

Maintenance Facility	Year Constructed	Age (years)	Percentage Remaining Life
Kalgoorlie	1991	34.5	31%
Katanning	1991	34.5	31%
Kewdale	1991	34.5	31%
Merredin	1991	34.5	31%
Midland	1991	34.5	31%
Narngulu	1991	34.5	31%
Narrogin	1991	34.5	31%
Northam	1991	34.5	31%
Picton	1991	34.5	31%
Pinjarra	1991	34.5	31%
Kalgoorlie	1991	34.5	31%

The average percentage remaining life was applied to all maintenance facilities.

[73] Arc Costings Principles (2024)

Table 6-32 Maintenance Facility Average Remaining Life (percent) and Depreciated Optimised Replacement Cost ($ million)

Network Group	ORC (million)	% Remaining Life	DORC (million)
Alternative A			
Metro	5.5	31%	**1.7**
EGR	41.9	31%	**13.0**
Midwest	12.6	31%	**3.9**
EBL	21.6	31%	**6.7**
LBL	13.5	31%	**4.2**
SWM	10.0	31%	**3.1**
Collie	3.5	31%	**1.1**
MR	24.3	31%	**7.5**
Central	35.4	31%	**11.0**
GSR	24.4	31%	**7.6**
Lakes	14.2	31%	**4.4**
CBH Sidings	4.6	31%	**1.4**
Sidings & Other	2.2	31%	**0.7**
Non-Operational	-	31%	**-**
TOTAL	**213.6**	**31%**	**66.2**
Alternative B			
Metro	5.5	31%	**1.7**
EGR	42.0	31%	**13.0**
Midwest	12.7	31%	**3.9**
EBL	21.7	31%	**6.7**
LBL	13.5	31%	**4.2**
SWM	10.0	31%	**3.1**
Collie	3.6	31%	**1.1**
MR	24.4	31%	**7.6**
Central	35.6	31%	**11.0**
GSR	24.5	31%	**7.6**
Lakes	14.2	31%	**4.4**
CBH Sidings	4.6	31%	**1.4**
Sidings & Other	2.2	31%	**0.7**
Non-Operational	-	31%	**-**
TOTAL	**214.5**	**31%**	**66.5**

6.6.3 Depots

Depots remaining life is based on the install year, against a Standard Design Life of 50 years.[74]The data provided to GHD indicates that all depots were set up in about 1991. A linear depreciation from this date has been applied to calculate the percentage remaining life, as shown in Table 6-33.

[74] **Arc Costings Principles** (2024)

Table 6-33 Depot percentage remaining life

Depots	Year Constructed	Age (years)	Percentage Remaining Life
Kenwick Flashbutt Welding Facility	1991	34.5	31%
Kewdale Training Facility	1991	34.5	31%
Hampton Ballast siding	1991	34.5	31%

The average percentage remaining life was applied to all depots.

Table 6-34 Depot Depreciated Optimised Replacement Cost by Network Group

Network Group	ORC (million)	% Remaining Life	DORC (million)
Alternative A			
Metro	0.5	31%	**0.2**
EGR	3.8	29%	**1.2**
Midwest	1.4	27%	**0.4**
EBL	1.9	31%	**0.6**
LBL	1.2	31%	**0.4**
SWM	1.3	26%	**0.3**
Collie	0.3	31%	**0.1**
MR	2.6	30%	**0.7**
Central	3.2	30%	**1.0**
GSR	2.2	31%	**0.7**
Lakes	1.3	31%	**0.4**
CBH Sidings	0.5	27%	**0.1**
Sidings & Other	0.2	31%	**0.1**
Non-Operational	3.7	0%	**-**
TOTAL	**24.0**		**5.9**
Alternative B			
Metro	0.5	31%	**0.2**
EGR	3.8	29%	**1.2**
Midwest	1.4	27%	**0.4**
EBL	1.9	31%	**0.6**
LBL	1.2	31%	**0.4**
SWM	1.3	26%	**0.3**
Collie	0.3	31%	**0.1**
MR	2.6	30%	**0.7**
Central	3.2	30%	**1.0**
GSR	2.2	31%	**0.7**
Lakes	1.3	31%	**0.4**
CBH Sidings	0.5	27%	**0.1**
Sidings & Other	0.2	31%	**0.1**
Non-Operational	3.7	0%	**-**
TOTAL	**24.1**		**6.0**

6.6.4 Depreciated Optimised Replacement Cost

The depreciated optimised replacement cost for building assets is shown in Table 6-35.

Table 6-35 Building Depreciated Optimised Replacement Cost by Network Group ($ million)

Network Group	Asset Category			
	Control Centres	Maintenance Facilities	Depots	Total DORC ($ million)
Alternative A				
Metro	0.3	1.7	0.2	**2.2**
EGR	2.1	13.0	1.2	**16.3**
Midwest	0.6	3.9	0.4	**4.9**
EBL	1.1	6.7	0.6	**8.4**
LBL	0.7	4.2	0.4	**5.3**
SWM	0.5	3.1	0.3	**3.9**
Collie	0.2	1.1	0.1	**1.4**
MR	1.2	7.5	0.7	**9.4**
Central	1.8	11.0	1.0	**13.8**
GSR	1.2	7.6	0.7	**9.5**
Lakes	0.7	4.4	0.4	**5.5**
CBH Sidings	0.2	1.4	0.1	**1.7**
Sidings & Other	0.1	0.7	0.1	**0.9**
Non-Operational	-	-	-	**0**
TOTAL	**10.7**	**66.2**	**5.9**	**82.8**
Alternative B				
Metro	0.3	1.7	0.2	**2.2**
EGR	2.1	13.0	1.2	**16.3**
Midwest	0.6	3.9	0.4	**4.9**
EBL	1.1	6.7	0.6	**8.4**
LBL	0.7	4.2	0.4	**5.3**
SWM	0.5	3.1	0.3	**3.9**
Collie	0.2	1.1	0.1	**1.4**
MR	1.2	7.6	0.7	**9.5**
Central	1.8	11.0	1.0	**13.8**
GSR	1.2	7.6	0.7	**9.5**
Lakes	0.7	4.4	0.4	**5.5**
CBH Sidings	0.2	1.4	0.1	**1.7**
Sidings & Other	0.1	0.7	0.1	**0.9**
Non-Operational	-	-	-	**0**
TOTAL	**10.7**	**66.5**	**6.0**	**83.2**

6.7 Associated Track Structures

6.7.1 Pedestrian Crossings

There is no data on condition or install date for level crossings. Consequently, a route averaged depreciation has been applied. We have seen no evidence to suggest that this assumption is not appropriate.

6.7.2 Depreciated Optimised Replacement Cost – Associated Track Structures

The depreciated optimised replacement cost for associated track structures is shown in Table 6-36.

Table 6-36 Depreciated Optimised Replacement Cost – Associated Track Structures

Network Group	MEA Type					
	Type 1 Active: Gated	Type 2 Active : Signalled	Type 3 Passive : Maze	Type 4 Passive : Path Only	Type 5 Unprotected	Total DORC ($million)
Alternative A						
Metro	-	0.5	1.4	-	0.0	**1.9**
EGR	2.7	0.6	3.3	0.2	0.4	**7.2**
Midwest	-	0.3	0.4	-	-	**0.6**
EBL	-	0.5	0.5	0.1	0.5	**1.6**
LBL	-	0.4	-	-	0.1	**0.4**
SWM	0.3	0.5	1.9	0.1	0.2	**2.9**
Collie	-	0.3	0.7	-	-	**0.9**
MR	1.2	0.5	2.2	0.1	0.1	**4.1**
Central	0.5	0.5	0.7	0.1	0.1	**2.0**
GSR	1.1	5.0	3.7	0.2	0.2	**10.1**
Lakes	-	0.3	-	-	-	**0.3**
CBH Sidings	-	-	0.2	-	-	**0.2**
Sidings & Other	0.2	1.4	0.5	0.0	0.0	**2.2**
Non-Operational	-	-	-	-	-	**-**
TOTAL	**6.0**	**10.7**	**15.4**	**0.8**	**1.6**	**34.5**
Alternative B						
Metro	-	0.5	1.6	-	0.0	**2.1**
EGR	2.9	0.7	3.5	0.2	0.4	**7.7**
Midwest	-	0.3	0.4	-	-	**0.7**
EBL	-	0.5	0.5	0.1	0.5	**1.6**
LBL	-	0.4	-	-	0.1	**0.4**
SWM	0.3	0.6	2.0	0.1	0.2	**3.2**
Collie	-	0.3	0.7	-	-	**1.0**
MR	1.2	0.6	2.4	0.1	0.1	**4.3**
Central	0.5	0.5	0.7	0.1	0.1	**2.0**
GSR	1.1	5.2	3.8	0.2	0.2	**10.6**
Lakes	-	0.3	-	-	-	**0.3**
CBH Sidings	-	-	0.2	-	-	**0.2**
Sidings & Other	0.2	1.4	0.5	0.0	0.0	**2.2**
Non-Operational	-	-	-	-	-	**-**
TOTAL	**6.3**	**11.2**	**16.4**	**0.8**	**1.7**	**36.4**

6.8 Miscellaneous

6.8.1 Plant Tools and Equipment

Plant and Equipment costs were calculated based on an inventory supplied by Arc. Unless age and/or asset condition data was available, it was assumed that the asset is at 50% of its economic life.

6.8.2 Depreciated Optimised Replacement Cost - Miscellaneous

The summary DORC values are captured below.

Table 6-37 Depreciated Optimised Replacement Cost – Miscellaneous

Asset Collection	Optimised Replacement Cost ($million)	Depreciation (%)	Depreciated Optimised Replacement Cost ($million)
Alternative A			
Plant tools and Equipment	101.0	-73.6	27.5
Signage	14.1	-8.9	5.2
Walkways	121.9	-46.2	75.6
TOTAL	**236.6**	**-128.4**	**108.2**
Alternative B			
Plant tools and Equipment	101.1	-73.6	27.5
Signage	14.1	-8.9	5.2
Walkways	122.3	-44.7	77.7
TOTAL	**237.5**	**-127.2**	**110.3**

6.9 Depreciated Optimised Replacement Cost by Asset Category

Table 6-38 Depreciated Optimised Replacement Cost by Asset Category ($ million)

Asset Category	ORC	Depreciation	DORC
Alternative A			
Right of Way	3,951.4	(538.8)	3,412.6
Civil Structures	1,461.5	(804.1)	657.4
Associated Track Structures	61.9	(27.4)	34.5
Track	16,640.4	(8,078.2)	8,562.2
Signalling and Control Systems	7,450.0	(5,014.7)	2,435.3
Buildings	252.0	(169.1)	82.9
Miscellaneous	236.6	(128.4)	108.2
TOTAL	**30,053.8**	**(14,760.8)**	**15,293.0**
Alternative B			
Right of Way	3,966.7	(530.3)	3,436.4
Civil Structures	1,467.1	(805.5)	661.6
Associated Track Structures	62.2	(25.8)	36.4
Track	16,703.2	(8,057.6)	8,645.5
Signalling and Control Systems	5,236.2	(3,532.6)	1,703.6
Buildings	252.9	(169.8)	83.2
Miscellaneous	237.5	(127.2)	110.3
TOTAL	**27,925.8**	**(13,248.8)**	**14,677.0**

6.10 Depreciated Optimised Replacement Cost by Network Group

The depreciated optimised replacement cost by Network Group is summarised in Table Table 6-39.

Table 6-39 Depreciated Optimised Replacement Cost by Network Group ($ million)

Network Group	ORC	Depreciation	DORC
Alternative A			
Metro	934.4	(472.5)	461.8
EGR	7,541.0	(3,318.7)	4,222.3
Midwest	1,721.2	(632.5)	1,088.7
EBL	3,785.2	(1,928.6)	1,856.6
LBL	1,181.2	(352.3)	828.9
SWM	2,259.1	(1,303.2)	955.9
Collie	431.9	(193.3)	238.6
MR	2,373.2	(1,003.5)	1,369.7
Central	2,622.2	(1,296.5)	1,325.7
GSR	2,521.9	(808.2)	1,713.6
Lakes	1,048.7	(375.0)	673.7
CBH Sidings	488.2	(246.9)	241.3
Sidings & Other	258.8	(104.9)	154.0
Non-Operational	2,886.8	(2,724.6)	162.2
TOTAL	**30,053.8**	**(14,760.8)**	**15,293.0**
Alternative B			
Metro	346.6	(337.6)	463.7
EGR	2,753.7	(2,593.2)	3,764.2
Midwest	688.4	(552.3)	1,027.9
EBL	1,595.1	(1,836.2)	1,843.7
LBL	534.7	(364.4)	855.8
SWM	789.7	(949.7)	875.4
Collie	166.3	(157.6)	225.7
MR	1,018.8	(972.7)	1,362.2
Central	1,127.5	(1,263.2)	1,319.4
GSR	1,079.8	(768.2)	1,717.4
Lakes	455.5	(370.9)	671.3
CBH Sidings	214.2	(249.0)	241.8
Sidings & Other	96.6	(82.8)	139.7
Non-Operational	1,276.3	(2,751.0)	168.7
TOTAL	**12,143.0**	**(13,248.8)**	**14,677.0**

Table 6-40 Depreciated Optimised Replacement Cost by Network Group ($ million) – Signalling Alternative A

Network Group	ORC	Depreciation by Asset Category ($million)								DORC
		Right of Way	Civil Structures	Associated Track Structures	Track	Signalling and Comms	Buildings	Miscellaneous	Subtotal	
Alternative A										
ORC		3,951.4	1,461.5	61.9	16,640.4	7,450.0	252.0	236.6	30,053.8	
Metro	934.4	(8.3)	(57.3)	(1.9)	(161.3)	(236.6)	(4.2)	(3.0)	(472.5)	**461.8**
EGR	7,541.0	(64.2)	(84.2)	(5.4)	(1,044.4)	(2,050.4)	(32.2)	(37.8)	(3,318.7)	**4,222.3**
Midwest	1,721.2	(26.3)	(71.7)	(0.6)	(391.8)	(124.9)	(10.0)	(7.2)	(632.5)	**1,088.7**
EBL	3,785.2	(49.8)	(30.4)	(1.8)	(522.6)	(1,295.3)	(16.6)	(12.1)	(1,928.6)	**1,856.6**
LBL	1,181.2	(17.5)	(39.2)	(0.2)	(257.8)	(21.3)	(10.4)	(6.0)	(352.3)	**828.9**
SWM	2,259.1	(31.3)	(124.9)	(2.9)	(376.5)	(753.2)	(8.0)	(6.4)	(1,303.2)	**955.9**
Collie	431.9	(5.9)	(43.2)	(0.9)	(80.5)	(56.3)	(2.7)	(3.6)	(193.3)	**238.6**
MR	2,373.2	(49.4)	(90.9)	(2.2)	(720.5)	(109.4)	(19.1)	(12.0)	(1,003.5)	**1,369.7**
Central	2,622.2	(63.3)	(42.2)	(1.7)	(1,048.3)	(95.9)	(27.2)	(17.8)	(1,296.5)	**1,325.7**
GSR	2,521.9	(30.0)	(79.8)	(5.1)	(525.7)	(135.4)	(18.8)	(13.5)	(808.2)	**1,713.6**
Lakes	1,048.7	(19.9)	(10.2)	(0.1)	(310.8)	(17.1)	(10.9)	(6.1)	(375.0)	**673.7**
CBH Sidings	488.2	(10.0)	(0.0)	(0.1)	(200.1)	(31.4)	(3.6)	(1.8)	(246.9)	**241.3**
Sidings & Other	258.8	(2.5)	(10.0)	(1.5)	(46.2)	(41.9)	(1.7)	(1.1)	(104.9)	**154.0**
Non-Operational	2,886.8	(160.4)	(120.2)	(3.0)	(2,391.7)	(45.6)	(3.7)	-	(2,724.6)	**162.2**
Sub-total	30,053.8	(538.8)	(804.1)	(27.4)	(8,078.2)	(5,014.7)	(169.1)	(128.4)	(14,760.8)	**15,293.0**
TOTAL		**3,412.6**	**657.4**	**34.5**	**8,562.2**	**2,435.3**	**82.9**	**108.2**	**15,293.0**	

Table 6-41 Depreciated Optimised Replacement Cost by Network Group ($ million) – Signalling Alternative B

Network Group	ORC	Depreciation by Asset Category ($million)								DORC
		Right of Way	Civil Structures	Associated Track Structures	Track	Signalling and Comms	Buildings	Miscellaneous	Subtotal	
Alternative B										
ORC		3,966.7	1,467.1	62.2	16,703.2	5,236.2	252.9	237.5	27,925.8	
Metro	801.3	(6.8)	(55.9)	(1.7)	(134.3)	(131.8)	(4.3)	(2.9)	(337.6)	**463.7**
EGR	6,357.4	(61.6)	(84.5)	(4.9)	(1,039.7)	(1,333.1)	(32.3)	(37.0)	(2,593.2)	**3,764.2**
Midwest	1,580.2	(25.6)	(72.0)	(0.5)	(392.7)	(44.4)	(10.0)	(7.2)	(552.3)	**1,027.9**
EBL	3,679.9	(49.0)	(30.5)	(1.7)	(522.6)	(1,203.6)	(16.7)	(12.0)	(1,836.2)	**1,843.7**
LBL	1,220.3	(17.5)	(39.3)	(0.2)	(259.8)	(31.2)	(10.4)	(6.0)	(364.4)	**855.8**
SWM	1,825.1	(30.3)	(125.3)	(2.7)	(373.9)	(403.0)	(8.1)	(6.3)	(949.7)	**875.4**
Collie	383.3	(5.6)	(43.4)	(0.8)	(80.7)	(20.9)	(2.7)	(3.5)	(157.6)	**225.7**
MR	2,334.9	(48.7)	(91.3)	(2.1)	(719.4)	(80.1)	(19.2)	(12.0)	(972.7)	**1,362.2**
Central	2,582.6	(63.0)	(42.3)	(1.7)	(1,051.6)	(59.4)	(27.3)	(17.8)	(1,263.2)	**1,319.4**
GSR	2,485.6	(28.9)	(80.1)	(4.7)	(523.4)	(98.8)	(18.8)	(13.4)	(768.2)	**1,717.4**
Lakes	1,042.3	(19.9)	(10.2)	(0.1)	(311.8)	(11.9)	(10.9)	(6.1)	(370.9)	**671.3**
CBH Sidings	490.9	(9.8)	(0.0)	(0.1)	(198.3)	(35.4)	(3.6)	(1.8)	(249.0)	**241.8**
Sidings & Other	222.4	(2.7)	(10.0)	(1.5)	(48.8)	(17.0)	(1.7)	(1.1)	(82.8)	**139.7**
Non-Operational	2,919.7	(161.0)	(120.6)	(3.0)	(2,400.7)	(61.9)	(3.7)	-	(2,751.0)	**168.7**
Sub-total	27,925.8	(530.3)	(805.5)	(25.8)	(8,057.6)	(3,532.6)	(169.8)	(127.2)	(13,248.8)	**14,677.0**
TOTAL		**3,436.4**	**661.6**	**36.4**	**8,645.5**	**1,703.6**	**83.2**	**110.3**	**14,677.0**	

7. Adjustments to the DORC

7.1 Contributed Capital

Contributed assets are those where the development cost has been funded (in part or in entirety) by other entities. The ORC value of these contributions would then be removed from the ORC of the existing assets.

Arc has confirmed that none of the assets in this DORC are contributed assets. There has therefore been no adjustment for any contributed investment.

7.2 Operating Costs

Any difference in operating costs between the existing asset and the optimised replacement asset needs to be reflected in the DORC of the existing asset. This is so that parity is maintained between the value of the existing asset and a new replacement.

The optimised modern equivalent replacement asset may have lower maintenance liabilities to the existing asset because:

– The optimised asset configuration has fewer or more optimally configured components. This could be because the existing asset may have evolved organically over time to meet current demand, whereas an efficient entity would develop a MEA equivalent networked to optimally meet demand.
– The MEAs are made of materials or use construction methods that require less maintenance over their life than the existing assets.

The assessment has assumed that the following costs would be the same for the optimised asset configuration and the existing assets:

– corporate overhead costs;
– office based engineering support; and
– general labour costs.

The DORC of the existing asset needs to be reduced by the present value of its increased maintenance liability compared to the optimised replacement. This difference in maintenance liability has been evaluated over the remaining life of the appropriate asset class, using a pre-tax WACC rate of 7.46%. The remaining life of the appropriate asset class has been used because it was assumed the asset would be replaced by the MEA at end-of-life.

Table 7-1Table shows the assets where there is likely to be an operating cost difference between the existing asset and the MEA.

Table 7-1 Basis of Operating Cost Differences

Asset Type	Basis
Rail	There are some route sections where the MEA rail weight is greater than the existing. This is because the existing track weights are imperial (pounds) but the MEA track weights are in the metric equivalent (as this is what is available in today's market). In most cases, the metric equivalent is marginally heavier than the imperial. Consequently, the MEA rail is likely to last longer between regrinding or replacement than its imperial equivalent, when subject to the same wheel loadings. This difference in the interval between maintenance interventions could result in a difference in maintenance (OpEx) costs over the life of the rail. The magnitude of this difference would be a function of the level of traffic over the rail. In Arc's network, the only sections that have imperial track weights are very lightly trafficked (typically one to two trains per day). The effect of this marginal difference in OpEx costs is therefore likely to be negligible (particularly when expressed in NPV terms) and have no material impact on the DORC value.

Asset Type	Basis
Sleepers	There are steel and timber sleepers across the Arc network. GHD has assumed all MEA sleepers to be concrete. Arc has a programme of replacement of timber and steel sleepers. The timing of sleeper replacement under this programme is accounted for in the remaining life assessment of the existing sleepers already included in the DORC. The cost associated with this replacement programme would be included in the DORC with OpEx Adjustment at the time the investment was made (subject to regulatory approval). In addition to the sleeper replacement programme, there is likely to the need for ad-hoc replacement of a small number of timber sleepers. The cost of this ad-hoc replacement is an additional cost associated with the existing asset. The NPV of this ad-hoc activity therefore needs to be deducted from the DORC. There are currently 3,015,084 timber sleepers across the Arc network. Arc does not have data on the number of ad-hoc sleeper replacements it undertakes. For the purposes of this assessment, GHD has assumed that 0.1% (3,015) of the timber sleepers would need to be replaced every year, until the end of life. This rate of ad-hoc replacement has been applied to all sections with timber sleepers, for every year of remaining life of that section. The remaining life in this context is the same as that used for the depreciation of sleeper assets. The costs for sleeper replacements under its scheduled replacement programme, where Arc undertake staged replacement of large number of sleepers in one campaign, indicate Arc anticipate a cost of about $600 per sleeper. For the purposes of this assessment, we have assumed that the ad-hoc sleeper replacement would be undertaken by a maintenance crew deployed to replace several sleepers in a day. The per-sleeper cost of this activity would be greater than the cost during a replacement campaign. For the purposes of this assessment,. GHD has assumed that the average cost of ad-hoc sleeper replacement would be about $1,000 per sleeper. The result of this cost in PV terms, using the WACC as the discount rate is shown in the below tables.
Turnouts	768 of the 1,003 (77%) of the existing turnouts on the network have timber bearers (either entirely, or mixed with steel). We have assumed that all MEA turnouts would have concrete bearers. There is likely to be the need for ad-hoc replacement of a small number of these timber bearers within the remaining life of the turnouts. The cost of this ad-hoc replacement is an additional cost associated with the existing asset. The NPV of this ad-hoc activity therefore needs to be deducted from the DORC. The number of bearers depends on the length of the turnouts. Most the turnouts in the Arc network are not on the main line, so we have assumed they would have about 70 bearers each on average. As the mechanism for premature failure requiring ad-hoc replacement is environmental, similar to timber sleepers, we have assumed that 0.1% (54, about one per week) of the timber bearers would need to be replaced every year, until the end of life. This rate of ad-hoc replacement has been applied to all turnouts with timber bearers, for every year of remaining life of that turnout. The remaining life in this context is the same as that used for the depreciation of the turnout. The costs for bearer replacements are likely to be greater than the cost of a sleeper replacement because of the increased complexity and component size. For the purposes of this assessment, we have assumed that the cost of ad-hoc bearer replacement to be $2,000 (double that of ad-hoc sleeper replacement). There could also be costs associated with track possessions to undertake turnout bearer replacement. These costs are not included in these infrastructure costs. The result of this cost in PV terms, using the WACC as the discount rate is shown in the below tables.
Signalling	**Alternative A - Conventional Signalling and Communications system using MEA equipment** Alternative A is essentially the same as the existing signalling system. Actual signalling maintenance cost data is not available in sufficient granularity to support this assessment. GHD has assumed that annual maintenance costs for the existing signalling assets are likely to be in the order of 3% of the signalling replacement costs. There is likely to be no material difference between maintenance costs for between Alternative A and the existing system.

Asset Type	Basis
	Alternative B – communication based enhanced train order working Alternative B represents a fundamentally different system with fewer physical asset components than the existing signalling system. Consequently, the optimised signalling system will have lower physical asset maintenance costs than the existing system, but this may be offset (to some extent) by the additional cost from the OEM to provide remote support for the optimised system over its life. Nevertheless, the absence of physical trackside assets in the optimised system will result in lower maintenance costs over their remaining life. As actual signalling maintenance cost data is not available in sufficient granularity to support this assessment, GHD has assumed that annual maintenance costs for the existing signalling assets are likely to be in the order of 3% of the signalling replacement costs. GHD has further assumed the additional costs of OEM remote support for the Optimised Replacement Cost are likely to be about 1% of the signalling replacement costs. On this basis, the net difference in maintenance costs between the optimised signalling system and the existing assets is likely to be about 2%. The result of this cost in PV terms, using the WACC as the discount rate is shown in the below tables.
Bridges	27 of the existing bridges on the Arc network have concrete superstructures. Of the other 297, 194 are noted as having steel superstructures, eight as timber and the remaining 80 as unknown structural form. All the MEA bridges are concrete. Concrete bridges typically require minimal remedial works and have lower routine maintenance needs over their 100-year life than other bridge types (typically routine inspections, joint and bearing replacement, clearing and erosion control around abutments). Steel bridges require additional routine maintenance of coatings to maintain integrity of the steel components. In GHD's experience, the protecting coatings on steel bridges typically require re-applying once during a bridge's life. This process requires removal of the existing coating. The existing bridge coatings often contain toxic chemicals requiring careful, safe and costly removal. The cost of the re-coating task is a function of the bridge deck area. Based on GHD's experience, we have allowed 20% of the bridge replacement cost to allow for removal of existing coatings and a further 15% of replacement cost for application of new coatings. GHD has also assumed that re-coating our occurs at mid-life. For bridges this is 50 years after construction. The remaining life used in the bridge depreciation assessment was the basis for determining the time until re-coating would be required. It was assumed that any bridges with less than 50% of their life remaining (<50 years) would not require re-coating within the remainder of their life. Bridges with more than 50% (>50 years) life remaining would require re-coating before the end of life. The time until the recoat would be required is the number of years until these bridges have 50% of their life remaining. The result of these discrete costs in PV terms, using the WACC as the discount rate is shown in the below tables.

Table 7-2 The Present Value of Operating Cost Differences as a Result of MEA Selection

Network group	Sleeper Replacement ($ million)	Turnout Replacement ($ million)	Signalling and communications assets ($ million)	Bridges ($ million)	Total
Alternative A					
Metro	(0.03)	(0.06)	-	(3.14)	(3.2)
EGR	(0.37)	(0.12)	-	(0.56)	(1.1)
Midwest	(0.22)	(0.01)	-	(0.21)	(0.4)
EBL	(2.37)	(0.04)	-	-	(2.4)
LBL	(2.68)	(0.06)	-	-	(2.7)
SWM	(0.16)	(0.03)	-	(0.97)	(1.2)
Collie	(0.17)	(0.01)	-	(0.83)	(1.0)
MR	(3.01)	(0.06)	-	(0.51)	(3.6)
Central	(2.77)	(0.08)	-	(0.89)	(3.7)
GSR	(2.44)	(0.10)	-	(5.25)	(7.8)
Lakes	(1.46)	(0.05)	-	(0.52)	(2.0)
CBH Sidings	(0.69)	(0.14)	-	-	(0.8)
Sidings & Other	(0.19)	(0.05)	-	-	(0.2)
Non-Operational	-	-	-	-	-
TOTAL	**(16.56)**	**(0.81)**	**-**	**(12.86)**	**(30.2)**
Alternative B					
Metro	(0.04)	(0.07)	(6.26)	(3.14)	(9.51)
EGR	(0.38)	(0.12)	(114.83)	(0.56)	(115.89)
Midwest	(0.22)	(0.01)	(9.30)	(0.21)	(9.74)
EBL	(2.38)	(0.04)	(29.20)	-	(31.62)
LBL	(2.67)	(0.06)	(0.90)	-	(3.63)
SWM	(0.17)	(0.04)	(24.45)	(0.97)	(25.62)
Collie	(0.18)	(0.01)	(2.13)	(0.83)	(3.14)
MR	(3.02)	(0.06)	(6.56)	(0.51)	(10.15)
Central	(2.78)	(0.08)	(3.20)	(0.89)	(6.95)
GSR	(2.46)	(0.10)	(3.86)	(5.25)	(11.67)
Lakes	(1.46)	(0.05)	(1.11)	(0.52)	(3.14)
CBH Sidings	(0.70)	(0.14)	(1.41)	-	(2.25)
Sidings & Other	(0.19)	(0.05)	(1.54)	-	(1.78)
Non-Operational	-	-	(1.11)	-	(1.11)
TOTAL	**(16.66)**	**(0.83)**	**(205.86)**	**(12.86)**	**(236.21)**

8. DORC With OpEx Adjustments

The DORC with the adjustments discussed in Section 7 is shown in Table 8-1.

Table 8-1 Adjustments to the DORC to Determine the DORC with OpEx Adjustment

Network group	DORC ($ million)	OpEx Adjustment ($ million)	DORC with OpEx Adjustment ($ million)
Alternative A			
Metro	461.8	(3.2)	458.6
EGR	4,222.3	(1.1)	4,221.2
Midwest	1,088.7	(0.4)	1,088.3
EBL	1,856.6	(2.4)	1854.2
LBL	828.9	(2.7)	826.2
SWM	955.9	(1.2)	954.7
Collie	238.6	(1.0)	237.6
MR	1,369.7	(3.6)	1,366.1
Central	1,325.7	(3.7)	1322
GSR	1,713.6	(7.8)	1,705.8
Lakes	673.7	(2.0)	671.7
CBH Sidings	241.3	(0.8)	240.5
Sidings & Other	154.0	(0.2)	153.8
Non-Operational	162.2	-	162.2
TOTAL	**15,293.0**	**(30.2)**	**15,262.8**
Alternative B			
Metro	463.7	(9.51)	454.2
EGR	3,764.2	(115.89)	3,648.3
Midwest	1,027.9	(9.74)	1,018.2
EBL	1,843.7	(31.62)	1,812.1
LBL	855.8	(3.63)	852.2
SWM	875.4	(25.62)	849.8
Collie	225.7	(3.14)	222.6
MR	1,362.2	(10.15)	1,352.1
Central	1,319.4	(6.95)	1,312.5
GSR	1,717.4	(11.67)	1,705.7
Lakes	671.3	(3.14)	668.2
CBH Sidings	241.8	(2.25)	239.6
Sidings & Other	139.7	(1.78)	137.9
Non-Operational	168.7	(1.11)	167.6
TOTAL	**14,677.0**	**(236.21)**	**14,440.8**

Alternative A:

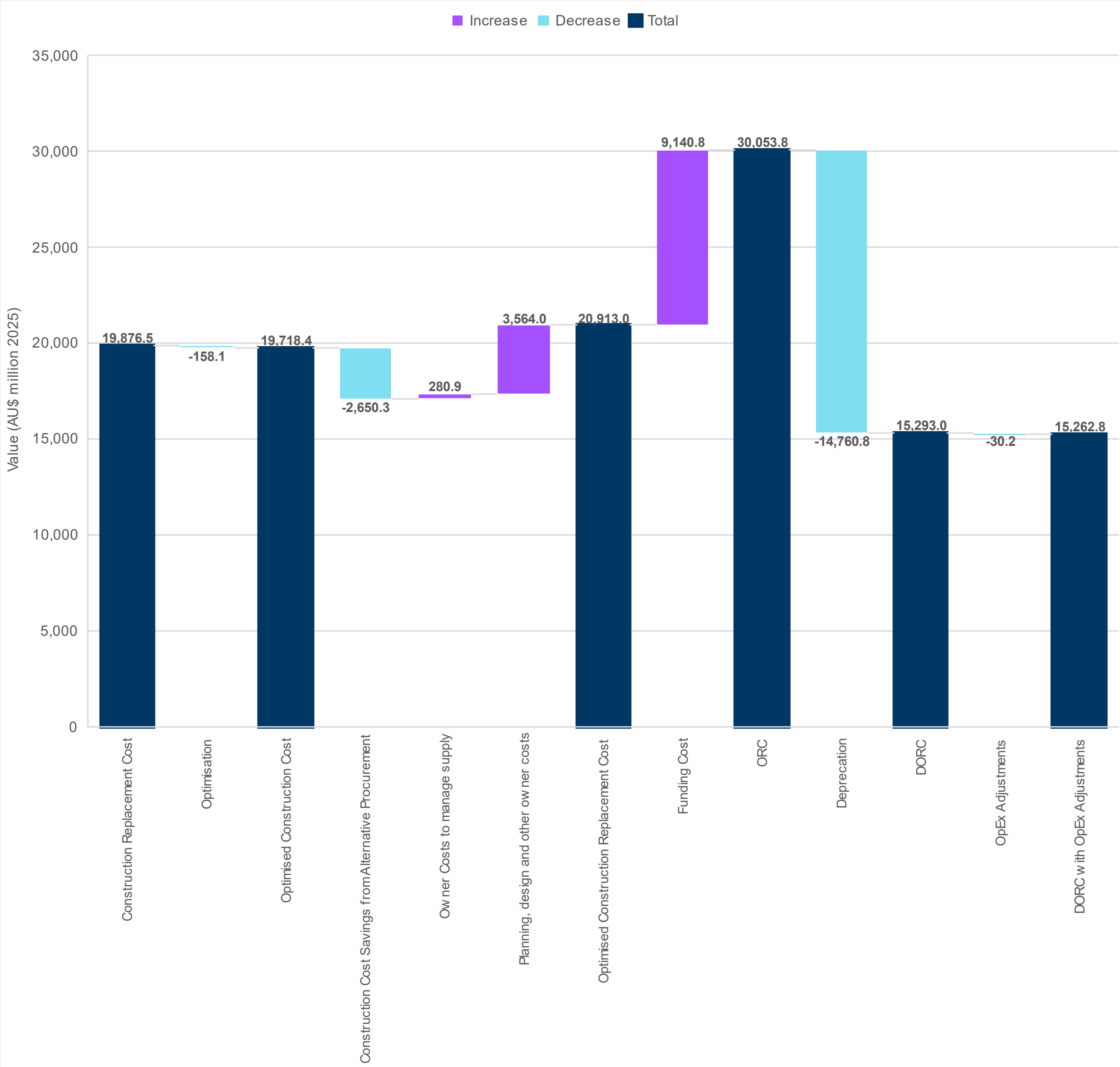


Figure 8-1 DORC and DORC with OpEx Adjustment summary

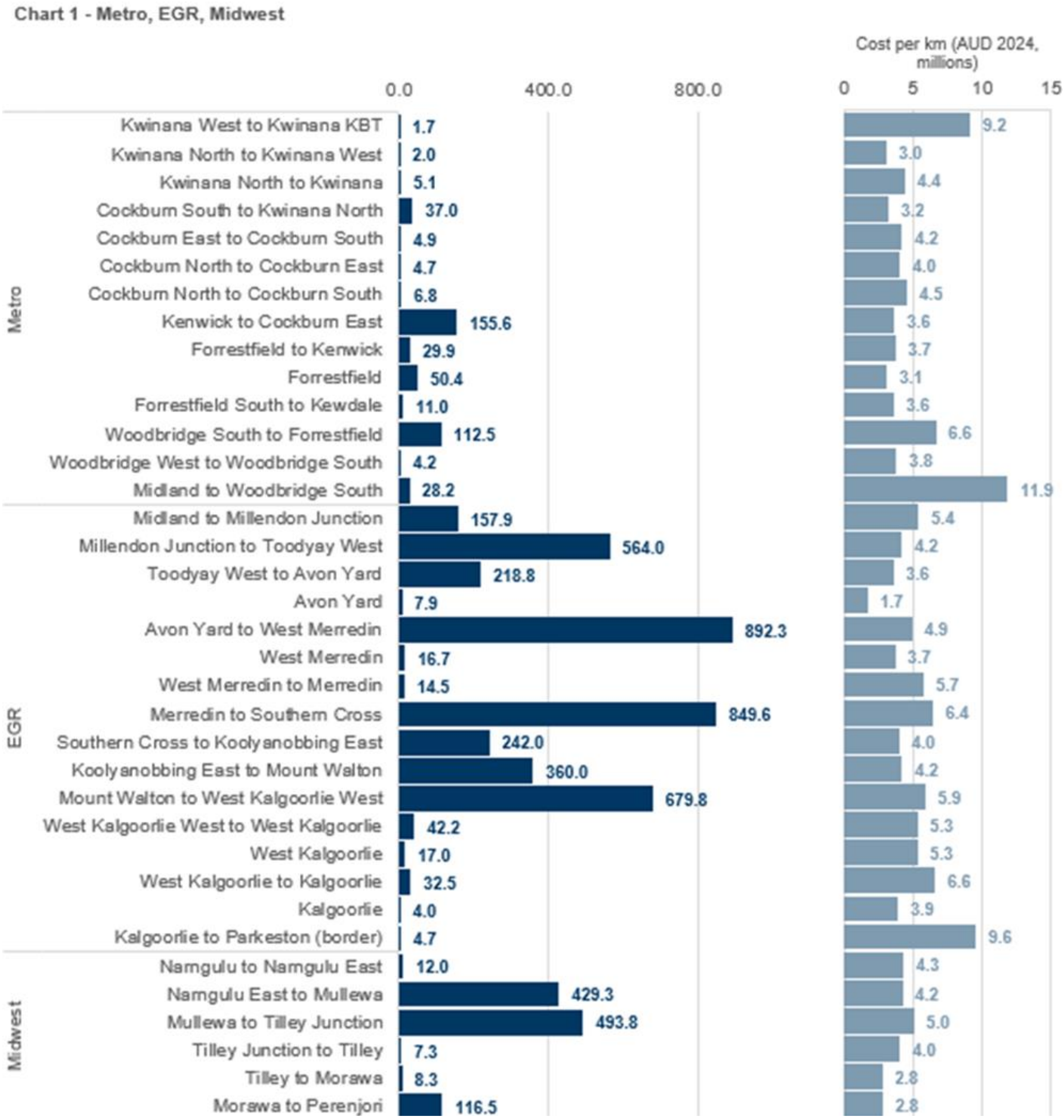


Figure 8-2 *DORC Alternative A by Route Section*

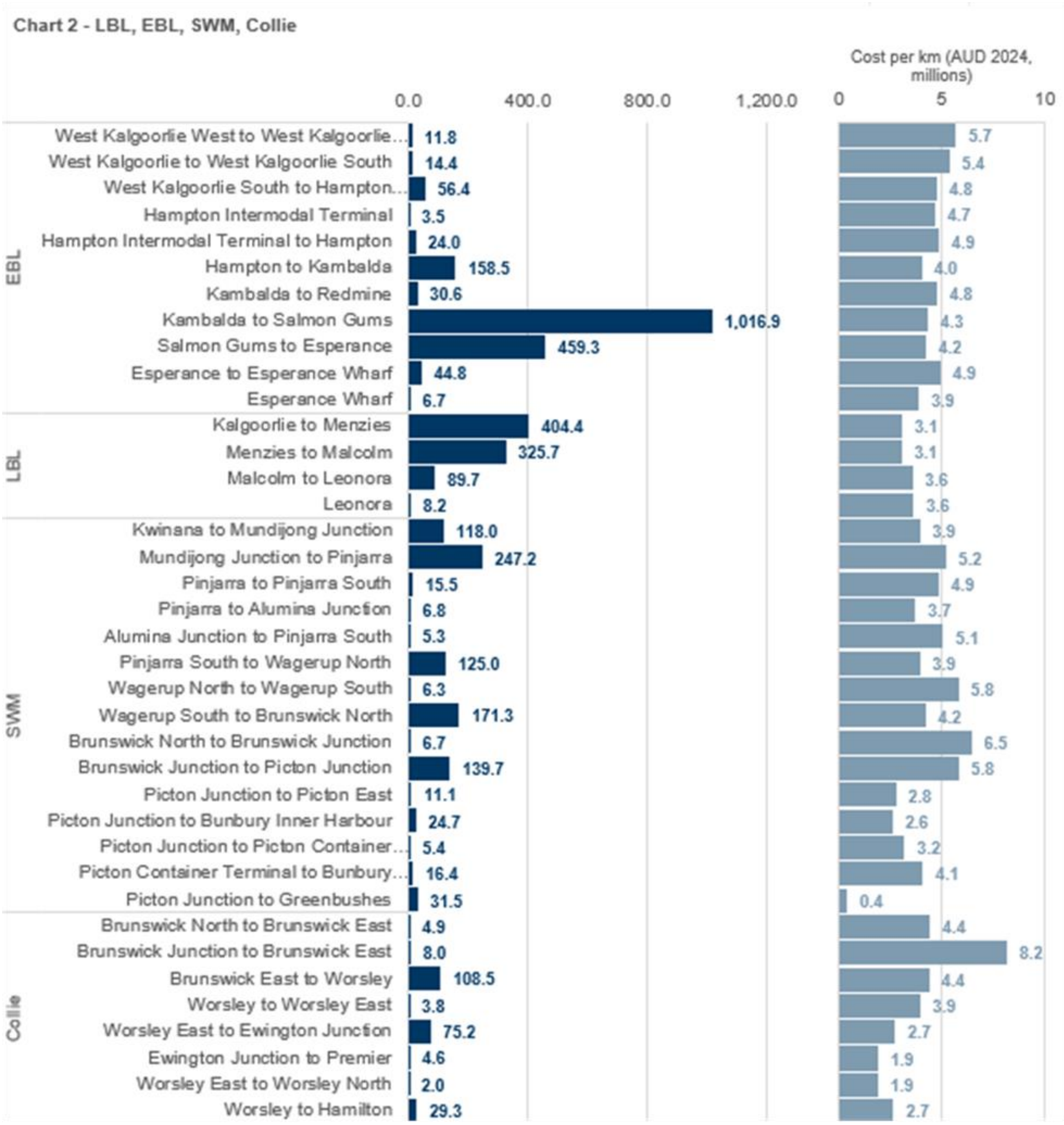


Figure 8-3 ***DORC Alternative A by Route Section***

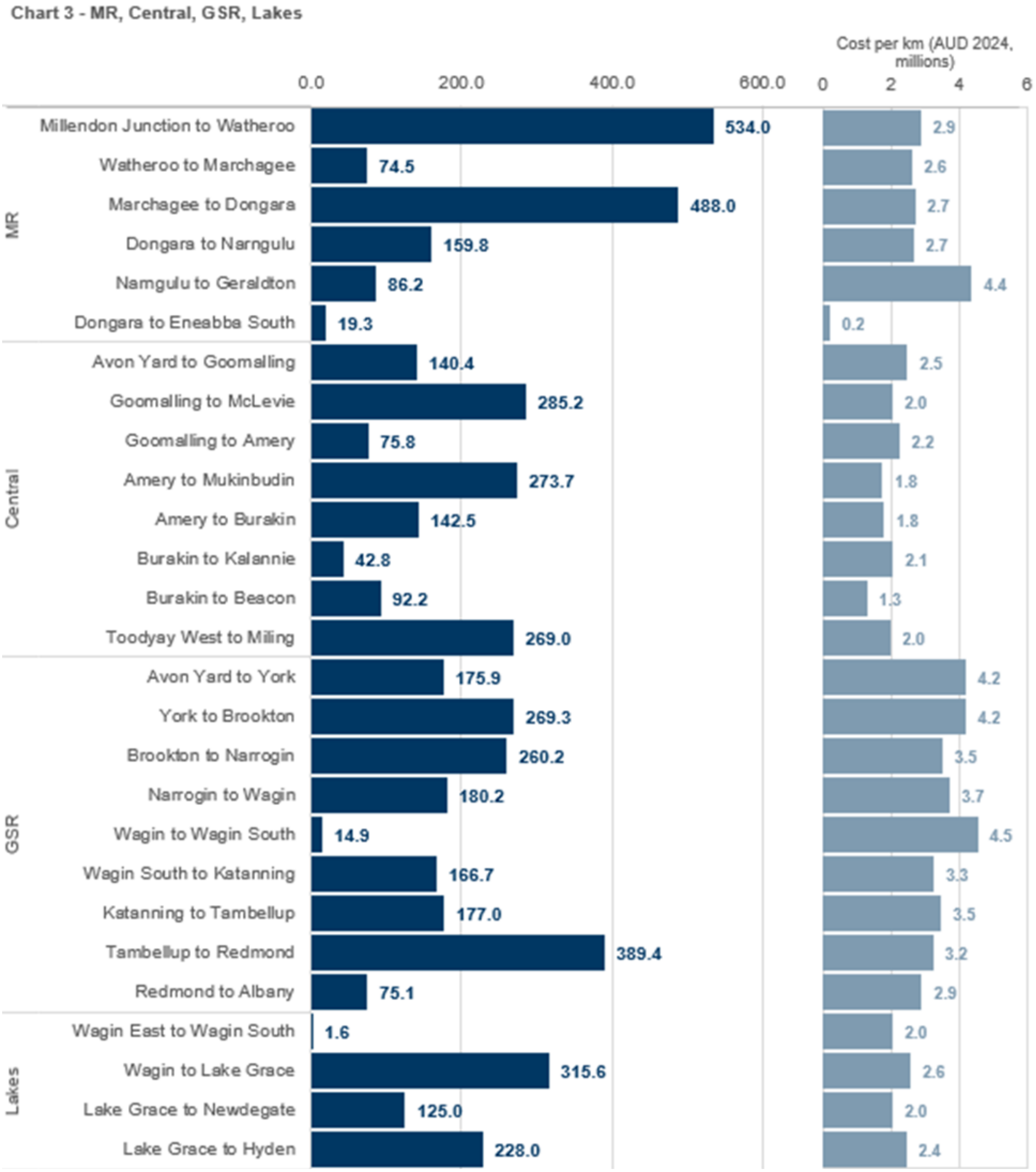


Figure 8-4 DORC Alternative A by Route Section

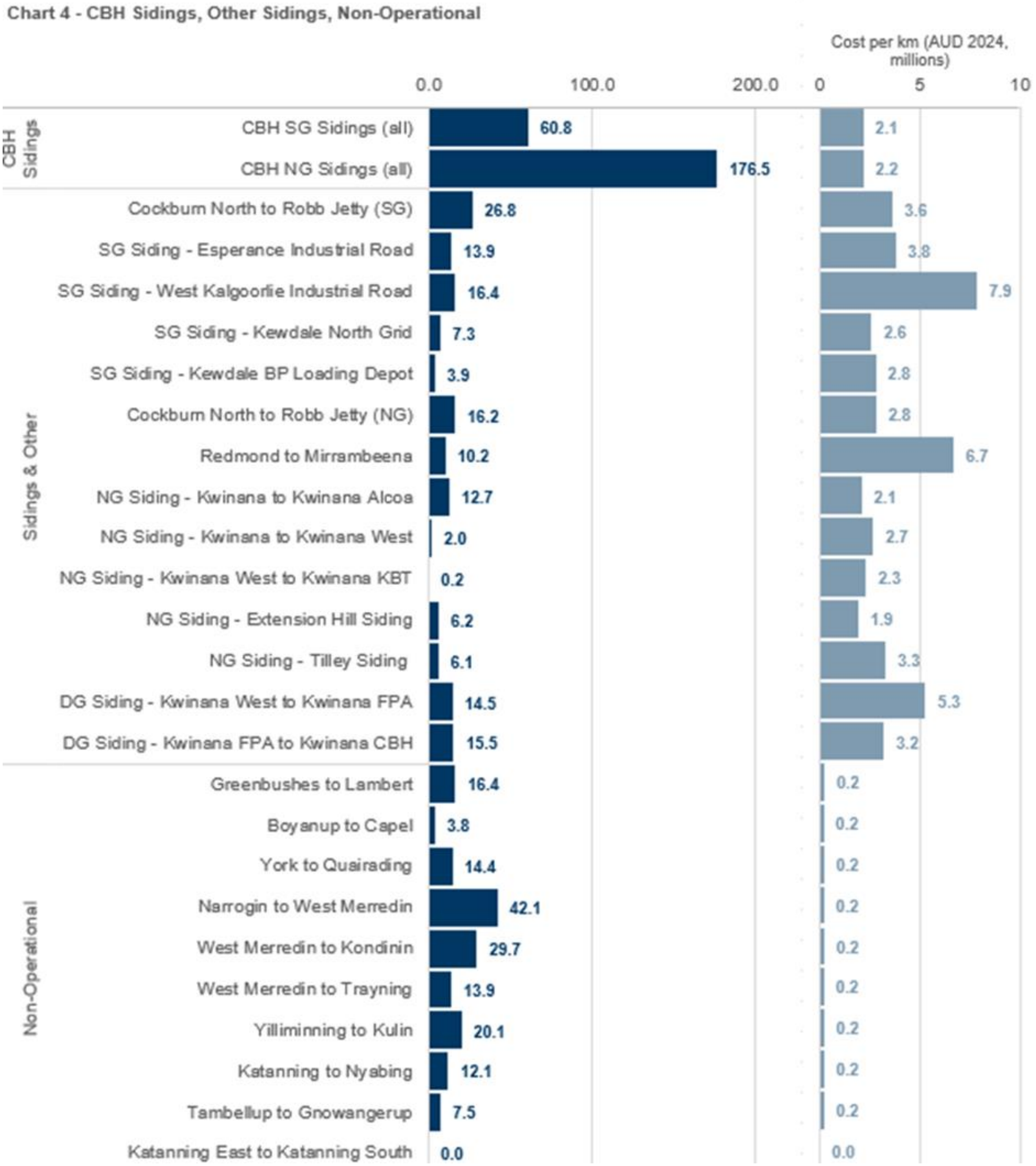


Figure 8-5 DORC Alternative A by Route Section

Alternative B:

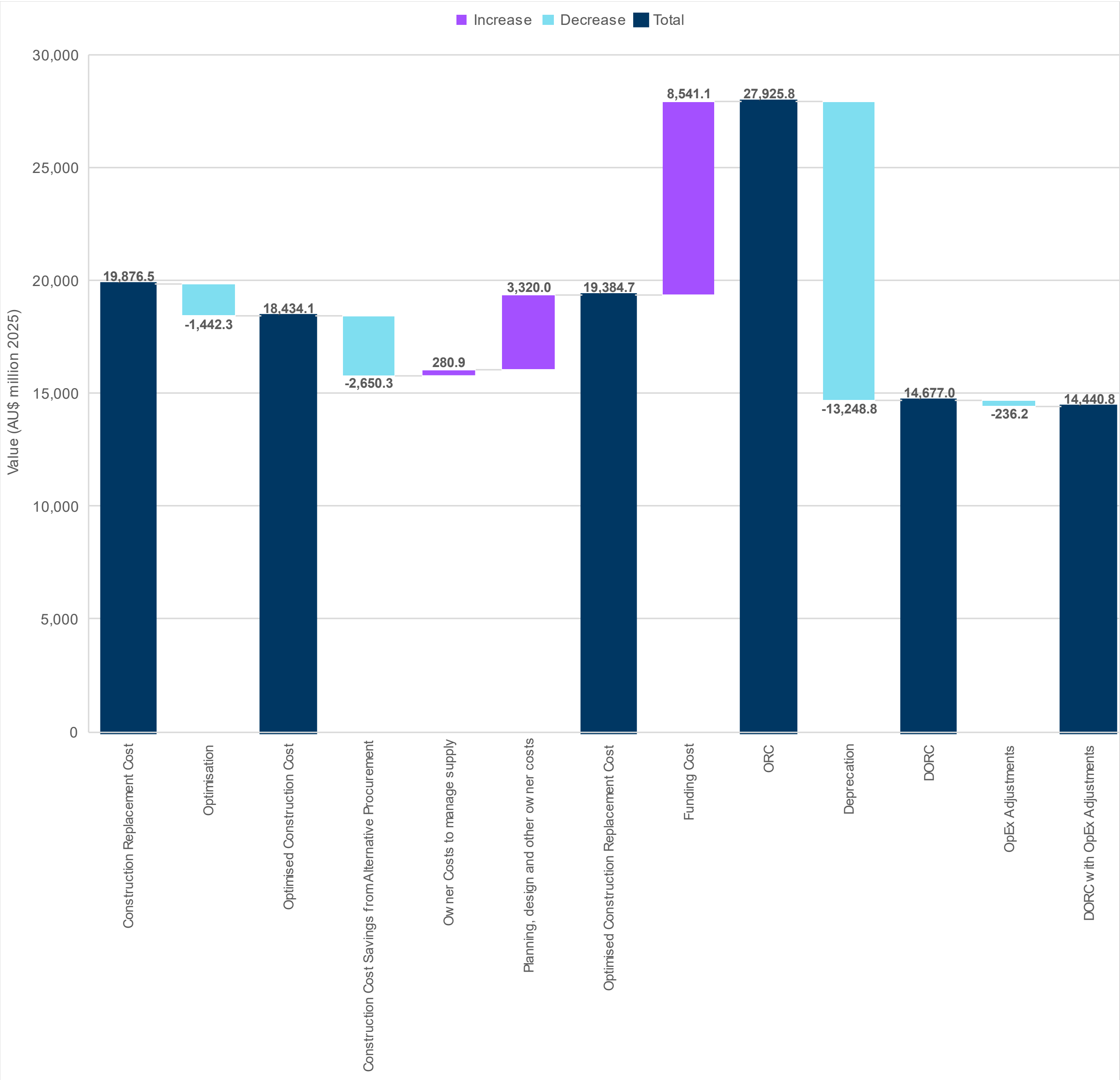


Figure 8-6 *DORC and DORC with OpEx Adjustment summary*

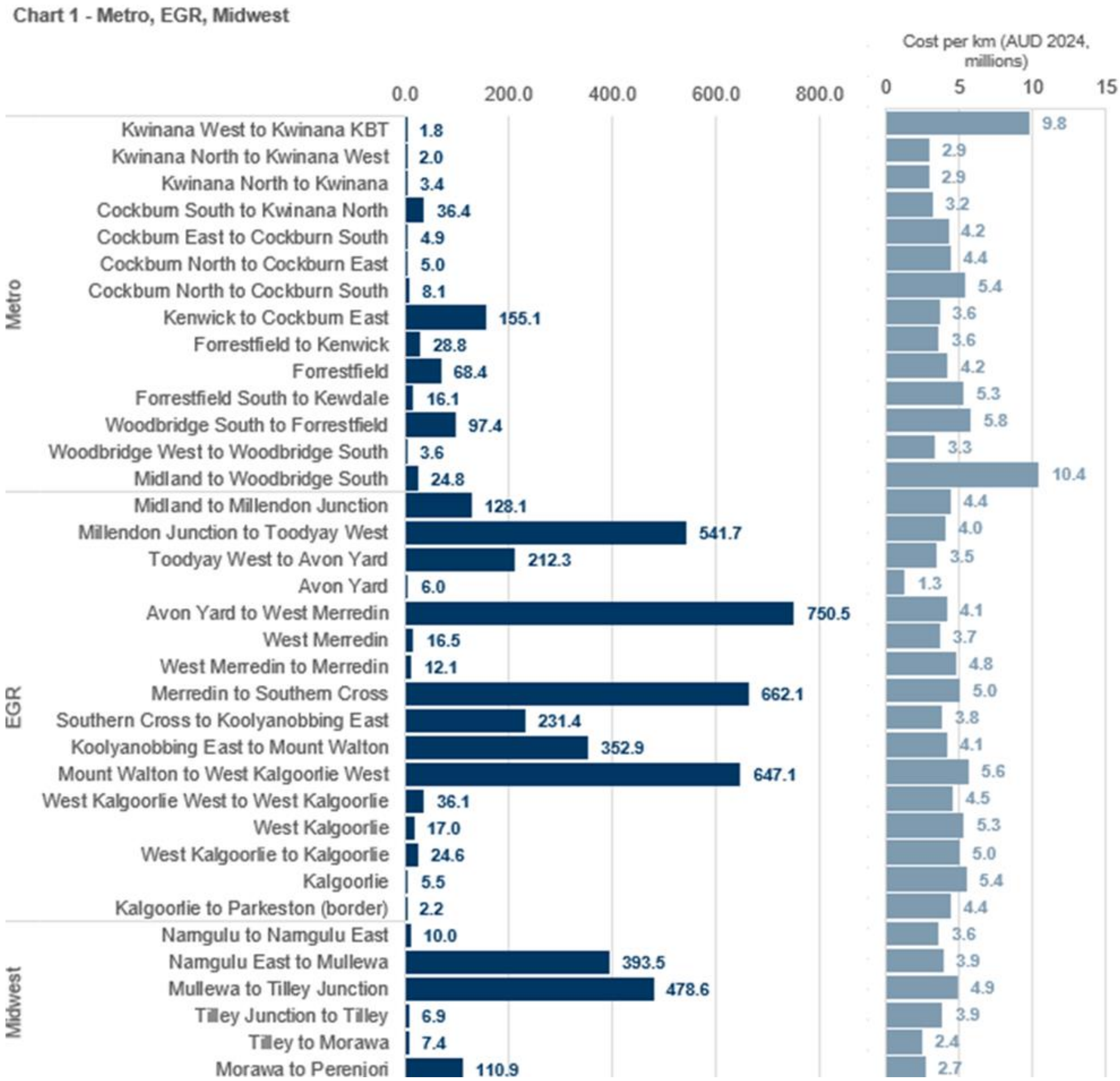


Figure 8-7 DORC Alternative B by Route Section

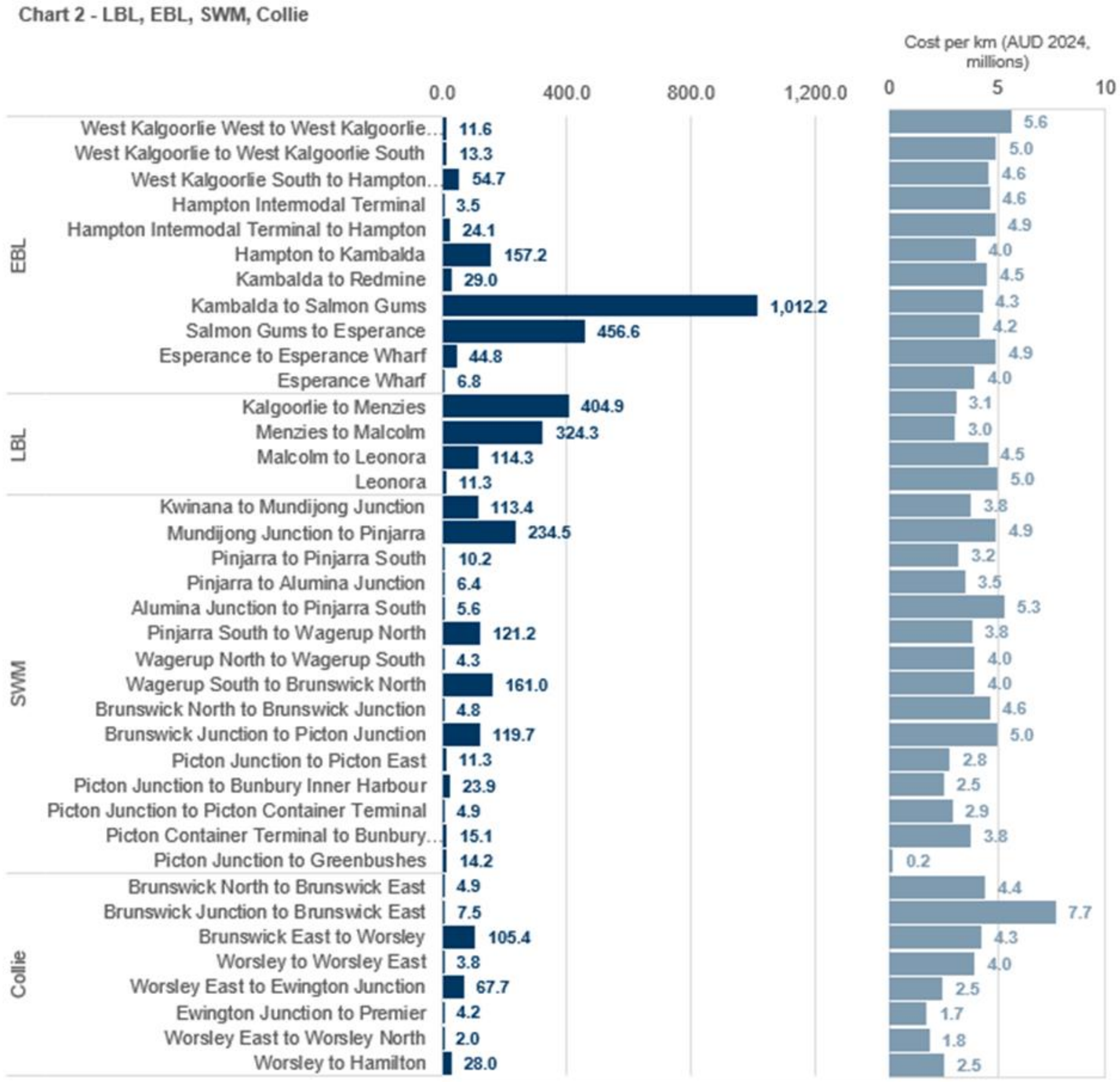


Figure 8-8 DORC Alternative B by Route Section

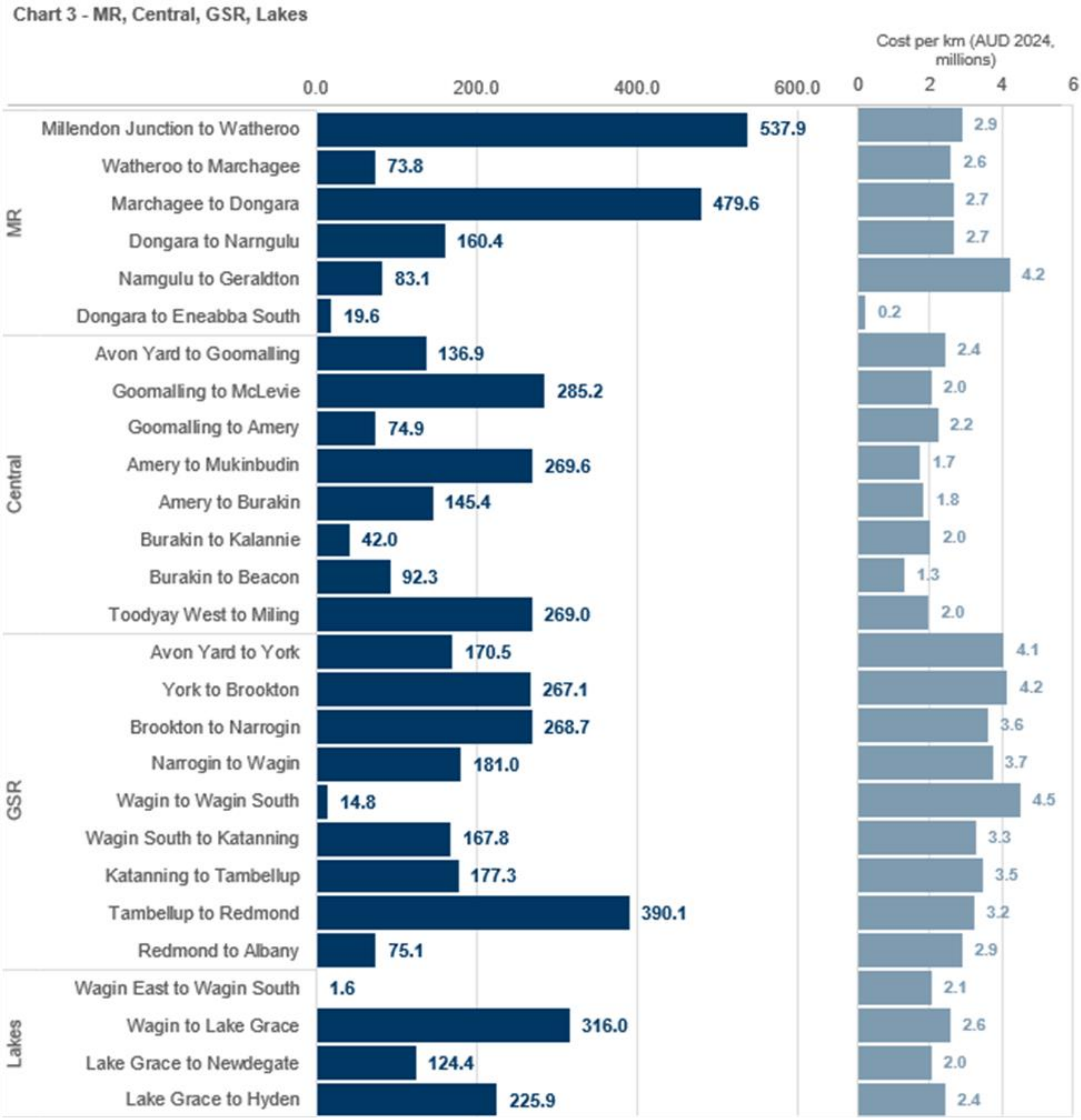


Figure 8-9 ***DORC Alternative B by Route Section***

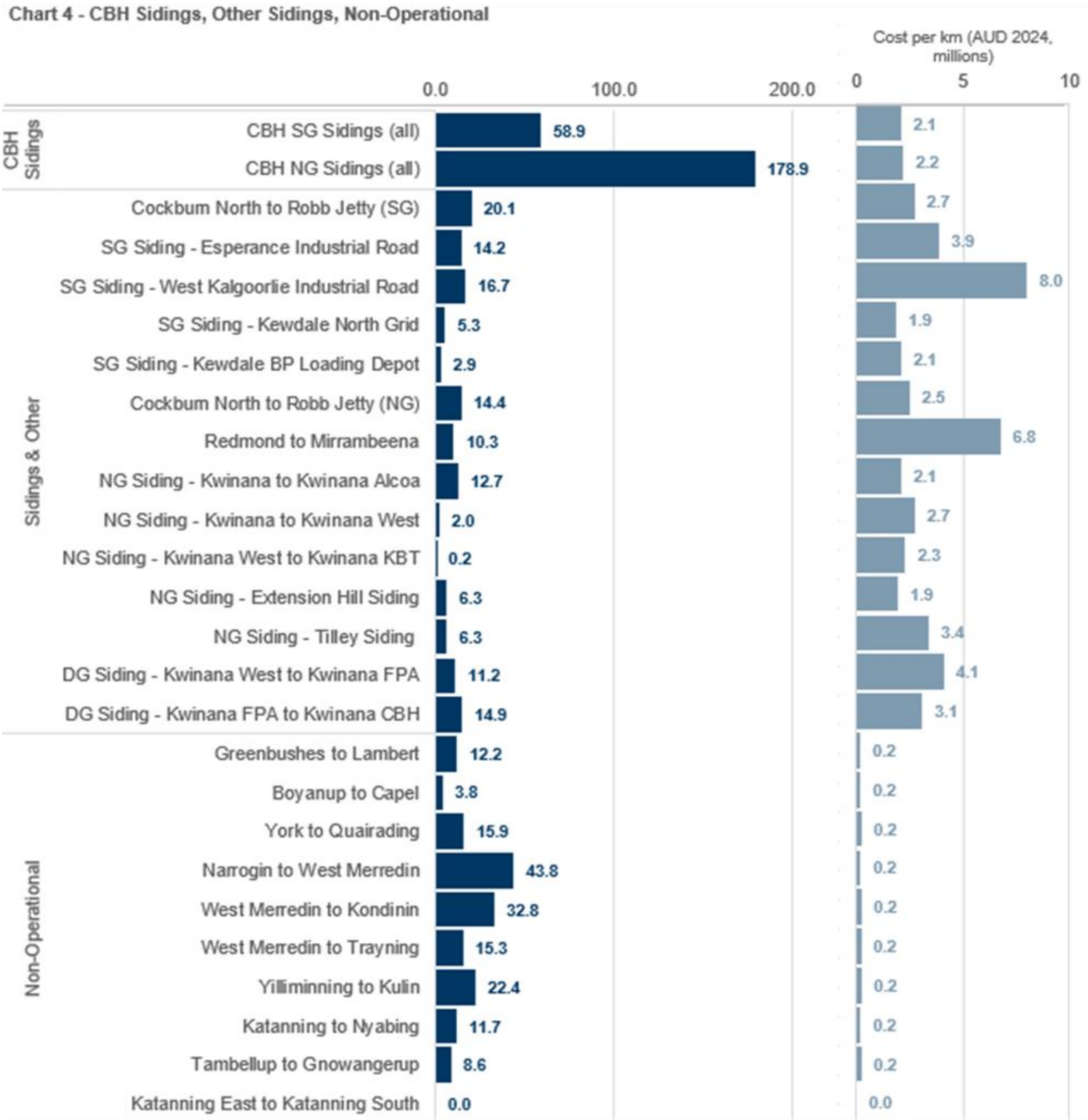


Figure 8-10 DORC Alternative B by Route Section

Appendices

A-1 Geography

Network Group	Route Section	Route Section UID	Route Code	Track Kilometres
Metro	Kwinana West to Kwinana KBT	45. DG Midland to Kwinana | Kwinana West to Kwinana KBT	45	0.182
	Kwinana North to Kwinana West	45.DG Midland to Kwinana | Kwinana North to Kwinana West	45	0.669
	Kwinana North to Kwinana	45.DG Midland to Kwinana | Kwinana North to Kwinana	45	1.166
	Cockburn South to Kwinana North	45.DG Midland to Kwinana | Cockburn South to Kwinana North	45	11.5272
	Cockburn East to Cockburn South	45.DG Midland to Kwinana | Cockburn East to Cockburn South	45	1.172
	Cockburn North to Cockburn East	46.DG Cockburn North to Cockburn East | Cockburn North to Cockburn East	46	1.152
	Cockburn North to Cockburn South	47.DG Cockburn North to Cockburn South | Cockburn North to Cockburn South	47	1.502
	Kenwick to Cockburn East	45.DG Midland to Kwinana | Kenwick to Cockburn East	45	42.74848
	Forrestfield to Kenwick	45.DG Midland to Kwinana | Forrestfield to Kenwick	45	8.043
	Forrestfield	45.DG Midland to Kwinana | Forrestfield	45	16.283
	Forrestfield South to Kewdale	2.SG Forrestfield South to Kewdale | Forrestfield South to Kewdale	2	3.067
	Woodbridge South to Forrestfield	45.DG Midland to Kwinana | Woodbridge South to Forrestfield	45	16.9354
	Woodbridge West to Woodbridge South	45.DG Midland to Kwinana | Woodbridge West to Woodbridge South	45	1.094
	Midland to Woodbridge South	45.DG Midland to Kwinana | Midland to Woodbridge South	45	2.38
EGR	Midland to Millendon Junction	44.DG Midland to Avon | Midland to Millendon Junction	44	29.231
	Millendon Junction to Toodyay West	44.DG Midland to Avon | Millendon Junction to Toodyay West	44	134.085
	Toodyay West to Avon Yard	44.DG Midland to Avon | Toodyay West to Avon Yard	44	61.467
	Avon Yard	44.DG Midland to Avon | Avon Yard	44	4.706
	Avon Yard to West Merredin	1.SG Avon to Kalgoorlie | Avon Yard to West Merredin	1	181.9222
	West Merredin	1.SG Avon to Kalgoorlie | West Merredin	1	4.509

	West Merredin to Merredin	1.SG Avon to Kalgoorlie | West Merredin to Merredin	1	2.5298
	Merredin to Southern Cross	1.SG Avon to Kalgoorlie | Merredin to Southern Cross	1	131.968
	Southern Cross to Koolyanobbing East	1.SG Avon to Kalgoorlie | Southern Cross to Koolyanobbing East	1	60.7363
	Koolyanobbing East to Mount Walton	1.SG Avon to Kalgoorlie | Koolyanobbing East to Mount Walton	1	85.3793
	Mount Walton to West Kalgoorlie West	1.SG Avon to Kalgoorlie | Mount Walton to West Kalgoorlie West	1	115.663
	West Kalgoorlie West to West Kalgoorlie	1.SG Avon to Kalgoorlie | West Kalgoorlie West to West Kalgoorlie	1	7.961
	West Kalgoorlie	1.SG Avon to Kalgoorlie | West Kalgoorlie	1	3.214
	West Kalgoorlie to Kalgoorlie	1.SG Avon to Kalgoorlie | West Kalgoorlie to Kalgoorlie	1	4.94
	Kalgoorlie	1.SG Avon to Kalgoorlie | Kalgoorlie	1	1.015
	Kalgoorlie to Parkeston (border)	1.SG Avon to Kalgoorlie | Kalgoorlie to Parkeston (border)	1	0.495
Midwest	Narngulu to Narngulu East	40.NG Narngulu to Maya | Narngulu to Narngulu East	40	2.776
	Narngulu East to Mullewa	40.NG Narngulu to Maya | Narngulu East to Mullewa	40	101.639
	Mullewa to Tilley Junction	40.NG Narngulu to Maya | Mullewa to Tilley Junction	40	98.107
	Tilley Junction to Tilley	40.NG Narngulu to Maya | Tilley Junction to Tilley	40	1.7981
	Tilley to Morawa	40.NG Narngulu to Maya | Tilley to Morawa	40	3.0079
	Morawa to Perenjori	40.NG Narngulu to Maya | Morawa to Perenjori	40	41.801
	Perenjori to Maya	40.NG Narngulu to Maya | Perenjori to Maya	40	54.498
EBL	West Kalgoorlie West to West Kalgoorlie South	4.SG West Kalgoorlie West to West Kalgoorlie South | West Kalgoorlie West to West Kalgoorlie South	4	2.065
	West Kalgoorlie to West Kalgoorlie South	4.SG West Kalgoorlie West to West Kalgoorlie South | West Kalgoorlie West to West Kalgoorlie South	4	2.68
	West Kalgoorlie South to Hampton Intermodal Terminal	5.SG West Kalgoorlie to Esperance | West Kalgoorlie South to Hampton Intermodal Terminal	5	11.84857
	Hampton Intermodal Terminal	5.SG West Kalgoorlie to Esperance | Hampton Intermodal Terminal	5	0.751

	Hampton Intermodal Terminal to Hampton	5.SG West Kalgoorlie to Esperance | Hampton Intermodal Terminal to Hampton	5	4.932
	Hampton to Kambalda	5.SG West Kalgoorlie to Esperance | Hampton to Kambalda	5	39.443
	Kambalda to Redmine	6.SG Kambalda to Redmine | Kambalda to Redmine	6	6.411
	Kambalda to Salmon Gums	5.SG West Kalgoorlie to Esperance | Kambalda to Salmon Gums	5	234.959
	Salmon Gums to Esperance	5.SG West Kalgoorlie to Esperance | Salmon Gums to Esperance	5	108.513
	Esperance to Esperance Wharf	5.SG West Kalgoorlie to Esperance | Esperance to Esperance Wharf	5	9.087
	Esperance Wharf	5.SG West Kalgoorlie to Esperance | Esperance Wharf	5	1.723
LBL	Kalgoorlie to Menzies	3.SG Kalgoorlie to Leonora | Kalgoorlie to Menzies	3	131.691
	Menzies to Malcolm	3.SG Kalgoorlie to Leonora | Menzies to Malcolm	3	106.578
	Malcolm to Leonora	3.SG Kalgoorlie to Leonora | Malcolm to Leonora	3	25.134
	Leonora	3.SG Kalgoorlie to Leonora | Leonora	3	2.25
SWM	Kwinana to Mundijong Junction	10.NG Kwinana to Mundijong Junction | Kwinana to Mundijong Junction	10	30.034
	Mundijong Junction to Pinjarra	11.NG Mundijong Junction to Picton Junction | Mundijong Junction to Pinjarra	11	47.5505
	Pinjarra to Pinjarra South	11.NG Mundijong Junction to Picton Junction | Pinjarra to Pinjarra South	11	3.196
	Pinjarra to Alumina Junction	18.NG Pinjarra to Alumina Junction | Pinjarra to Alumina Junction	18	1.826
	Alumina Junction to Pinjarra South	19.NG Alumina Junction to Pinjarra South | Alumina Junction to Pinjarra South	19	1.05491
	Pinjarra South to Wagerup North	11.NG Mundijong Junction to Picton Junction | Pinjarra South to Wagerup North	11	31.8
	Wagerup North to Wagerup South	11.NG Mundijong Junction to Picton Junction | Wagerup North to Wagerup South	11	1.08
	Wagerup South to Brunswick North	11.NG Mundijong Junction to Picton Junction | Wagerup South to Brunswick North	11	40.675
	Brunswick North to Brunswick Junction	11.NG Mundijong Junction to Picton Junction | Brunswick North to Brunswick Junction	11	1.036

	Brunswick Junction to Picton Junction	11.NG Mundijong Junction to Picton Junction | Brunswick Junction to Picton Junction	11	24.025
	Picton Junction to Picton East	15.NG Picton Junction to Picton East | Picton Junction to Picton East	15	4.0386
	Picton Junction to Bunbury Inner Harbour	16.NG Picton Junction to Bunbury Inner Harbour | Picton Junction to Bunbury Inner Harbour	16	9.465
	Picton Junction to Picton Container Terminal	17.NG Picton Junction to Bunbury Terminal | Picton Junction to Picton Container Terminal	17	1.699
	Picton Container Terminal to Bunbury Terminal	17.NG Picton Junction to Bunbury Terminal | Picton Container Terminal to Bunbury Terminal	17	4
	Picton Junction to Greenbushes	13.NG Picton Junction to Lambert | Picton Junction to Greenbushes	13	78.3104
Collie	Brunswick North to Brunswick East	21.NG Brunswick North to Brunswick East | Brunswick North to Brunswick East	21	1.111
	Brunswick Junction to Brunswick East	20.NG Brunswick Junction to Premier | Brunswick Junction to Brunswick East	20	0.975
	Brunswick East to Worsley	20.NG Brunswick Junction to Premier | Brunswick East to Worsley	20	24.761
	Worsley to Worsley East	20.NG Brunswick Junction to Premier | Worsley to Worsley East	20	0.954
	Worsley East to Ewington Junction	20.NG Brunswick Junction to Premier | Worsley East to Ewington Junction	20	27.468
	Ewington Junction to Premier	20.NG Brunswick Junction to Premier | Ewington Junction to Premier	20	2.41
	Worsley East to Worsley North	22.NG Worsley to Hamilton | Worsley East to Worsley North	22	1.082
	Worsley to Hamilton	22.NG Worsley to Hamilton | Worsley to Hamilton	22	11.034
MR	Millendon Junction to Watheroo	38.NG Millendon Junction to Geraldton | Millendon Junction to Watheroo	38	185.9137
	Watheroo to Marchagee	38.NG Millendon Junction to Geraldton | Watheroo to Marchagee	38	28.511
	Marchagee to Dongara	38.NG Millendon Junction to Geraldton | Marchagee to Dongara	38	180.588
	Dongara to Narngulu	38.NG Millendon Junction to Geraldton | Dongara to Narngulu	38	60.192

	Narngulu to Geraldton	38.NG Millendon Junction to Geraldton | Narngulu to Geraldton	38	19.681
	Dongara to Eneabba South	39.NG Dongara to Eneabba South | Dongara to Eneabba South	39	94.383
Central	Avon Yard to Goomalling	34.NG Avon Yard to McLevie | Avon Yard to Goomalling	34	56.429
	Goomalling to McLevie	34.NG Avon Yard to McLevie | Goomalling to McLevie	34	139.968
	Goomalling to Amery	35.NG Goomalling to Mukinbudin | Goomalling to Amery	35	33.779
	Amery to Mukinbudin	35.NG Goomalling to Mukinbudin | Amery to Mukinbudin	35	156.105
	Amery to Burakin	36.NG Amery to Kalannie | Amery to Burakin	36	79.349
	Burakin to Kalannie	36.NG Amery to Kalannie | Burakin to Kalannie	36	20.798
	Burakin to Beacon	37.NG Burakin to Beacon | Burakin to Beacon	37	71.733
	Toodyay West to Miling	41.NG Toodyay West to Miling | Toodyay West to Miling	41	136.231
GSR	Avon Yard to York	23.NG Avon to Albany | Avon Yard to York	23	41.903
	York to Brookton	23.NG Avon to Albany | York to Brookton	23	64.1802
	Brookton to Narrogin	23.NG Avon to Albany | Brookton to Narrogin	23	74.1778
	Narrogin to Wagin	23.NG Avon to Albany | Narrogin to Wagin	23	48.414
	Wagin to Wagin South	23.NG Avon to Albany | Wagin to Wagin South	23	3.281
	Wagin South to Katanning	23.NG Avon to Albany | Wagin South to Katanning	23	51.126
	Katanning to Tambellup	23.NG Avon to Albany | Katanning to Tambellup	23	51.059
	Tambellup to Redmond	23.NG Avon to Albany | Tambellup to Redmond	23	120.692
	Redmond to Albany	23.NG Avon to Albany | Redmond to Albany	23	25.825
Lakes	Wagin East to Wagin South	27.NG Wagin to Newdegate | Wagin East to Wagin South	27	0.776
	Wagin to Lake Grace	27.NG Wagin to Newdegate | Wagin to Lake Grace	27	122.716
	Lake Grace to Newdegate	27.NG Wagin to Newdegate | Lake Grace to Newdegate	27	61.09
	Lake Grace to Hyden	28.NG Lake Grace to Hyden | Lake Grace to Hyden	28	93.183
CBH Sidings	CBH SG Sidings (all)			28.302
	CBH NG Sidings (all)			81.51796

Sidings & Other	Cockburn North to Robb Jetty (SG)			7.398
	Esperance Industrial Road			3.673
	West Kalgoorlie Industrial Road			2.0867
	Kewdale North Grid			2.845
	Kewdale BP Loading Depot			1.392
	Cockburn North to Robb Jetty (NG)			5.771
	Redmond to Mirrambeena			1.522
	NG Siding - Kwinana to Kwinana Alcoa			6.078
	NG Siding - Kwinana to Kwinana West			0.734
	NG Siding - Kwinana West to Kwinana KBT			0.095
	NG Siding - Extension Hill Siding			3.248
	NG Siding - Tilley Siding			1.8499
	Kwinana West to Kwinana FPA			2.75
	Kwinana FPA to Kwinana CBH			4.83
Non-Operational	Greenbushes to Lambert	13.NG Picton Junction to Lambert | Greenbushes to Lambert	13	71.682
	Boyanup to Capel	14.NG Boyanup to Capel | Boyanup to Capel	14	21.816
	York to Quairading	24.NG York to Quairading | York to Quairading	24	74.432
	Narrogin to West Merredin	25.NG Narrogin to West Merredin | Narrogin to West Merredin	25	223.166
	West Merredin to Kondinin	32.NG West Merredin to Kondinin | West Merredin to Kondinin	32	146.893
	West Merredin to Trayning	33.NG West Merredin to Trayning | West Merredin to Trayning	33	76.125
	Yilliminning to Kulin	26.NG Yilliminning to Kulin | Yilliminning to Kulin	26	99.8206
	Katanning to Nyabing	29.NG Katanning to Nyabing | Katanning to Nyabing	29	61.905
	Tambellup to Gnowangerup	31.NG Tambellup to Gnowangerup | Tambellup to Gnowangerup	31	38.6
	Katanning East to Katanning South			0

A-2 Level of Service

Network Group	Route Section	Max TAL and Speed	Maximum Train Length
Metro	Kwinana West to Kwinana KBT	24t: 40 23t: 40 21t: 55 19t: 55 16t: 55 PassTrain: - PassRailCar: -	1700-1800m
	Kwinana North to Kwinana West	24t: 40 23t: 40 21t: 55 19t: 55 16t: 55 PassTrain: - PassRailCar: -	1700-1800m
	Kwinana North to Kwinana	24t: 40 23t: 40 21t: 55 19t: 55 16t: 55 PassTrain: - PassRailCar: -	1700-1800m
	Cockburn South to Kwinana North	24t: 70 23t: 70 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar: -	1700-1800m
	Cockburn East to Cockburn South	24t: 70 23t: 70 21t: 80 19t: 80 16t: 80 PassTrain: 80 PassRailCar: 80	1700-1800m
	Cockburn North to Cockburn East	24t: 40 23t: 40 21t: 80 19t: 80 16t: 80 PassTrain:- PassRailCar: 80	1700-1800m
	Cockburn North to Cockburn South	24t: - 23t: - 21t: 50 19t: 50 16t: 65 PassTrain: - PassRailCar :-	1700-1800m

	Kenwick to Cockburn East	24t: 70 23t: 70 21t: 80 19t: 80 16t: 80 PassTrain: 80 PassRailCar :80	1700-1800m
	Forrestfield to Kenwick	24t: 70 23t: 70 21t: 80 19t: 80 16t: 80 PassTrain: 80 PassRailCar :80	1700-1800m
	Forrestfield	24t: 20 23t: 20 21t: 20 19t: 20 16t: 20 PassTrain: 20 PassRailCar :20	-
	Forrestfield South to Kewdale	24t: 20 23t: 20 21t: 20 19t: 20 16t: 20 PassTrain: 20 PassRailCar :20	1700-1800m
	Woodbridge South to Forrestfield	24t: 70 23t: 70 21t: 80 19t: 80 16t: 80 PassTrain: 80 PassRailCar :80	1700-1800m
	Woodbridge West to Woodbridge South	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: 80 PassRailCar :80	1700-1800m
	Midland to Woodbridge South	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: 80 PassRailCar :80	1700-1800m

EGR	Midland to Millendon Junction	24t: 70 23t: 80 21t: 80 19t: 80 16t: 80 PassTrain: 100 PassRailCar :100	1700-1800m
	Millendon Junction to Toodyay West	24t: 70 23t: 80 21t: 80 19t: 80 16t: 80 PassTrain: 100 PassRailCar :100	1700-1800m
	Toodyay West to Avon Yard	24t: 70 23t: 80 21t: 80 19t: 80 16t: 80 PassTrain: 100 PassRailCar :100	1700-1800m
	Avon Yard	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar :25	-
	Avon Yard to West Merredin	24t: 80 23t: 110 21t: 110 19t: 110 16t: 110 PassTrain: 110 PassRailCar :160	1700-1800m
	West Merredin	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar :25	-
	West Merredin to Merredin	24t: 80 23t: 80 21t: 110 19t: 110 16t: 110 PassTrain: 110 PassRailCar :160	1700-1800m

	Merredin to Southern Cross	24t: 80 23t: 80 21t: 110 19t: 110 16t: 110 PassTrain: 110 PassRailCar :160	1700-1800m
	Southern Cross to Koolyanobbing East	24t: 80 23t: 80 21t: 110 19t: 110 16t: 110 PassTrain: 110 PassRailCar :160	1700-1800m
	Koolyanobbing East to Mount Walton	24t: 80 23t: 90 21t: 115 19t: 115 16t: 115 PassTrain: 115 PassRailCar :160	1700-1800m
	Mount Walton to West Kalgoorlie West	24t: - 23t: 90 21t: 115 19t: 115 16t: 115 PassTrain: 115 PassRailCar :160	1700-1800m
	West Kalgoorlie West to West Kalgoorlie	24t: - 23t: 90 21t: 115 19t: 115 16t: 115 PassTrain: 115 PassRailCar :160	1700-1800m
	West Kalgoorlie	24t: - 23t: 90 21t: 115 19t: 115 16t: 115 PassTrain: 115 PassRailCar :160	-
	West Kalgoorlie to Kalgoorlie	24t: - 23t: 90 21t: 115 19t:115 16t: 115 PassTrain: 115 PassRailCar : 160	1700-1800m
	Kalgoorlie	24t: 25 23t: 25 21t: 25 19t: 25	-

		16t: 25 PassTrain: 25 PassRailCar :25	
	Kalgoorlie to Parkeston (border)	24t: - 23t: 90 21t: 115 19t:115 16t: 115 PassTrain: 115 PassRailCar : -	1700-1800m
Midwest	Narngulu to Narngulu East	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar : -	1000-1100m
	Narngulu East to Mullewa	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar : -	1000-1100m
	Mullewa to Tilley Junction	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar : -	1000-1100m
	Tilley Junction to Tilley	24t: - 23t: - 21t: - 19t: - 16t: 50 PassTrain: - PassRailCar : -	1000-1100m
	Tilley to Morawa	24t: - 23t: - 21t: - 19t: - 16t: 50 PassTrain: - PassRailCar : -	1000-1100m
	Morawa to Perenjori	24t: - 23t: - 21t: - 19t: - 16t: 50 PassTrain: - PassRailCar: -	1000-1100m

	Perenjori to Maya	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
EBL	West Kalgoorlie West to West Kalgoorlie South	24t: 40 23t: 60 21t: 70 19t: 70 16t: 70 PassTrain: - PassRailCar: -	1700-1800m
	West Kalgoorlie to West Kalgoorlie South	24t: 40 23t: 60 21t: 70 19t: 70 16t: 70 PassTrain: - PassRailCar: -	1700-1800m
	West Kalgoorlie South to Hampton Intermodal Terminal	24t: 40 23t: 60 21t: 70 19t: 70 16t: 70 PassTrain: - PassRailCar: -	1700-1800m
	Hampton Intermodal Terminal	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	Hampton Intermodal Terminal to Hampton	24t: 40 23t: 60 21t: 70 19t: 70 16t: 70 PassTrain: - PassRailCar: -	1700-1800m
	Hampton to Kambalda	24t: 40 23t: 40 21t: 60 19t: 70 16t: 70 PassTrain: - PassRailCar: -	1700-1800m

	Kambalda to Redmine	24t: 40 23t: 40 21t: 60 19t: 70 16t: 70 PassTrain: - PassRailCar: -	700-800m
	Kambalda to Salmon Gums	24t: - 23t: 50 21t: 60 19t: 60 16t: 70 PassTrain: - PassRailCar: -	1700-1800m
	Salmon Gums to Esperance	24t: - 23t: 50 21t: 60 19t: 60 16t: 70 PassTrain: - PassRailCar: -	1700-1800m
	Esperance to Esperance Wharf	24t: - 23t: 50 21t: 60 19t: 60 16t: 70 PassTrain: - PassRailCar: -	1700-1800m
	Esperance Wharf	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	1700-1800m
LBL	Kalgoorlie to Menzies	24t: - 23t: 50 21t: 50 19t: 60 16t: 60 PassTrain: - PassRailCar: -	700-800m
	Menzies to Malcolm	24t: - 23t: 50 21t: 50 19t: 60 16t: 60 PassTrain: - PassRailCar: -	700-800m

	Malcolm to Leonora	24t: - 23t: 50 21t: 50 19t: 60 16t: 60 PassTrain: - PassRailCar: -	700-800m
	Leonora	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
SWM	Kwinana to Mundijong Junction	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar: -	800-900m
	Mundijong Junction to Pinjarra	24t: - 23t: - 21t: 115 19t: 115 16t: 115 PassTrain: - PassRailCar: 110	800-900m
	Pinjarra to Pinjarra South	24t: - 23t: - 21t: 70 19t: 70 16t: 80 PassTrain: - PassRailCar: 110	800-900m
	Pinjarra to Alumina Junction	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar: -	800-900m
	Alumina Junction to Pinjarra South	24t: - 23t: - 21t: 40 19t: 50 16t: 60 PassTrain: - PassRailCar: -	800-900m

	Pinjarra South to Wagerup North	24t: - 23t: - 21t: 70 19t: 70 16t: 80 PassTrain: - PassRailCar: 110	500-600m
	Wagerup North to Wagerup South	24t: - 23t: - 21t: 70 19t: 70 16t: 80 PassTrain: - PassRailCar: 110	500-600m
	Wagerup South to Brunswick North	24t: - 23t: - 21t: 70 19t: 70 16t: 80 PassTrain: - PassRailCar: 110	500-600m
	Brunswick North to Brunswick Junction	24t: - 23t: - 21t: 70 19t: 70 16t: 80 PassTrain: - PassRailCar: 110	500-600m
	Brunswick Junction to Picton Junction	24t: - 23t: - 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar: 110	600-700m
	Picton Junction to Picton East	24t: - 23t: - 21t: 40 19t: 40 16t: 40 PassTrain: - PassRailCar: -	600-700m
	Picton Junction to Bunbury Inner Harbour	24t: - 23t: - 21t: 115 19t: 115 16t: 115 PassTrain: - PassRailCar: -	600-700m
	Picton Junction to Picton Container Terminal	24t: - 23t: - 21t: - 19t: -	600-700m

		16t: - PassTrain: - PassRailCar: 70	
	Picton Container Terminal to Bunbury Terminal	24t: - 23t: - 21t: - 19t: - 16t: - PassTrain: - PassRailCar: 70	600-700m
	Picton Junction to Greenbushes	24t: - 23t: - 21t: - 19t: 50 16t: 50 PassTrain: - PassRailCar: -	400-500m
Collie	Brunswick North to Brunswick East	24t: - 23t: - 21t: 50 19t: 50 16t: 50 PassTrain: - PassRailCar: -	600-700m
	Brunswick Junction to Brunswick East	24t: - 23t: - 21t: 40 19t: 40 16t: 40 PassTrain: - PassRailCar: -	600-700m
	Brunswick East to Worsley	24t: - 23t: - 21t: 50 19t: 50 16t: 50 PassTrain: - PassRailCar: -	600-700m
	Worsley to Worsley East	24t: - 23t: - 21t: 50 19t: 50 16t: 50 PassTrain: - PassRailCar: -	400-500m
	Worsley East to Ewington Junction	24t: - 23t: - 21t: - 19t: 30 16t: 30 PassTrain: - PassRailCar: -	400-500m

	Ewington Junction to Premier	24t: - 23t: - 21t: - 19t: 30 16t: 30 PassTrain: - PassRailCar: -	400-500m
	Worsley East to Worsley North	24t: - 23t: - 21t: 50 19t: 50 16t: 50 PassTrain: - PassRailCar: -	600-700m
	Worsley to Hamilton	24t: - 23t: - 21t: 50 19t: 50 16t: 65 PassTrain: - PassRailCar: -	600-700m
MR	Millendon Junction to Watheroo	24t: - 23t: - 21t: - 19t: - 16t: 50 PassTrain: - PassRailCar: -	800-900m
	Watheroo to Marchagee	24t: - 23t: - 21t: - 19t: - 16t: 50 PassTrain: - PassRailCar: -	800-900m

	Marchagee to Dongara	24t: - 23t: - 21t: - 19t: - 16t: 50 PassTrain: - PassRailCar: -	800-900m
	Dongara to Narngulu	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	800-900m
	Narngulu to Geraldton	24t: - 23t: - 21t: 60 19t: 60 16t: 60 PassTrain: - PassRailCar: -	1000-1100m
	Dongara to Eneabba South	24t: - 23t: - 21t: - 19t: - 16t: 40 PassTrain: - PassRailCar: -	800-900m
Central	Avon Yard to Goomalling	24t: - 23t: - 21t: - 19t: 70 16t: 80 PassTrain: - PassRailCar: -	900-1000m
	Goomalling to McLevie	24t: - 23t: - 21t: - 19t: - 16t: 40 PassTrain: - PassRailCar: -	700-800m

	Goomalling to Amery	24t: - 23t: - 21t: - 19t: 80 16t: 80 PassTrain: - PassRailCar: -	900-1000m
	Amery to Mukinbudin	24t: - 23t: - 21t: - 19t: 45 16t: 50 PassTrain: - PassRailCar: -	800-900m
	Amery to Burakin	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m
	Burakin to Kalannie	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m
	Burakin to Beacon	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	900-1000m
	Toodyay West to Miling	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
GSR	Avon Yard to York	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	1100-1200m

	York to Brookton	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	1100-1200m
	Brookton to Narrogin	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	1000-1100m
	Narrogin to Wagin	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	1000-1100m
	Wagin to Wagin South	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m
	Wagin South to Katanning	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m
	Katanning to Tambellup	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m
	Tambellup to Redmond	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m

	Redmond to Albany	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m
Lakes	Wagin East to Wagin South	24t: - 23t: - 21t: - 19t: 70 16t: 80 PassTrain: - PassRailCar: -	900-1000m
	Wagin to Lake Grace	24t: - 23t: - 21t: - 19t: 70 16t: 80 PassTrain: - PassRailCar: -	900-1000m
	Lake Grace to Newdegate	24t: - 23t: - 21t: - 19t: 45 16t: 50 PassTrain: - PassRailCar: -	900-1000m
	Lake Grace to Hyden	24t: - 23t: - 21t: - 19t: 60 16t: 70 PassTrain: - PassRailCar: -	900-1000m
CBH Sidings	CBH SG Sidings (all)	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	CBH NG Sidings (all)	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-

Sidings & Other	Cockburn North to Robb Jetty (SG)	24t: 40 23t: 40 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar: 25	1700-1800m
	Esperance Industrial Road	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	West Kalgoorlie Industrial Road	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	Kewdale North Grid	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	Kewdale BP Loading Depot	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	Cockburn North to Robb Jetty (NG)	24t: 40 23t: 40 21t: 80 19t: 80 16t: 80 PassTrain: - PassRailCar: 80	600-700m
	Redmond to Mirrambeena	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	200-300m

	NG Siding - Kwinana to Kwinana Alcoa	24t: - 23t: - 21t: 55 19t: 55 16t: 55 PassTrain: - PassRailCar: -	-
	NG Siding - Kwinana to Kwinana West	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	NG Siding - Kwinana West to Kwinana KBT	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	NG Siding - Extension Hill Siding	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	NG Siding - Tilley Siding	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	Kwinana West to Kwinana FPA	24t: 25 23t: 25 21t: 25 19t: 25 16t: 25 PassTrain: 25 PassRailCar: 25	-
	Kwinana FPA to Kwinana CBH	24t: 40 23t: 40 21t: 55 19t: 55 16t: 55 PassTrain: - PassRailCar: -	-
Non-Operational	Greenbushes to Lambert	24t: - 23t: - 21t: - 19t: 50 16t: 50	400-500m

	PassTrain: - PassRailCar: -	
Boyanup to Capel	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
York to Quairading	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
Narrogin to West Merredin	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
West Merredin to Kondinin	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
West Merredin to Trayning	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
Yilliminning to Kulin	24t: - 23t: - 21t: - 19t: - 16t: 40 PassTrain: - PassRailCar: -	400-500m
Katanning to Nyabing	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m
Tambellup to Gnowangerup	24t: - 23t: - 21t: - 19t: - 16t: 30	300-400m

	PassTrain: - PassRailCar: -	
Katanning East to Katanning South	24t: - 23t: - 21t: - 19t: - 16t: 30 PassTrain: - PassRailCar: -	400-500m

A-3 Direct Costs

Asset Class	Asset Type	Unit of Measurement	Effective Design Life (years)	Direct Unit Cost ($)	Contractor Risk (%)	Contractor Preliminaries (%)	Contractor Overhead and Profit (%)	Supply Cost Proportion	Install Cost Proportion
Formation	Applicable	m2	100	43.19	5.0%	30.0%	9.5%	55.6%	44.4%
Formation	Non-applicable	m2	100	8	5.0%	30.0%	9.5%	0.0%	100.0%
Formation	Savings-earthworks	m2	100	- 12.19	5.0%	30.0%	9.5%	0.0%	100.0%
Clearing and grubbing	All	m2	100	4	5.0%	30.0%	9.5%	0.0%	100.0%
Earthworks	All	m2	100	9	5.0%	30.0%	9.5%	0.0%	100.0%
Cuttings	All	m3	100	10	5.0%	30.0%	9.5%	0.0%	100.0%
Embankments	Sourced from cut	m3	100	15	5.0%	30.0%	9.5%	0.0%	100.0%
Embankments	Externally sourced	m3	100	31	5.0%	30.0%	9.5%	80.6%	19.4%
Fencing	All	Route / m	15	-	5.0%	30.0%	9.5%		
Access Roads	All	Track / KM	10	59,500	5.0%	30.0%	9.5%	0.0%	100.0%
Bridges	Type 1 - PCBC	m	100	315,000	5.0%	30.0%	9.5%	inc	inc
Bridges	Type 2a - PSC Plank	m2	100	8,500	5.0%	30.0%	9.5%	inc	inc
Bridges	Type 2b - PSC Teeroff	m2	100	9,000	5.0%	30.0%	9.5%	inc	inc
Bridges	Type 3 - Steel Composite	m2	100	9,000	5.0%	30.0%	9.5%	inc	inc
Bridges	Type 4 - Steel Composite	m2	100	8,500	5.0%	30.0%	9.5%	inc	inc
Bridges	REPLACED SIZE UNKNOWN	m3	100	8,500	5.0%	30.0%	9.5%	inc	inc
Bridges	ERADU	m2	100	29,650	5.0%	30.0%	9.5%	inc	inc
Tunnels	Cut and cover	m	100	47,500	5.0%	30.0%	9.5%	inc	inc
Culverts	600	m	50	600	5.0%	30.0%	9.5%	inc	inc
Culverts	900		50	900	5.0%	30.0%	9.5%	inc	inc
Culverts	1200		50	1,200	5.0%	30.0%	9.5%	inc	inc
Culverts	1500		50	1,500	5.0%	30.0%	9.5%	inc	inc
Culverts	1800		50	1,800	5.0%	30.0%	9.5%	inc	inc
Culverts	2400		50	2,400	5.0%	30.0%	9.5%	inc	inc
Culverts	3000		50	3,000	5.0%	30.0%	9.5%	inc	inc
Culverts	3600		50	3,600	5.0%	30.0%	9.5%	inc	inc
Level Crossings	Active: Gated		20	171,292	5.0%	30.0%	9.5%	inc	inc
Level Crossings	Active: Signals		20	129,278	5.0%	30.0%	9.5%	inc	inc
Level Crossings	Passive: Maze		20	74,024	5.0%	30.0%	9.5%	inc	inc
Level Crossings	Passive: Path Only		20	28,728	5.0%	30.0%	9.5%	inc	inc
Level Crossings	Unprotected		20	28,048	5.0%	30.0%	9.5%	inc	inc
Rail	41kg	Track / KM (includes 2 rails. i.e. DG = 1.5x this rate)	60	348,215	5.0%	30.0%	9.5%	63.9%	36.1%
Rail	50kg	Track / KM (includes 2 rails. i.e. DG = 1.5x this rate)	60	353,496	5.0%	30.0%	9.5%	63.9%	36.1%
Rail	60kg	Track / KM (includes 2 rails. i.e. DG = 1.5x this rate)	60	376,196	5.0%	30.0%	9.5%	66.1%	33.9%
Sleepers	Concrete	Track / km sleeper (Assumes 1500 sleepers per km)	50	210	5.0%	30.0%	9.5%	88.1%	11.9%
Sleepers	Timber	Track / KM	15		5.0%	30.0%	9.5%		
Sleepers	Steel	Track / KM	40		5.0%	30.0%	9.5%		
Ballast	All	Track km	60	132,500	5.0%	30.0%	9.5%	69.8%	30.2%
Turnouts	NG	No.	20	250,000	5.0%	30.0%	9.5%	86.7%	13.3%
Turnouts	SG	No.	20	300,000	5.0%	30.0%	9.5%	86.7%	13.3%
Turnouts	DG	No.	20	700,000	5.0%	30.0%	9.5%	86.7%	13.3%
Turnouts	100% steel		20	-	-	-	-		
Turnouts	1-2 Steel/Timber		15	-	-	-	-		
Turnouts	1-3 Steel/Timber		15	-	-	-	-		
Turnouts	1-4 Steel/Timber		15	-	-	-	-		
Turnouts	Concrete		40	-	-	-	-		
Turnouts	Timber		15	-	-	-	-		
Turnouts	Timber/Steel Adhoc		15	-	-	-	-		
Communication Towers and Infrastructure	All	-	15	-	5.0%	30.0%	9.5%	#DIV/0!	#DIV/0!
CTC	All	-	15	-	5.0%	30.0%	9.5%	#DIV/0!	#DIV/0!
Signalling Assets	All	Route / KM	20	660,977	5.0%	30.0%	9.5%	#DIV/0!	#DIV/0!
CTC	All	-	15	-	5.0%	30.0%	9.5%	#DIV/0!	#DIV/0!
Control Centre	All	No.	50	5,002,400	5.0%	30.0%	9.5%	inc	inc
Depot	All	Total	50	150	5.0%	30.0%	9.5%	inc	inc
Signage	All	Track / KM	10	486	5.0%	30.0%	9.5%	inc	inc
Walkways	All	m2	100	40	5.0%	30.0%	9.5%	inc	inc

Item	Unit	Rate	Signalling Contractor Preliminaries	Signalling Contractor Overheads and Profit	Total Rate
			35%	20%	
AC Supplies	EA	50,000	17,500	13,500	81,000
Axle Counter System (1 Evaluator, 4 Heads)	EA	15,000	5,250	4,050	24,300
Boom barrier Level Crossing Protection	EA	685,168	239,809	184,995	1,109,972
Communications cabling	km	503,867	176,354	136,044	816,265
Computer Based Interlockings	EA	150,000	52,500	40,500	243,000
Control Centre		15,000	5,250	4,050	24,300
DC Supplies	EA	15,000	5,250	4,050	24,300
Depot		100,000	35,000	27,000	162,000
Equipment Cabinet	EA	20,000	7,000	5,400	32,400
Equipment Room	EA	50,000	17,500	13,500	81,000
Fencing	m	85	30	23	138
Flashlight Level Crossing Protection	EA	342,584	119,904	92,498	554,986
Indication Panels	EA	25,000	8,750	6,750	40,500
Miscellaneous Track Side Equipment		5,000	1,750	1,350	8,100
Optic Fibre (incl. civils)	m	504	176	136	816
Pedestrian Crossings	EA	171,292	59,952	46,249	277,493
Points Electric	EA	100,000	35,000	27,000	162,000
Points Mechanical	EA	25,000	8,750	6,750	40,500
Radio Base Station	EA	60,030	21,010	16,208	97,248
Radio Tower	EA	840,650	294,227	226,975	1,361,853
Router	EA	35,000	12,250	9,450	56,700
Signalling Equipment Hut Including Interlocking (minor)		150,000	52,500	40,500	243,000
Signalling Equipment Hut Including Interlocking		300,000	105,000	81,000	486,000
Signalling Cables	km	30,000	10,500	8,100	48,600
Signalling Line Routes	km	200,000	70,000	54,000	324,000
Signalling Location case	EA	20,000	7,000	5,400	32,400
Signalling Location Case Double Width	EA	35,000	12,250	9,450	56,700
Signals	EA	40,000	14,000	10,800	64,800
Speedboards	EA	300	105	81	486
Signs	EA	300	105	81	486
Switchlocks	EA	5,000	1,750	1,350	8,100
TDM Systems		100,000	35,000	27,000	162,000
Track Circuits - Audio Frequency Overlay		8,000	2,800	2,160	12,960
Track Circuits - Coded		8,000	2,800	2,160	12,960
Track Circuits - Predictors		8,000	2,800	2,160	12,960
Track Circuits - Solid State Controlled		8,000	2,800	2,160	12,960
Track Circuits DC		8,000	2,800	2,160	12,960
Track Circuits Pulse		8,000	2,800	2,160	12,960
Track Side Warning Systems		100,000	35,000	27,000	162,000
Train Order Cabin		100,000	35,000	27,000	162,000
Train Detection Systems		15,000	5,250	4,050	24,300

A-4 Planning and Development Consent Activities

Planning and Development Costs

Development and Planning activity	Cost ($million)
Contaminated land investigations	1.0
Surface Hydrology	0.5
Ecological investigations	5.0
Noise and vibration investigations	2.0
Cultural heritage investigations	2.6
Stakeholder consultation	0.8
Road traffic investigations	2.0
Initial environmental review report (review of environmental factors)	0.3
Input into engineering design	0.1
Total Feasibility and input to preliminary design	14.3
Preparation of referral under s. 38 of the EP Act	0.2
EPBC Act Referral	0.1
Preparation of Environmental Review Documents to support Public	4.5
Supporting Construction Environmental Management Plans	1.0
Supporting Operational Environmental Management Plans	0.6
Statutory fees for State and Commonwealth applications	1.0
Environmental Offsets	169.0
Public and stakeholder consultation	0.4
Public submissions and response process	0.6
Assessment finalisation and negotiation of conditions of approval	0.2
Town Planning Scheme Amendment (TPSA)	3.2
Development Application (DA)	2.4
Building work	0.8
Cultural Heritage Management Plans (CHMP).	1.5
Bushfire Management Plan (BMP)	0.5
Total Design Development and Planning Approval	186.0
Compliance assessment reporting (State)	1.8
Compliance assessment reporting (EPBC Act)	1.8
Environmental management representatives	15.6
Environmental monitoring (terrestrial)	3.6
CHMP	2.2
Environmental mitigation measures	0.0
Community consultation	12.5
Total Construction Support	37.5
Total	237.7

Relationship between Planning and Development Costs to Construction Schedule items

Scheduled	Task	Subtask	Cost($million)
2	Pre-construction planning, design and approvals	Environmental Constraints analysis and option shortlisting	14.3
4	Pre-construction planning, design and approvals	Environmental scoping, EIS, consultation, consideration and planning approval	176.0
7	Post Approvals	Prepare CEMPs, management plans and obtain secondary approvals	10.0
10	Construction Monitoring	Ongoing monitoring	37.5

Feasibility Cost Buildup

Component	Scope	Assumptions	Timeframe considerations	Estimated Cost ($m)
Physical Environment (Sediment, Soil and Land)				
Contaminated land investigations	Includes sampling and analysis of soil to meet State regulatory requirements and define baseline levels and inform design.	Assumes that land has limited previous contamination. Assessment level limited to Preliminary Site Investigation (PSI).	6 months	1.00
Surface Hydrology	Hydrological study and flood modelling to inform drainage design and environmental risks.	Assumes elevation data available to inform pre-construction flood modelling	6 months	0.50
Ecological				
Ecological investigations	Ecological surveys for migratory birds, terrestrial threatened fauna and flora species, communities and habitat values. The surveys are required to: - Take into account seasonality of survey work. - Consider State and Commonwealth listed species, communities and populations. - Include requirements for targeted flora surveys as per current regulations.	Assumes single year (multi-season surveys conducted) with no survey limitations (i.e.. adequate rainfall prior).	1 year (seasonal dependant surveys)	5.00
Social (Noise, Air, Visual, Cultural, Stakeholders)				
Noise and vibration investigations	Noise assessment to provide baseline and subsequent modelling at identified sensitive receptors.	One study for each LGA	6 months	2.00
Cultural heritage investigations	Cultural heritage encompasses Aboriginal and non-Aboriginal heritage. The investigations include: - Identification and site survey of cultural heritage matters (Aboriginal and non-Aboriginal) - Consultation with relevant Aboriginal corporations.	Assumes that limited development has occurred on site.	1 year	2.60
Stakeholder consultation	Stakeholder consultation would include: - Initial consultation with regulatory agencies. - Consultation with local stakeholders		1 year	0.80
Road traffic investigations	Including investigations of existing traffic volumes and road capacities.	One study for each LGA	0.5 years	2.00
Reporting and Engineering				
Initial environmental review report (review of environmental factors)	Development of a whole of project Preliminary Environmental Impact Assessment and associated report, based on desktop environmental information, initial survey findings, identification of opportunities and constraints and Regulatory Approvals Plan.		3 months	0.25
Input into engineering design	Periodic review of preliminary designs as they develop, with appropriate environmental planning input and advice.		As needed	0.10
Total Feasibility and Preliminary Design Costs				14.25

Design Development Cost Buildup

Component	Scope	Assumptions	Timeframe considerations	Estimated Cost ($m)
Primary Environmental Approvals				
Preparation of referral under s. 38 of the EP Act	Key tasks involve: - Preparation of s. 38 referral form and supporting document	Assumes assessment of one single project Timeframe includes acceptance and decision of level of assessment (highly likely to be Public Environmental Review [PER])	6 months	0.15
EPBC Act Referral	For protected matters under the EPBC Act.	Assumes project is a controlled action and is to be assessed as an accredited assessment by WA EPA.	6 months (concurrent with above task)	0.10
Preparation of Environmental Review Documents to support Public Environmental Review (under EP Act).	Preparation of ERD (including project scoping).	Includes document preparation and reviews prior to public comment period.	2 years	4.50
Supporting Construction Environmental Management Plans	Four environmental management plans for construction - Base CEMP (Dust, hydrocarbons etc.) - Noise CEMP - Flora and Vegetation CEMP - Fauna CEMP		6 months	1.00
Supporting Operational Environmental Management Plans	Three environmental management plans for operations - Base OEMP - Biodiversity OEMP - Offset Environmental Management Plan and strategy		6 months	0.60
Statutory fees for State and Commonwealth applications	Includes fees likely to be associated with State and Commonwealth approvals (cost recovery).	Assumes fees associated with Part IV assessment and EPBC Act Referral	n/a	1.00
Environmental Offsets	Implementation of offset strategy: - Land acquisition - Other reporting/ studies/ research requiring upfront commitment	Assumes the following $/ha for each bioregion: - Swan Coastal Plain $10,000/ha - Jarrah Forest $8,000/ha - Avon Wheatbelt $5,000/ha - Geraldton Sandplains $5,000/ha - Warren $8,000/ha - Mallee $8,000/ha - Murchison $5,000/ha - Esperance Plains $8,000/ha - Yalgoo $5,000/ha	2 years	169.00
Public and stakeholder consultation	It covers the likely consultation program with key stakeholders and regulatory agencies by the proponent during the Primary approvals process.		2 years	0.40
Public submissions and response process	Preparation of responses to public comments.	Assumes single round of comment response	6 months	0.60
Assessment finalisation and negotiation of conditions of approval	Condition setting.	Assumes single round of comment responses.	6 months	0.20
Planning Approvals				
Town Planning Scheme Amendment (TPSA)	TPSA require to secure rail line easement.	One TPSA for each Local Government Authority (LGA).	6 months	3.20
Development Application (DA)	DA for construction of rail within easement as well as associated supporting building infrastructure.	One DA for each LGA	6 months	2.40
Building work	Building approvals	One application for each LGA	6 months	0.80
Other Approvals				
Cultural Heritage Management Plans (CHMP).	CHMPs are likely required. The process includes extensive consultation with Aboriginal Parties supporting the section 18 process under the *Aboriginal Heritage Act 1978*. The estimated cost includes legal fees and signatories.	One CHMP for each Native title determination.	6 months	1.50
Bushfire Management Plan (BMP)	BMP to support DA	One BMP for each bioregion.	6 months	0.50
Total Design Development and Planning Approval				185.95