Deloitte.

Australian Rail Track Corporation Ltd

Operating and Maintenance Expenditure Analysis

September 2018

Australian Rail Track Corporation (ARTC) is Australia's largest rail freight network operator, operating and managing over 8,500 kilometres of track. Its Hunter Valley Coal Network has unique operating characteristics and ARTC plays a critical role in moving a range of commodities and the provision of passenger services across the coal network.

Executive Summary

This report provides a third party review of Australian Rail Track Corporation's (ARTC's) operating and maintenance expenditure in relation to the Hunter Valley Coal Network for Calendar Year 2015 (CAL15) in order to assess the efficiency of the costs, taking into account the operating context of the Hunter Valley Coal Network.

A number of internal and external factors influenced ARTC's operations in CAL15:

- Transformation and Growth Project: in 2014, ARTC commenced a large-scale transformation to drive greater focus on customers and their requirements, addressing feedback obtained through proactive engagement with ARTC customers, staff and leadership. This resulted in establishment of two autonomous, customer-focussed business units, Hunter Valley Network and Interstate Network.
- Coal Market Environment: in CAL15, the coal market was characterised by a continued decline in the export thermal coal price, while export coal shipments remained relatively stable. These conditions resulted in increased cost pressure on ARTC as customers sought to reduce their cost base.
- Coal Chain Capacity: ARTC's fundamental role is to provide sufficient capacity to meet the contracted volumes based on principles outlined in the 2011 Hunter Valley Coal Network Access Undertaking dated 23 June 2011 (and varied on 17 October 2012 and 25 June 2014) (HVAU) being the access undertaking relevant for the 2015 Compliance Assessment.

The Hunter Valley Coal Network forms an integral part of the world's largest coal export supply chain. It has been developed progressively over more than 150 years and is structured into three Pricing Zones, each with its own set of characteristics and customers. The following operating constraints and customer requirements drive ARTC's operating and maintenance expenditure and must be taken into account when reviewing the efficiency of the Hunter Valley Coal Network or comparing it with other coal rail networks across the world:

- Historical Legacy: the Hunter Valley Coal Network has progressively developed since the 1850's to meet demand and the majority of it is built on a formation constructed during the early 1900's. It was not purpose built for heavy haul traffic and the early 1900's design did not envisage the running of 30 Tonne Axle Load (TAL) services.
- Mixed Use: in addition to the coal traffic, the Hunter Valley Network accommodates other non coal freight, as well as local metropolitan and regional passenger services. As a result, ARTC is required to configure and optimise network for mixed use, including all types of traffic.
- Customer Expectations: ARTC proactively engages with its customers on a continuous basis, and customer expectations regarding the operation and management of the network drive decisions on operating and maintenance expenditure.

The Hunter Valley Coal Chain is operated as an integrated, shared supply chain. The central coordination function was formalised in 2009 with the incorporation of the Hunter Valley Coal Chain Coordinator (HVCCC) and is based on the principle that assets, although owned by different parties, should be operated as a whole to achieve an optimal outcome for the supply chain participants, including the asset owners and customers. The two key constructs that govern ARTC's role in the Hunter Valley Coal Chain are:

- HVAU: it specifies Coal Access Rights and provides guiding principles on management and pricing of the access to track capacity for the Hunter Valley coal industry to achieve an appropriate balance between the interests of ARTC, the users of the network and the public.

- HVCCC: is a central planning body incorporated in 2009 to plan and coordinate the operation and alignment of the coal chain in order to maximise the volume of coal transported, at minimum total logistics costs and in accordance with the agreed collective needs and contractual obligations between the participants.

The nature of the Hunter Valley Coal Network and the associated operating conditions result in scarcity of like-for-like comparators for all costs for ARTC, both domestically and internationally. Our review found that there are also very limited sources of publicly available cost information, particularly in relation to the heavy haul networks that are privately owned, due to commercial sensitivity of the information. The evaluation of efficiency for some cost categories has therefore been limited by the availability of data.

Analysis of the efficiency of operating and maintenance costs requires an understanding of 'efficient' expenditure in the context of the HVAU. The HVAU provides the framework for customers to negotiate and obtain access rights to the network, including fair and reasonable commercial terms. The HVAU details (Clause 4.5 b) that costs are assessed on an 'efficient' basis, which is defined as:

"costs incurred by a prudent service provider managing the Network, acting efficiently, having regard to any matters particular to the environment in which management of the Network occurs including:

- *The Hunter Valley Coal Chain where a key objective in maintenance planning is to maximise coal chain throughput and reliability;*
- *ARTC's obligations to maintain the Network having regard to the terms of the applicable Access Agreements and Access Holder Arrangements; and*
- *ARTC's obligations under the law, applicable legislation (including regulations) or the NSW Lease."*

Consequently, the definition 'efficient' recognises ARTC's obligations to its customers and community (through the NSW Lease), as well as its obligations to maximising coal chain throughput and reliability.

Operating Expenditure Review Findings

Taking into account the abovementioned operating context, Deloitte reviewed ARTC's Hunter Valley Coal Network operating and maintenance expenditure in CAL15.

The review considered the two elements that comprise the Hunter Valley Coal Network operating expenditure (Opex):

- Corporate overhead costs (Corporate Overheads)
- Operating, administration and indirect maintenance costs (Business Unit Management and Network Control).

CAL15 Opex costs have increased year-on-year. Particularly for Business Unit Management, this reflects the reallocation of Full Time Equivalents (FTE) following the 2014 Transformation and Growth Project.

The review of Hunter Valley Coal Network Corporate Overhead costs found that they were efficient when benchmarked against rail operators and a cross industry peer group. It was noted that:

- While costs have increased, ARTC's overhead allocation to the Hunter Valley Coal Network, on a percentage of revenue basis, is efficient compared to its peers
- A subset of Hunter Valley Coal Network's overhead costs, namely, Finance, Human Resources (HR), Property, Legal and Information Technology (IT) costs was benchmarked against a cross-industry peer group. These costs were also found to be efficient.

The review of ARTC's Network Control costs found that they are comparable to the costs of its closest peer, Aurizon Network.

Due to limited publicly available information, Business Unit Management costs could not be benchmarked.

Maintenance Expenditure Review Findings

ARTC's maintenance expenditure includes direct maintenance costs. The review identified that there were a number of factors that influenced the CAL15 maintenance program expenditure:

- Major Periodic Maintenance (MPM) expenditures increased at 19% Compound Annual Growth Rate (CAGR) from CAL12 to CAL15 due to strong historic growth in network shipments, Zone 3 capacity and axle load upgrades, and Zone 2 initial ballast cleaning work to address planned requirements
- Changing coal market environment, customer priorities and customer feedback drove a reduction in MPM expenditures as ARTC optimised work scopes, estimates, and project plans to respond to market conditions.

ARTC's CAL15 maintenance expenditure was also strongly influenced by the following inherent characteristics of the Hunter Valley rail infrastructure:

- Compliance with accredited Safety Management System and technical standards
- Customer expectations in relation to network capacity and reliability
- Integrated and complex nature of the Hunter Valley Coal Chain
- Underlying track formations constructed to different standards from late 1800's.

Taking into account ARTC's commercial, operational and technical constraints, ARTC's maintenance expenditure was found to be efficient and consistent with external benchmarks on a cost per Gross Tonne Kilometre (GTK) basis. ARTC's asset management planning practices are consistent, at a high-level, with general industry approaches and practices. The maintenance program delivered required network quality and reliability performance. In particular, we observed that:

- Key CAL15 maintenance activity expenditures were reflective of industry norms, that is, planning guidelines and unit rates were consistent with industry approaches
- Overall maintenance expenditures appear consistent with external benchmarks on a cost per GTK basis as well as on a cost per net tonne basis.

Bottom-up analysis of key MPM activities and projects noted some areas where costs were higher than we would have expected. On further investigation these costs reflected either increased scope of work, weather related impacts or the delivery arrangements.

Summary

CAL15 was year of transition for both ARTC and the market with the substantive completion of a significant infrastructure investment program in 2015, implementation of the Transformation and Growth Project in the organisation, and continued pressure on costs as a result of coal price volatility.

In summary, in the context of the operating environment leading up to and including CAL15, ARTC's Opex and maintenance costs appear to be efficient relative to peers within the rail industry.

The review identified that for CAL15 four of the five overhead cost categories benchmarked, found that ARTC's costs were lower than other similar sized organisations, with costs ranking in Quartile 1. The fifth overhead costs category (Property) was ranked in Quartile 2. Network Control costs were also benchmarked and were found to be comparable with their closest peer, Aurizon Network.

ARTC's approach to maintenance is reflective of industry norms and their costs appear consistent with industry benchmarks across two dimensions (GTK and $/tonne). Moving forward ARTC will need to engage with their customers to better understand the trade-offs to identify where there is scope to undertake investments to make efficiency improvements.

We note that CAL15 is not reflective of ARTC's ongoing cost base. Opex reflected a period of transition and included the costs associated with the Transformation and Growth Project. Maintenance costs reflected the market conditions at the time with lower coal market returns driving customer requests for lower costs.

Contents

Table of Figures and Tables

Figures

Tables

Acronyms

Acronym	Definition
ACCC	Australian Competition and Consumer Commission
AMP	Asset Management Plan
ARTC	Australian Rail Track Corporation Limited
AUD	Australian Dollar
B	Billion
BIC	Business Investment Committee
CAGR	Compound Annual Growth Rate
CAL	Calendar Year
CBI	Computer Based Interlocking
CEO	Chief Executive Officer
CIP	Continuous Improvement Program
CQCN	Central Queensland Coal Network
CRN	Country Regional Network
DIT	Declared Inbound Throughput
FTE	Full Time Equivalent
FY	Financial Year
GTK	Gross Tonne Kilometre
HH	Head Hardened
Hr	Hour
HR	Human Resources
HSEC	Health Safety Environment and Community
HVAU	Hunter Valley Access Undertaking
HVCCC	Hunter Valley Coal Chain Coordinator Limited
IT	Information Technology
Km	Kilometre
KPI	Key Performance Indicator
LICB	Lasting Infrastructure Cost Benchmarking
M	Million
MGT	Million Gross Tonnes
MPM	Major Periodic Maintenance
MST	Maintenance Scheduled Task
Mt	Million Tonnes

Acronym	Definition
NSW	New South Wales
Opex	Operating Expenditure
PC	Provisioning Centre
PMP	Project Management Plan
PN	Pacific National
QCA	Queensland Competition Authority
RBI	Relay Based Interlocking
RCG	Rail Capacity Group
RCRM	Routine Corrective and Reactive Maintenance
SC	Standard Carbon
T	Tonne
TAL	Tonne Axle Load
TMP	Technical Maintenance Plan
TMS	Top Moving Sum
TPI	The Pilbara Infrastructure
TSR	Temporary Speed Restrictions
UIC	International Union of Railways
US	United States
W	Watt
WA	Western Australia

Glossary

Term	Definition
Direct Maintenance	Activities related to routine corrective and reactive maintenance, major periodic maintenance and sustaining capital works.
Full Time Equivalent (FTE)	A unit to measure employed persons in a way that makes them comparable, although they may work a different number of hours per week. The unit is obtained by comparing an employee's average number of hours worked to the average number of hours of a full-time worker. A full-time person is therefore counted as one Full Time Equivalent, while a part-time worker is a proportion of a Full Time Equivalent.
Gross Tonne Kilometre (GTK)	A standard measure of track usage. The gross weight of a train (usually including locomotive power rather than just trailing weight) multiplied by kilometres travelled.
Indirect Maintenance	Maintenance-related activities that cannot be directly attributed to a line segment. Includes shared maintenance services, such as track monitoring services and environmental governance.
Major Periodic Maintenance (MPM)	Cyclical or planned activities that maintain the operating performance and asset life of operational infrastructure, and aim to reduce the level of defects and corrective maintenance.
Operating Expenditure (Opex)	Includes corporate overhead costs, and operating, administration and indirect maintenance costs.
Routine Corrective and Reactive Maintenance (RCRM)	Scheduled activities used to inspect or service asset condition on a routine basis, including reactive and corrective activities that are required as a result of inspections or defect identification that, because of their nature, are dealt with on the spot or as soon as is reasonably practical thereafter.
Sustaining Capital	Activity that will give rise to a future economic benefit that is readily identifiable and measurable. Economic benefit must create or extend the useful life of the asset by more than 12 months and/or provide additional functionality or increase the operating standard. Can be minor works that sustain existing capacity, for example asset replacement, cost reduction or safety related projects.
Track Kilometres (Track Km)	Kilometres of track, including mainline, sidings and terminals, but excluding passing loops.
Train Kilometres (Train Km)	A standard measure of track usage. Number of trains multiplied by the total kilometres travelled.
UT4	Aurizon Network's 2016 Access Undertaking.
UT5	Aurizon Network's 2017 Draft Access Undertaking.

1 Introduction

1.1 Background

The HVAU requires ARTC to submit documentation to the Australian Competition and Consumer Commission (ACCC) for the purposes of an annual compliance assessment. Section 4.10 and Schedule G of the HVAU require the ACCC to determine whether ARTC has complied with the financial model and pricing principles specified in the undertaking and whether there has been any under or over recovery of revenue from users that needs to be reconciled.

The ACCC is currently conducting a detailed review of the compliance assessment for CAL15. The compliance assessment includes a review of ARTC's CAL15 Opex and direct maintenance costs for Hunter Valley Coal Network.

The intent of the HVAU is to reach an appropriate balance between the legitimate business interests of ARTC and the public. Specifically, Section 1.2 (d) (i) of the HVAU describes ARTC's legitimate business interests as including:

- Recovery of at least sufficient revenue to meet the efficient costs associated with Access to the network, having regard to the efficient operation of the Hunter Valley Coal Chain
- A fair and reasonable return on ARTC's investment in the Network and Associated Facilities commensurate with its commercial risk
- Encouraging customer confidence and market growth in the rail industry and also, in particular, the Hunter Valley coal industry.

From a public interest perspective, the HVAU balances:

- Increasing competition and ensuring efficient use of resources
- The promotion of economically efficient investment, use and operation of the network.

Consequently, a review of the CAL15 Opex and maintenance costs must take into consideration factors influencing ARTC's operations and the role of CAL15 within the longer term (10-year) Asset Management Plan (AMP).

1.2 Purpose of This Report

The purpose of this Report is to provide a third party review of ARTC's Opex and maintenance costs in relation to the Hunter Valley Coal Network for CAL15 in order to assess the efficiency of the costs. Costs associated with the Interstate Network have not been considered as part of this review.

As part of this review, ARTC has provided Deloitte with the data sets provided to the ACCC.

The report provides a top-down analysis of the Hunter Valley Coal Network Opex and maintenance costs to compare, where possible, with other like systems taking into consideration:

- The 2015 coal market and the consequential customer expectations
- The efficient operation of the Hunter Valley Coal Chain
- The provisions outlined in the HVAU and customer contracts.

1.3 Approach

Our approach to providing a third party review of the efficiency of ARTC's Opex and maintenance costs in relation to the Hunter Valley Coal Network for CAL15 included the following five steps:

- Data Gathering: collecting ARTC 2015 Opex and maintenance data, along with the relevant information.

- **Initial Top-down Analysis:** high-level overview and analysis of ARTC 2015 Opex and maintenance data.
- **Review and Refinement:** clarification of the 2015 Opex and maintenance data, including understanding any significant cost changes or outliers.
- **Deep-dive Analysis:** more detailed analysis and benchmarking of 2015 Opex and maintenance data against ARTC's peers.
- **Reporting:** summarising the results of the analysis.

1.4 Assumptions and Limitations

The analysis undertaken reflects activities in CAL15 only, unless otherwise noted.

Analysis of maintenance expenditure reflected the following assumptions:

- Analysis of maintenance costs focused on MPM and Routine Corrective and Reactive Maintenance (RCRM) activities, work scope and costs assumed planned and agreed capital renewal investments
- Analysis assessed ARTC MPM and RCRM scope and costs at a Pricing Zone, line segment and project level
- Analysis used transactional activity and project-level costs and work scope data from ARTC's works ledger
- Analysis of forecast MPM and RCRM expenditures used the Financial Year (FY)14/15 10-year AMP as the basis
- Analysis of maintenance costs addressed unit maintenance rates at a project and activity level and excluded detailed analysis of labour and/or contract productivity.

The key limitations of the report are set out below:

- The focus of the analysis is on Opex and maintenance costs in CAL15. Subsequent years' Opex and maintenance costs are not included as part of the analysis scope
- Due to the uniqueness of the Hunter Valley Coal Network operating conditions, there is a scarcity of like-for-like comparators for the purpose of any benchmarking analysis
- Comparison of the Opex and maintenance costs with similar operations is limited to publicly available information.

1.5 The Year in Review – 2015

The ACCC has selected CAL15 to undertake a detailed review of ARTC's Opex and maintenance costs. In undertaking a review of CAL15 Opex and maintenance costs it is necessary to understand the internal and external factors influencing ARTC's operations in that year, including:

- The impact of the Transformation and Growth Project which would restructure ARTC to drive a greater focus on customers and their requirements
- The coal market which was in a period of continued decline
- The infrastructure requirements based on the requirements in the HVAU and customer contracts and the stage in the planning cycle.

1.5.1 ARTC Transformation and Growth Project

The Transformation and Growth Project, which commenced in late 2014, was in direct response to feedback obtained through proactive engagement with ARTC customers, staff and leadership. During the engagement process, it was found that ARTC needed to:

- Have a stronger focus on customer success
- Put customer plans and needs at the forefront of considerations when developing strategic initiatives
- Be more innovative in terms of using systems and technology in order to improve the service offering to customers, rail reliability and ultimately, the optimisation of costs
- Be timely and clear in its responses to customer requests and initiatives.

The Transformation and Growth Project resulted in a large-scale transformation to augment ARTC's operating model to place delivering value to the customer at the forefront of all its business activities and performance metrics. In particular, there was a dedicated focus on the proposed restructure of the business and its associated processes to enable a renewed focus on customer and service delivery.

The new corporate structure was centred on establishing two autonomous, customer-focussed business units, Hunter Valley Network and Interstate Network, which were underpinned by an efficiency-focussed support structure as outlined in Figure 1.1 below. Going forward the dedicated business units would be responsible for:

- Managing the customer relationship
- Achieving business outcomes in terms of operational performance, financial accountability and building network capacity to meet demand
- Asset management functions.

Figure 1.1: ARTC corporate restructure and responsibilities

Source: ARTC

1.5.2 Coal Market in 2015

The coal market in CAL15 was characterised by a continued decline in the export thermal coal price, as highlighted in Figure 1.2.

Figure 1.2: Historical thermal export coal prices (CAL05-18 in Australian Dollars (AUD) per Metric Tonne)

Source: Index Mundi Australian Thermal Coal Monthly Price

While the coal price declined in CAL15, export coal shipments remained relatively stable. These challenging coal market conditions and increasing cost pressure led to changes in customer expectations, with an increased focus on greater efficiency and safety culture, which in turn led to increasing cost pressure on ARTC from its customers.

1.5.3 Coal Chain Capacity

Between 2005 and 2015, export coal prices fluctuated considerably, while export coal shipments doubled. As ARTC's fundamental role is to provide sufficient capacity to meet the contracted volumes based on principles in the HVAU, this dramatic growth in export shipments have driven operations and maintenance expenditures. Key drivers include:

- Network Upgrades: ARTC completed a range of agreed capital network upgrades, which increased capacity but also added assets requiring ongoing maintenance.
- Maintenance Strategies: the annual maintenance works program also expanded over this period to cater for higher track wear related to increased tonnage.
- Network Reliability: in addition to capital upgrades, increased capacity demands also resulted in higher customer and coal chain stakeholder expectations for network reliability, that is, consistent transit times, and lower planned and unplanned downtime.
- Resource Constraints: delivery of the contracted capacity in the context of an integrated coal chain planning approach aligns network closedowns across the coal chain. This closedown regime is used to deliver capital upgrades and maintenance work, and required mobilisation of significant contracted resources to deliver work in a short period of time. The demand for high numbers of contract resources (people and equipment) over short periods of time can challenge available supply within the market.

2 Network Overview

- ARTC is Australia's largest rail freight network operator, and it controls, operates and maintains over 8,500 kilometres (Km) of track.
- ARTC has two autonomous, customer-focussed business units: Hunter Valley and Interstate, which have been established to provide and coordinate the delivery of network capacity and operations in response to their customers' needs.
- The Hunter Valley Network has been developed progressively over more than 150 years.
- It is divided into three Pricing Zones, each with its own set of characteristics and customers.
- Opex and maintenance costs for the Hunter Valley Network are driven by:
  - The historical legacy – the majority of the Hunter Valley Network is built on earthworks formation from early 1900s, which was not purpose built for heavy haul coal traffic
  - The need to configure and optimise the network for mixed use, including coal traffic, passenger trains and other freight
  - Customer expectations regarding the operation and management of the network.

2.1 ARTC Network Overview

ARTC controls, operates and maintains 8,500 Km of standard gauge rail infrastructure under freehold and long-term leasehold arrangements across Australia.

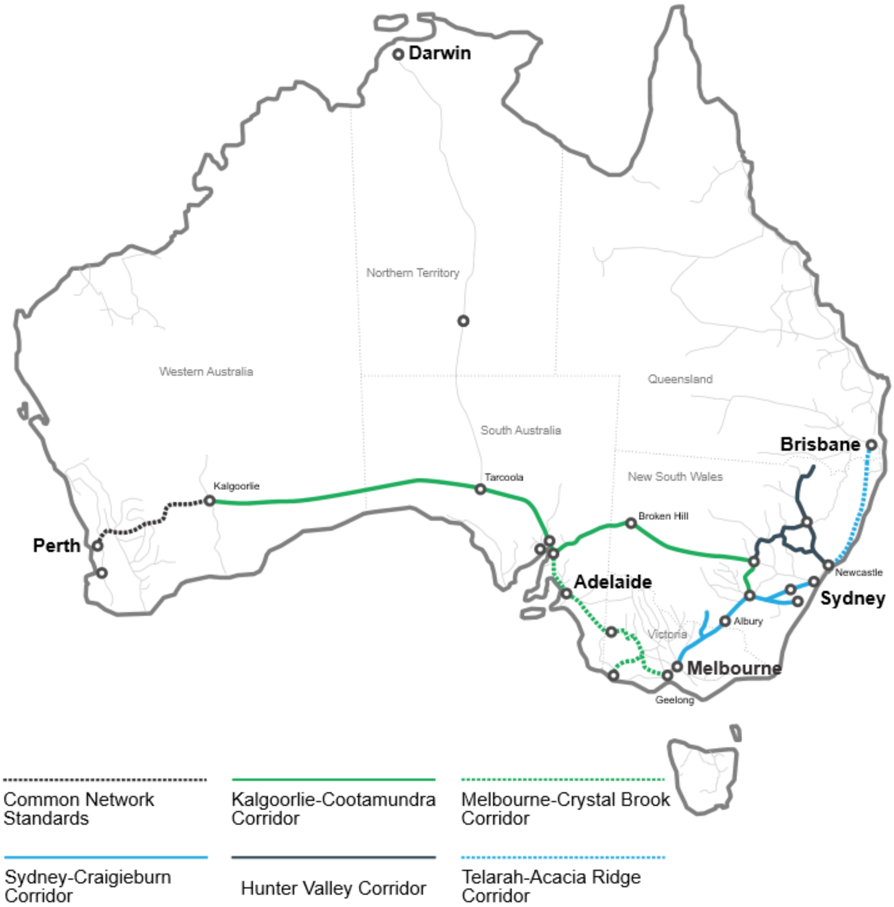
It is the integrated manager of critical Australian infrastructure, and has two autonomous, customer-focussed business units that were established following the 2014 Transformation and Growth Project:

- **Hunter Valley:** responsible for the Hunter Valley Network and providing and coordinating the delivery of network capacity to customers.
- **Interstate:** responsible for management of the Interstate Network and provision of transport services to customers across the interstate track, including the following corridors:
  - Kalgoorlie-Cootamundra corridor
  - Melbourne-Crystal Brook corridor
  - Sydney-Craigieburn corridor
  - Telarah-Acacia Ridge corridor.

The ARTC national network map is presented in the Figure 2.1 below.

The focus of this report is the Hunter Valley Network, which is described in more detail in the following sections.

Figure 2.1: ARTC network map



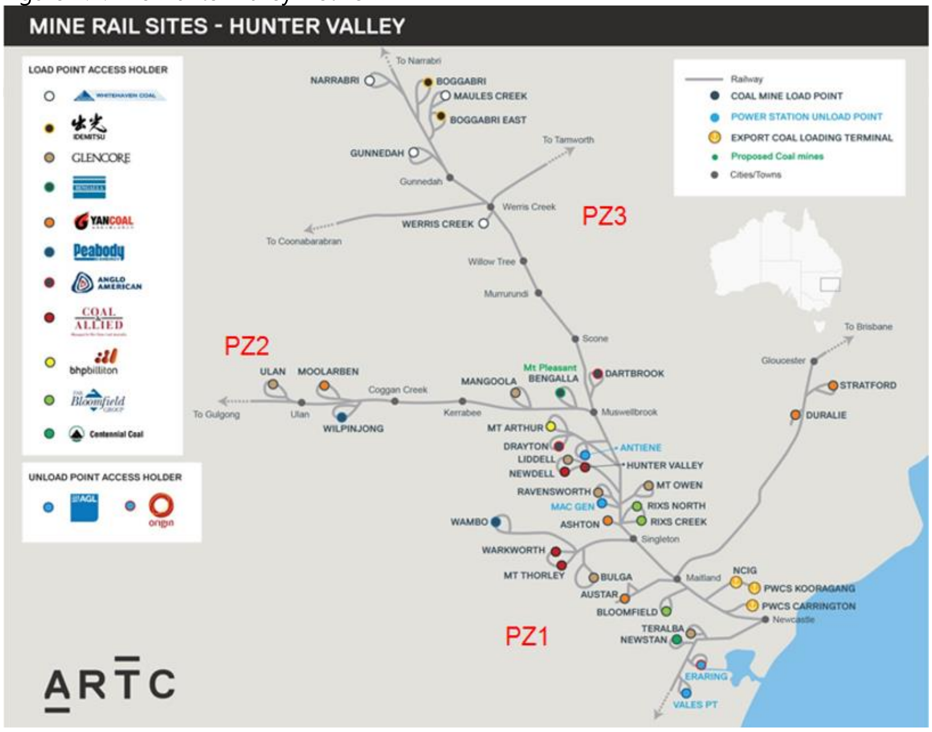
Source: ARTC

2.2 Hunter Valley Network Overview

2.2.1 Geography

The Hunter Valley Network is situated on the East Coast of Australia and extends considerably beyond the Hunter Valley, to the Gunnedah Basin (364 Km to the north west of the Port of Newcastle) and to the Ulan region (up to 276 Km west of the Port of Newcastle). It plays a pivotal role in connecting the coal mines to the Port of Newcastle and the three terminal operations that load export coal, and to domestic end users, as set out in Figure 2.2.

Figure 2.2: The Hunter Valley Network



Source: ARTC

2.2.2 Dimensions

The Hunter Valley Network is divided into three Pricing Zones, further detail on the operational characteristics of which is provided in section 2.3. It consists of a dedicated double track 'coal line' between Maitland and Kooragang/Carrington terminals (Pricing Zone 1), a shared double track line (with some significant stretches of third track) from Maitland to Muswellbrook in the upper Hunter Valley, and a shared single track with passing loops from north and west of Muswellbrook (Pricing Zones 2 and 3).

Train length on the Hunter Valley Network is limited to 1,543 metres. This length reflects the constraints of departure roads, the Hexham holding roads, Ulan line loop lengths, balloon loop constraints, and standing distances between signals and level crossings.

The majority of the bridge structures on the coal network are of concrete construction. However, there are also 49 steel structures and one masonry structure which, whilst they are adequate for the current operating requirements of the Hunter Valley Coal Network, do provide a different risk profile due to age, condition and location on the network.

2.2.3 Use

The Hunter Valley Coal Network is an integral part of the world's largest coal export supply chain. Export coal shipped through Newcastle is principally transported by rail across this network for loading and export from Carrington (Port Waratah), or one of the two terminals on Kooragang Island. Domestic coal is also transported over the parts of the Hunter Valley Network. In addition to the coal traffic, Hunter Valley Network carries other freight, as well as passenger trains.

The summary of the GTK and Train Kms over the Hunter Valley Network for CAL15 is provided in Table 2.1.

Table 2.1: CAL15 GTK and Train Km summary

	2015 GTK (millions)		2015 Train Kms ('000)	
	Actual	Contracted*	Actual	Contracted*
Coal (Pricing Zones 1, 2&3)				
Pricing Zone 1	25,701	26,995	3,845	4,056
Pricing Zones 2&3	15,445	5,891	2,398	867
Total Coal	41,146	42,020	6,242	6,413
Non-Coal	2,217		2,231	
Total Hunter Valley	*43,363*	*42,020*	*8,473*	*6,413*

Source: ARTC

*Note: *Contracted volumes represent the number of paths x Km for the train path x the gross tonnes of the assumed train service (i.e. empty and loaded weight).*

2.2.4 Network Characteristics

The Hunter Valley Coal Network has unique operating conditions, described in further detail below, that must be taken into account when comparing it with other coal rail networks across the world.

2.2.4.1 Historical Legacy

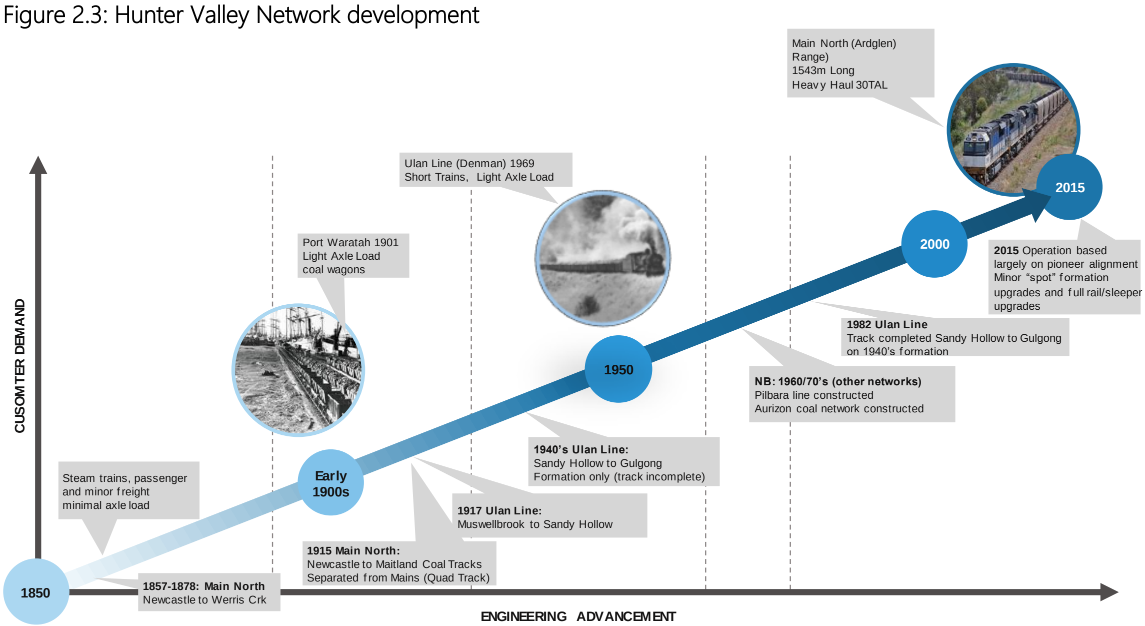
The Hunter Valley Network's historical legacy should be taken into account when assessing the network's performance.

The Hunter Valley Network has progressively developed since the 1850's to meet demand. The majority of the Hunter Valley Coal Network is built on an earthworks formation, which was constructed during the early 1900's. The history of the development of the network is further illustrated in Figure 2.3.

The Hunter Valley Network was not purpose built for heavy haul traffic. The original timber sleepers and track weight were not designed for running of 30 TAL rolling stock.

As a result of the Hunter Valley Network's historical legacy, the condition and quality of the track and hence engineering and asset maintenance requirements vary across the network.

Figure 2.3: Hunter Valley Network development



Source: ARTC

2.2.4.2 Mixed Use Rail Network

The Hunter Valley Network operates up to 230 train services per day, handled approximately 167 million net tonnes of coal traffic in 2015, and accommodates mixed uses of heavy coal freight services, mixed freight and local metropolitan and regional passenger services.

Part of the network, between the Gunnedah Basin and Muswellbrook, is highly complex and services coal traffic, passenger trains (New South Wales (NSW) Trains services to and from Scone and Moree/Armidale) and a proportionately high level of grain, cotton and flour trains. The non-coal traffic is up to seven trains each way per day between Narrabri and Scone, and 10 trains each way per day south of Scone.

The section of the network between Ulan and Muswellbrook is mainly used by coal trains, however it is also used by one or two country ore and grain trains per day and occasionally by interstate freight trains that are bypassing Sydney during possessions.

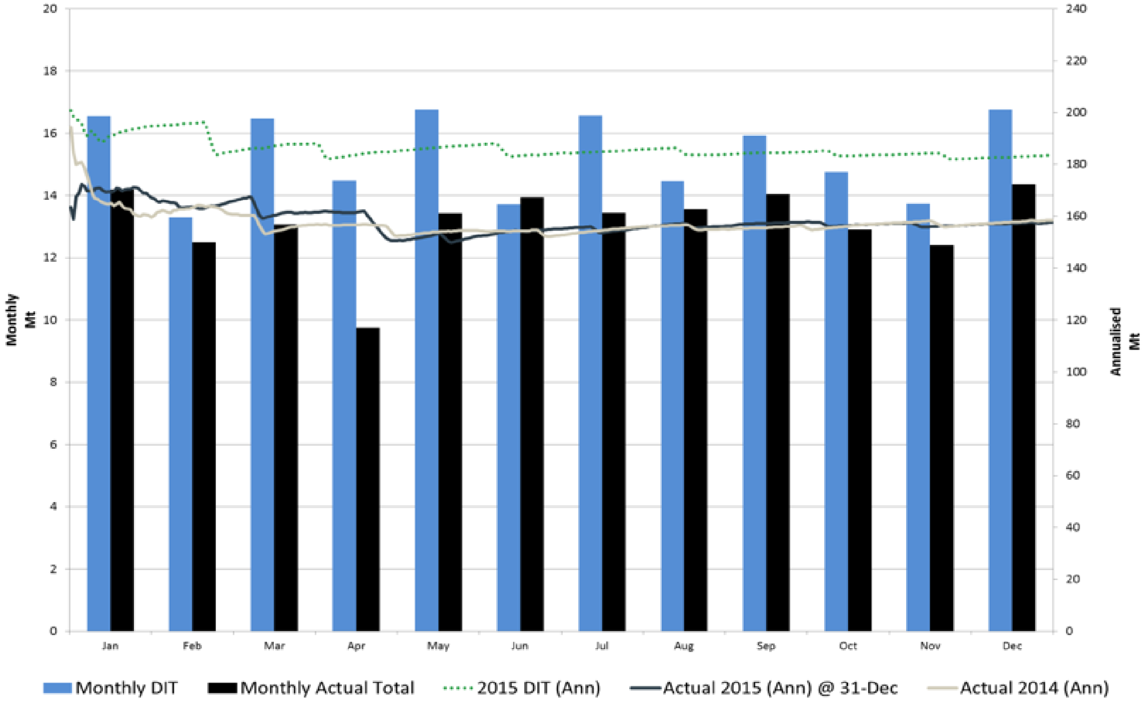
The Muswellbrook to Port Waratah section is the core part of the Hunter Valley Network, with the majority of the coal mines in the Hunter Valley connected to this section. This part of the network also carries all of the non-coal freight and passenger trains from the Gunnedah and Ulan lines, as well as an additional daily Muswellbrook passenger service. The volume of coal, however, means that coal dominates operations across this corridor.

Passenger trains are assigned fixed train paths, while freight train paths are assigned by ARTC. The Hunter Valley Corridor Capacity Strategy noted that effective integration of coal and non-coal programming is required to recognise the different performance characteristics and deliver optimal capacity and network control. Consequently, the mixed use of the network by passenger services, as well as coal and non-coal freight has the following impact on ARTC's network planning and programming:

- Provisions are required to integrate passenger services, as well as coal and non-coal freight in the network program
- Integrated network program is required to be optimised based on different performance characteristics in order to ensure effective network control.

The 2015 coal export volumes and annualised Declared Inbound Throughput (DIT), which were transported on the Hunter Valley Network, are showed in Figure 2.4.

Figure 2.4: 2015 coal export volumes and annualised DIT (Mt)



Source: ARTC

Given that Hunter Valley is a mixed use rail network, it is required to cater to the needs of both passenger train and freight operators and cannot be fully optimised for coal operations, creating additional pressure on track maintenance. ARTC is therefore required to configure and optimise the network for mixed use, including coal traffic, passenger trains and other freight.

2.3 Hunter Valley Pricing Zones

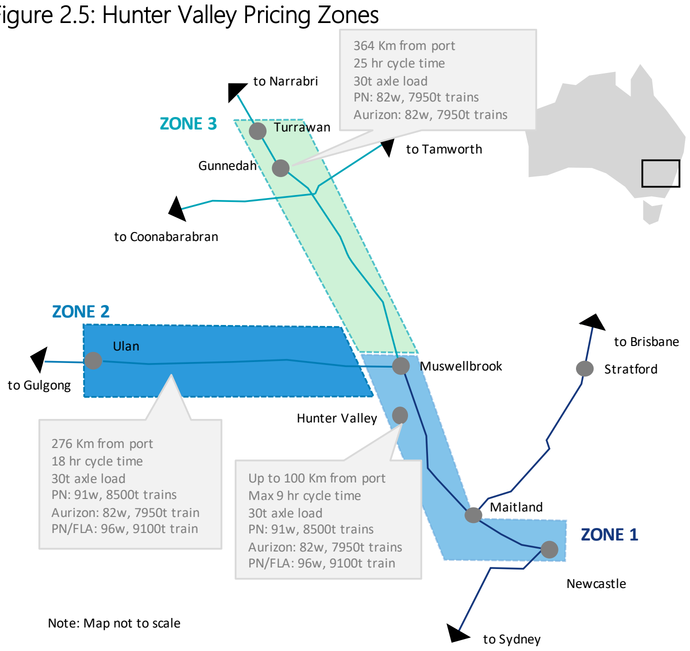
2.3.1 Pricing Zones Overview

Hunter Valley Network comprises three Pricing Zones:

- Zone 1: Bengalla to Newcastle
- Zone 2: Ulan to Bengalla
- Zone 3: Turrawan to Muswellbrook.

These zones are presented in Figure 2.5.

Figure 2.5: Hunter Valley Pricing Zones



Source: ARTC

Each zone in the network has unique characteristics and asset management challenges, as outlined below.

2.3.1.1 Zone 1: Newcastle Ports to Bengalla

Zone 1 includes rail infrastructure from the vicinity of the Newcastle port terminals to Bengalla.

Zone 1's original formation was constructed in the late 1800's to early 1900's, with track segments around Hexham constructed on swampland. Much of the original foundation remains despite track duplications and triplications, axle load increases and trebling of network line tonnages since the early 1990's.

2.3.1.2 Zone 2: Bengalla to Ulan

Zone 2 is a single-track railway from Bengalla to just beyond the Ulan junction. It traverses a range of topography, with four tunnels on the higher-grade sections of track and many tight radius curves that increase track wear. Its main use is heavy-haul coal train services; however it also supports a small number of long-haul metalliferous and intermodal trains. This means track geometry and standards also cater for higher speed, lower weight trains as well as the heavy-haul coal fleet.

Construction of Zone 2's original formation occurred from 1915 to 1950 on top of sections of an existing ~100 year-old roadway. It was largely unused until the early 1980's, when ballast, sleepers and rail were installed on the existing formation to support the transport of coal from mine sites in the Ulan area. This zone's complex terrain and remoteness of infrastructure affects maintenance costs due to travel and set-up times.

2.3.1.3 Zone 3: Muswellbrook to Turrawan

Zone 3 is a single-track line from Muswellbrook to Turrawan. The line accommodates regional passenger services (with trains at speeds above 100 Km/hr), bulk grain and intermodal traffic, as well as the slower (60 Km/hr) heavy-haul freight services. Since 2000-2005, significant growth has occurred with the development of several new mines in the Gunnedah Basin. Increased customer demand requires ARTC to minimise temporary speed restrictions (TSR) and track defects.

Similar to Zone 1, construction of Zone 3's original formation began in the late 1800's as a passenger and light-freight network. Completion of some capital minor upgrades (upgraded rail sections on curves and passing loops) occurred prior to the introduction of 30 TAL trains in January 2015.

2.4 Customers of the Hunter Valley Network

2.4.1 Customer Base Overview

Customers, including coal producers, contract directly with ARTC for access to the rail network. In 2015, customers in the Hunter Valley included the world's five largest resource companies:

- BHP Billiton
- Rio Tinto
- Vale
- Anglo America
- Glencore.

Other export focussed coal companies that operated in the Hunter Valley include:

- Peabody Energy
- Yancoal Australia Limited
- Whitehaven Coal Limited
- Idemitsu Australia Resources
- Centennial Coal
- Bloomfield.

Four major rail operators that were hauling coal in the Hunter Valley include:

- Pacific National (PN)
- Aurizon
- Freightliner/Glencore
- Southern Shorthaul Rail.

2.4.2 Customer Engagement and Interaction

ARTC's operating model places delivering value to the customer at the forefront of all its business activities and performance metrics.

In 2014 an internal ARTC team, Customer Services and Operations was established to engage with ARTC's customers on a continuous basis. To ensure customer needs are addressed, ARTC proactively engages with its customers through a combination of surveys and direct feedback.

The Rail Capacity Group (RCG) is a formal forum for consultation with customers and endorsement of capital investment in the network. The RCG has been in place since the commencement of the HVAU and has evolved to also become a forum for industry engagement and transparency on network operations including Health Safety Environment and Community (HSEC), operational and reliability performance and the key drivers and influences of maintenance costs. One key component of ARTC's engagement with customers is an annual independent Customer Satisfaction Survey to gauge satisfaction and areas for improvement, with results compiled separately for Hunter Valley and Interstate Networks. The approach to this survey is presented in Table 2.2.

Table 2.2: Approach to Customer Satisfaction Survey

	Description
Customers Engaged	• Engage with *all* customers • Across levels, strategic through to operational • Customers who have involvement with different business areas • Multiple contacts per customer • Comparable to previous 2 waves in 2014 & 2013
Approach to engagement	• Face-to-face in-depth interviews • 45 minutes - 1 hour (hr) duration • More probing and questioning • Telephone interviews at an operational level
Aspects of service covered	• Value • Performance • Brand Image & Reputation • Customer Service • Product, Service & Support • Innovation • Pricing • Advocacy

Source: ARTC

The outputs of this survey form an integral input into the development of the ARTC Strategy to ensure that the customer is at the focus of ARTC's future direction and decision-making.

Feedback from historic Customer Satisfaction Surveys on areas of importance indicated that price and performance are of significant importance to the customer, and as a result of this, ARTC has:

- Delivered contracted network availability and throughput by minimising failures and unplanned losses due to cancellation of scheduled train paths, and maintaining punctuality and speed of train services by minimising speed restrictions on the network
- While export coal prices and, hence, volumes fluctuate, effectively managed rail infrastructure assets with consistent asset plans and service delivery.

ARTC has focused on delivering value to customers, based on the feedback obtained through these processes.

2.5 Hunter Valley Coal Chain

2.5.1 Hunter Valley Coal Chain Overview

The Hunter Valley Coal Chain is made up of all of the coal producers operating approximately 40 mines through 27 load points over a 450 Km network in the Hunter Valley into stockpiles at three export terminals at the Port of Newcastle. There are a number of different types of coal which are blended and sold, depending on the specific needs of the end user.

Collectively the Hunter Valley Coal Chain facilitates more than 20,000 coal train trips and the loading of 1,800 vessels annually in order to export more than 125 different brands of coal to destinations around the world.

At the heart of the Hunter Valley Coal Chain's success a commitment to working in partnership through the HVCCC who schedules the train movements to align with stockyard capacity at the Port as well as vessel arrivals.

Hunter Valley Coal Chain is operated as an integrated, shared supply chain. The central coordination function was formalised in 2009 with the incorporation of the HVCCC and is based on the principle that assets, although owned by different parties, should be operated as a whole to achieve an optimal outcome for the supply chain participants, including the asset owners and customers. The two key constructs that govern ARTC's role in the Hunter Valley Coal Chain are:

- HVAU: it specifies Coal Access Rights and provides guiding principles on management and pricing of the access to track capacity for the Hunter Valley coal industry to achieve an appropriate balance between the interests of ARTC, the users of the network and the public.
- HVCCC: is a central planning body incorporated in 2009 to plan and coordinate the operation and alignment of the coal chain in order to maximise the volume of coal transported, at minimum total logistics costs and in accordance with the agreed collective needs and contractual obligations between the participants.

2.6 Comparability with Other Networks

The nature of the Hunter Valley Coal Network operating conditions results in scarcity of like-for-like comparators. As an operator of a coal network in Australia, Aurizon Network represents the closest one, with a similar traffic mix, level of intensity and comparably high levels of coal transported on the network. It should be noted, however, that Aurizon has narrow gauge rail network configuration, impacting the required level of maintenance.

Table below sets out examples of other heavy haul networks across the world.

Table 2.3: Select global heavy haul networks

Network	Operator	Country	Size	Traffic Mix	Movement of coal/freight
Domestic					
Hunter Valley Coal Network	ARTC	Australia	~450 Route-Km	Mixed (coal, other freight and passenger services)	~41.1 billion (B) coal GTK in CAL15
CQCN	Aurizon Network	Australia	~2,600 Km	Mixed (coal, other freight and passenger services)	~89.5B coal GTK in CAL15
Rail network across the South West of Western Australia (WA)	Arc Infrastructure (ex Brookfield Rail)	Australia	~5,500 Km	Mixed (grain, alumina, bauxite, iron ore and interstate freight, as well as passenger services)	~1.0B GTK in 2015
International					
Rail network across Canada and Mid-America	Canadian National Railway Company	Canada & Unites States (US)	~32,000 Km	Mixed freight (intermodal, grain & fertilisers, petroleum and chemicals, forest products, metals & minerals, automotive and coal)	~645.5B GTK in 2015

Network	Operator	Country	Size	Traffic Mix	Movement of coal/freight
Rail network across Canada and Mid-America	Canadian Pacific Railway	Canada & US	~20,000 Km	Mixed (intermodal, grain, coal, potash, fertilizers & sulphur, energy, chemicals & plastics, metals, minerals & consumer products, automotive, forest products and passenger services)	~384.4B GTK in 2015
Carajás Railroad from iron ore mine in Carajás to the Ponta da Madeira Port, in São Luís	VALE	Brazil	892 Km	Mixed (iron ore, dry bulk (soy and other grains), liquids (fuels and fertilizers) and passenger services)	~120 million tonnes (Mt) of ore annually
Vitória – Minas Railroad linking Minas Gerais state to Tubarão Port	VALE	Brazil	905 Km	Mixed (iron ore, coal and agricultural products and passenger services)	~110Mt in 2014
Daqin Railway (north China)	Daqin Railway Company Limited	China	653 Km	Coal	~440Mt in 2011
National passenger and freight network	Indian Railways	India	~66,000 Km	Mixed (coal (40% of tonne-kilometres), fertilizers, grain, cement, iron & steel, iron ore, petroleum, oil and lubricants, and passenger services)	~1.1Bt of freight in 2015 ~533Mt of Coal in 2017
National passenger and freight network	Russian Railways	Russia	~85,500 Km	Mixed (bulk, dry, liquid and containerised cargo, and heavy industry, as well as passenger services)	~1.2Bt in 2015
Freight rail network across South Africa that connects with other rail networks in the sub-Saharan region	Transnet Freight Rail	South Africa	~22,390 Route-Km	Mixed freight (agriculture & bulk liquids, containers, coal, iron ore & manganese, minerals & chrome, steel & cement)	~226.6Mt of freight in 2015 ~90.4Mt of coal
Nordic iron ore line	LKAB Malmtrafik, CargoNet and SJ AB	Sweden	473 Km	Mixed (iron ore, other freight and passenger services)	~33Mt (LKAB Malmtrafik)

Source: Desktop research

3 Operating Expenditure

- CAL15 Opex costs have increased compared to CAL14 primarily due to the reallocation of FTEs following the 2014 Transformation and Growth Project.
- While costs have increased, ARTC's overhead allocation on a percentage of revenue basis is efficient compared to its peers.
- A subset of ARTC's overhead costs, namely, Finance, HR, Property, Legal and IT was also benchmarked against a cross-industry peer group and found to be efficient.
- ARTC's Network Control costs are comparable to the costs of its closest peer, Aurizon Network who manages the Central Queensland Coal Network.
- Due to limited publicly available information, Business Unit Management costs could not be benchmarked.

3.1 Overview

This section summarises the review of ARTC's CAL15 Opex for the Hunter Valley Coal Network. The review of Opex focuses on two broad cost categories:

- Corporate overhead costs (Corporate Overheads)
- Operating, administration and indirect maintenance costs (Business Unit Management and Network Control).

The costs for the Hunter Valley Coal Network are determined by applying the methodology outlined in the HVAU approved by the ACCC, and are categorised into:

- Business Unit Management
- Corporate Overheads
- Network Control.

A summary of the review of ARTC's direct maintenance costs is provided in section 4 of this report.

3.1.1 Objectives and Scope

The review considers the efficiency of CAL15 Opex costs for the Hunter Valley Coal Network derived using the CAL15 allocators specified in the HVAU. The review takes into consideration the 2015 context, in particular the outcomes of the Transformation and Growth Project (refer section 1.5.1) and the associated impact on Opex.

3.1.2 Approach

The review assesses the efficiency of the ARTC's Opex taking the following approach:

- **Data Gathering:** collecting ARTC 2015 Opex data and the relevant information in relation to the overhead allocation methodology.
- **Initial Top-down Analysis:** high-level analysis of ARTC 2015 Opex data and overhead allocation methodology.
- **Review and Refinement:** clarification of the 2015 Opex data and any significant movements.
- **Deep-dive Analysis:** detailed analysis and benchmarking of 2015 Opex data against ARTC's peers.
- **Reporting:** summarising results of the analysis in the report.

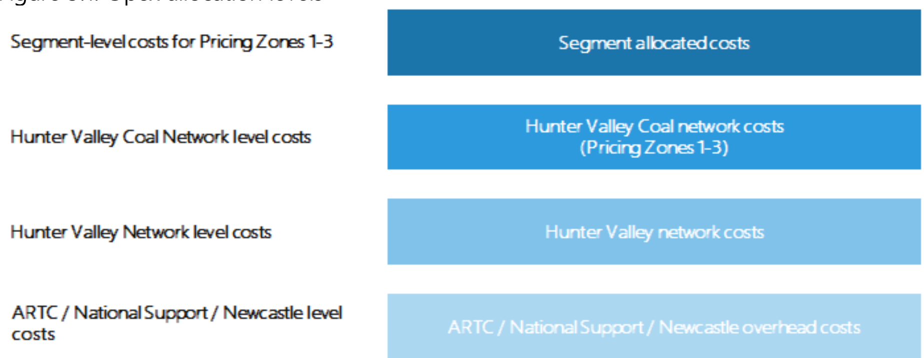
3.2 Allocation Methodology

The costs attributable to the Hunter Valley Coal Network are determined by allocating ARTC's non segment specific costs, as per the methodology specified in the HVAU, to determine the costs attributable to the Hunter Valley Coal Network. The following sections outline the allocation methodology and describe the nature of the costs included in each cost category.

3.2.1 Overview of Allocation Methodology

The overhead allocation methodology is specified in the ACCC approved HVAU. Section 4.6 'Cost allocation', states *"where possible, costs will be directly attributed to a Segment"*. Where costs cannot be directly attributed to a segment, costs are allocated to the most appropriate allocation level as outlined in Figure 3.1.

Figure 3.1: Opex allocation levels



Source: ARTC

Accordingly, where segment-level allocation is not possible, costs are allocated to Hunter Valley Coal Network level. If that is not possible, costs are allocated to the Hunter Valley Network as a whole. If costs cannot be allocated to the Hunter Valley Network level, they are classified as ARTC/National Support overhead costs.

3.2.2 Categorisation of Costs

In the 2015 Compliance Return (which was provided to Deloitte by ARTC), Opex activities were classified into the following three categories:

- Business Unit Management
- Corporate Overheads
- Network Control.

These Opex categories are described in further detail below, and the nature of the Opex costs at the delivery unit level is summarised in response to ACCC request number 2 (submitted on 6 June 2018), extract from which is provided in Appendix 1.

3.2.2.1 Business Unit Management Costs

Business Unit Management costs comprise Hunter Valley direct costs, where the resources are located in the Hunter Valley.

There are five functions included under this classification:

- Hunter Valley Customer and Operations
- Hunter Valley Asset Management Delivery
- Hunter Valley Asset Management Development
- Hunter Valley Management and Support
- Interstate Customer & Commercial.

10 delivery units are included under Business Unit Management.

3.2.2.2 Corporate Overheads

Corporate Overheads include labour and materials associated with the following areas: HR, Property, Legal, IT, Finance, Procurement, Risk and Safety and Chief Executive Officer (CEO).

There are eight functions included under this classification:

- Corporate Affairs
- Corporate Services and Safety
- Executive
- Finance
- Forecast Adjustment
- Hunter Valley Asset Management Development
- Interstate Asset Management
- Strategy.

There are 27 delivery units included under the Corporate Overheads classification.

3.2.2.3 Network Control

Network Control includes costs associated with ARTC's Network Control Centre North (located at Broadmeadow). The control centre controls the train movements for the entire Hunter Valley business unit including the coal network and non-coal segments that adjoin the coal network.

There is one function included under this classification, namely Hunter Valley Customer and Operations. There is also one delivery unit included under the Network Control classification.

3.2.3 Cost Allocators

Section 4.6 of the HVAU, 'Cost allocation', states that non-segment specific costs should be allocated in proportion to an appropriate cost driver. These include:

- GTK which is used as a cost allocator for track maintenance related activities
- Train Km which is used as a cost allocator for non-track maintenance related activities
- Network Control Board usage (Boards) which has been used as a cost allocator to allocate Broadmeadow Train Control Centre costs. The Board allocator allows ARTC to allocate costs directly attributed to traffic usage on the network (e.g. train control communication costs).

While these allocators are relevant for the allocation of CAL15 costs, in 2017 the allocators were reviewed to assess how well they reflected the true costs of each segment. The review recommended changes to the current allocators and on 29 June 2017, the ACCC consented to the ARTC's 16 June 2017 application to vary its 2011 HVAU to include a revised Corporate Overhead allocation methodology and allocators. The revised cost allocators are outlined in the HVAU dated 23 June 2011 (as varied on 29 June 2017).

3.3 Opex

Using the methodology outlined above, the costs attributable to the Hunter Valley Coal Network have been derived for CAL15. Total Opex in CAL15 was $51.4M. Table 3.1 sets out the Hunter Valley Opex for CAL14 and CAL15. Compared to CAL14, CAL15 Opex costs were $4.4M higher, largely reflecting the reallocation of costs and FTEs following the 2014 Transformation and Growth Project.

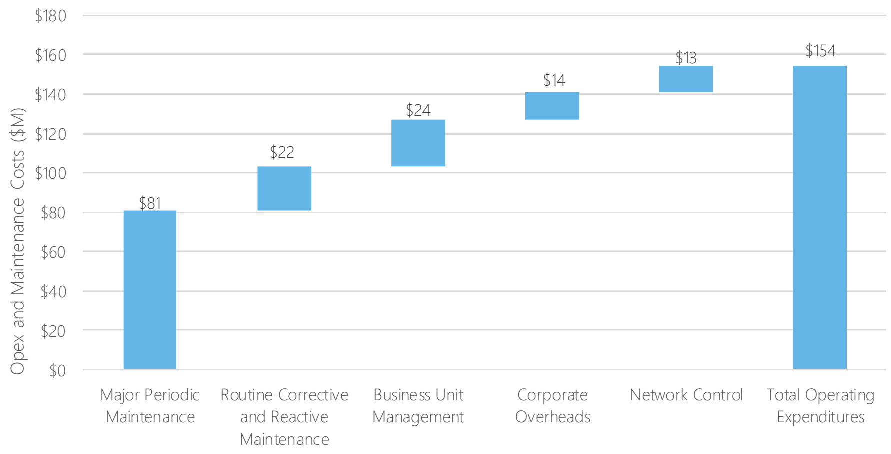
Table 3.1: CAL14 and CAL15 Opex

Classification	CAL14 Costs ('000)	CAL15 Costs ('000)	Variance ('000)
Business Unit Management	20,834	23,754	2,920
Corporate Overheads	13,458	14,470	1,012
Network Control	12,742	13,168	426
Total Opex	47,034	51,393	4,359

Source: ARTC

Figure 3.2 shows Opex costs in the context of total ARTC's Opex and maintenance expenditure.

Figure 3.2: CAL15 Opex and maintenance costs breakdown



Source: ARTC

3.3.1 Business Unit Management

CAL15 Business Unit Management costs increased $2.9M year-on-year due to:

- $1.2M increase for the transfer of Hunter Valley Logistics delivery unit from Hunter Valley Operations delivery unit to Hunter Valley Customer Service and Operations Management delivery unit, reflecting the Transformation and Growth Project
- $0.4M increase for an additional two employees to support Customer Contracts and Logistics teams
- Additional $0.3M for 5 employees transferred from Corporate Finance from July 2015
- $1.0M increase reflecting the transfer of Asset Delivery and Safety and Environmental roles which were previously allocated to the Hunter Valley Asset Management Delivery function. Further, a new General Manager Asset Delivery role commenced during 2015.
- $0.3M for consultancy costs relating to safety and leadership
- $0.5M decrease in costs associated with Hunter Valley Asset Management Delivery and Management Development.

3.3.2 Corporate Overheads

Between CAL14 and CAL15, Corporate Overhead costs increased by $1.0M. The change was primarily due to the following cost increases:

- Increase of $0.4M from the prior year due primarily due to an increase in the National ARTC train control communications costs, such as emergency radio communications costs

- Increase in insurance costs of $0.3M reflecting insurance premiums being directly costed on the basis of insured risk values to the Hunter Valley for each type of insurance taken out
- Cost increase of $0.3M primarily due to the Hunter Valley Coal Network's share of additional professional fees incurred during 2015 for the Effectiveness and Efficiency review. Hunter Valley's share of expenditure for this review was $0.3M.

3.3.3 Network Control

Overall CAL15 Network Control costs increased $0.4M compared to CAL14 due to:

- $1.7M increase in the Operations line segment due applying the Hunter Valley boards allocator in CAL15 compared to a corporate boards allocator in CAL14 and filling five long term vacant roles in CAL15 to maintain continuous operations. The five vacant roles were in budget and filled to provide a fully resourced team across the coal boards and ensure continuity of operations and manage fatigue requirements. In 2015 there was a strong focus of the Network Control team on leadership and service delivery to customers, including sustainably achieving train flow requirements in line with the coal chain capacity uplift project and train control system continuity requirements
- $1.2M decrease for the transfer of Hunter Valley Logistics delivery unit from Hunter Valley Operations delivery unit to Hunter Valley Customer Service and Operations Management delivery unit, reflecting the Transformation and Growth Project, with addition of operations performance officers and reporting role.

3.4 Benchmarking of Opex Costs

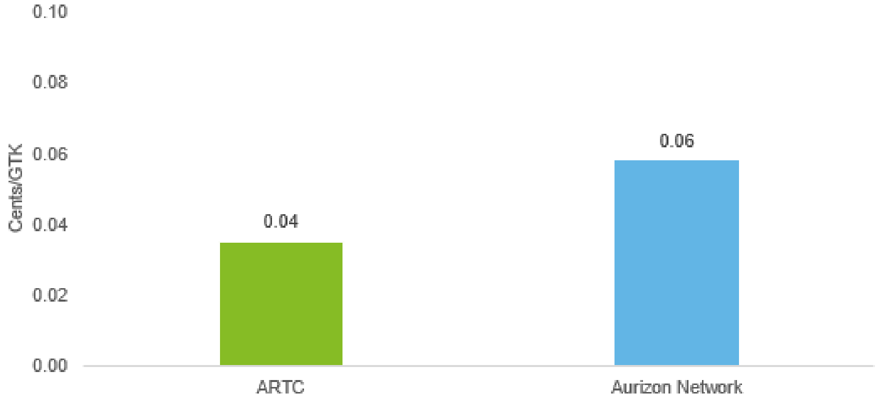
Where possible we have benchmarked ARTC's Opex with relevant comparators. Corporate Overhead costs have been benchmarked against a range of railway network operators and defined subsets of the Corporate Overhead costs have been benchmarked against peer group companies. Similarly, Network Control costs have been benchmarked against a relevant railway network operators. While Business Unit Management costs have been reviewed, they have not been formally benchmarked due to the lack of relevant publicly available comparators. Further detail on the review of these costs can be found in section 4.5.3.

3.4.1 Corporate Overhead Benchmarking

The ARTC Corporate Overhead cost allocation to the Hunter Valley Coal Network has been benchmarked against other rail networks' costs. The benchmarking analysis is based on the most recent final decision by the respective regulator and has been used as a reference point to assess the reasonableness of the Opex.

The nature of the Hunter Valley Coal Network operating conditions results in scarcity of like-for-like comparators for the purpose of benchmarking analysis. As an operator of a coal network in Australia, Aurizon Network represents the closest comparator for overhead costs. The following figure compares CAL15 overhead costs per GTK for ARTC and Aurizon. It was found that ARTC's overhead cost per GTK was lower at $0.04/GTK compared with $0.06/GTK.

Figure 3.3: Comparison of overhead costs per GTK (CAL15)

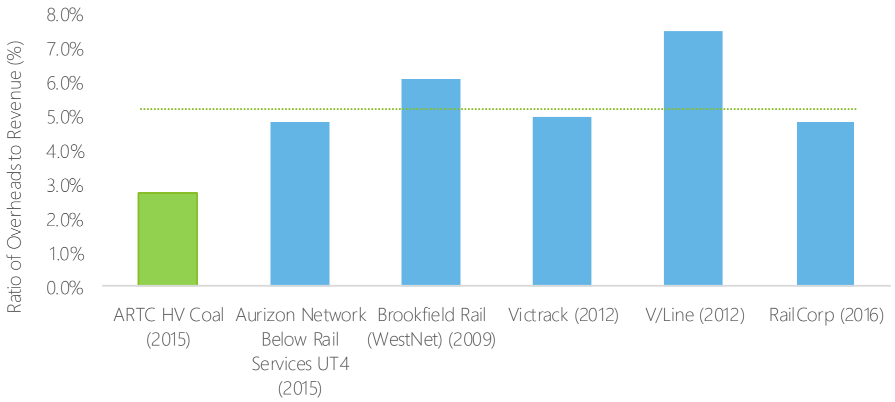


Source: Deloitte analysis

Benchmarking against rail businesses that include passenger services shows that the ratio of overheads to revenue ranges between 4.8% and 7.5%, with the average being 5.6%[1].

Under the allocation methodology that was used in CAL15, Hunter Valley Coal Network overhead costs to revenue ratio is 2.7%. Based on publicly available information, it was found that ARTC's Hunter Valley Coal Network is more efficient compared to its peers, Aurizon and Brookfield Rail, both of which are railways that focus on freight and heavy haul and other passenger railways (refer Figure 3.4).

Figure 3.4: Ratio of overhead costs to revenue



Source: Deloitte analysis

A subset of the Corporate Overhead costs reflects generic support functions that are able to be benchmarked against a cross-industry peer group from Deloitte's global benchmarking database (refer Table 3.2 for description of ARTC costs that have been benchmarked). As part of this analysis the relevant ARTC costs have been adjusted to ensure a like-for-like comparison (e.g. insurance costs were removed from the legal function).

[1] Average calculation excludes ARTC overhead to revenue ratio.

Table 3.2: ARTC costs benchmarked against a cross-industry peer group

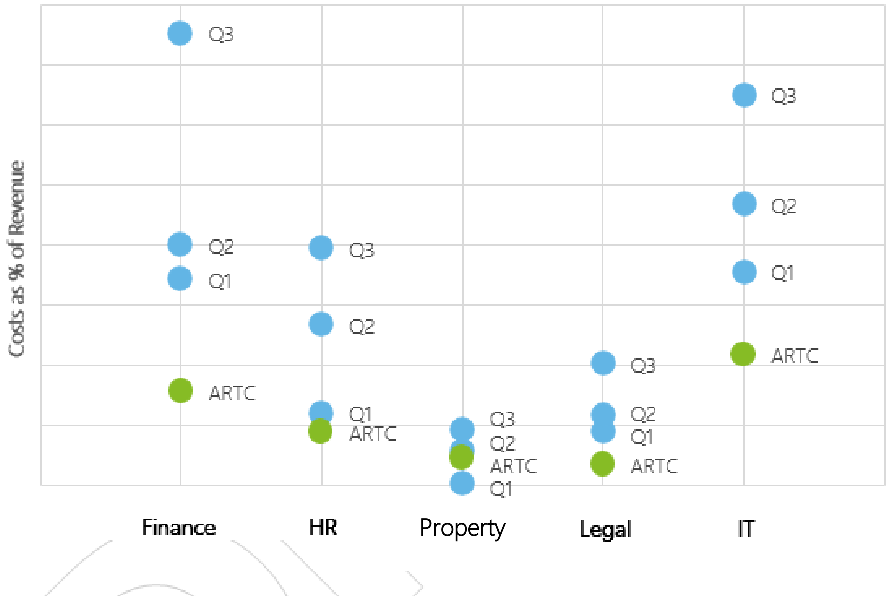
Costs	Description of activities the costs relate to
Finance	• Corporate accounting, including activities related to statutory and technical accounting, taxation, fixed assets, payroll, accounts payable and accounts receivable • Corporate financial services, including budget and corporate planning, forecasting, external and internal reporting requirements, and financial systems administration • Corporate treasury activities, including managing the general liquidity of the business and management of long, medium and short term treasury funds.
HR	• Activities related to HR, including recruitment, contract hiring, compensation management, industrial relations and people and performance management.
Property	• Services and advice to the business units relating to ARTC's property portfolio of leased and licenced land, buildings and infrastructure. This includes advice in relation to land boundaries and ownership.
Legal	• Activities related to legal framework and provision of legal services to the business.
IT	• Services related to IT infrastructure, such as management and maintenance of servers, network and data centres • Activities related to management, maintenance and enhancement of IT applications and software.

Source: ARTC

The peer group comprises 19 companies for Finance, IT, HR and Legal, and 16 companies for Property, including industries such as retail and distribution, consumer and industrial products, transportation, oil and gas, power and utilities, and energy and resources.

In CAL15, benchmarked cost elements as a percentage of revenue were in line with industry standards. The Finance, HR, Legal and IT functions all perform at Quartile 1 (0%-25%) of the benchmark set, therefore below the median. The Property function is in Quartile 2 (25%-50%).

Figure 3.5: Cross industry peer group benchmarking (2015 data)



Source: Deloitte analysis

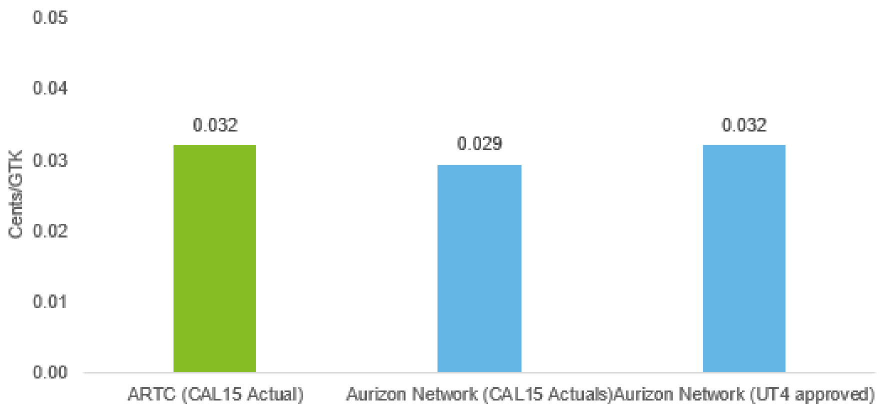
Considering all the elements of ARTC costs and given the size and complexity of the ARTC's operations, our assessment is that these costs are reasonable and comparable to organisations of similar size and complexity.

3.4.2 Network Control Cost Benchmarking

ARTC's Network Control costs relate to costs of controlling rail traffic on ARTC's network. Network control is managed from the Network Control Centre North and covers normal day-to-day operations and disruption management. Network Control costs include salaries, wages and other expenses of the Network Control Centre staff, as well as some IT, equipment, and property maintenance and rental costs.

ARTC's Network Control costs have been benchmarked against its closest comparator, Aurizon Network. Figure 3.6 benchmarks the ARTC costs against the Aurizon CAL15 actuals and the allowance approved by the Queensland Competition Authority (QCA) as part of the Aurizon Network's 2016 Access Undertaking (UT4). It can be seen that ARTC's cost are comparable on a GTK basis. Although GTK is a good reflector of the overall task and activity, it does not necessarily provide an accurate comparison of network density and complexity in the network management task. Our preferred comparative benchmark would be number of trains, path density or occupation, however these data sets were not readily available across other networks.

Figure 3.6: Network Control cost benchmarking (CAL15)



Source: Deloitte analysis

3.5 Observations and Findings

- Opex has increased between CAL14 and CAL15, largely driven by the Transformation and Growth Project. With the establishment of two customer-focussed business units, Hunter Valley and Interstate, there has been an increase in the number of FTEs to support services going forward. In addition, new delivery units were created, and some costs were reallocated between the delivery units
- When compared against relevant peers ARTC is competitively efficient in terms of Corporate Overhead costs
- In terms of Network Control costs, ARTC's costs are comparable to those of its most relevant peer
- It was not possible to benchmark Business Unit Management costs due to the lack of a publicly available comparator.

4 Asset Management and Maintenance

- ARTC CAL15 maintenance expenditures were efficient, within ARTC's commercial, operational and technical constraints
  - Overall maintenance expenditures are consistent with external benchmarks on a cost per GTK basis as well as on a cost per net tonne basis
  - Individual CAL15 maintenance activity expenditures were reflective of industry norms, that is, planning guidelines and unit rates were consistent with industry approaches
  - ARTC maintenance program delivered required network quality and reliability performance
  - ARTC's asset management planning practices are consistent, at a high-level, with general industry approaches and practices.
- ARTC CAL15 maintenance expenditures were strongly influenced by the overall operating context and inherent technical characteristics of the Hunter Valley rail infrastructure
  - Compliance with accredited Safety Management System and technical standards
  - Customer expectations for network capacity and reliability
  - Integrated and complex nature of the Hunter Valley Coal Chain
  - Underlying track formations constructed to different standards and from late 1800's.
- CAL15 maintenance program expenditures were influenced by a number of historic and unique factors
  - MPM expenditures increased at 19% CAGR from CAL12 to CAL15 due to strong historic growth in network shipments, network capacity and axle load upgrades in Zone 3, and increased ballast cleaning work to address planned requirements
  - Changing coal market environment, customer priorities and customer feedback resulted in reduced CAL15 MPM expenditures from the FY14/15 AMP by optimising work scopes, estimates, and project plans
  - Bottom-up analysis of key MPM activities and projects highlights some potential higher-cost areas due to increased work scopes, weather delays, and planned delivery arrangements.

4.1 Overview

This section outlines the objectives, scope and approach for assessment of 2015 ARTC maintenance costs, including definitions of ARTC maintenance activities and 'efficiency'.

4.1.1 Objectives

Key objectives of the analysis of ARTC's asset management and maintenance program 2015 expenditures included:

- A top-down review of ARTC's 2015 maintenance costs
- Identification and explanation around the drivers of costs

- Assessment of the efficiency of unit maintenance cost in relation to ARTC's network and operating environment, and comparison to accepted industry practices and benchmarks, where appropriate.

Analysis of the efficiency of maintenance costs requires an understanding of 'efficient' expenditure in the context of the HVAU. The Access Undertaking provides the framework for customers to negotiate and obtain access rights to the network, including fair and reasonable commercial terms. The Access Undertaking details (Clause 4.5 b) that costs are assessed on an 'efficient' basis, which is defined as:

"costs incurred by a prudent service provider managing the Network, acting efficiently, having regard to any matters particular to the environment in which management of the Network occurs including:

- *The Hunter Valley Coal Chain where a key objective in maintenance planning is to maximise coal chain throughput and reliability;*
- *ARTC's obligations to maintain the Network having regard to the terms of the applicable Access Agreements and Access Holder Arrangements; and*
- *ARTC's obligations under the law, applicable legislation (including regulations) or the NSW Lease."*

Consequently, the definition 'efficient' recognises ARTC's obligations to its customers and community (NSW Lease), as well as its obligations to maximising coal chain throughput and reliability.

4.1.2 Scope

ARTC classifies network maintenance in three work programs as outlined in the table below. The scope of our analysis focused on MPM and RCRM.

Table 4.1: ARTC maintenance program descriptions

Maintenance Program	Description
RCRM	RCRM are scheduled activities used to inspect or service asset condition on a routine basis. RCRM extends to include reactive and corrective activities that are required as a result of inspections or defect identification that, because of their nature, are dealt with on the spot or as soon as is reasonably practical thereafter
MPM	MPM are cyclical or planned activities that maintain the operating performance and asset life of operational infrastructure, and aim to reduce the level of defects and corrective maintenance
Sustaining Capital	Generally characterised as an activity that will give rise to a future economic benefit that is readily identifiable and measurable. Economic benefit must create or extend the useful life of the asset by more than 12 months and/or provide additional functionality or increase the operating standard. Can be minor works that sustain existing capacity, for example asset replacement, cost reduction or safety related projects

Source: ARTC

4.1.3 Approach

Our analysis approach included the following five steps:

- **Data Gathering:** providing a baseline understanding of ARTC asset management and maintenance processes, activities, drivers, outcomes and historic as well as forecast expenditure levels.

- Initial Top-down Analysis: assessing customer demand, outcomes of ARTC's maintenance program, scope of maintenance work, and high-level benchmark comparisons of planning guidelines and unit maintenance costs.
- Review and Refinement: reviewing and refining initial analysis based on rail infrastructure and maintenance knowledge and consultation, and identify specific areas for further investigation.
- Deep-dive Analysis: undertaking bottom-up analysis of selected issues and maintenance activities to assess cost drivers, identify potential outliers, and efficiency of expenditure.
- Reporting: summarising analysis and key findings that provide the context in which ARTC operates, its maintenance strategy, and specific analysis of CAL15 maintenance expenditures.

4.1.4 Structure

The structure of the analysis and findings into the efficiency of ARTC's 2015 maintenance costs address the following areas:

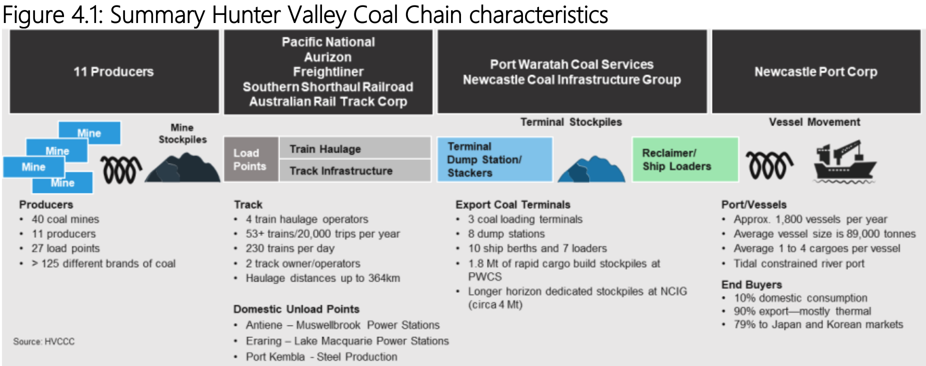
- Sections 4.2 and 4.3 assess the business and operational context, and rail infrastructure configuration to identify the key regulatory, operational, customer and technical drivers of ARTC's Hunter Valley asset management and maintenance program
- Section 4.4 assesses the ARTC's asset management strategy, planning processes and planning guidelines to identify alignment with customer and other stakeholder requirements, and to assess the 'prudency' of ARTC's processes and planning guidelines in defining the scope of work required to meet these requirements
- Section 4.5 addresses the key resources required to deliver the planned maintenance work programs, including network access through the coordinated annual possession plan, external contractors for the MPM program, and internal ARTC staff for asset planning, project management and delivery of RCRM activities
- Section 4.6 and 4.7 detail performance and maintenance expenditure trends, and CAL15 MPM and RCRM expenditures to highlight the overall effectiveness and efficiency of actual expenditures within the overall operating context and environment.

4.2 ARTC Hunter Valley Business and Operational Drivers

As illustrated in Figure 4.1 below and mentioned in section 2.5, the Hunter Valley Coal Network is an integral part of the world's largest export coal chain, which involves a complex system of mines, rail service providers, export coal terminals, port authority, and an overall coordinating agency, the HVCCC. In 2015, the rail network operated up to 230 train services per day, and handled approximately 167 million net tonnes of coal traffic.

It accommodates heavy coal freight along with mixed freight and local metropolitan/regional passenger services.

Figure 4.1: Summary Hunter Valley Coal Chain characteristics



Source: ARTC

As part of the Hunter Valley Coal Chain, ARTC plans, manages and maintains the rail infrastructure assets within an industry and operational context that includes:

- Rail safety obligations under the National Rail Safety Model Law
- Lease arrangements with the NSW Government
- ACCC Access Undertaking and associated customer access agreements
- Alignment with stakeholders in the Hunter Valley Coal Chain.

4.2.1 Rail Safety Obligations

ARTC is an accredited Rail Infrastructure Manager. Accreditation incorporates ARTC's overall Safety Management System, risk management framework, technical standards, and Technical Maintenance Plans (TMP). TMPs set out the routine inspection policies for ARTC rail infrastructure assets in terms of:

- Which items are to be inspected
- What inspection tasks are to be carried out
- When inspection is required.

Maintenance Scheduled Tasks (MSTs) establish the specific asset inspections that form the basis of ARTC's RCRM program.

4.2.2 Customer Reliability and Condition Monitoring

ARTC's Lease with the NSW Government and its HVAU establish customer expectations for network condition and reliability that influence ARTC's asset management and maintenance program. For the Lease, performance is reported through Transport NSW TrainLink. For the Access Undertaking, performance is reported to the RCG.ARTC leases the Hunter Valley infrastructure from the NSW Government, which expires on 3 September 2064 (NSW Interstate and Hunter Valley Lease). The Lease largely governs passenger and non-coal freight access to the network. Under the Lease, risk and liability are with ARTC as if it owned the assets, and at the end of the Lease period ARTC is required to return the leased assets in a working condition. Network reliability and condition performance key performance requirements defined in the Lease include:

- Track geometry and Track Quality Index
- TSRs affecting freight and passenger trains
- Numbers of large rail defects.

The HVAU governs coal traffic on the network. It defines a number of performance measures, which, from a network condition and reliability perspective, includes ARTC reliability and infrastructure losses.

ARTC also monitor a range of additional network condition and reliability key performance indicators (KPI) that are included in its monthly performance reports.

The following table summarises key network condition and reliability KPIs, definition and targets.

Table 4.2: Summary asset management and maintenance output KPIs

KPI	Definition	Target
Coal Reliability and Infrastructure Loss	Network reliability and infrastructure losses are unavailable or cancelled train paths due to network reliability or infrastructure causes as a percentage of declared throughput	Reliability Loss: 1.0% Infrastructure Loss: 0.7%
TSR	TSRs are those that impact train transit times and are applied to sections of the track in response to track conditions to ensure safe operation. Reports include open and time lost due to TSR by Zone	Z1: Open - 5; Time – 13.8 min Z2: Open – 4; Time – 4.6 min Z3: Open – 15; Time – 23.6 min
Track Quality	Track Quality is measured as percentage of track where the Top Moving Sum (TMS) is greater than 300. TMS is the sum of all the 0.5 metre top values recorded by the AK car for each rail in a 50 metre section of track, calculated every 10 metres	Z1: 6.0% Z2: 10.6% Z3: 19.6%
Rail Breaks	Records the number of rail breaks on each zone	Z1: 6 Z2: 1 Z3: 2
Track Defects	The AK Car surveys track condition to identify and log defects or faults in the track that require repair. They are classified in terms of severity – Emergency and Priority 1, 2 and 3 - which have corresponding response times	Reports Overdue E, P1 and P2 defects as well as Open P3 defects

Source: ARTC Hunter Valley Performance Report and ARTC RCG Monthly Performance Report

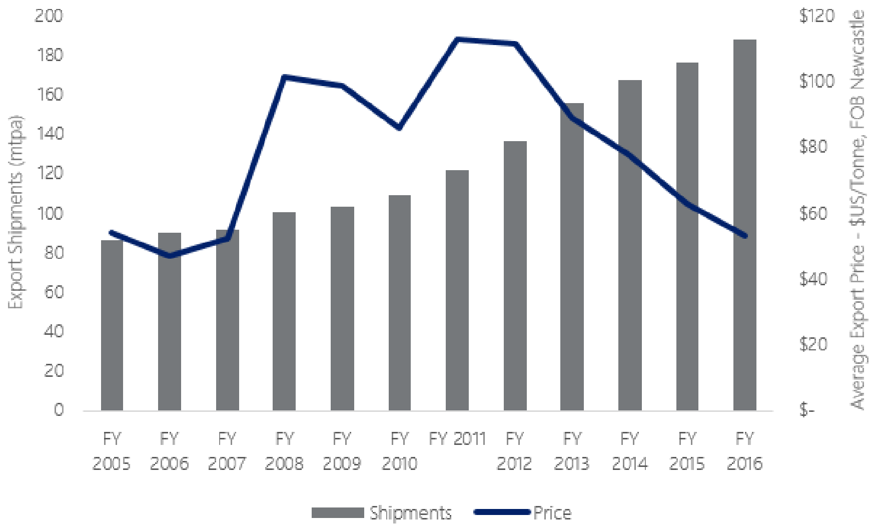
These customer performance expectations are monitored to establish a strong focus for ARTC's asset management and maintenance program on:

- Delivering planned network availability by minimising failures and unplanned losses due to cancellation of scheduled train paths
- Maintaining punctuality and speed of train services by minimising speed restrictions on the network
- Completing maintenance work within the planned duration of network possessions.

4.2.3 Hunter Valley Export Coal Market

The overall export coal market strongly influences ARTC's Hunter Valley operations. As illustrated in the figure below, after a long period of decreasing coal prices, global demand for both thermal and metallurgical coal resulted in higher export coal prices beginning in 2007 (shown in Figure 4.2) and steadily increasing coal shipments from the Hunter Valley.

Figure 4.2: Historical thermal export coal prices (CAL05-16 in AUD per Metric Tonne)

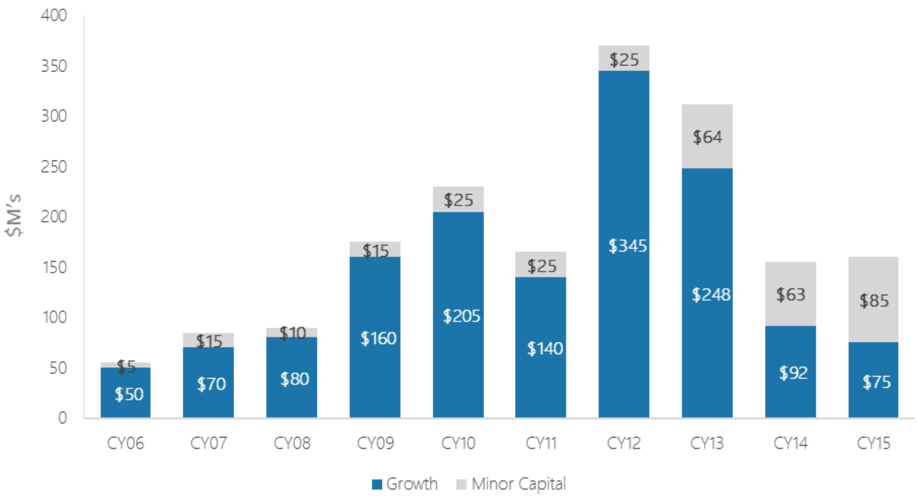


Source: Coal Price – Indexmundi, export thermal coal price average for FY, $US/tonne FOB Newcastle; Export shipments – Coal Industry Profile FY 2005 – 14; ARTC Master Tonnage FY 2015 - 2016

The export coal market impacted ARTC's asset management and maintenance program in three areas, as follows:

- Capital Investment: to meet coal industry demand, ARTC constructed and delivered a Hunter Valley Coal Network capacity in advance of the forecast demand of its coal customers. As illustrated in Figure 4.3, ARTC invested over $1.5B in expanding the Hunter Valley Coal Network between CAL06-15. These capacity investments added assets (track, turnouts, signals, etc.) that require maintenance.

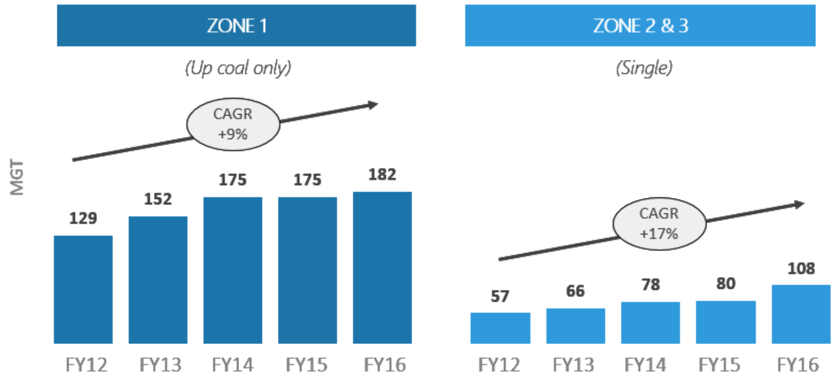
Figure 4.3: ARTC current capital investment in Hunter Valley Coal Chain (CAL06-15 in $M's)



Source: ARTC

- Customer Demand: throughput and gross tonnage across the network is a strong driver of asset management and maintenance requirements. Figure 4.4 outlines the growth in coal demand across Zone 1 and Zones 2&3. Note Zone 3 includes new mine developments in the Gunnedah region, including Narrabri, Boggabri, and Maules Creek. Increased customer demand resulted in significant track upgrades, as well as additional maintenance costs.

Figure 4.4: Hunter Valley coal shipments by Zone (in Million Gross Tonnes (MGT))



Source: ARTC Master Tonnage Track Km

- Reliability: maximising throughput and reliability of the network also required minimising train transit times, increasing axle loadings in Pricing Zone 3 to handle larger trains, and minimising interruptions from infrastructure failures. ARTC asset management and maintenance strategies and plans aimed to complete maintenance within planned downtime by preventing failures, ensuring rapid response to defects, and by coordinating closedowns/possessions across the coal chain.

By 2015, export thermal and metallurgical coal prices were significantly lower than peak prices in 2011 and 2012. In response, coalmine owners generally maintained production levels, but focused on minimising all aspects of coal production unit-operating costs, including rail infrastructure, rail haulage and port costs. This resulted in pressure on the ARTC to constrain capital and maintenance expenditures.

4.2.4 Hunter Valley Coal Chain Coordination

The HVCCC is responsible for planning and co-ordinating the daily operation and long-term capacity alignment of the Hunter Valley Coal Chain. Its strategic objectives include;

- To plan and schedule the movement of coal through the Hunter Valley Coal Chain in accordance with the agreed collective needs and contractual obligations of asset owners and customers
- To ensure minimum total logistics cost and maximised volumes through the provision of appropriate analysis and advice on capacity constraints (whether physical, operational or commercial) affecting the efficient operation of the Hunter Valley Coal Chain
- To advocate positions, on behalf of asset owners and customers, to other stakeholders and governments on issues relevant to the efficient operation of the Coal Chain in order to maximise opportunities for improved co-ordination and/or further expansion of the coal chain[2].

[2] HVCCC Website, https://www.hvccc.com.au/AboutUs/Pages/History.aspx

From the ARTC's perspective, the HVCCC facilitates a more coordinated approach to planning and validating capacity impacts of track closedowns across all Hunter Valley coal chain participants.

4.2.5 Observations and Findings

- Rail Safety: ARTC is an accredited Rail Infrastructure Manager, which requires its asset management and maintenance program to comply with its Safety Management System and technical standards. At a minimum, it requires management of network risks and establishes regular inspections of all network assets.
- Customer Expectations: ARTC's Lease and Access Undertaking establish network condition and reliability performance measures aimed at delivering contracted network availability and throughput by minimising failures and unplanned losses due to cancellation of scheduled train paths, and maintaining punctuality and speed of train services by minimising speed restrictions on the network.
- Operational Environment: substantial increases in export thermal and metallurgical coal prices beginning in 2007 resulted in strong customer demand for rail infrastructure capacity and reliability. This resulted in capital investment in rail infrastructure to deliver increased network capacity and reliability. Increased demand, higher customer expectations, and more coordinated coal chain capacity management fundamentally drive ARTC's asset management and maintenance programs.

4.3 Hunter Valley Coal Network Infrastructure

4.3.1 Overview

As mentioned in section 2.2, the Hunter Valley Coal Chain primarily delivers export coal from mines in the Hunter Valley, western region around Ulan, and the growing area around Gunnedah in the North, to the export terminals in Newcastle. The network also supports domestic coal shipments to Macquarie Generation's power plants serviced by the Antiene unloading point near Muswellbrook and to power plants just south of Newcastle. In addition to the coal traffic, Hunter Valley Network carries other freight, as well as passenger trains.

4.3.2 Rail Network Development History

Unlike many dedicated heavy-haul rail networks in Australia, ARTC's Hunter Valley Coal Network has developed over the past 150 years from initial passenger and light freight services. While upgrades have occurred since initial construction, the network still relies on much of the original formation, earthworks and drainage.

Therefore, in addition to the business and operational drivers, the development history and technical characteristics of the Hunter Valley Coal Network also drive ARTC's asset management and maintenance requirements, particularly, across the different Pricing Zones in the Hunter Valley.

4.3.3 Overview of Rail Network Characteristics

Table 4.3 below summarises the key characteristics of each zone.

Table 4.3: Hunter Valley Pricing Zones overview

Characteristic	Zone 1	Zone 2	Zone 3
Coverage	405 Track Km, Newcastle to Bengalla	197 Track Km, Bengalla to Ulan	342 Track Km, Muswellbrook to Turrawan
Tonnage*	Coal Net Tonnes: 151MT Gross Tonnes: 44MT Coal Road Down Gross Tonnes: 175MT Coal Roads Up *(Measured at Segment 936 Sandgate Junction)*	Coal Net Tonnes: 44MT Gross Tonnes: 63MT *(Measured at Segment 971 Bengalla)*	Coal Net Tonnes: 19MT Gross Tonnes: 30MT *(Measured at Segment 962 Dartbrook)*

Characteristic	Zone 1	Zone 2	Zone 3
Track	Quad track Newcastle to Maitland, (2 coal, 2 non-coal) Double track Maitland to Muswellbrook	Single track Four tunnels; Bylong tunnel is 2 Km long Tight track geometry	Single track Steep track grades on Liverpool plain & Great Dividing Range Ardglen tunnel is ~480 metres long
Train Services	Coal, including heavy-haul coal, non-coal, freight & passenger Max 9hr cycle time 30 TAL PN: 91w, 8500t trains Aurizon: 82w, 7950t trains	Coal, including heavy-haul coal, non-coal & freight 18hr cycle time 30 TAL PN: 91w, 8500t trains Aurizon: 82w, 7950t trains Glencore: 96w, 9100t trains	Coal, including heavy-haul coal, non-coal, freight & passenger 25hr cycle time 30 TAL PN: 82w, 7950t trains Aurizon: 82w, 7950t trains

Source: ARTC

[*] Coal Net Tonnes and Gross Coal Tonnes from Master Tonnage Track for FY14/15

Notes:

Net coal tonnes reflect net shipments of coal from mines

Gross coal tonnes estimated based on coal net tonnes and assumptions on rolling stock configuration

Coal shipped from south of Newcastle and North Coast line does not traverse Segment 936 in Zone 1 and is not reflected in the Zone 1 tonnage figures above

Track Km includes mainline, sidings and terminals

4.3.4 Network Characteristics

Each zone in the network has unique characteristics and asset management challenges, as outlined below.

4.3.4.1 Zone 1: Newcastle Ports to Bengalla

Zone 1 includes rail infrastructure from the Newcastle port terminals to Bengalla. This includes the segment on the Ulan line to Bengalla. Zone 1 has a quad track from Newcastle to Maitland (2 coal, 2 non-coal), and a double track from Maitland to Muswellbrook. Between Maitland and Muswellbrook, construction of some triplicated track sections occurred since 2010 to cater for the mixed traffic, allow faster trains to pass slower trains without capacity impacts, and to sustain the 8-10 minute headways in the Newcastle-bound direction.

Zone 1's original formation was constructed in the late 1800's to early 1900's, with track segments around Hexham constructed on swampland. Much of the original foundation remains despite track duplications and triplications, axle load increases and trebling of network line tonnages since the early 1990's.

In this Zone, track access for maintenance outside of scheduled maintenance closedowns is challenging because of the:

- Short intervals or headways between trains
- Linear nature of the network
- Short transfer windows between adjacent networks
- Bulk terminal unloading sequences and cargo assembly requirements.

4.3.4.2 Zone 2: Bengalla to Ulan

Zone 2 is a single-track railway from Bengalla to just beyond the Ulan junction. It traverses a range of topography, with four tunnels on the higher-grade sections of track and many tight radius curves that increase track wear. Its main use is heavy-haul coal train services; however it also supports a small number of long-haul metalliferous and intermodal trains. This means track geometry and standards also cater for higher speed, lower weight trains as well as the heavy-haul coal fleet.

Construction of Zone 2's original formation occurred from 1915 to 1950 on top of sections of an existing ~100 year-old roadway. It was largely unused until the early 1980's, when ballast, sleepers and rail were installed on the existing formation to support the transport of coal from mine sites in the Ulan area. This zone's complex terrain and remoteness of infrastructure affects maintenance costs due to travel and set-up times.

4.3.4.3 Zone 3: Muswellbrook to Turrawan

Zone 3 is a single-track line from Muswellbrook to Turrawan. Zone 3 also has challenging geotechnical conditions, topography and geology, including steep gradients across the zone, and reactive alluvial black soil in the Liverpool plain. The line accommodates regional passenger services (with trains at speeds above 100 Km/hr), bulk grain and intermodal traffic, as well as the slower (60 Km/hr) heavy-haul train fleet. Since 2000-2005, significant growth has occurred with the development of several new mines in the Gunnedah Basin. Increased customer demand requires ARTC to minimise TSR and track defects.

Like Zone 1, construction of Zone 3's original formation began in the late 1800's as a passenger and light-freight network. Completion of some capital minor upgrades (upgraded rail sections on curves and passing lanes) occurred prior to the introduction of 30 TAL trains in January 2015. The combination of difficult geotechnical conditions and increasing tonnage/axle loads poses a number of unique maintenance challenges in this zone, including:

- Formation problems, impacting track integrity standards
- Increased track wear, particularly in traversing the Dividing Range
- Mud-hole and drainage issues
- Steel-bridge and culvert maintenance.

Time and capacity constraints, to allow additional maintenance activities.

4.3.5 Network Asset Technical Attributes

While analysis focused on maintenance expenditure at the line segment level and not the asset level, table below summarises, for context, the density and complexity of individual rail infrastructure assets within each Pricing Zone.

Table 4.4: Hunter Valley Network assets

Asset	Zone 1	Zone 2	Zone 3
Track Length (Km)	405.01	197.05	341.62
Turn-outs In-service	354	59	179
Track Insulated Joints	1358	235	1122
Level Crossings	30	93	93
Over/Under Bridges	70	18	120
Culverts	549	184	424
Tunnels	0	4 (3.49 km)	1 (0.49 km)

Source: ARTC Hunter Valley Coal Network - Ellipse Equipment Register Summary
Notes: Track length includes mainline, sidings and terminals

As illustrated in Table 4.5, ARTC has progressively upgraded rail infrastructure in critical sections in all zones to heavier duty rail sections and concrete sleepers. For example, the 53kg Standard Carbon (SC) section is legacy rail that has higher risk of defects and is more susceptible to breakage. The 60kg Head Hardened (HH) rail is the current industry standard and is stronger and better performing than 53kg SC rail. However, higher maintenance rail sections and timber sleepers still exist in low speed environments around unloading loops, yards and sidings.

Table 4.5: Network asset technical characteristics

		Zone 1	Zone 2	Zone 3	Comments
Rail Section	60kg HH*	●	●	●	**Zone 1 and 2:** Some 53kg SC installed in low speed environments (e.g. Ports and sidings), **Zone 3:** 60kg HH Installed on tight curves and over Liverpool range only. Straights and shallow curves progressively upgraded to 60kg HH to accommodate 30TAL
	53kg SC**			●	
Sleepers	Concrete	●	●	●	**Zone 3:** Mainline was predominately timber sleepers until start 2014 – accommodating planned 30TAL transition, **ALL Zones:** Some timber sleepers in crossing loops and sidings
Turnouts	Concrete	●	●	●	**Zone 1:** Timber turnouts in yards and sidings, **Zone 3:** Programme of mainline turnout upgrades (53kg timber to 60kg concrete) in response to 30TAL continuing during 2015
	Timber	●		●	
Signalling System	CBI***	●	●	●	**Zone 2:** Upgrade from Electric Staff to CBI during 2008, **Zones 1 and 3:** Programme of retiring 40+ year old relay based systems to CBI ongoing
	RBI****	●		●	
Structures	Steel	●	●	●	**All Zones:** Predominately concrete structures; however mix of up to 100+year old steel structures present in all zones, **Zone 3:** Brick arched culverts prevalent in this Zone
	Concrete	●	●	●	

Source: ARTC
Notes:
Single Track: Up and down coal

ARTC is also progressively upgrading the Hunter Valley signalling system from Relay-Based Interlocking (RBI) to Computer-Based Interlocking (CBI) (automated) systems. Upgrades continue in Zones 1 and 3, and on-going use of RBI systems will affect routine signal maintenance in these zones.

4.3.6 Observations and Findings

- Network Usage: the Hunter Valley Network supports heavy-haul (coal), light freight and passenger rail traffic. As a result, track geometry and standards cater for higher speed, lower weight trains as well as the heavy-haul coal fleet. Track wear rates are potentially higher than if tracks were optimised for heavy-haul fleets.

- Asset Age and History: most the Hunter Valley asset base is fit for purpose with track, sleepers and signals progressively upgraded to modern standards. However, much of the Hunter Valley Network relies on track formations originally constructed in the late 1800's to early 1900's. These formations have significantly different design and construction standards than today's modern railways. This impacts on reliability, transit times (through speed restrictions), as the formation is more prone to failure, especially in wet weather. This requires increased undercutting and track reconditioning maintenance.

4.4 ARTC Asset Management Framework

ARTC's asset management framework focuses on compliance with rail safety obligations as defined in the Safety Management System, delivery of customer business requirements in terms of capacity and reliability, and prudent management of infrastructure assets to maintain their condition and optimise their life cycle. To achieve this, an asset management framework includes strategic objectives, defined planning processes, and associated technical standards or guidelines that define the maintenance approaches and scope required to achieve the organisation's overall business outcomes.

4.4.1 Asset Management Strategy and Objectives

At a high level, ARTC's overall asset management strategic objective is to provide safe and reliable rail infrastructure capacity (i.e. contracted train paths) required by its customers. To achieve this objective, ARTC's asset management program and plans balance the following inter-related elements:

- Rail Safety: to minimise rail infrastructure risk through compliance to its Safety Management System, including engineering standards and risk management framework
- Network Quality and Reliability: to maintain rail infrastructure quality and reliability in accordance with its Lease and Access Undertaking obligations in order to minimise disruptions, including TSR, and deliver the contracted rail infrastructure capacity
- Customer Outcomes: to manage network assets to meet current customer priorities, contracted requirements and forecasted future network demands. This includes working with the HVCCC and other stakeholders to align the capacity of the rail infrastructure, trains and ports with coal production demands through coordinated network closedowns for maintenance and capital upgrades.

These elements are well understood by the ARTC Asset Development staff, and guide development and delivery of the rail infrastructure asset management plans.

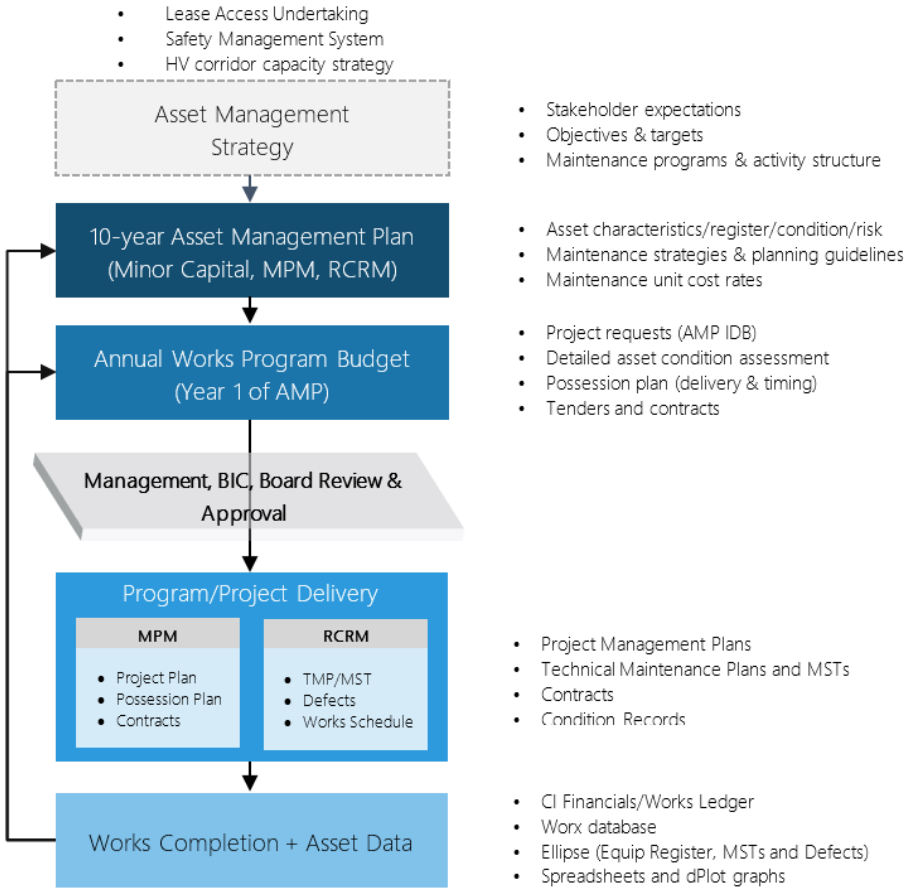
4.4.2 Asset Planning Process

ARTC has established processes to identify, plan, schedule, approve and execute required maintenance on its network infrastructure to deliver its safety and commercial objectives. While the overall process is integrated, it involves two general approaches as follows.

- For capital and MPM requirements, development involves a structured approach involving a combination of condition data, internationally accepted planning guidelines, and the judgement of experienced front-line and engineering staff
- For RCRM, top-down estimates, based on previous years' actuals and changing external factors e.g. operational conditions and staffing, establish the forecast RCRM plan and budget. As such, RCRM activities and budget are reasonably consistent from year to year, accounting for some price escalation and throughput growth.

The key outcomes of asset planning are a 10-year forecast of maintenance expenditures, and a more detailed annual works program that lists the scope and cost of specific maintenance activities and projects across the network. Figure 4.5 outlines ARTC's overall asset management planning process.

Figure 4.5: ARTC Asset Management Planning Process



Source: ARTC

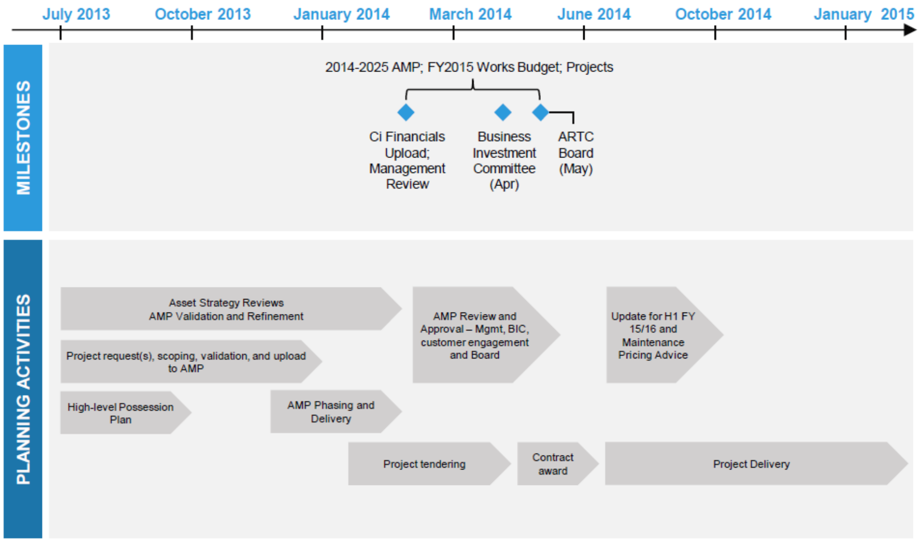
Key stages in the asset management planning process include:

- AMP (10-year Plan): the 10-year AMP establishes a forecast scope of MPM, RCRM and sustaining capital works. Key inputs include asset data (configuration, history and condition), defined maintenance strategies (e.g. activity-based maintenance strategies and planning guidelines), operating parameters (e.g. tonnage and axle loads), and estimated unit cost rates based on location, procurement methods and historical performance. For years 2-10 of the AMP, the output is a forecast of expected work scope and cost at an activity and line segment level
- Annual Works Program and Budget: for year 1 of the AMP, ARTC's annual work program validates and refines the scope, cost and timing of specific MPM projects. Input includes detailed asset condition assessments (e.g. mechanised inspection results, ballast fouling indices, etc.), inspections and site visits by the Provisioning Centre Area Managers, reliability engineer and subject matter expert, specific project requests, contracting arrangements and more detailed costs, and deliverability assessments including track access availability during planned maintenance possessions/track closedowns. The output is a more detailed breakdown of budgeted maintenance work and cost by activity, line segment and specific, identified projects.
- Review and Approval: review and approval of the annual works program and budget involves several ARTC stakeholders, those being ARTC's Hunter Valley Management team, its Business Investment Committee (BIC), Executive Committee, Board and Shareholder. Briefings are also held with customers as part of the RCG
- Program and Project Delivery. Delivery of the approved annual works program involves parallel activities to develop and execute detailed work plans for the MPM and RCRM programs. For the MPM program can include:

 - Detailed site investigation and refinement of scope and cost estimates
 - Preparation of activity-based and, if warranted, project-specific management plans
 - Tendering, value for money assessments and management of MPM activity contracts
 - Integrated scheduling and coordination of work completion within the overall annual possession program for the network.
- Program and Project Completion. A good asset management framework is driven by the quality and quantity of data on asset condition and performance, e.g. fault histories, track recording data, resurfacing data, failure modes, etc. On completion, ARTC's Ci Financials and Works Ledger records actual costs and completed work scope. A range of other systems record and update inspection details, defects and repairs, asset condition and asset configuration data. These systems include the Worx database, Ellipse, associated spreadsheets, and dPlots graphical representations of track condition and completed work.

As illustrated in Figure 4.6, the asset management planning process is a year-long process aligned to the Australian FY. Key review and approval milestones by the ARTC's BIC and Board occur annually in April/May. As such, CAL15 maintenance activities and expenditure involved two annual planning cycles, that is, FY14/15 for activities in January to June 2015 and FY15/16 for activities in July to December 2015.

Figure 4.6: ARTC asset management planning timeline



Source: ARTC

4.4.3 MPM Planning Guidelines and Drivers

Specific planning and maintenance guidelines exist for cyclic or tonnage-based MPM activities that comprise ~60% of total MPM program expenditures. The following sections summarise the purpose and key planning drivers for these activities.

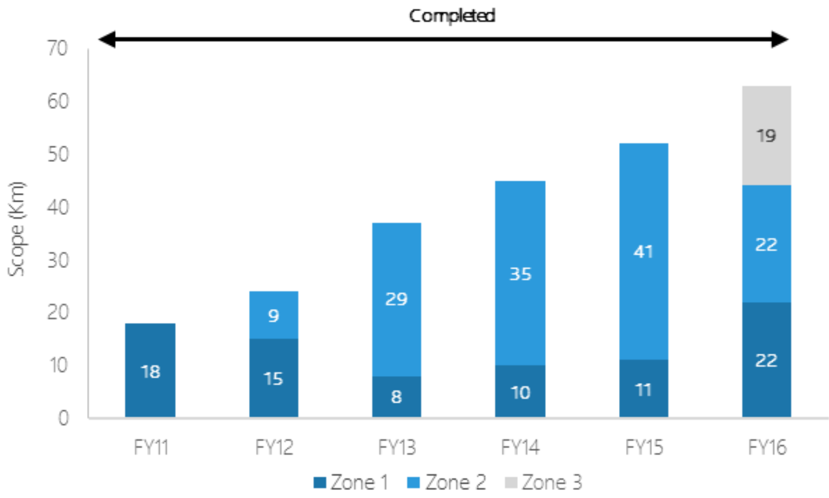
4.4.3.1 Full Ballast Cleaning (Activity 286)

Ballast cleaning is the mechanical excavation of deteriorated track ballast up to 500mm below the bottom of the sleeper across the entire track cross-section. Screens process the excavated material to remove unwanted fines. Full reinstatement of the track ballast profile includes this screened material as well as new ballast material. The activity's purpose is to reinstate the function of the ballast as a free-draining medium that holds the track to its correct geometry under the passage of trains.

ARTC forecasts full ballast cleaning scope based on a 1300 million gross tonne (MGT) cycle (accumulated gross tonnage over the line segment), as well as the monitoring of the accumulation of fines such as coal debris, through ground-penetrating radar inspection. This 1300 MGT planning cycle is consistent with international models and approaches. Validation of specific project requirements involves the assessment of track and ballast condition, which includes fouling, the recurrence interval of track geometry maintenance, and the ability to manage the risk to rail operations from ballast-related geometry loss.

Figure 4.7 illustrates the historical levels of ballast cleaning scope. Ballast cleaning scope in Zone 2 increased significantly between FY12 and FY15 to reflect initial cleaning of the Zone 2 track. A more effective ballast cleaning contractual arrangement facilitated improved delivery of planned ballast cleaning work scope. The overall ballast cleaning program reflects that the track in Zone 2 and Zone 3 had never previously undergone ballast cleaning, and the program adopted a campaign-style approach in these Zones. In June 2016, the ballast cleaning strategy was updated and reduced forecast ballast cleaning total work scopes from those in the FY14/15 AMP to provide a more balanced approach between customer needs, asset condition and track access arrangements. The fluctuations in work scope from zone to zone is due to long periods between ballast cleaning cycles per zone.

Figure 4.7: Ballast cleaning work scope (FY11-16 in Km)



Source: Worx and FY14/15 10-year AMP

4.4.3.2 Track and Turnout Resurfacing (Activities 203 and 205)

Track resurfacing restores the track geometric parameters of top, line, superelevation and alignment by mechanised on track machinery.

Like ballast cleaning, the accumulated gross tonnage over the line segment determines initial resurfacing scope. ARTC's resurfacing frequency depends on the environment, track structure and condition, and train axle load and speed. Table below summarises track resurfacing planning cycles, which are consistent with accepted industry approaches.

Table 4.6: Track resurfacing maintenance planning guidelines

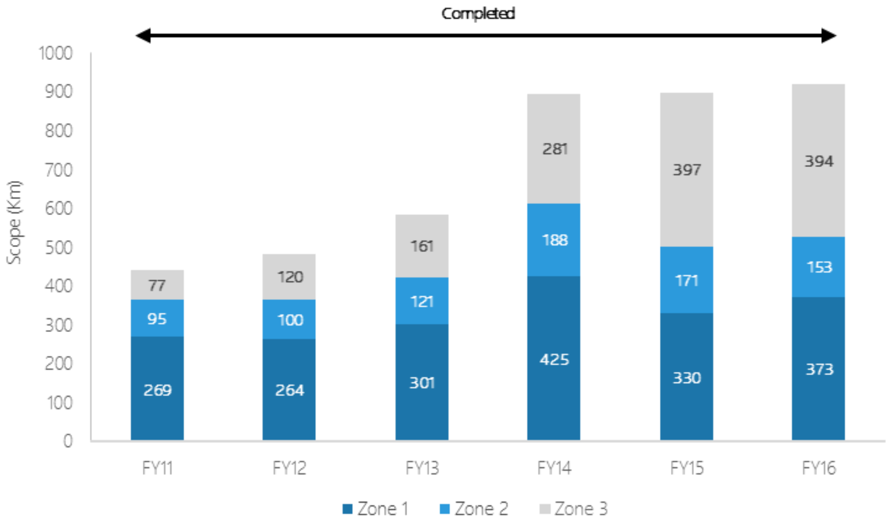
Zone	Line	Track	Planning Cycle (MGT)	Estimated Frequency
1	Whittingham to Maitland	Up Main	109	2.5 years
	Whittingham to Maitland	Down Main	100	1 year
	Mt Thorley to Whittingham	Single Track	60	1.5 years
	Muswellbrook to Whittingham	Up Main	92	0.6 years
	Muswellbrook to Whittingham	Down Main	67	2 years
	Maitland to Sandgate	Up Main	84	0.5 years
	Maitland to Sandgate	Down Main	64	1.5 years
2	Muswellbrook to Ulan	Single Track	60	1 year
3	Werris Creek to Turrawan	Single Track	35	0.9 years
	Murrulla to Werris Creek	Single Track	20	0.5 years
	Muswellbrook to Murrulla	Single Track	46	1 year

Source: Track resurfacing maintenance planning guidelines
Note: Cycle per year is estimated based on actual FY15/16 MGT for these line segments

Track condition, specifically where track geometric parameters are either out of tolerance or expected to be below the maintenance limit, validates and refines the specific mainline and turnout resurfacing project requirements.

Figure 4.8 illustrates the historical levels of resurfacing scope. Resurfacing scope in Zone 1 and 2 have increased largely in line with both increasing tonnages in each zone and ARTC planning guidelines. Since the amount of resurfacing is related to the condition of ballast and formation as well as axle load and speed, significant resurfacing scope was completed in Zone 3 in 2015 as a result of the introduction of 30 TAL trains in order to improve track quality (TMS) and reduce TSR.

Figure 4.8: Track resurfacing work scope (FY11 – 16 in Km)



Source: Worx and FY14/15 10-year AMP

4.4.3.3 Rail and Turnout Grinding (Activities 171 and 172)

Rail grinding is the periodic grinding of rail to manage its profile and stress-related fatigue. Grinding improves wheel and rail interaction, including minimised flange contact and true running without hunting, thus reducing rail wear, wheel wear and rail defects from rolling-contact fatigue.

Rail grinding frequency depends on rail type, type of traffic, tonnage (in MGT) and track geometry. Detailed analysis of rail performance in the network establishes the optimal rail grinding frequency to maximise rail life and minimise the risk of development of rail defects. Table below outlines ARTC standard preventive grinding frequency for 60kg HH rails.

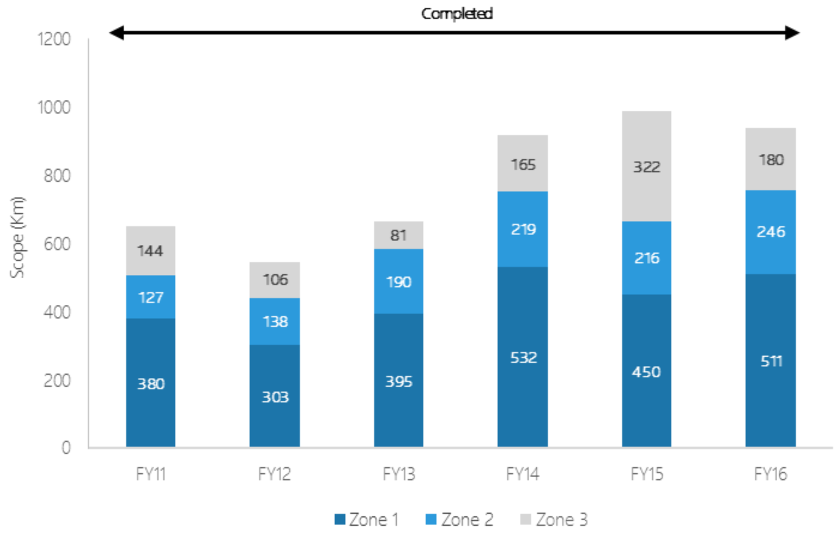
Table 4.7: Rail grinding planning guidelines

Track Curvature (m)	Grinding Cycles (MGT)	
	Loaded Coal Traffic (Single Track and Up Coal Mains)	Empty Coal Traffic (Down Coal Mains)
<450	15	30
450 to 900	30	55
>900	55	80

Source: ARTC Rail Grinding Strategy Document

Figure 4.9 illustrates the historical levels of rail grinding scope. ARTC has historically completed approximately 80% of planned grinding requirements as a result of access constraints, grinding machine availability and grinding performance.

Figure 4.9: Rail grinding work scope (FY11 – 16 in Km)



Source: Worx and FY14/15 10-year AMP

4.4.3.4 Track Formation Reconstruction (Activity 293)

Track reconditioning is the reconstruction of the track formation (track bed). This includes subgrade treatment, the installation of structural earthworks, a capping layer and new ballast, followed by track and drainage restoration. Track reconditioning's purpose is to effectively manage the risk to rail operations from track geometry deterioration. Drivers of track reconditioning are the track's failure rate and type of failure, its performance (determined by the frequency of imposing speed restrictions, and geometric deterioration rate), maintenance effectiveness and recurrence interval, and formation and subgrade configuration.

Annual reconditioning program estimates depend on the ability to manage the risk to rail safety from ongoing and unpredictable geometry deterioration, the financial cost of reconditioning, and the impact of repeated and ongoing maintenance, i.e. speed restrictions and resurfacing requirements.

Current empirical planning guidelines establish a percentage of the network for reconditioning per year, based on historical activity and line segment tonnage. Track reconditioning scope is limited to approximately 0.25 – 0.5% of the network per annum. In 2015, this consists of mainly of formation reconstruction work on short track sections, which are planned on a reactive basis in response to immediate/localised discrete problem areas. While potentially effective in resolving localised issues, these short track section repairs are potentially less effective and efficient, in the long-term, than longer, more extensive reconditioning works.

4.4.3.5 Rerailing (Activity 168)

Rerailing is the in-situ replacement of the running rails, clips and rail pads, and is primarily an asset renewal activity that returns the asset to its original design specification. In the case of small sections (less than 200 metres) it is treated as a condition-based maintenance activity. The purpose of this activity is to replace the rail before it reaches its engineering and condemning limits, and poses an unacceptable risk of failure, which can result in derailments or high-cost breakdown repairs.

Rerailing scope depends on a variety of factors, including rail wear, rolling contact damage, internal defect rates and weld density. Rerailing scope also depends on operational parameters (line segment tonnage), resource availabilities and track access. The theoretical life of rail aligns to preventive rail grinding cycles and reductions of rail-head depth. Based on ARTC's grinding cycle, the average theoretical life of head-hardened rail ranges from 475 MGT (for track with <450m radius curves) to 1600 MGT (>900m radius curves). Actual rail life varies based on the degree of rolling contact damage and the quantum of metal removed in each rail grinding cycle.

Forecast rerailing scope due to wear is expected to be 25Km per year, with a forecast maximum export coal tonnage of 180 Million Net Tonnes. Total planned rerailing scope (MPM and sustaining capital) in FY14/15 and FY15/16 was ~33Km, and much of this was part of the upgrade program in Zone 3 to accommodate higher axle loads.

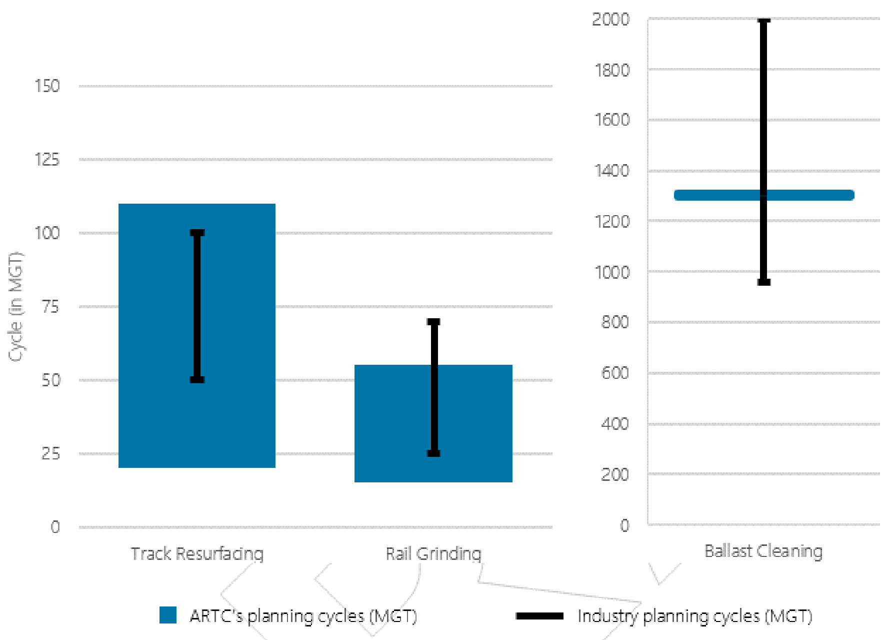
4.4.3.6 Summary Planning Guidelines and Driver Comparison

Figure 4.10 below compares ARTC's planning guidelines and strategies for cyclic MPM activities to the reported planning guidelines of a limited number of rail networks. As illustrated, ARTC's planning guidelines are largely consistent with reported industry approaches, as follows:

- Ballast Cleaning: reported industry ballast cleaning cycles range from 500-1,500 MGT. Ballast cleaning cycles depend heavily on degree of fouling from coal. Networks with longer cycles typically have lower coal traffic levels. ARTC's established target of 1,300 MGT is higher than Aurizon's reported planning guidelines of ~960MGT on its Blackwater and Goonyella systems. For ARTC, the 1300 MGT target translates to a 7-8 year cycle on the Main Coal Road Up segments in Zone 1, and a 20+year cycle in Zones 2 and 3 at current tonnages
- Resurfacing: with the exception of the track segments in Zone 3 between Murrulla and Turrawan, ARTC's resurfacing cycles range from ~50-100 MGT, which are consistent with common industry approaches. Resurfacing cycles in Zone 3 are lower at 20-35 MGT resulting in higher rates of resurfacing activities. This may be due to the quality of the track and formation, and the condition/effectiveness of drainage. In the future, the demand for resurfacing in Zone 3 may be reduced by ballast cleaning, and reconditioning works

- **Grinding:** ARTC's planned grinding cycles vary according to track curvature and load; however, on track with a curvature radius greater than 900 metres, grinding cycles are 50-80 MGT, which are comparable to the grinding cycles of 39-63 MGT for the Aurizon Network.

Figure 4.10: ARTC's maintenance planning cycles per activity compared to heavy haul rail industry benchmarks (in MGT)[3]



Source: Benchmarking data, ARTC maintenance strategies, Deloitte analysis

4.4.4 RCRM Planning Guidelines and Drivers

RCRM involves a mix of recurrent (e.g. routine track inspections) and one-off (e.g. reactive maintenance for signal repairs) tasks and expenditure. Current planning methods are top-down involving a year-on-year calculation where future year's forecast and budget is based on the previous years' actual expenditure, with an increase to cover input cost escalation and inflation. Budget estimates also incorporate inputs from Area Managers to address changes in operations and/or other initiatives.

While some data exists to support bottom-up or zero-based planning of RCRM budgets, several limitations exist that make it difficult to assess the detailed scopes and costs on an activity-level basis. For recurrent tasks, TMPs and associated MSTs in the Enterprise Asset Management system (Ellipse) provide high-level information, e.g. number of inspections, at an asset level. However, estimating planned work effort or costs is difficult as the MSTs align to the Ellipse Equipment Register and not the Ci Financials cost structure, and do not include consistent completion history and scope/cost data. For one-off tasks, historical data exists on defects and repairs; however, work data also references the Ellipse Equipment Register and not the Ci Financials cost structure, and lacks completion/cost data.

Further improvements in ARTC work management processes and better use of its EAM system, Ellipse, will improve the quality and level of detail in RCRM planning. Specifically, this requires alignment of EAM work orders to activity codes, and consistent use of work orders to capture work completion and cost data (labour hrs, materials and services).

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[3] Sources include: GHD – Review of the Prudency and Efficiency of Aurizon Networks Proposed UT5 Maintenance Expenditure, November 2017; Evans and Peck - Operating and Maintenance Costs: Investigation and Benchmarking – Final Report, October 2012; Worley Parsons – Benchmark Heavy Haul Lines: International and National Comparison, 18 August 2008

4.4.5 Capital Expenditure Trade-offs

While this analysis focuses on maintenance expenditure, trade-offs exist with levels of renewal capital, i.e. investments in sustaining capital for upgrades or component renewal can offset or reduce MPM activities. For ARTC, dependencies between the MPM program and sustaining capital exist in three areas as illustrated in Table 4.8.

Table 4.8: MPM and Capital Expenditure

Activity	Combined Cost and Scope (FY14/15 and FY15/16 in $M's and Km)		Comments
	MPM	Sustaining Capital	
Reraiiling	[redacted] 5.4 Km	[redacted] 27.8 Km	Significant investment in Zone 3 reraiiling for 30 TAL program Combined scope less than forecast steady-state requirement of 25 Km per annum
Turnout Component Replacement/ Turnout Upgrades	$6.3M 401	$20.5M 39	Investment in Zone 3 to upgrade turnouts for the 30 TAL program
Track Reconditioning/ Track Strengthening	$16.5M 6.7 Km	$49.9M 44 Km	Increased capital investment in FY15/16 for track strengthening for 30 TAL program Combined scope is 0.6% of total network track length

Source: ARTC 10-year AMP

As illustrated, rerailing and track reconditioning/strengthening are primarily sustaining capital programs. The sustaining capital program in FY 14/15 to FY15/16 included several projects related to 30TAL upgrades in Zone 3, as did the MPM program. The distinctions between sustaining capital and MPM appear small, and assessment of total expenditure may provide better visibility of total network maintenance requirements.

4.4.6 Asset Management Framework Issues and Opportunities

While the ARTC's asset management planning practices are consistent, at a high-level, with general industry approaches and practices, several opportunities exist to improve the effectiveness of this process. The table below highlights observed issues and potential improvement opportunities.

Table 4.9: Asset management framework issues and opportunities

Area	Issue	Potential Opportunities
Asset management strategy and objectives	Current (2015) strategy, objectives, performance targets and planning guidelines exist in multiple documents Consolidated understanding and application reliant on experienced staff within Asset Development business unit	Develop wider and more transparent understanding of Hunter Valley asset management strategy, objectives, performance targets and trade-offs through a consolidated, documented strategy, e.g. a Strategic AMP
AMP - MPM planning approach	10-year AMP reliant on capacity forecasts, however, different forecast data sources and methodologies exist	Develop consistent Hunter Valley network capacity forecasts and general forecast methods, aligned to

Area	Issue	Potential Opportunities
	Forecast growth rates also vary considerably year-on-year and between annual forecasts	overall corridor capacity strategies – these are key inputs to throughput-driven MPM activities in the AMP
AMP - MPM Project Detail	The 10-year AMP forecasts scope and costs by MPM activity and line segment Specific project details exist mainly for the upcoming financial/budget year, as project scope review and validation other than the current year is low (<6%) With several hundred projects per annum, a standard project prioritisation method appears to exist, but application appears to vary by MPM activity Project set-up often aggregate and include multiple distinct sub-tasks over the year within a line segment	Review current AMP structure and planning processes to: • Extend validated project scopes beyond upcoming FY • Apply consistent project prioritisation approaches across MPM activities and projects • Establish project structures that better match delivery strategies, e.g. possession timing and contracts
Project and work completion	Difficulty exists comparing planned work scopes (in AMP and Project Management Plans (PMP)) and actual work completed Variances also exist between work scopes captured in Ci Financials and Worx database, with accuracy varying by MPM activity Difficulty exists in assessing project-specific detailed costs using Ci Financials data due limited transparency of cost data, e.g. sub-tasks, vendors, cost categories, and internal labour allocations Limited asset-level data exists since financial data is recorded at the segment level, and planning data is often recorded as linear distances, and inspection/repairs are recorded by equipment references (equipment register).	Align project and work completion data to: • Facilitate comparison of planned and actual work scopes and costs • Ensure more complete, consistent capture of work scope information • Ensure more consistent and complete completion and capture of asset-level work and cost data This likely requires enhancement of work management, including equipment register and work order, data structures, processes and system

Source: Deloitte analysis

4.4.7 Observations and Findings

- Consistent Asset Management Practices: ARTC's asset management planning practices are consistent, at a high-level, with general industry approaches and practices. They rely on the knowledge and experience of ARTC Asset Development staff, and several opportunities exist to improve the effectiveness of these practices and processes.
- Prudent Planning Guidelines: ARTC cycle-based MPM activities, such as ballast cleaning, resurfacing and grinding, comprise approximately 60% of total MPM program expenditures. Planning guidelines and strategies for these activities are consistent with accepted industry approaches.

- **Optimise Overall MPM and Capital Investments:** potential may exist to further optimise MPM and sustaining capital program expenditures through investigation of capital business cases that will reduce maintenance costs, provide capacity and improve reliability, particularly in longer and more extensive formation strengthening/reconstruction and turnout upgrades. These would need to be subject to the annual corridor capital consultation, review and endorsement processes with the RCG.

4.5 Asset Management and Maintenance Program Delivery

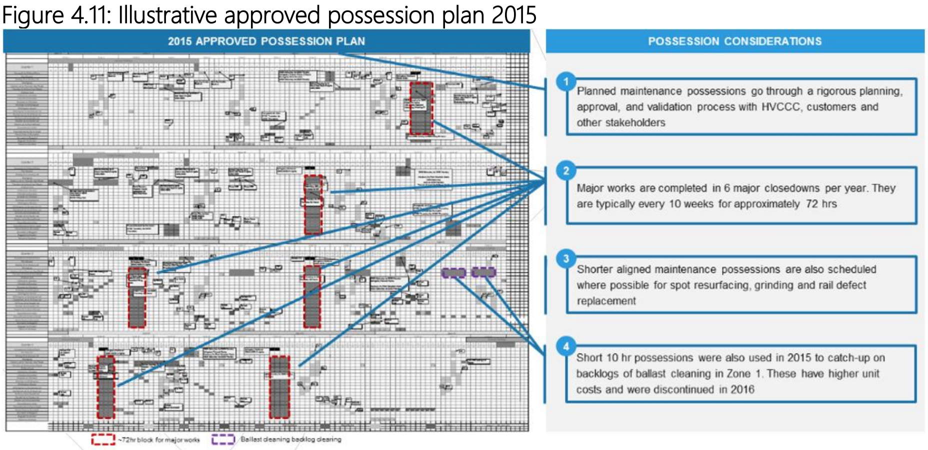
Asset management and maintenance program delivery depends on:

- **Track access arrangements:** delivery of maintenance work is coordinated across the Hunter Valley Coal Chain in a series of approved possessions
- **Contract delivery resources:** MPM activities are largely outsourced to align with the annual possession plan
- **Internal ARTC development and delivery resources:** internal ARTC staff and resources plan and develop the ARTC's asset management and maintenance program, and deliver the RCRM program.

4.5.1 Track Access Arrangements

Track access is a key resource and constraint. To accommodate customer, operational and safety requirements, possession planning is coordinated across the Hunter Valley Coal Chain and is designed to minimise overall service disruptions. Most planned maintenance occurs in six annual network closedowns. Additional shorter aligned possessions accommodate maintenance where necessary. Figure 4.11 outlines the approved 2015 possession plan and key planning considerations.

Figure 4.11: Illustrative approved possession plan 2015



Source: ARTC

4.5.2 Contracting and Procurement

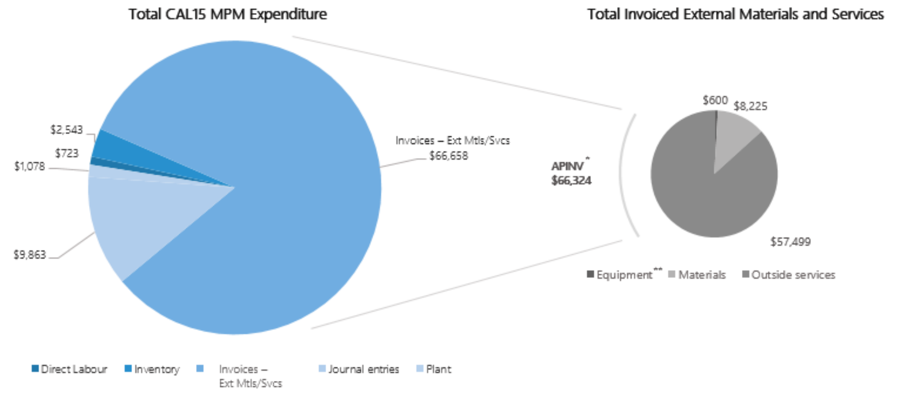
ARTC outsources its MPM activities due to a range of commercial and operational reasons, including:

- **Cyclic Demand:** the scope of work for MPM activities, like ballast cleaning, are cyclic in nature and demand can vary from year-to-year resulting in peaks and troughs in resource requirements
- **Limited Network Access:** to achieve contracted network capacity, the HVCCC has established a limited number of closedowns for maintenance work. This requires mobilisation of significant resources for short periods of time in the year, rather than lower levels of resources spread more evenly across the year

- **Specialised Equipment and Expertise:** grinding, ballast cleaning and track inspection in particular require specialised equipment that would be costly to own, given limited periods of use over a year. The possession plan for ARTC also has an influence on contractor rates due to possession work being restricted to approximately 18 days per year resulting in some contractors recovering their overheads over low utilisations, especially for captive maintenance machines and resources.

As illustrated in Figure 4.12 the following figure, almost all CAL15 MPM expenditures relate to external materials and services.

Figure 4.12: Financial transactional breakdown for MPM activities (CAL15 in $M)



Source: CAL15 Ci Financials transactional level report; APINV refers to the majority of document types that covers materials and services
*Note: *Value only includes APINV and does not include APCRED, APJNL, ARADJ, ARINV, GRNI, RECEIPT document types*
***Equipment refers to e.g. excavators, trucks; Materials refer to e.g. ballast, screws*

Table 4.10 lists major contracts for major maintenance activities. In most cases, contracts appear to align to ARTC's planning, budgeting process and timetable, i.e. contracts are short-term and generally are for work in FY15/16. Contracting uses formal tender processes, usually to a select list of tenderers with the required rail experience and specialised equipment, if necessary, or standing offer arrangements for smaller plant and labour hire requirements.

Table 4.10: Example maintenance contracts and strategies

Activity	Contract Strategy	Contractor Names
Ballast Cleaning	The 2015 Ballast Cleaning program was delivered using a multiyear contract (2014 to 2016). Expressions of Interest were called in the international market followed by a competitive tender process. The contract terms were based on a pay per meter ballast cleaned rate.	[redacted]
Turnout & Plain Track Resurfacing Works	Hunter Valley plain track and turnout resurfacing strategy in 2015 required ARTC to engage with all available machines and suppliers in the Hunter Valley to deliver the required program in scheduled closedowns to meet customer track access needs. As a result, resource-based contracts were negotiated with each supplier individually. Negotiated contracts include all rates used for available	[redacted]

Activity	Contract Strategy	Contractor Names
	resurfacing resources from each supplier, with an estimated upper limiting fee as the capped contract value.	
Turnout and Track Grinding	In 2015 high production Track Grinding was conducted via the 8 year National Grinding contract (2009-2017). The National Grinding contract was established using a competitive tender process. All other grinding work was carried out using established Standing Offer Contracts with various contractors. The HV used all available grinding resources during major closedowns	[redacted]
Track Formation Reconditioning	Formal tender to select list of tenderers. Work packages included work portions in at least 5 of 6 major possessions. This provide successful tenderers with 12 months of consistent work with one possession contingency, and thus is an opportunity for ARTC to improve contractors' performance throughout the contract duration	[redacted]
Steel Component Replacement	In 2015 the work was delivered via both contractors and internal staff. The contractors were engaged using established Standing Offer Contracts. Scopes are determined 2 months prior to major closedowns based on emerging conditions.	[redacted]
Ballast Undercutting	In 2015 contractors were engaged using established Standing Offer Contracts. Scopes are determined 2 months prior to major closedowns based on emerging conditions.	[redacted]
Cutting and Embankment Stabilisation	Formal tender to select list of tenderers. Work package tendered as one package for 12 months of work	[redacted]
Vegetation Management (RCRM)	Formal tender to select list of tenderers	[redacted]

Source: ARTC contracts database

4.5.3 Internal Asset Management and Maintenance Delivery Arrangements

ARTC's Asset Development and Asset Delivery business units support development and delivery of ARTC's Hunter Valley asset management and maintenance program.

4.5.3.1 Asset Development

Asset Development staff are organised in three main groups, as illustrated in Table 4.11. This excludes the Major Projects Group.

Table 4.11: Hunter Valley asset development staff

Positions	Asset Delivery Management	Corridor Works	Engineering, incl. possessions and signalling
Indirect Labour			
Management	3	7	5
Administration	1	5	2
Engineering/Planners			17
Direct Labour			
Project Engineers/Leaders/ Coordinators	1	23	1
Grand Total	**5**	**35**	**25**

Source: FTE Report as at 2015

Table 4.12 summarises the 2015 Asset Development business unit costs.

Table 4.12: Hunter Valley asset development costs (2015)

Account Group	Hunter Valley Cost ($Thousands)	Comments
Direct Labour (includes Contract Labour)	$1,516	This includes Corridor Works project and contract management costs allocated to MPM and sustaining capital projects/activities
Indirect Labour	$3,948	Average indirect FTE costs is ~$90K per annum
Other Overhead Costs	$1,103	Overhead costs (~15%) appear reasonable for this group
Standard Labour Costs	-$1,516	Direct costs charged to MPM and RCRM projects
Grand Total Labour and Overhead Costs	$5,051	

Source: CAL15 Overhead Model Transactional Report; Includes costs allocated to the Hunter Valley Coal Network

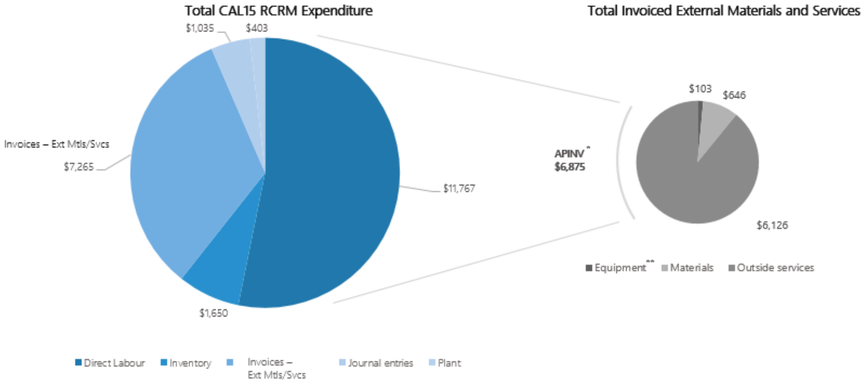
Note: Excludes plant and rail grinding contract costs; Direct staff labour costs allocated to MPM and Capital activities and projects; Indirect staff and other overheads are allocated to line segments based on GTKs

Asset Development planning and program management staff levels and costs appear consistent with other infrastructure businesses, and small in comparison to annual RCRM, MPM and sustaining capital program costs.

4.5.3.2 Asset Delivery

ARTC maintenance staff deliver the RCRM program and activities. As illustrated in the following figure, approximately 50% of CAL15 RCRM expenditures costs are internal ARTC maintenance labour costs.

Figure 4.13: Financials transactional breakdown for RCRM activities (CAL15 in $M)



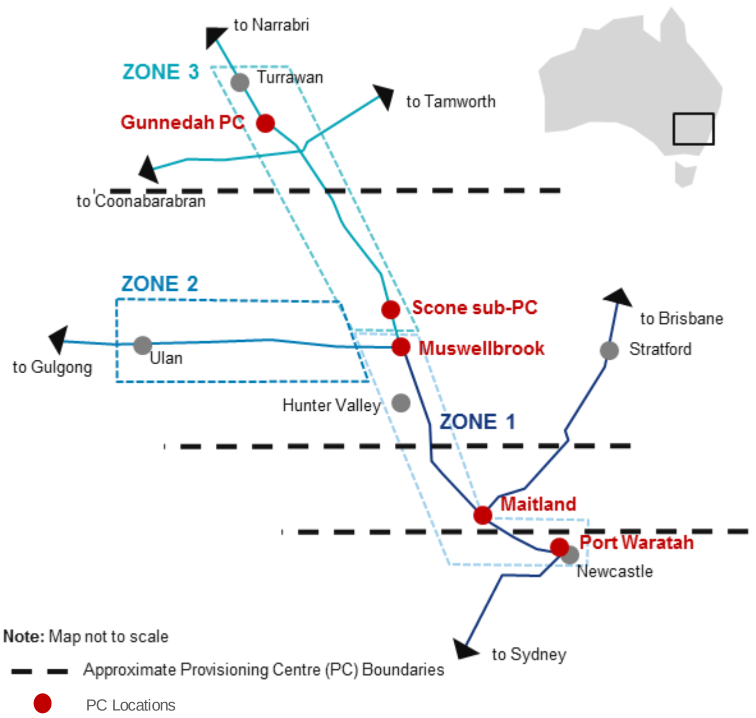
Source: CAL15 Ci Financials transactional level report; APINV refers to the majority of document types that covers materials and services

*Note: *Value only includes APINV and does not include APCRED, APJNL, ARADJ, ARINV, GRNI, ARADJ document types*

***Equipment refers to e.g. excavators, trucks; Materials refer to e.g. ballast, screws*

ARTC delivers the RCRM work program using staff and maintenance equipment, based at four PCs – Port Waratah, Maitland, Muswellbrook, and Gunnedah, as illustrated in Figure 4.14.

Figure 4.14: Hunter Valley maintenance PCs



Source: Based on the information provided by ARTC

Table 4.13 summarises PC indirect and direct staff numbers.

Table 4.13: Hunter Valley asset delivery organisation and staffing (2015)

Positions	Hunter Valley Office-Broad-meadow	Port Waratah	Mait-land	Muswell-brook (inc Scone)	Gunnedah	Grand Total
Indirect Labour						
Management	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	10
Administration		[redacted]	[redacted]	[redacted]	[redacted]	6
Tech Support	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	14
Direct Labour						
Signals Maint.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	35
Civil Maint.		[redacted]	[redacted]	[redacted]	[redacted]	76
Grand Total	12	33	34	41	25	145

Source: FTE Report as at 2015

Note: Technical support includes Engineers; Administration includes Asset Data Administrators; Management includes Area Managers and Team Leaders; Maintenance teams includes Work Group Leaders and Maintainers/Technicians

Table 4.14 summarises the 2015 Asset Delivery business unit costs.

Table 4.14: Hunter Valley asset delivery costs (2015)

Account Group	Hunter Valley Cost ($Thousands)	Comments
Direct Labour (includes Contract Labour)	$14,829	Both overtime and on-costs as a percentage of ordinary time are high: 30% and 53% respectively Total FTE costs are ~$113,000 per annum, which appears consistent with industry norms
Indirect Labour	$5,695	Average indirect FTE costs in approximately $150,000 per annum
Temporary Staff	$931	Includes Apprentice costs of $450K
Property and Related Costs	$1,267	Includes property and power costs for communications and signals
Motor Vehicles	$2,563	Includes approximately 90 vehicles including 20+ larger trucks. Individual vehicle charges average $2,000 - $2,500 per month
Other Overhead Costs	$2,332	
Standard Labour Cost	-$14,688	Direct costs charged to MPM and RCRM projects
Grand Total Labour and Overhead Costs	$12,929	

Source: CAL15 Overhead Model Transactional Report; Includes costs allocated to the Hunter Valley Coal Network

Asset Delivery had approximately 145 total FTEs in 2015 with a Direct/Indirect ratio of approximately 4:1, which is comparable to industry practices. The indirect staff within Asset Delivery include asset data administrators and technical and engineering support, mainly for signalling and control systems. The lack of detailed work order data limits the assessment of the efficiency and utilisation of ARTC internal labour.

Overhead costs are ~20% of total business unit costs, and include apprentice costs, property and power costs for communications and signals, and motor vehicle costs.

4.5.4 Observations and Findings

- Major Annual Network Closedowns: the HVCCC coordinates alignment of maintenance across the coal chain with major work concentrated in six annual ~72hr closedowns. This approach optimises network capacity but requires strong shutdown planning capabilities, and the ability to resource short, intense maintenance periods.
- Annual, Market-Based Contracts: external contractors deliver the MPM program. While longer-term contracts exist for ballast cleaning and grinding, most contracts are annual or rely on panel rates. Additionally, regular tendering processes test competitive market rates.
- Internal ARTC Development and Delivery Staffing: ARTC Asset Development plans, develops and program manages the overall asset management program. Overall staff levels and costs are consistent with the scope of the asset management program. Asset Delivery undertakes RCRM work. While overall costs and staff levels appear reasonable, assessment of staff utilisation and effectiveness requires detailed work order data.

4.6 Asset Management Expenditure and Performance Outcomes

This section addresses the top-down analysis of ARTC network performance outcomes, historic maintenance expenditure trends, CAL14 and CAL15 maintenance expenditures, and high-level benchmark comparisons of ARTC's maintenance expenditures.

4.6.1 Network Performance

As noted in section 4.1, a key objective of ARTC's asset management and maintenance plans and expenditures is to maximise coal chain throughput and reliability.

Table 4.15 summarises ARTC's 2015 performance against the infrastructure condition and reliability KPIs outlined in section 4.2.2. Appendix 2 provides more detailed historic performance trends on Temporary Speed Restrictions, Track Quality and Track Defects.

Overall, ARTC network infrastructure losses are small in comparison to overall coal chain reliability losses. In 2015, overall coal chain reliability losses, excluding ARTC, were 5.74% against a target of 6.4%. As noted below, ARTC infrastructure losses in 2015 were 0.63% against a target of 0.7%.

As illustrated, in 2015, network reliability and condition (TSR's and Track Quality) in Zones 1 and 2 had generally improved since 2011, and met ARTC's targets. Network performance and condition in Zone 3, on an absolute basis, was significantly worse than Zones 1 and 2. Zone 3 performance had some improvement since 2011 and was close to ARTC's targets.

Table 4.15: ARTC 2015 network reliability and condition performance

Measure	Status	Actual	Plan	Trend
Network Reliability				
Network Infrastructure Loss	●	0.63%	0.7%	→
Network Condition				
Zone 1				
TSR (#)	●	4	5	↓

Measure	Status	Actual	Plan	Trend
TSR Time Loss (Minutes)	🟢	9	13.8	↓
Track Quality - % TMS > 300	🟡	5.9%	5.1%	↓
Zone 2				
TSR (#)	🟢	2	4	↓
TSR Time Loss (Minutes)	🔴	6	4.6	↓
Track Quality - % TMS > 300	🟢	8.2%	10.6%	↓
Zone 3				
TSR (#)	🟢	10	15	→
TSR Time Loss (Minutes)	🔴	50	23.6	→
Track Quality - % TMS > 300	🟡	20.2%	19.6%	↓

Source: TSR Update for TE June 2018, TMS Infr Losses_Defects
Notes: Actual is average monthly performance for 2015; Targets are based ARTC RCG Report

4.6.2 MPM Expenditures

4.6.2.1 Historic Trends

The following tables illustrates historic MPM expenditure from CAL12-15. Overall MPM expenditures increased at a CAGR of 19% for this period, due to:

- On-going ballast cleaning work in Zones 1 and initial ballast cleaning in Zone 2
- Increased GTKs driving higher grinding, resurfacing, and component replacement costs
- Substantial increases in Zone 3 MPM costs to accommodate both increasing tonnages and higher axle loads.

Table 4.16: MPM Expenditure Historic Trends ($ Thousands)

	CAL2012	CAL2013	CAL2014	CAL2015
Zone 1	$22,951	$27,106	$29,546	$37,400
Zone 2	$14,548	$18,881	$21,622	$21,435
Zone 3	$10,326	$11,004	$17,027	$22,031
Total	$47,825	$56,990	$68,195	$80,865

Source: ARTC

Table 4.17: Top MPM Activity Historic Trends ($Thousands)*

	CAL2012	CAL2013	CAL2014	CAL2015
Zone 1				
Ballast Cleaning	[redacted]	[redacted]	[redacted]	[redacted]
Rail Grinding	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance Resurfacing	$2,300	$2,691	$3,520	$2,641
Track Formation Reconstruction	$6,010	$1,463	$2,909	$962
Ballast Under-cutting	$855	$534	$1,016	$1,869

	CAL2012	CAL2013	CAL2014	CAL2015
Turnout Steel Component Rep.	$1,549	$1,486	$2,850	$3,582
Zone 2				
Ballast Cleaning	[redacted]	[redacted]	[redacted]	[redacted]
Rail Grinding	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance Resurfacing	$1,280	$1,249	$1,531	$1,639
Track Formation Reconstruction	$1,735	$708	$1,098	$1,246
Ballast Under-cutting	$91	$63	$143	$302
Turnout Steel Component Rep.	$40	$43	$38	$130
Zone 3				
Ballast Cleaning	[redacted]	[redacted]	[redacted]	[redacted]
Rail Grinding	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance Resurfacing	$1,320	$1,460	$4,252	$5,242
Track Formation Reconstruction	$1,811	$2,668	$2,388	$2,426
Ballast Under-cutting	$914	$620	$1,570	$4,835
Turnout Steel Component Rep.	$180	$371	$210	$285

Source: ARTC

*Note: *Figures may not reconcile due to rounding*

The following figure illustrates total maintenance expenditures per Track Km by line segment, with and without ballast cleaning, over the period from 2011 to 2015. It highlights the progressive increasing maintenance costs in most line segments driven by customer demand.

Figure 4.15: Maintenance expenditure trends by line segment 2011 – 2015

Source: ARTC

4.6.2.2 Forecast MPM expenditures – 10 Year AMP

The following table shows the FY14/15 AMP forecast of total MPM expenditures by zone. Future MPM maintenance expenditure remain at similar levels to those in CAL15 with growth forecast at less than 3% per annum. This is based on an anticipated growth in demand of 1-2% per annum.

Table 4.18: Forecast MPM expenditures – 10-year AMP ($Thousands)

Plan FY	Zone 1	Zone 2	Zone 3	Grand Total
14-15	$47,102	$24,393	$17,879	$89,375
15-16	$36,623	$21,648	$32,492	$90,763
16-17	$47,948	$10,227	$49,413	$107,588
17-18	$43,132	$14,108	$37,707	$94,948
18-19	[redacted]	[redacted]	[redacted]	$90,630
19-20	[redacted]	[redacted]	[redacted]	$101,081
20-21	[redacted]	[redacted]	[redacted]	$100,708
21-22	[redacted]	[redacted]	[redacted]	$108,274
22-23	[redacted]	[redacted]	[redacted]	$110,259
23-24	[redacted]	[redacted]	[redacted]	$116,221

Source: ARTC FY14/15 AMP

The following table details the 10-year forecast of MPM expenditures by activity. It shows the expected annual variation in forecast MPM activity work scope and expenditures, such as for activities like ballast cleaning and track formation reconstruction. For some activities, an annual expenditure focus may miss longer-term trends and programs. Since development of the FY14/15 AMP, a revised ballast cleaning strategy prepared in June 2016, extended the ballast cleaning cycle and deferred some planned ballast cleaning projects. This reduced forecast ballast cleaning work scope and costs.

Table 4.19: FY14/15 10 Year AMP – MPM Activity Forecast ($Thousands)

MPM Activity	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	Grand Total
Full Ballast Cleaning	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$317,234
Track Resurfacing	$8,948	$10,928	$11,617	$12,448	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$129,178
Rail Grinding	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$117,987
Full Track Reconditioning	$4,660	$11,828	$16,626	$5,792	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$67,099
Engineering Investigations	$8,325	$5,403	$4,639	$4,484	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$54,955
Ballast Undercutting	$5,058	$3,068	$6,211	$2,303	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$53,209
Turnout Tamping	$2,809	$3,094	$3,265	$3,688	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$38,359
Ballasting	$2,070	$2,038	$2,078	$2,347	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$26,563
Steel Component Replacement	$4,219	$2,078	$2,114	$2,147	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$24,970
Turnout Grinding	$1,44	$1,673	$1,923	$1,953	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$21,263
Sub-total other MPM activities	$15,324	$16,712	$33,538	$20,897	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$269,341
Grand Total	$89,375	$90,763	$107,588	$94,948	$90,630	$101,081	$100,708	$108,274	$110,259	$116,221	$ 850,818

Source: ARTC FY14/15 AMP

4.6.2.3 CAL15 MPM Maintenance Expenditures

Table 4.20 provides a more detailed breakdown of the actual CAL15 MPM program activity costs by zone. Major CAL15 MPM activity costs and drivers that accounted for over 80% of total CAL15 MPM expenditures, were:

- Ballast Cleaning ($[redacted]) which included specific projects in Zone 1 and Zone 2 aligned to the overall ballast cleaning strategy
- Maintenance and Turnout Resurfacing ($12.2M), which included tonnage driven projects in Zones 1 and 2, as well as $5.5M delivered in Zone 3 to accommodate increased train axle loads and customer capacity requirements
- Ballast Undercutting, Ballast and Formation Reconstruction ($14.4M), of which $8.4M or 60% was completed in Zone 3 to accommodate increased train axle loads and customer capacity requirements
- Rail and Turnout Grinding ($[redacted]M), which included primarily tonnage-driven requirements
- Turnout Steel Component Replacement ($4M), which addressed component wear and replacement requirements in Zone 1.

Table 4.20: MPM Program Activity Expenditure (CAL15 in $Thousands)

MPM Activity	Pricing Zone 1	Pricing Zone 2	Pricing Zone 3	Grand Total
Ballast Cleaning	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance Resurfacing	$2,641	$1,639	$5,242	$9,522
Rail Grinding	[redacted]	[redacted]	[redacted]	[redacted]
Ballast Undercutting	$1,869	$302	$4,835	$7,007
Track Formation Reconstruction	$962	$1,246	$2,426	$4,634
Turnout Steel Component Replacement	$3,582	$130	$285	$3,997
Engineering Investigations	$2,065	$384	$981	$3,430
Ballasting	$1,388	$166	$1,188	$2,742
Turnout Resurfacing	$2,232	$217	$260	$2,710
Cess & Top Drain Maintenance	$965	$0	$1,615	$2,580
Turnout Grinding	$1,982	$374	$156	$2,512
Cutting/Embankment Maintenance	$10	$1,070	$270	$1,349
Vegetation Control – Planned	$343	$79	$415	$837
Shoulder Ballast Cleaning	$709	$0		$709
Signals	$354	$238	$107	$699
Sundry Maintenance	$218		$451	$669
Bridge Transoms	$0	$327	$171	$497
Culvert Structural Repairs	$136	$223	$125	$485
Turnout Retimbering	$13	$0	$456	$469
Level Crossing Maintenance	$84	$185	$188	$456
Tunnel Maintenance	$191	$0	$226	$417
Power Supply	$246		$23	$269
Steel Underbridge Repairs	$40	$141	$81	$262

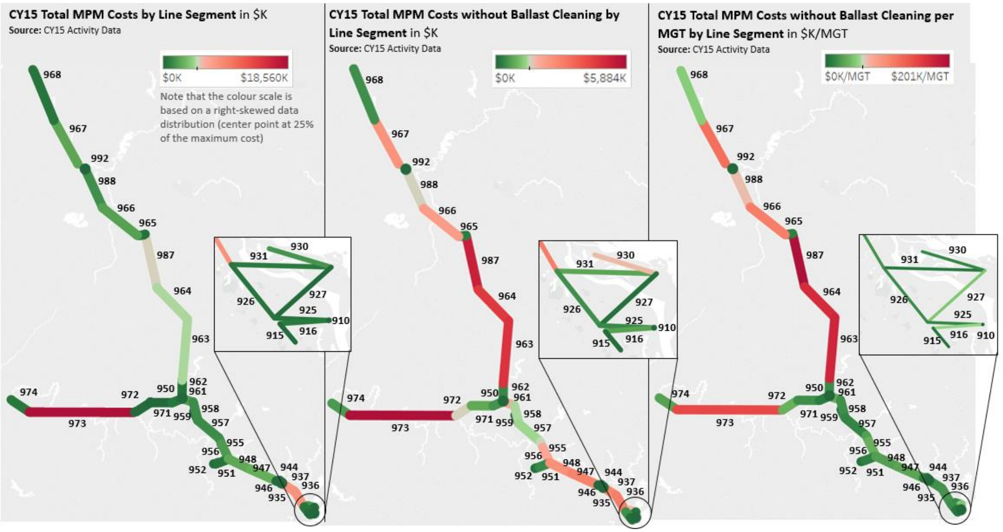
MPM Activity	Pricing Zone 1	Pricing Zone 2	Pricing Zone 3	Grand Total
Pad Replacement	$205			$205
*Other minor activities (<$200 k p.a.)**	$769	$43	$445	$1,257
Grand Total	$37,340	$21,435	$22,031	$80,865

*Note: *Includes activities such as minor re-railing, fencing, re-sleepering, siding rehabilitation, etc, that had a total activity cost of less than $200,000 in CAL15.*

Figure 4.16 further breaks down these MPM activity expenditures by line segment both with and without ballast cleaning. As major MPM activities are driven by tonnage-based planning cycles, MPM costs are also displayed at the line segment level in terms of cost by $/MGT. This segment-level analysis highlights the following:

- Ballast Cleaning Impact: high MPM costs in segments 936, 937 and 973 were due to ballast cleaning projects completed in 2015 in these line segments
- High Zone 2 MPM Costs: in general, excluding ballast cleaning, MPM line segment costs range from $5,000 to $30,000 per MGT. In Zone 2, line segment 973, Sandy Hollow to Wilpinjong, CAL15 MPM costs were almost $150K per MGT. This is a very long 90 Km segment, and MPM costs either reflected the length of this segment or related to specific projects. Key segment costs included the following major costs/projects:
    - Rail Grinding - $[redacted]
    - Cutting stabilisation - $975K (Kerrabee)
    - Resurfacing - $862K
    - Track Reformation Reconstruction - $824K (Coggan Creek and Wollar)
    - Bridge Transom Repairs - $327K
- High Zone 3 MPM Costs: CAL15 MPM costs in line segments 963, 964 and 987, Dartbrook Junction to Werris Creek, were $166K to $200K per MGT. These were driven by high resurfacing, ballast undercutting (30 TAL program), track formation reconstruction (Kankool - $495K, Willow Tree - $315K, and Quirindi - $950K) and drainage maintenance costs. These higher costs are due to track condition, customer demand and higher axle loads.

Figure 4.16: MPM costs by line segment (CAL15)



Source: ARTC

Note: Up direction only (Coal Traffic MGT), Pt Warratah (MGT Total plus Background & Adjustment)

Zone	Line #	Line Name	MPM $	MPM $ w/o Ballast*	MPM $ w/o Ballast* per MGT
Z1	910	Port Waratah Provisioning Centre	0K	[redacted]	[redacted]
	915	Islington Jct To Scholey St Jct	67K	[redacted]	[redacted]
	916	Scholey St Jct To Port Waratah	686K	[redacted]	[redacted]
	917	Scholey St Jct To Waratah (Via Coal)	205K	[redacted]	[redacted]
	925	Waratah To Hanbury Jct (Via Coal)	386K	[redacted]	[redacted]
	926	Hanbury Jct To Sandgate (Via Coal)	462K	[redacted]	[redacted]
	927	Hanbury Jct To Kooragang East Jct	80K	[redacted]	[redacted]
	930	Kooragang East Jct To Kooragang Island	1,754K	[redacted]	[redacted]
	931	Kooragang East Jct To Sandgate	726K	[redacted]	[redacted]
	935	Maitland Provisioning Center	0K	[redacted]	[redacted]
	936	Sandgate To Thornton (Via Coal)	8,684K	[redacted]	[redacted]
	937	Thornton To Maitland (Via Coal)	8,417K	[redacted]	[redacted]
	944	Telarah To Farley	11K	[redacted]	[redacted]
	946	Maitland To Farley	959K	[redacted]	[redacted]
	947	Farley To Branxton	2,891K	[redacted]	[redacted]
	948	Branxton To Whittingham	2,578K	[redacted]	[redacted]
	950	Muswellbrook Provisioning Centre	0K	[redacted]	[redacted]
	951	Whittingham To Saxonvale Jct	385K	[redacted]	[redacted]
	952	Saxonvale Jct To Mount Thorley	99K	[redacted]	[redacted]
	955	Whittingham To Camberwell Jct	2,009K	[redacted]	[redacted]
	956	Camberwell Jct To Glennies Creek	1,486K	[redacted]	[redacted]
	957	Glennies Creek To Newdell Jct	1,381K	[redacted]	[redacted]
	958	Newdell Jct To Draytons Jct	1,414K	[redacted]	[redacted]
	959	Newdell Branch	66K	[redacted]	[redacted]
	961	Draytons Jct To Muswellbrook	2,093K	[redacted]	[redacted]
	970	Muswellbrook to Bengalla Jct	507K	[redacted]	[redacted]
Z2	971	Bengalla Jct To Anvill Hill	792K	[redacted]	[redacted]
	972	Anvill Hill so Sandy Hollow Junction	1,553K	[redacted]	[redacted]
	973	Sandy Hollow Jct To Wilpinjong	18,560K	[redacted]	[redacted]
	974	Wilpinjong To Ulan Colliery Jct	595K	[redacted]	[redacted]
Z3	962	Muswellbrook to Dartbrook Jct	378K	[redacted]	[redacted]
	963	Dartbrook Junction to Murulla (Bickham Co.	4,699K	[redacted]	[redacted]
	964	Murulla to Willow Tree	4,724K	[redacted]	[redacted]
	965	Werris Creek to Gap	254K	[redacted]	[redacted]
	966	Gap to Watermark	2,258K	[redacted]	[redacted]
	967	Whitehaven Gunnedah Jct to Boggabri Jct	2,496K	[redacted]	[redacted]
	968	Boggabri to Turrawan Loop	464K	[redacted]	[redacted]
	987	Willow Tree to Werris Creek	5,219K	[redacted]	[redacted]
	988	Watermark to Gunnedah	1,538K	[redacted]	[redacted]
	992	Gunnedah Provisioning Centre	0K	[redacted]	[redacted]

** 'Ballast' refers to only maintenance activity 286, Ballast Cleaning*

As noted, MPM activities and expenditures in CAL15 were influenced by a number of unique factors, including strong historic growth in network shipments and volume, network capacity and axle load upgrades in Zone 3, and increased ballast cleaning work to address planned requirements. Overall market pressures and reductions in the export coal price resulted in changing customer priorities and, in particular, heightened cost concerns.

As noted in section 4.4.2, MPM expenditures in CAL15 spanned two annual planning processes (FY14/15 and FY 15/16). Forecast expenditures in FY14/15 and FY15/16 were $89.4 and $90.8 million, respectively. As a result of customer feedback, ARTC reduced MPM expenditures, through its asset planning processes, by optimising individual project plans, work scopes and estimates, and procurement and contracting practices.

Table 4.21: Comparison of Planned MPM (FY14/15 AMP) and Actual MPM Expenditures (Top 85% of expenditures) ($Thousands)

MPM activity	Forecast Expenditure (FY14/15 AMP)	Actual Expenditure (CAL15)	Variance
Ballast Cleaning	[redacted]	[redacted]	-$4,598
Maintenance Resurfacing	$8,948	$9,522	$574
Rail Grinding	[redacted]	[redacted]	$1,230
Ballast Undercutting	$5,058	$7,007	$1,948
Track Formation Reconstruction	$4,660	$4,634	-$27
Turnout Steel Component Replacement	$4,219	$3,997	-$222
Engineering Investigations	$8,326	$3,430	-$4,896
Ballasting	$2,069	$2,742	$674
Turnout Resurfacing	$2,809	$2,709	-$100
Cess & Top Drain Maintenance	$4,058	$2,580	-$1,477
Total (85% of Expenditures)	**$76,664**	**$69,771**	**-$6,893**

Source: ARTC

Major changes to planned expenditures occurred in the following areas:

- Reduction in ballast cleaning costs (-$4.6M): planned ballast cleaning work scope was 56,621 metres in FY14/15 and 40,000 metres in FY15/16. CAL15 ballast cleaning scope was reduced to 53,310 metres, and ballast cleaning was focused on more efficient major closedowns rather than the higher cost Zone 1 aligned maintenance possessions
- Reduction of engineering investigations (-$4.9M), through deferral of discretionary initiatives and studies
- Increases in resurfacing, grinding and ballast undercutting costs (+$3.8M), due to increased work scope in Zone 3 to accommodate higher axle load trains.

In addition, rationalisation of requirements and priorities resulted in a reduction in other MPM activities of $3 million.

4.6.3 Routine Corrective and Reactive Maintenance Costs

4.6.3.1 RCRM Expenditure trends

Table 4.22 below illustrates the historic RCRM expenditure from CAL12-15. RCRM costs reflect the network asset base within each zone and general year-on-year cost escalation of 4% cumulative annual growth rate.

Table 4.22: RCRM Expenditure Historic Trends ($ Thousands)

	CAL2012	CAL2013	CAL2014	CAL2015
Zone 1	$11,357	$11,505	$12,825	$12,940
Zone 2	$2,074	$2,010	$1,893	$2,700
Zone 3	$5,418	$5,766	$6,654	$6,062
Total	$18,848	$19,281	$21,372	$21,702

Source: ARTC

4.6.3.2 CAL15 RCRM Expenditures

Table 4.23 provides a more detailed breakdown of the CAL15 RCRM program and activity costs. RCRM activity costs are generally driven by inspections, as detailed in the relevant TMPs, and the rectification of reported defects.

Approximately 65% of RCRM costs are related to track and civil infrastructure. CAL15 costs appear reasonable with key drivers including:

- Rail Defect Removal ($2.74 M) – this covers defect repairs across 817 km of track at a unit rate of approximately $3,400 per track km, which compares to similar costs at Aurizon Network of $2,600 per Track Km
- Reactive Track Geometry Correction ($2.0 M) – this included $1 M of expenditure in Zone 3 due to introduction of higher axle loads. Costs are largely (>70%) internal labour
- Mudhole Rectification ($1.9 M) – this includes $1 M in Zone 1 due mainly to repairs on the main coal roads
- Routine Track Inspections – this includes both visual patrols ($1.7 M) and mechanised track geometry recording ($[redacted] M). Unit costs were approximately $2,700 per Track Km which compares to similar costs at Aurizon Network of $2,500 per Track Km.

The remaining RCRM activity costs relate to maintenance of signalling and communications infrastructure. Different technologies and maintenance activity definitions make comparison of these costs more challenging.

Table 4.23: RCRM program activity expenditures (CAL15 in $Thousands)

RCRM Activity	All Zones	Pricing Zone 1	Pricing Zone 2	Pricing Zone 3	Grand Total
Rail Defect Removal	$0	$1,838	$315	$588	$2,742
Reactive Track Geometry Correction		$684	$239	$1,090	$2,013
Mud hole Rectification		$1,073	$385	$488	$1,946
Inspect Testing & Minor Repairs – Points	$0	$1,431	$148	$329	$1,909
Routine Inspections – Track	$0	$845	$116	$795	$1,757
Inspect Testing & Minor Repairs – Track Circuit		$710	$161	$398	$1,269
Insulated Rail Joints		$790	$45	$95	$930
Turnout Maintenance – Reactive		$562	$84	$64	$710
Ultrasonic Test Car		[redacted]	[redacted]	[redacted]	[redacted]
Inspect Testing & Minor Repairs – Signals	$0	$327	$51	$289	$667
Callouts – Signalling		$392	$145	$131	$667
Inspect Testing & Minor Repairs – Signals Power Supplies		$423	$83	$122	$628
Callouts - Track & Structures		$235	$80	$159	$475
Training	$18	$368		$83	$470

RCRM Activity	All Zones	Pricing Zone 1	Pricing Zone 2	Pricing Zone 3	Grand Total
Level Crossings (Signals) – Inspect, Test & Minor Repairs	$0	$158	$108	$196	$463
Track Geometry Recording		$246	$39	$144	$429
Welded Track Stability		$161	$91	$124	$375
Terminal Drainage		$372			$372
Ultrasonic Rail Examination		[redacted]	[redacted]	[redacted]	[redacted]
Cable & Pole Lines – Inspect, Test & Minor Repairs		$261	$27	$53	$341
Wayside Detection Systems	$304	$28			$332
Inspect & Minor Repairs – Enclosures/Location		$264	$31	$17	$312
Underbridge: Reactive Repairs		$183	$38	$86	$306
Facilities, Housekeeping and Store		$175		$89	$264
Routine Inspect – Culvert		$38	$70	$105	$213
Rail Lubrication		$91	$75	$36	$203
Signals High Voltage Power Supply – Inspect, Test & Repairs		$96	$51	$44	$191
Access Road Maintenance		$42	$87	$39	$168
Routine Inspections – Turnouts		$101	$22	$29	$151
*Other minor activities (<$100 k p.a.)**	$94	$309	$118	$226	$746
Grand Total**	$417	$12,940	$2,700	$6,062	$22,119

Source: ARTC

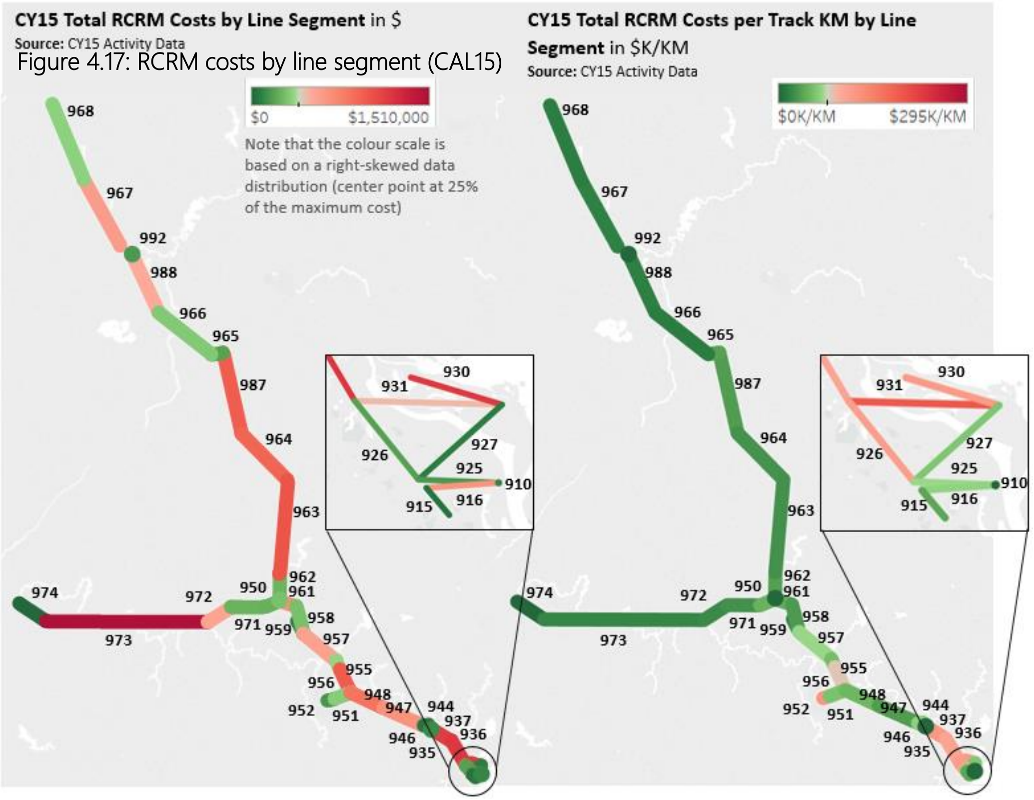
*Note: * Includes a range of RCRM activities that had a total activity cost of less than $100,000 in CAL15*

Figure 4.17 illustrates RCRM expenditure by line segment across the Hunter Valley Network. As routine inspection and repairs drive RCRM costs, costs are influenced by the density of assets and segment length. RCRM line segment costs generally range from $20K - $60K per Track Km.

Segment-level analysis highlights:

- Zone 1 Costs: the high-use and complex track sections near the port facilities, that is, segments 926, 930, 931, 936, 937 and 946 had RCRM unit costs greater than $100K per Track Km. These higher costs may reflect high numbers of turnout and signal assets, as well as repairs of rail defects
- Zone 2 Costs: CAL15 RCRM costs in line segment 973, Sandy Hollow to Wilpinjong, were $1.6M, which included high Rail Defect Removal and Mud-hole Rectification costs ($212K and $161K respectively). Total RCRM costs reflect the 93 Km track length of this line segment
- Zone 3 Costs: CAL15 RCRM costs for line segments 963, 964 and 987, Dartbrook Junction to Werris Creek – were over $3M, which included $1M in Reactive Track Geometry Correction and Mudhole Rectification Dig Outs that were related to increasing axle loads.

Figure 4.17: RCRM costs by line segment (CAL15)



Source: ARTC

Zone	Line #	Line Name	RCRM $	RCRM $ per Track KM
Z1	910	Port Waratah Provisioning Centre	104K	
	915	Islington Jct To Scholey St Jct	37K	42K
	916	Scholey St Jct To Port Waratah	752K	72K
	917	Scholey St Jct To Waratah (Via Coal)	160K	115K
	925	Waratah To Hanbury Jct (Via Coal)	171K	75K
	926	Hanbury Jct To Sandgate (Via Coal)	199K	121K
	927	Hanbury Jct To Kooragang East Jct	69K	62K
	930	Kooragang East Jct To Kooragang Island	1,401K	127K
	931	Kooragang East Jct To Sandgate	526K	211K
	935	Maitland Provisioning Center	122K	
	936	Sandgate To Thornton (Via Coal)	1,409K	115K
	937	Thornton To Maitland (Via Coal)	1,370K	132K
	944	Telarah To Farley	36K	71K
	946	Maitland To Farley	440K	325K
	947	Farley To Branxton	752K	35K
	948	Branxton To Whittingham	980K	53K
	950	Muswellbrook Provisioning Centre	317K	
	951	Whittingham To Saxonvale Jct	359K	60K
	952	Saxonvale Jct To Mount Thorley	155K	133K
	955	Whittingham To Camberwell Jct	1,147K	91K
	956	Camberwell Jct To Glennies Creek	389K	56K
	957	Glennies Creek To Newdell Jct	631K	74K
	958	Newdell Jct To Draytons Jct	314K	33K
	959	Newdell Branch	61K	17K
	961	Draytons Jct To Muswellbrook	784K	46K
	970	Muswellbrook to Bengalla Jct	256K	49K
Z2	971	Bengalla Jct To Anvill Hill	267K	27K
	972	Anvill Hill so Sandy Hollow Junction	621K	22K
	973	Sandy Hollow Jct To Wilpinjong	1,662K	18K
	974	Wilpinjong To Ulan Colliery Jct	150K	15K
Z3	962	Muswellbrook to Dartbrook Jct	275K	37K
	963	Dartbrook Junction to Murulla (Bickham Coal)	1,208K	28K
	964	Murulla to Willow Tree	1,096K	19K
	965	Werris Creek to Gap	202K	38K
	966	Gap to Watermark	345K	13K
	967	Whitehaven Gunnedah Jct to Boggabri Jct	676K	16K
	968	Boggabri to Turrawan Loop	373K	14K
	987	Willow Tree to Werris Creek	982K	75K
	988	Watermark to Gunnedah	731K	48K
	992	Gunnedah Provisioning Centre	172K	

4.6.3.3 Margin on RCRM

ARTC has applied a 10% margin to the costs incurred on RCRM. This approach is consistent with alliance style contracts which are applied within the rail industry.

The specific application of a 10% margin is consistent with the arrangements that ARTC has entered into historically with third party maintenance providers and where it is providing maintenance to other rail network operators.

Specifically:

- As of July 2015, ARTC entered into an agreement with [redacted] for maintenance services on the [redacted] network where the negotiated market price was cost plus 10%
- Up to January 2012 ARTC performed RCRM work on the [redacted] at cost plus a margin of 10%
- From its formation, ARTC went to market for maintenance activities and subsequently entered into alliance contracts for maintenance services, including RCRM and MPM, with [redacted], initially for the [redacted] network (including areas of [redacted], later extended to cover [redacted] to [redacted] and with [redacted] segments of the [redacted] corridor at a price of cost plus 10%.

4.6.4 Maintenance Benchmark Comparison

Benchmarking provides useful indications of relative performance between comparable organisations. However, in the case of heavy rail infrastructure maintenance, comparable organisations and available data sets are limited. Within Australia, publicly available data on rail infrastructure organisations is limited to 'regulated' networks including Aurizon's Central Queensland Coal Network (CQCN), The Pilbara Infrastructure (TPI) network linking Fortescue Metals Group Pilbara mines and Port Hedland, and Brookfield Rail in WA. Internationally, the International Union of Railways (UIC) developed a database of European rail infrastructure costs as part of its Lasting Infrastructure Cost Benchmarking (LICB) exercise; however, this data set provides only high-level information and has comparability issues regarding currency and purchasing power, network configuration and classification of maintenance and capital expenditures.

Aurizon's recent regulatory submissions to the QCA provide the most recent set of accessible data on similar rail infrastructure. The following table provides a comparison between ARTC and Aurizon network's infrastructure.

Table 4.24: ARTC and Aurizon network's infrastructure comparison

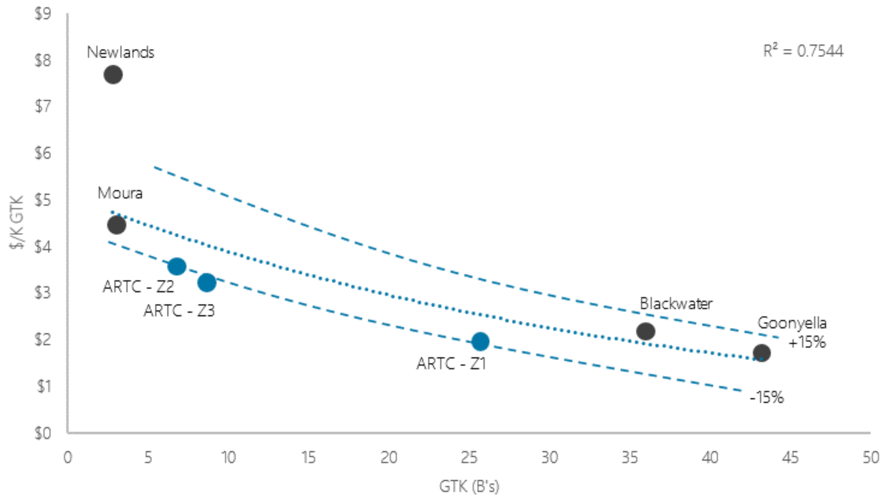
	Aurizon Network				ARTC		
	Goonyella System	Blackwater System	Newlands System	Moura System	Zone 1	Zone 2	Zone 3
Track (km)	1,021	1171	311	315	405	197	342
Turnouts (#)	424	447	76	128	354	59	179
Crossings (#)	275	228	82	149	30	93	93
Train Axle Load	26.5 TAL				30 TAL		
Shipments (mtpa)	119	64	15	12	161	40	24

Source: GHD Report on Prudency and Efficiency of Aurizon Networks Proposed Aurizon Network's 2017 Draft Access Undertaking (UT5) Maintenance Expenditure

Notes: Goonyella and Blackwater systems are electrified. Maintenance of traction power is approximately 5% of total infrastructure maintenance costs

Figure 4.18 compares ARTC zonal RCRM and MPM maintenance costs with the four Aurizon network system maintenance costs on a GTK basis. ARTC's average maintenance costs are roughly comparable at $2.40 /'000 GTK to Aurizon's average of $2.20 /'000 GTK. ARTC Zone 1 costs at $1.96 /'000 GTK are similar to the average of Aurizon network's Blackwater and Goonyella system costs of $1.92 /'000 GTK. ARTC CAL15 Zone 2 and 3 unit costs are both higher than Zone 1 and Aurizon network's costs due to ballast cleaning in Zone 2 and the impact of higher axle loads in Zone 3. ARTC Zone 2 and 3 costs compare favourably to Aurizon's Moura and Newlands systems.

Figure 4.18: Expenditure benchmarking: ARTC vs Aurizon ($/K GTK and B GTK)*



Source: Aurizon 2017 Annual Performance Report, Deloitte analysis of ARTC CAL15 MPM and RCRM expenditures

** ARTC data is for 2015, Aurizon Data is for 2017 due to availability of consistent cost and volume data.*

*** Trendlines show approximate correlation and spread of data points. R2 is a statistical correlation*

In addition to network age, track condition and maintenance policies, benchmark maintenance costs are also influenced by:

- Asset Density: more assets (turnouts, signals, crossings, etc.) per Track Km increases maintenance costs since there are more assets to maintain and indicates greater network complexity. In the Hunter Valley Network, this is apparent in line segments on the main coal roads adjacent to the Port
- Utilisation and Gross Tonnage: generally higher network utilisation and loads result in increased wear and maintenance to repair defects. In the Hunter Valley Network, this is most evident in Zone 3 where increasing utilisation and tonnage have increased maintenance costs substantially
- Track Possession Strategy: longer possession windows (≥48hrs) result in lower costs due to more efficient use of maintenance resources and 'track-time'. Fewer but longer possessions are therefore more efficient, align with other coal chain participant requirements, and optimise capacity. They require resource strategies that allow flexibility and the ability to mobilise significant resources for short periods of time, i.e. contractors.

4.6.5 Observations and Findings

- Network Condition and Performance: network quality and reliability performance has improved over past 5 years and mostly meets current ARTC targets. Targets reflect more challenging track conditions in Zone 3.

- **MPM Expenditure Trends:** MPM program expenditures grew at 19% per annum (CAGR) from CAL12 to CAL15, and were influenced by a number of unique factors, including strong historic growth in network shipments and volume, network capacity and axle load upgrades in Zone 3, and increased ballast cleaning work to address planned requirements.
- **CAL15 MPM Program Adjustments:** as a result of changing coal market environment, customer priorities and customer feedback, ARTC reduced MPM expenditures, through its asset planning processes, by optimising individual project plans, work scopes and estimates, and procurement and contracting practices.
- **RCRM Program Expenditure:** grew more modestly at 4% per annum (CAGR), reflecting constrained resources and planning methodology.
- **Comparable Overall Maintenance Expenditures:** comparison of maintenance expenditures with other rail infrastructure maintainers is difficult due to limited availability of accessible and comparable data sets. Based on the available data set, ARTC maintenance expenditures appear consistent with external benchmarks on a cost per GTK basis as well as on a cost per net tonne basis.

4.7 Detailed MPM Maintenance Expenditure Analysis

Detailed bottom-up analysis focused on select MPM activities to assess underlying cost drivers, compare ARTC MPM activity unit rates to industry averages, and identify projects where significant variances existed to either planned or target unit cost rates.

4.7.1 Overall MPM Bottom-up Analysis

Table 4.25 includes the top 90% of CAL15 MPM activity costs, and illustrates highlighted activities where further bottom-up analysis was completed. Analysis focused on exceptions in the 2015 MPM program activities and projects where planned activity frequencies were greater than industry norms, and where actual costs and unit rates were higher than planned. This included specific focus on:

- Zone 1 ballast cleaning as unit rates were higher than planned
- Zone 1 and 2 maintenance resurfacing in all zones as unit rates were higher than comparable industry practices
- Zone 3 maintenance resurfacing as unit rates and frequency were higher than comparable industry practices.

Table 4.25: Heat-map bottom-up analysis MPM expenditures (top 90% of CAL15 Expenditures, $Thousands)

MPM Activities	Pricing Zone 1	Pricing Zone 2	Pricing Zone 3	Grand Total
Ballast Cleaning	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance Resurfacing	$2,641	$1,639	$5,242	$9,522
Rail Grinding	[redacted]	[redacted]	[redacted]	[redacted]
Ballast Undercutting	$1,870	$302	$4,835	$7,007
Track Formation Reconstruction	$962	$1,246	$2,426	$4,634
Turnout Steel Component Replacement	$3,582	$129	$285	$3,997
Engineering Investigations	$2,065	$384	$981	$3,430
Ballasting	$1,388	$166	$1,188	$2,742
Turnout Resurfacing	$2,232	$217	$260	$2,709
Cess & Top Drain Maintenance	$965	$0	$1,615	$2,580

MPM Activities	Pricing Zone 1	Pricing Zone 2	Pricing Zone 3	Grand Total
Turnout Grinding	$1,982	$374	$156	$2,512
Cutting/Embankment Maintenance	$10	$1,070	$270	$1,350
Top 90% MPM Expenditures	$34,091	$20,198	$19,344	$73,633

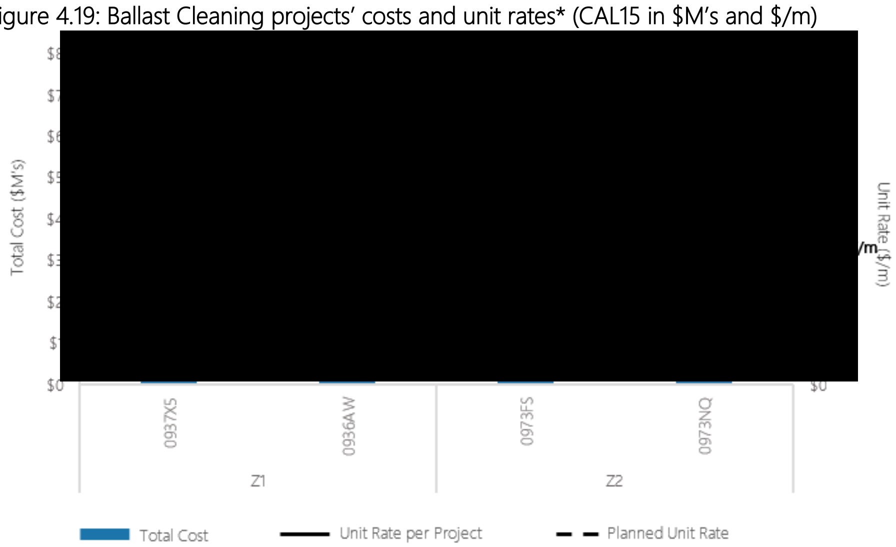
Legend:
No colouring – Neutral/Not Assessed
Green – Comparable planning cycle and unit rates
Orange – Planning Cycle Comparable/Materially higher unit rate on key projects
Red – Higher frequency planning cycles/higher unit rates

4.7.2 Ballast Cleaning (286)

The 2015 MPM program included significant ballast cleaning projects in Zone 1 on the main coal road segments adjacent to the coal export terminals in Newcastle, and in Zone 2 on the Ulan line.

Figure 4.19 compares actual total project costs and unit rates across the completed ballast cleaning projects in 2015. Planned unit rates for these projects ranged from [redacted] per metre in Zone 2 to [redacted] per metre in Zone 1.

Figure 4.19: Ballast Cleaning projects' costs and unit rates* (CAL15 in $M's and $/m)



Source: CAL15 Financials and MPM Completed Projects
**Z3 project 0964NO excluded [redacted] project cost)*

As illustrated, ballast cleaning in Zone 2 on line segment 973 delivered a scope of 38,906m at a unit rate of approximately $[redacted] per track metre, which was below plan and compares favourably with Aurizon's reported unit rates of $400 per track metre[4].

Ballast cleaning on the main coal roads in Zone 1 on line segments 936 and 937 delivered a scope of 17,264m but at much higher unit rates of $[redacted] and $[redacted] per metre respectively. Delivery of planned ballast cleaning scope of works on the main coal roads involved both major track closedowns as well as shorter aligned maintenance possessions (10-hr closedowns at night). Unit rates for these projects were high because:

[4] GHD Report to QCA on Aurizon Proposed UT5 Maintenance Expenditures – Appendix B. Actual average ballast cleaning costs in UT4 ranged from $356 to $467 per metre with an overall average of $407 per metre. Costs are in constant $FY 2015 dollars

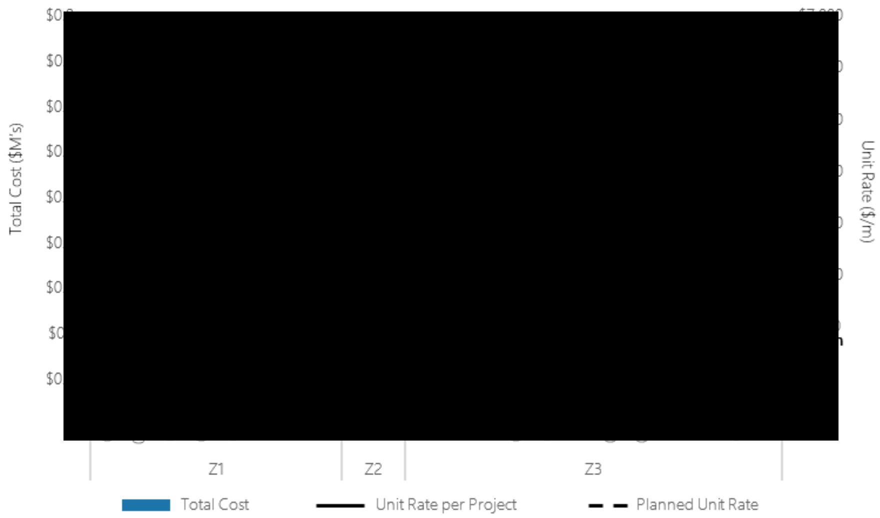
- The shorter aligned maintenance possessions, while increasing track access for maintenance, are inherently less efficient in terms of resource utilisation due to set-up time, spoil removal, tamping and the time to return track to service
- Severe weather events affected the Hunter Valley in April 2015, which resulted in significant infrastructure damage and operational disruption. This deferred the April planned possession, including ballast cleaning work, to later in 2015. Ultimately, the 0936AW project scope was reduced by 4,000m as the planned possession was cancelled; however, contracted costs of $[redacted] had been incurred resulting in a much higher unit rate.

4.7.3 Ballast Undercutting (286)

Ballast Undercutting addresses localised defects on track sections (typically less than 100m in length), and involves a small crew using an excavator and cutter bar to remove a mud-hole and/or area of highly fouled ballast. It can defer the need for full track reconditioning if performed in a timely manner.

Figure 4.20 summarises actual project costs and unit rates for 2015 ballast undercutting projects. Planned unit rates are typically $900 per metre.

Figure 4.20: CAL15 Ballast Undercutting projects' costs and unit rates* (CAL15 in $M's and $/m)



[redacted]

Source: CAL15 Financials and MPM Completed Projects
**Projects less than $100,000 have been excluded from the Graphical representation of Projects*

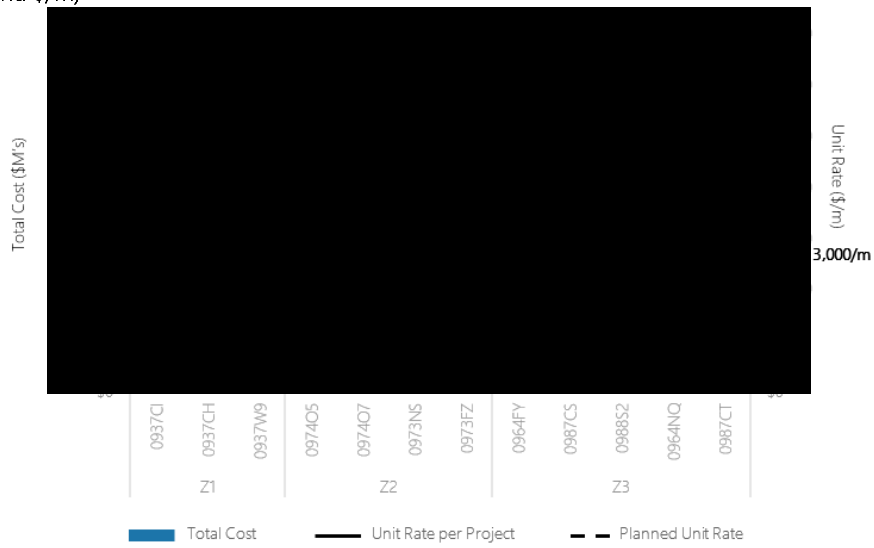
As noted in section 4.6.1, track conditions, defects and the level of TSR in Zone 3 were more challenging than experienced in Zones 1 and 2. With the introduction of 30 TAL trains in Jan 2015, the comparatively poor Zone 3 track condition resulted in significant ballast undercutting scope and cost in 2015 ($[redacted] for approximately 5,200 metres). These costs included:

- Several projects related to the 30 TAL program which had a combined scope of over 1,600 metres
- Ballast Undercutting projects 0967J9 at Boggabri 517.180 Km - 517.380 Km and Project 0987C8 (Quirindi, Hunter Valley Main North Line, 390.14 Km - 390.6 Km) that were actually track formation reconstruction work.

4.7.4 Track Formation Reconstruction (293)

Figure 4.21 summarises actual project costs and unit rates for 2015 track formation reconstruction projects. Planned unit rates per project are typically $[redacted] - $[redacted] per metre.

Figure 4.21: Track Formation Reconstruction projects' costs and unit rates* (CAL15 in $M's and $/m)



Source: CAL15 Financials and MPM Completed Projects
**Projects less than $70,000 have been excluded from the Graphical representation of Projects*

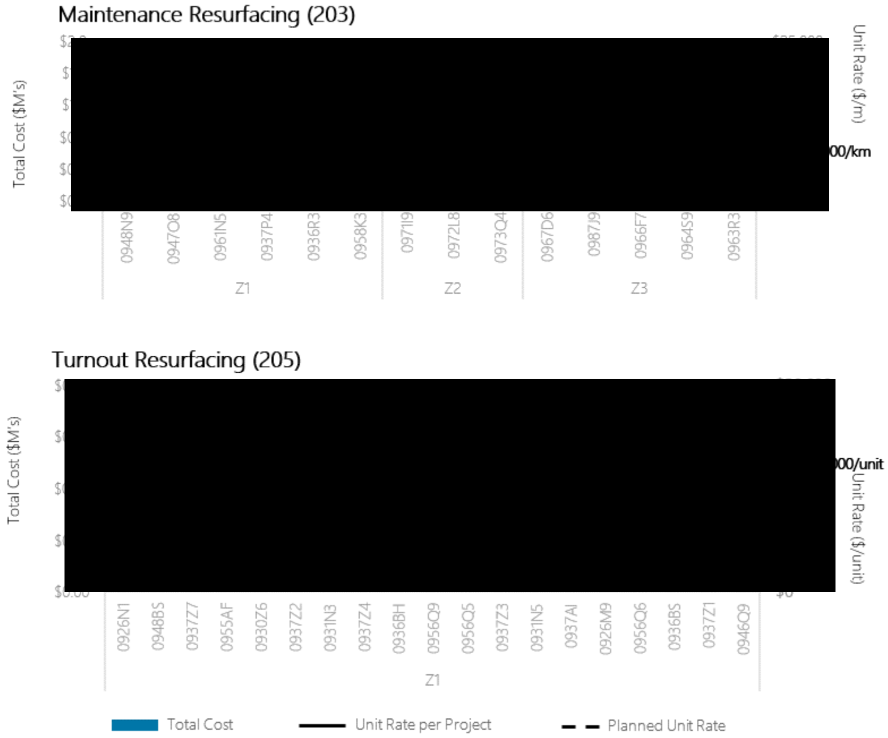
Actual track formation reconstruction unit rates averages $[redacted] - $[redacted] per track metre per project. Actual costs may have been higher due to track access restrictions, the disposal of material, and the depth of reconstruction.

4.7.5 Maintenance and Turnout Resurfacing (203 and 205)

Figure 4.22 summarises actual project costs and unit rates for 2015 maintenance and turnout resurfacing projects. Planned maintenance resurfacing unit rates range from $[redacted] to $[redacted] per Track Km, which are higher than Aurizon Network's historic resurfacing costs of $8,200 per Track Km[5]. Planned turnout resurfacing unit costs range $[redacted] to $[redacted] per turnout, which are also higher than Aurizon Network's turnout resurfacing costs of $7,000 - $9,000 per turnout.

[5] GHD Assessment of Aurizon Networks Proposed UT5 Maintenance Expenditure – Appendix C. UT4 actual costs ranged from $7,600 to $9,300 per Track Km with an average cost of $8,200 per Track Km. GHD also estimated that with high-volume machines and productive shifts that this unit rates were potentially 30% higher than optimal.

Figure 4.22: Maintenance/Turnout Resurfacing projects' costs and unit rates* (CAL15 in $M's and $/m)



Source: CAL15 Financials and MPM Completed Projects
**Projects less than $200,000 for 203 and $25,000 for 205 have been excluded from the Graphical representation of Projects*

The total actual resurfacing cost in Zone 3 (CAL15 $5.24M) was ~35% times higher than the estimated cost in the AMP (CAL15 $3.85M). Drivers of Zone 3 project costs included resurfacing planning cycles (20MGT between Murrulla and Werris Creek vs 60 - 80MGT on segments in Zone 1 and 2), increased throughput and axle loads, track conditions and differences between contractor performance rates.

As noted in section 4.5.2, the resurfacing contract strategy aimed to deliver the required resurfacing capacity, and resource-based contracts were individually negotiated with suppliers. While this delivered the required resurfacing strategy, it resulted in significant variation between resurfacing machine capabilities and supplier performance. Table 4.26 summarises cost, scope and unit rate for Zone 3 projects completed in CAL15.

Table 4.26: Zone 3 resurfacing contractor performance

Contractor[6]	Scope (Km)	Cost ($ Thousands)	Contractor Unit Rate ($/Km)
Vendor A	27	[redacted]	[redacted]
Vendor B	45	[redacted]	[redacted]
Vendor C	47	[redacted]	[redacted]
Vendor D	54	[redacted]	[redacted]
Vendor E	89	[redacted]	[redacted]
Vendor F	90	[redacted]	[redacted]

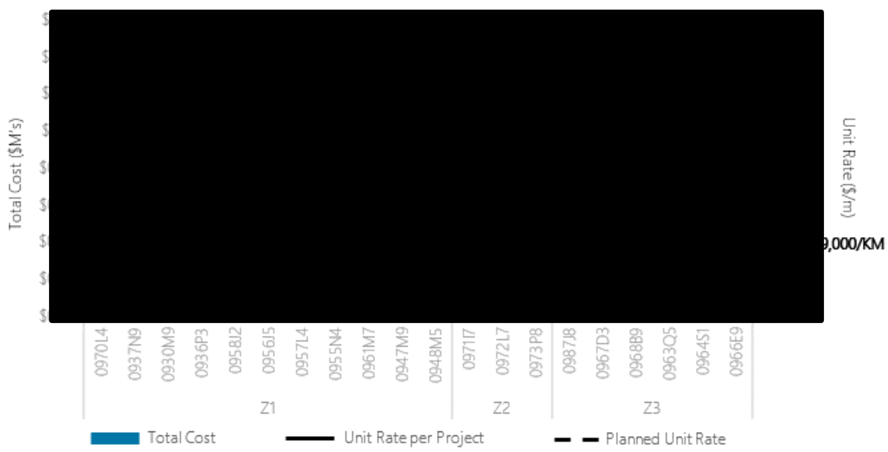
Source: CAL15 Worx and Ci Financials data

This analysis highlights significant variations in unit costs per contractor, and suggests that future sourcing strategies explore alternative delivery models to reduce unit rates given large on-going resurfacing program.

4.7.6 Rail and Turnout Grinding (171 and 172)

[redacted] provide rail-grinding services across the Hunter Valley Network. Figure 4.23 summarises actual project costs and unit rates for 2015 grinding resurfacing projects. Planned unit rates range from $[redacted] to $[redacted] per Track Km, but depend on the number of grinding passes completed per Km. Typical per pass unit rates are $[redacted] to $[redacted] per pass Km, which are consistent with Aurizon Network's forecast unit rates of $3,400 per pass Km[7]. Planned turnout grinding unit costs were approximately $3,300 per turnout.

Figure 4.23: Rail Grinding projects' costs and unit rates* (CAL15 in $M's and $/m)



Source: CAL15 Financials and MPM Completed Projects
**Projects less than $115,000 have been excluded from the Graphical representation of Projects*

Actual unit rates are reasonably consistent across projects as the majority of cost is attributed to the [redacted] rail grinding contract. Two potential exceptions exist:

- There is a high overall cost for project 0973P8. This track segment in 90 Km in length and the CAL15 scope included 135.6 Km of grinding. The scope is consistent with the planning cycles and tight radius curves on this section of track

[6] Vendor A – [redacted] Vendor B – [redacted]; Vendor C – [redacted]; Vendor D – [redacted]; Vendor E – [redacted]; Vendor F – [redacted]

[7] GHD Assessment of Aurizon Network's Proposed UT5 Maintenance Expenditure: Appendix D. For UT5 average per pass grinding unit costs were approximately $3,300 per pass Km. Turnout grinding cost were $5,100 per turnout.

- The high unit rate cost for project 0930M9 is due to its location at the port where access is more restricted.

4.7.7 Turnout Steel Component Replacement (187)

Wear and grinding from use affects turnout steel components. Replacement of worn and defective steel rail components reduces the risk of component failure and derailment. Field staff identify turnout steel component replacement requirements based on condition assessments.

In CAL15, the majority of work occurred in Zone 1 as there are a higher number of turnouts and associated tonnage compared to the rest of the network. In Zone 1, ARTC replaced 97 turnout steel components in CAL15 at an average cost of $[redacted] per replacement. The number of component replacements reflect the higher level of turnouts in Zone 1. Unit replacement costs were also higher than average costs in Zone 2 and 3 potentially due to access and more complex turnouts and scope of replacements in this zone. Main cost drivers for turnout component replacements were component costs (53% of total project cost) and contract materials and services (47% of total project cost), which included a mix of materials, plant hire and contractors.

4.7.8 Cess and Top Drain Maintenance (281)

Drainage maintenance is an efficient and effective way to protect the track formation from water inundation, and includes establishment of profile and grade and path for surface water to leave the track, reinstating existing surface drains, and removal of vegetation and sediment build up in established drain profiles. Forecast drainage maintenance activities are planned on a 5-year cycle, and are ideally aligned to full ballast cleaning or shoulder ballast-cleaning activities. As these activities can generate spoil material that fouls the side drains, alignment of drainage maintenance provides a complete drainage solution. Drainage requirements also include priority requirements of area managers based on track condition assessments.

In CAL15, Cess and Top Drainage work was concentrated in Zone 1 and Zone 3. Significant works were completed in Zone 3 to address localised flooding in low-lying sections. In addition, the older civil earthworks in Zone 3 have narrow cuttings and poorly constructed drainage pathways so drainage more critical, and significant work (21 Km) was completed on segment 963.

4.7.9 Observations and Findings

- Consistent Planned Unit Rates: ARTC planned and actual unit cost rates for key MPM activities, i.e., ballast cleaning, resurfacing and grinding, are consistent with industry norms. Consequently, the cost of most MPM projects completed in 2015 were efficient.
- Some Variances Exist at the Project Level: some exceptions exist in the 2015 MPM program where actual costs and unit rates are higher than planned. These are attributed to increased scope of works, weather-related impacts, and delivery impacts.

5 Summary and Insights

This report has provided a third party review of ARTC's Opex and maintenance expenditure in relation to the Hunter Valley Coal Network for CAL15. The review has considered the efficiency of the costs, taking into account the operating context of the Hunter Valley Coal Network.

Overall, we have concluded that in the context of the operating environment leading up to and including CAL15, ARTC's Opex and maintenance costs appear to be efficient relative to peers within the rail industry. It should be noted that the nature of the Hunter Valley Coal Network and the associated operating conditions result in scarcity of like-for-like comparators for all costs for ARTC, both domestically and internationally. There is also limited publicly available cost information, particularly in relation to the heavy haul networks that are privately owned, due to commercial sensitivity of the information. The evaluation of efficiency for some cost categories has therefore been limited by the availability of data.

The review considered the two elements of ARTC's operating expenditure:

- Corporate overhead costs (Corporate Overheads)
- Operating, administration and indirect maintenance costs (Business Unit Management and Network Control).

CAL15 Opex costs have increased over CAL14. Particularly for Business Unit Management, this reflects the reallocation of FTEs following the 2014 Transformation and Growth Project

The review of ARTC's Corporate Overhead costs found that they were efficient when benchmarked against rail operators and a cross industry peer group. It was noted that:

- While costs have increased, ARTC's overhead allocation on a percentage of revenue basis is efficient compared to its peers
- When benchmarked against a cross-industry peer group, a subset of ARTC's overhead costs, namely, Finance, HR, Property, Legal and IT costs were also found to be efficient.

The review of ARTC's Network Control costs found that they are comparable to the costs of its closest peer, Aurizon Network.

Due to limited publicly available information, Business Unit Management costs could not be benchmarked.

Taking into account ARTC's commercial, operational and technical constraints, ARTC's maintenance expenditure was found to be efficient and consistent with external benchmarks on a cost per GTK basis. ARTC's asset management planning practices are consistent, at a high-level, with general industry approaches and practices. The maintenance program delivered required network quality and reliability performance. In particular, we observed that:

- Key CAL15 maintenance activity expenditures were reflective of industry norms, that is, planning guidelines and unit rates were consistent with industry approaches
- Overall maintenance expenditures appear consistent with external benchmarks on a cost per GTK basis as well as on a cost per net tonne basis.

Bottom-up analysis of key MPM activities and projects noted some areas where costs were higher than we would have expected. On further investigation these costs reflected either increased scope of work, weather related impacts or the delivery arrangements.

We note that the following network and operating characteristics have impacted on the level of the Opex and maintenance costs incurred in CAL15 on the Hunter Valley Coal Network:

- The majority of the Hunter Valley Coal Network was not purpose built for heavy haul traffic – the network has evolved on an earthworks formation from the early 1900's, generating additional maintenance activity and costs relative to a newer purpose built heavy axle load network
- The Hunter Valley Coal Network is a mixed use network accommodating heavy coal freight services, non coal freight and local metropolitan and regional passenger services – it is therefore challenging to fully optimise for export coal operations
- There is a high level of interdependency within assets deployed in the Hunter Valley Coal Chain including the Hunter Valley Coal Network, and coordination is required to maximise the volume of coal transported through the coal chain, at minimum total logistics cost
- Customer expectations regarding the operation and management of the network drive decisions on operating and maintenance expenditure.

Finally, CAL15 was year of transition for both ARTC and the market with implementation of the Transformation and Growth Project in the organisation and continued pressure on costs as a result of coal price volatility. Given the transition within ARTC and the impact of market conditions on ARTC's operations, CAL15 would need to be normalised if it was to be used as a base year for analysis going forward.

Post 2015, ARTC has undertaken a number of improvement initiatives including:

- Increased focus on conditions based maintenance
- Increased transparency of available data in order to assess network performance
- Leveraging technology to improve operations and decision making
- Revision of cost allocators to ensure that they are more reflective of the underlying data.

Moving forward, these improvements will alter comparisons with historical costs.

Looking forward, ARTC has indicated that it will continue to focus on customer requirements and seek to actively manage costs within the constraint of maximising access and balancing risk. While the focus of this review is the efficiency of the Opex and maintenance costs for CAL15, the process has identified areas that we believe ARTC may wish to explore as part of their continuous improvement program. To continue to deliver capacity and reliability enhancements and value to their customers and shareholders, ARTC could consider:

- Expand use of condition-based and predictive analytics to drive further efficiency, particularly in common MPM activities such as resurfacing
- Develop wider and more transparent understanding of Hunter Valley asset management strategy, objectives, performance targets and trade-offs through a consolidated, documented strategy, e.g. a Strategic AMP Enhance current AMP structure and planning processes to extend validated project scopes beyond upcoming financial year, apply consistent project prioritisation approaches across MPM activities and projects, and establish project structures that better match delivery strategies, e.g. possession timing and contracts
- Improvements in work management processes, systems and data to better align project and work completion data to facilitate comparison of planned and actual work scopes and costs, ensure more complete, consistent capture of work scope information, and ensure more consistent and complete completion and capture of asset-level work and cost data.

Appendix 1

APPENDIX A

Description and Mapping of Opex Activities

Purpose: Provide a listing and detailed descriptions of opex activities (at the delivery unit level) that comprise Network Control, Business Unit Management and Corporate Overheads for 2015.

The table below (Table 2) provides a detailed description of opex activities for the respective delivery units in calendar year 2015. In the following table each delivery unit is mapped to a function and a compliance return classification. Please note that the table only includes opex activities associated with the Hunter Valley Access Undertaking (HVAU).

Table 2: Description and Mapping of Key Opex Activities to Compliance Return

Function	Delivery Unit		Description of Key Opex Activities
Network Control			
HV Customer & Operations (HVC&C)	OPHV	Operations HV	This relates to network train control operations at the Network Control Centre North based in Broadmeadow. The Network Control Centre controls the movement of rail traffic flow in the Hunter Valley Network. The Network Control Centre authorises access to track for maintenance during live run operations. The staff at the network control centre are accountable for the application and monitoring of safe working rules approved under the Office of the National Rail Safety Regulator.
Business Unit Management			
HV Customer & Operations (HVC&C)	CSOHV	Customer Service & Operations Management HV	Activities in this delivery unit comprise customer service and operations management such as managing the HV logistics centre, customer contracts, revenue, and non-coal business development. Note, non-coal business development costs do not form part of the compliance return.
HV Asset Management Delivery (HVDEL)	DELHV	Delivery HV	This includes asset delivery (routine, preventative and breakdown maintenance) and signalling overhead activities in the HV network including management of maintenance, safety, Work, Health and Safety (WHS), signalling and systems. Note, actual segment specific maintenance costs are included as part of MPM and RCRM.
	HV	Asset Maintenance HV	Costs incurred for administering provisioning centres, wayside and maintenance support teams.
	HV Other	HV Pricing Zones 1, 2, 3	This includes provisioning centre costs, trackside equipment and line segment specific operating costs not included in the above, but coal related.

HV Asset Management Development (HVDEV)	CWKHV	Corridor Works HV	Support activities associated with corridor works and project management in the HV network. This includes the planning, management, coordination and execution of the network's major closedowns undertaken in conjunction with all other coal chain service providers and customers.
	ENGHV	Engineering HV	Activities related to works planning, schedule development, standards compliance, and the engineering design component for corridor projects and track reliability. This includes both the annual and the long term (10 year) asset plan.
	MPHV	Major Projects HV	This includes activities associated with major projects (and all capacity related infrastructure projects) in the HV network including design, property management and project management.
HV Management & Support (HVMGT)	MGTHV	Management & Support HV	This includes activities related to track corridor management and finance support for the HV network.
Interstate Customer & Commercial (INTCC)	ENGPERF	Engineering Performance Management (Interstate) (HV Portion)	Activities related to engineering performance management related to track and signalling. Note that only the costs allocated to HV are included.
	OPSP	Operations Planning	This unit is directly responsible for train planning operations (interstate) and managing the movement of rail traffic on standard gauge track in New South Wales, South Australia, Victoria and Western Australia. Note, only the costs allocated to HV are included.
Corporate Overheads			
Corporate Affairs (CORPA)	HRSUP	HR Support	This includes activities related to HR including recruitment, contract hiring, compensation management, industrial relations, people and performance management.
	MEDIA	Media	This includes managing the corporate media office. Responsibilities include management of the ARTC's reputation in the community through to responsibility over community engagement, sponsorship, and other stakeholder engagements.
Corporate Services & Safety (ESSVC)	COMMS	Communications	This includes track related communications costs, including In-cab Communications Equipment radio.
	ENGSVCS	Engineering Services	Engineering Services involve national rules, configuration and technical standards management. The activities include providing engineering advice on standards, procedures, and rules to underpin safety across the network.
	ENVIRON	Environment	Activities related to implementing and auditing the environmental governance, regulatory, procedural and training frameworks that support the business's commitment to No Harm as it relates to environmental sustainability.

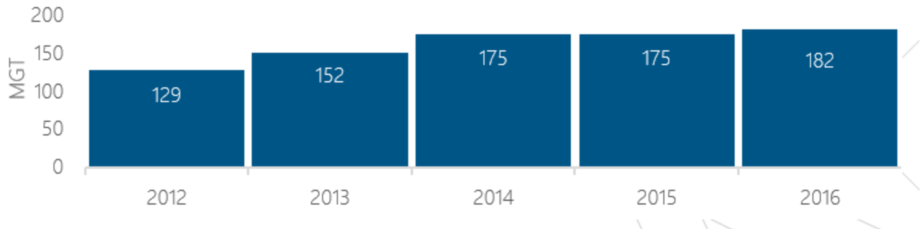
	ESMGT	Enterprise Services Management	Activities associated with corporate management of engineering services, environment, information and communication technology services, IT applications, procurement and contracts, corporate safety, corporate risk and corporate WHS.
	ITINFRA	IT Infrastructure	IT Infrastructure includes services such as management and maintenance of servers, network and data centres.
	ITSYSTEM	IT Systems	This delivery unit includes activities related to management, maintenance and enhancement of IT applications and software.
	PROC	Procurement & Contracts	This team manages the end-to-end purchase of goods and services through effective systems and proactive supplier relationships for fleet; inventory; supply and contract services activities.
	PROP	Property	The property team provides services and advice to the business units relating to ARTC's property portfolio of leased and licenced land, buildings and infrastructure. This includes advice in relation to land boundaries and ownership.
	R&C	Risk and Compliance	This is the Corporate Safety team and it is responsible for managing ARTC's regulatory and industry relationships with a specific focus on rail safety, accreditation and legislative compliance. The activities include providing advice and data on significant rail safety incidents and investigations, overseeing the management of ARTC's safety management system and coordination of the internal safety audit program.
	RISK	Corporate Risk Management	The risk team is responsible for identifying, managing and monitoring risks to people, property, the environment and effectively meeting the organisational objectives.
	WHS	Corporate Work Health & Safety	This delivery unit includes activities related to Corporate WHS. The team is responsible for the overall strategy for WHS.
Executive (EXECU)	BOARD	BOARD	The costs associated with this unit are related to the Chairman and Board (Company Directors).
	CEO	CEO	This relates to corporate and executive costs including direct project and general HR costs that are directly attributable to the Chief Executive Officer.
	INSURANCE	Corporate Insurance	This records corporate insurance costs and is a shared service to the business.
	INTAUDIT	Internal Audit	The internal audit team provides assurance to the Board and senior management on business processes and controls to effectively manage ARTC's key non-safety risks.
	LEGAL	General Counsel	This team is responsible for the legal framework and provides legal services to the business.

	SAFETY	Records Corporate Safety	This team is responsible for ensuring regulatory compliance on rail safety. Activities include recording corporate safety costs and managing ARTC's safety, compliance and response on rail safety.
Finance (FINAN)	ACC	Corporate Accounting	This delivery unit includes activities related to statutory and technical accounting, taxation, fixed assets, payroll, accounts payable and accounts receivable.
	FINSERV	Corporate Financial Services	Corporate financial services include budget and corporate planning, forecasting, external and internal reporting requirements, and financial systems administration.
	TREASURY	Corporate Treasury	This delivery unit undertakes treasury related activities such as managing the general liquidity of the business and the management of long, medium and short term treasury funds.
Forecast Adjustment (FORAD)	FORADJ	Forecast Adjustment	This includes costs related to defined benefit fund reassessment, Employee Leave Entitlements provision reassessment and accrual of consultant and other sundry expenses at 31 December 2015.
HV Asset Management Development (HVDEV)	PLANT	Plant Department	This includes heavy plant management, including shoulder ballast cleaner management.
	RGC	Rail Grinding Contract	The activities under this delivery unit include rail grinding and ultrasonic testing contract management.
Interstate Asset Management (INTAM)	TMS	Track Monitoring Services	This delivery unit is responsible for supplying accurate, reliable and repeatable track condition monitoring information from ARTC's Track Recording Vehicle to assist with reporting, trending and planning of track maintenance works.
Strategy (STRAT)	COML	Commercial Management & Industry Support	The commercial management team provides support on strategic planning, economic regulation and infrastructure capacity.

Appendix 2

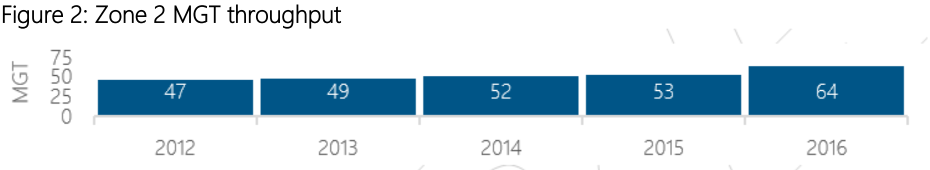
Throughput

Figure 1: Zone 1 MGT throughput



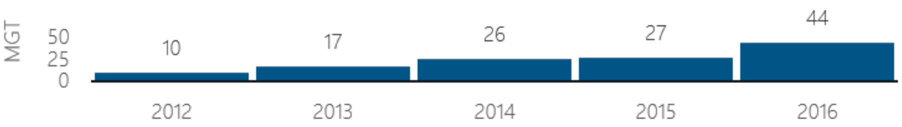
Source: ARTC

Figure 2: Zone 2 MGT throughput



Source: ARTC

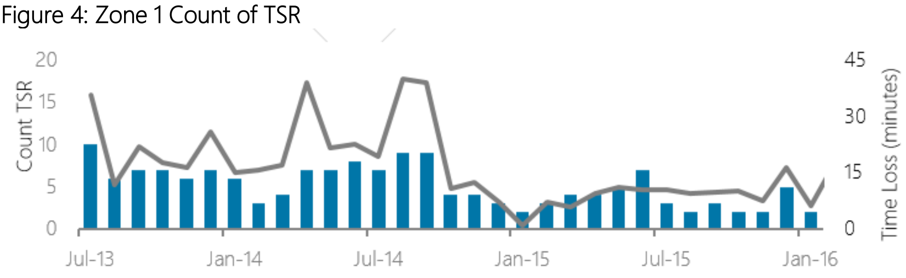
Figure 3: Zone 3 MGT throughput



Source: ARTC

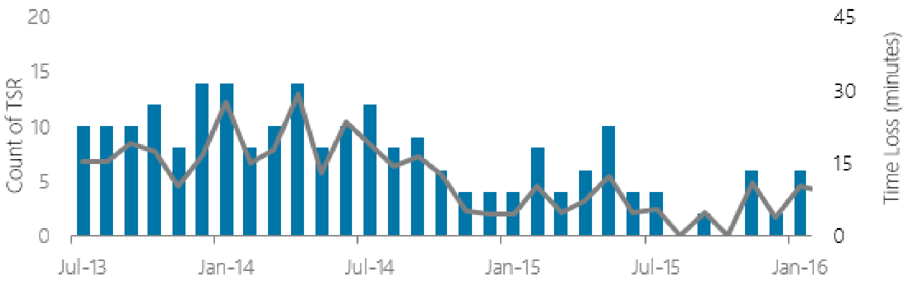
Temporary Speed Losses

Figure 4: Zone 1 Count of TSR



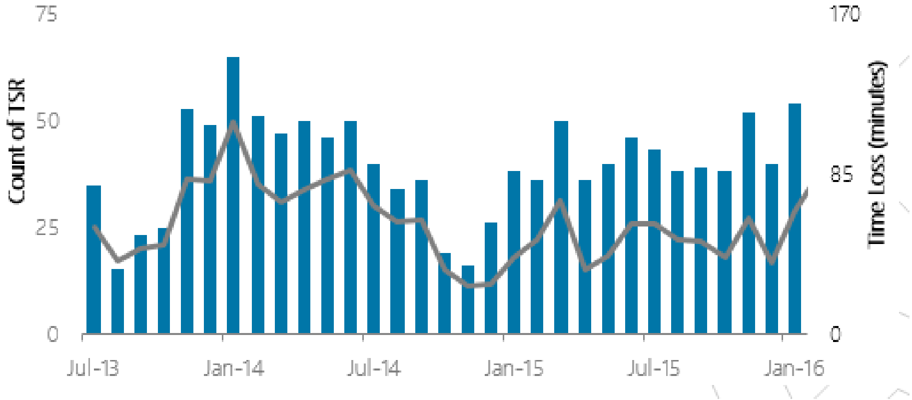
Source: ARTC

Figure 5: Zone 2 Count of TSR



Source: ARTC

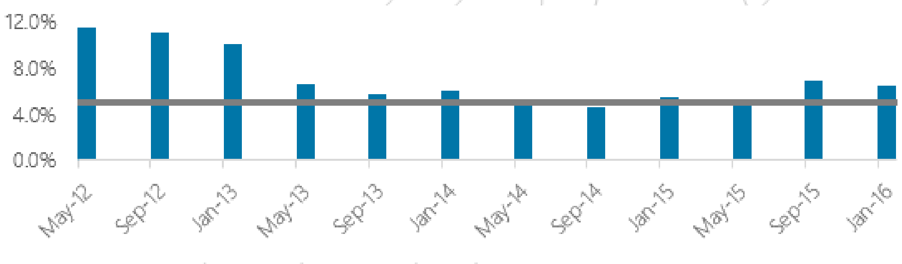
Figure 6: Zone 3 Count of TSR



Source: ARTC

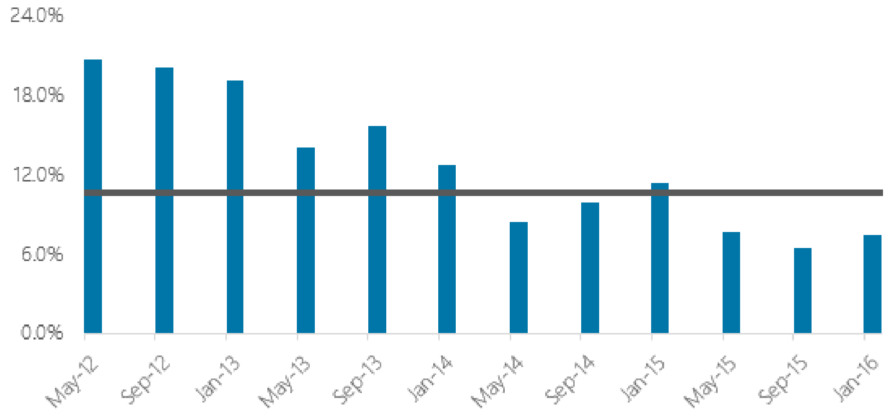
Track Quality

Figure 7: Zone 1 % Track with TMS >300 (KPI Before Jan-16: 5.1%, After: 6.0%)



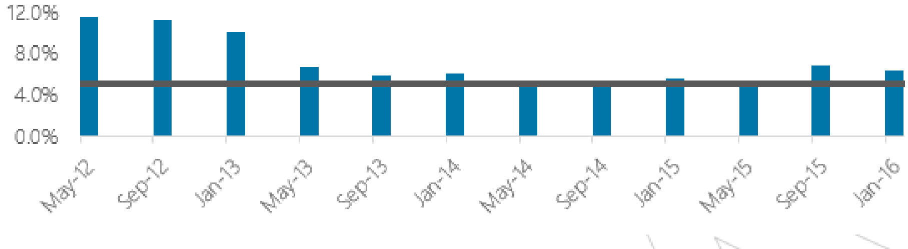
Source: ARTC

Figure 8: Zone 2 % Track with TMS >300 (KPI: 10.6%)



Source: ARTC

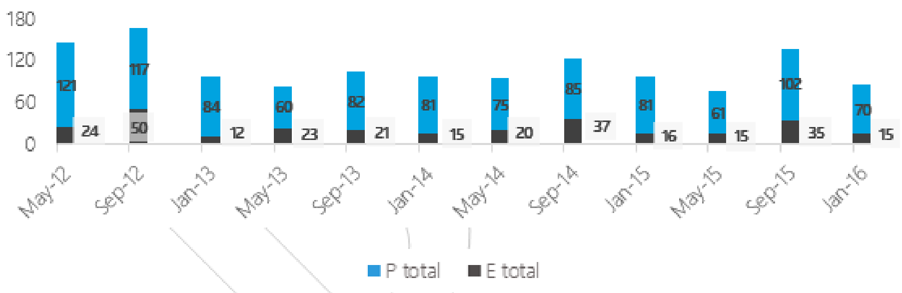
Figure 9: Zone 3 % Track with TMS >300 (KPI Before Jan-16: 5.1%, After: KPI: 19.6%)



Source: ARTC

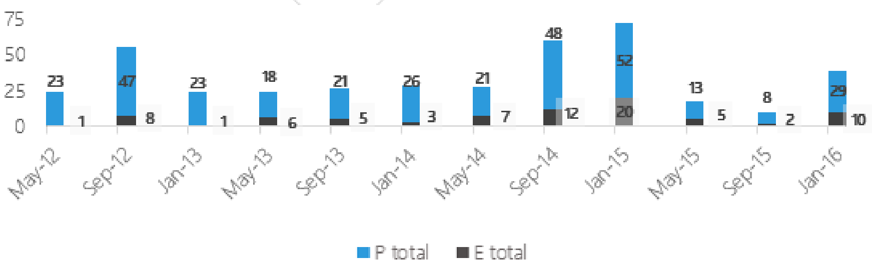
Track Defects

Figure 10: Zone 1 # Reported AK Car Track Defects



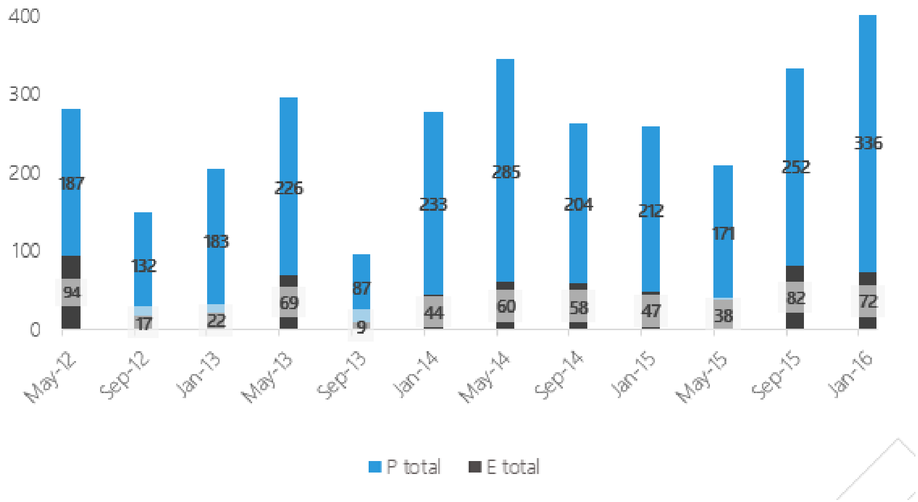
Source: ARTC

Figure 11: Zone 2 # Reported AK Car Track Defects



Source: ARTC

Figure 12: Zone 3 # Reported AK Car Track Defects



Source: ARTC

Limitations of Our Work

General Use Restriction

This report is prepared solely for the internal use of Australian Rail Track Corporation Limited. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose set out in our engagement letter dated 23 May 2018. You should not refer to or use our name or the advice for any other purpose.