ASSET MANAGEMENT CONTEXT

HUNTER VALLEY

2024

Australian Rail Track Corporation
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1 Introduction

1.1 Purpose

This document is an Appendix to and provides context and detailed information for both the Annual Maintenance Plan and Sustaining Capital submissions.

It includes:

- Contextual information on the network and its usage to enable an understanding of the historical and operational characteristics, safety and lease requirements, as well as the individual features that are unique to each Pricing Zone;
- Explanation of the treatment of maintenance costs under the HVAU; and
- An overview of ARTC's Asset Management Framework and supporting processes that guide ARTC's asset strategies, scope and budget development.

1.2 Regulatory Context

ARTC has an access undertaking in place for the Coal Network with the Australian Competition and Consumer Commission (**ACCC**) pursuant to Part IIIA of the *Competition and Consumer Act 2010* (Cth) known as the Hunter Valley Access Undertaking (**HVAU**). The term of this undertaking is 2 June 2021 to 31 December 2026 and it stipulates the requirements for ARTC's customer engagement for its maintenance and capital works programs.

1.2.1 Maintenance Plan

As per section 9.11 of the HVAU, the Maintenance Plan will include:

- An overview of ARTC's 10-year asset management strategy, the timing of cyclical activities, maintenance practices and approach to procuring suppliers for maintenance work;
- Indicative maintenance budget for the planned annual works program for each Pricing Zone for each calendar year;
- For the top 10 maintenance activities by cost in each Pricing Zone (**Key Maintenance Activities**):
    - Asset strategies;
    - The scope of work and key deliverables in the planned annual works program; and
    - Indicative budget.
- The proposed structure of maintenance possessions.

By 31 August of each year, ARTC will consult with the RCG on the Maintenance Plan for the following calendar year before publishing the standard access charges. During each calendar year, ARTC will provide to the RCG:

- A quarterly report of actual and forecast maintenance costs;
- An update on scope completion and key deliverables after major closedowns; and
- Updates on operational performance of the Network.

The ACCC will continue to review the efficiency of ARTC's actual maintenance costs as part of the annual compliance assessment process.

1.2.2 Capital Works

There are two categories of capital projects:

1. Expansion capital capacity projects; and
2. Sustaining capital projects

As part of its obligations under the HVAU, ARTC is required to engage with the relevant stakeholders regarding the capital expenditure program for the Hunter Valley rail network.

Under Section 9.1 of the HVAU, the objectives of the capital consultation process are to:

- Provide the forum for the applicable RCG members to participate in the management and decision-making process and to endorse Expansion and Sustaining Capital as prudent.
- Inform the RCG of any additional capacity requirements and investment strategies.
- Provide a forum for the RCG to participate and provide input into the alignment of projects to provide additional capacity.
- In relation to projects in Pricing Zone 1, endorse Capital allocations for Expansion Capital and to be informed of the proposed Capital Allocations for Sustaining Capital.

For all capital projects, a submission is provided for review and endorsement by the RCG. Expansion projects and major sustaining capital renewal projects are submitted individually, while the annual sustaining capital works program is submitted at a collective pricing zone level in April each year.

For both expansion and sustaining capital projects, ARTC provides quarterly progress update reports to inform the RCG of the project performance against cost, scope and timing.

Where forecast costs exceed 10% of the endorsed value or exceed an endorsed contingency value and or there is a material variance from the endorsed project schedule, ARTC will seek the endorsement of the RCG for the variation.

However, ARTC utilises its internal governance and delegation processes to manage variability for sustaining capital at an individual project level. This includes allowing underspends from approved budgets at a project-by-project level to be utilised to fund overspends on approved budgets at a project-by-project level, with variances reported to the RCG. This internal variation process has been communicated to the RCG.

2 Hunter Valley Coal Network Overview

2.1 Location

The Coal Network is situated on the east coast of Australia and extends north west from the Port of Newcastle to the Gunnedah Basin and to the Ulan region. The Coal Network is divided into three Pricing Zones, as illustrated in Figure 2-*1* below. Each Pricing Zone has differing network configurations, cost profiles and volumes/traffic, as expanded on in subsequent sections. The boundaries for these coal zones comprise of:

- Zone 1 – Port to Muswellbrook/Bengalla;
- Zone 2 – Bengalla to Ulan; and
- Zone 3 – Muswellbrook to Turrawan.

Figure 2-1 shows the geographical layout of the Coal Network and the relative size of each zone.

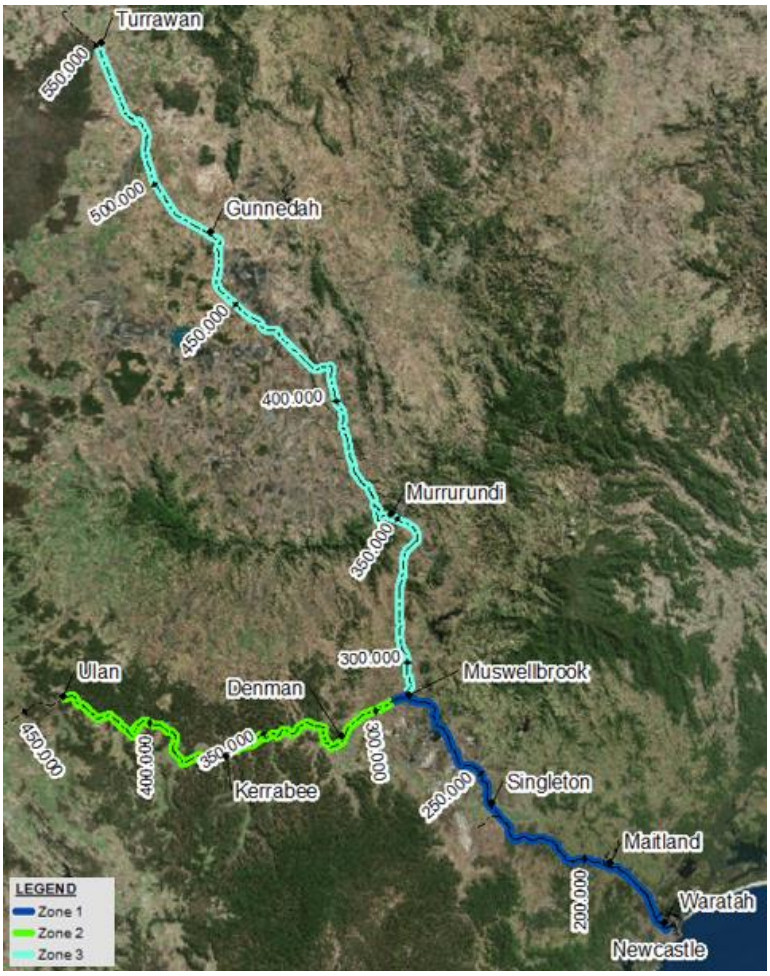


Figure 2-1: Pricing Zones 1, 2 and 3

2.2 Mixed Use Network

Up to 230 train services per day are operated on the Coal Network comprising heavy haul coal services, mixed freight and local and regional passenger services. The different types of train services on the network have different performance characteristics (including axle loads and allowable speeds) and pathing arrangements. The network has experienced 172 million net tonnes of coal at its peak.

Pricing Zones 1 and 3 service coal, non-coal freight and passenger services, whereas Pricing Zone 2 predominantly supports coal trains with small numbers of non-coal freight services. There are dedicated lines for coal and non-coal between Maitland and Newcastle, with some cross usage during periods of disruption.

The mixed use of the network creates additional complexity, meaning the network infrastructure cannot be fully optimised for heavy haul coal services alone. Asset standards must account for both higher speed and lower weight trains as well as the heavy-haul coal fleet. This affects both the maintenance and possessions approach.

2.3 Coal Customers

ARTC's coal customers in the Hunter Valley are coal producers and domestic energy suppliers.

Figure 2-2 shows the location of the mine rail loading points, and the export and domestic unloading points adjacent to ARTC's infrastructure in the Hunter Valley.

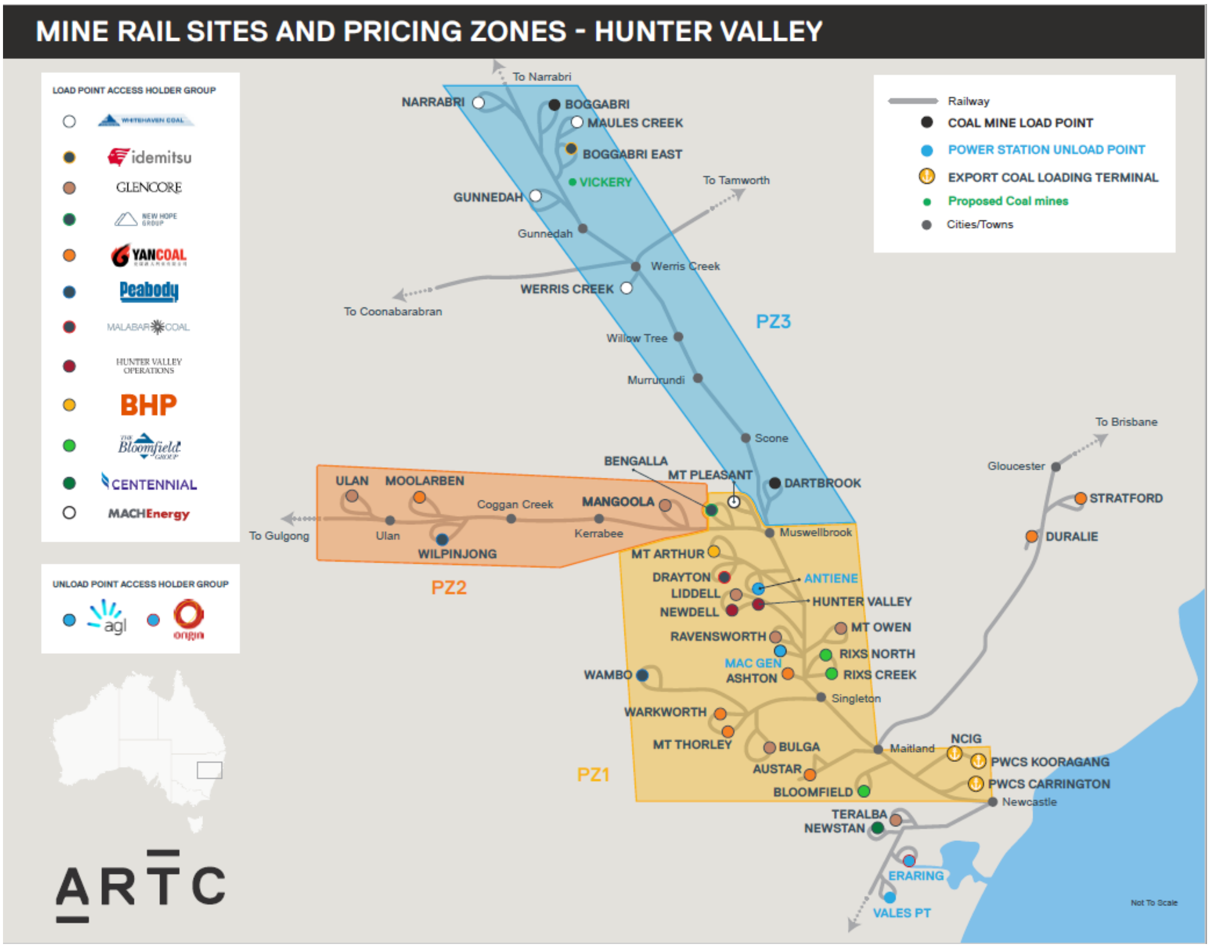


Figure 2-2: ARTC's Coal Customers in the Hunter Valley

2.4 Hunter Valley Coal Chain

The Coal Network is an integral component of the world's largest export coal chain and is the arterial route between the coal producers' mines, the terminals at the Port of Newcastle and to the domestic power station unload points[1].

Figure 2-3 below shows the core elements of the Hunter Valley Coal Chain:

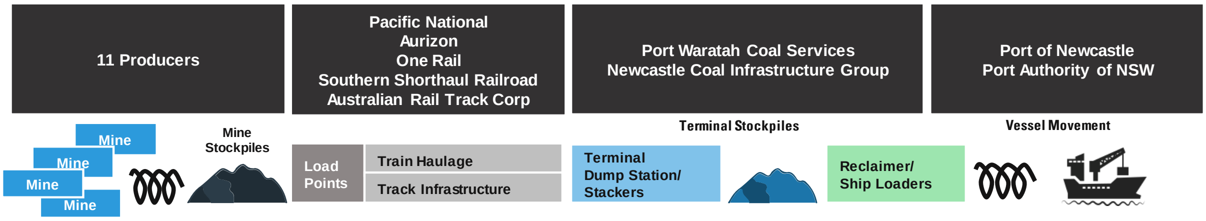


Figure 2-3: Core Elements of the Hunter Valley Coal Chain

Given the complex multi-use nature of the Coal Network and a recognition that track capacity without corresponding system capacity provides no benefit, the coal chain is managed as an integrated supply chain.

The Hunter Valley Coal Chain Coordinator (HVCCC) performs a coordinating role with established mechanisms for aligning long-term capacity planning, as well as the annual, medium-term and day-to-day maintenance planning across the service providers. The current HVCCC members include all the key service providers and all coal producers in the Hunter Valley.

Photo: Port of Newcastle – Rail, Coal Loader and Port Interface

[1] For further explanation of ARTC's critical role in the Hunter Valley Coal Chain: https://www.accc.gov.au/system/files/ARTC%20Submission%20to%20ACCC%20Opex%20Review%20-%20Appendix%20B%20-%20Deloitte.pdf

2.5 Network Configuration

The Hunter Valley Rail Network configuration comprises the following levels:

- Level 1 – Asset System (HV Rail Network)
- Level 2 – Asset Sub-System 1 (Rail Corridors)
- Level 3 – Asset Sub-System 2 (Line Segments)
- Level 4 – Asset Class (Functional Asset Group)
- Level 5 – Asset Type (Individual Asset/Equipment)

In some cases, the asset is further broken down to an associated equipment (asset component) level and is identified in the Enterprise Asset Management System Asset (Equipment) Register.

The Asset Classification System for Hunter Valley is as follows:

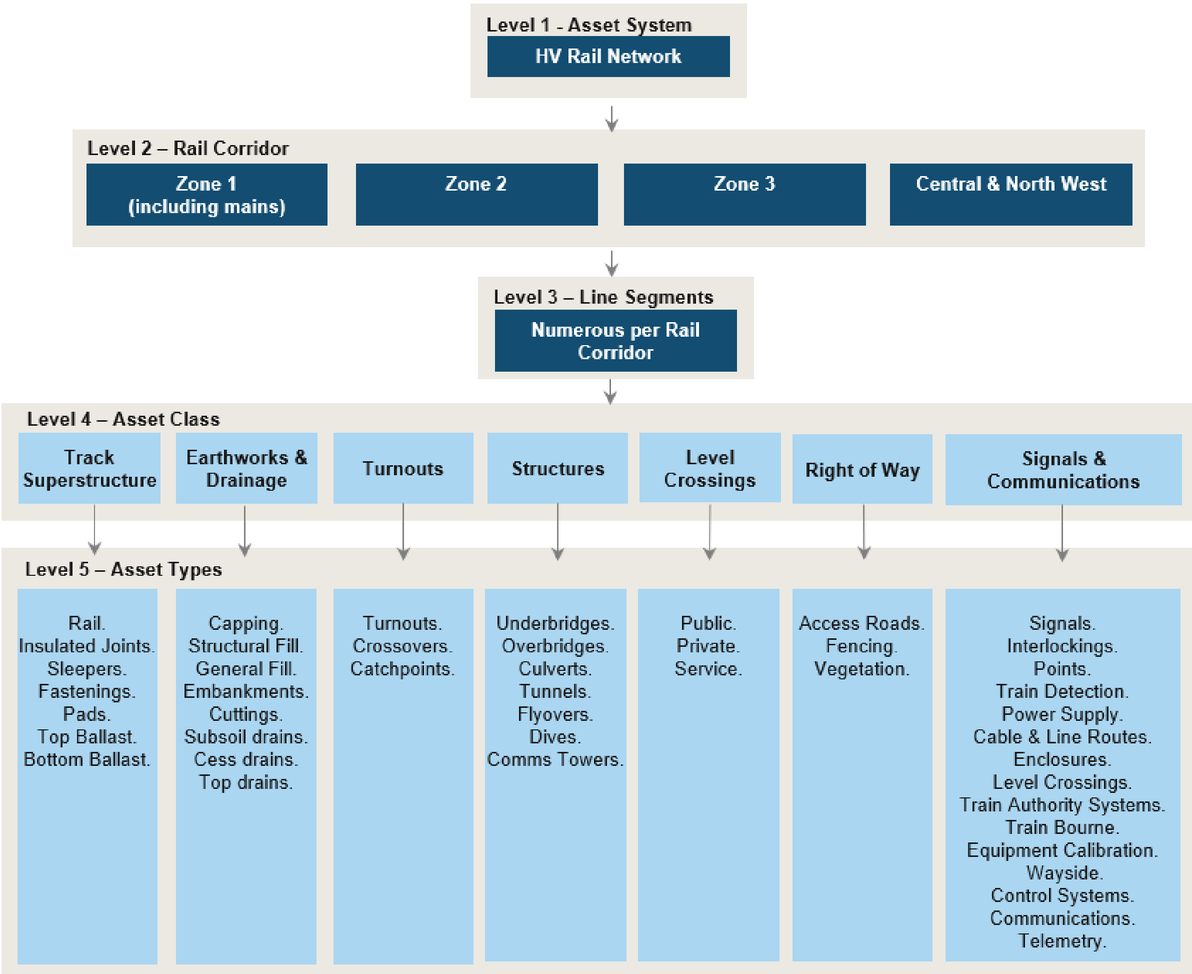


Figure 2-4: Asset Classification System

Note: The Central and North West and Mains are not a part of the Hunter Valley Coal Network as defined in the HVAU.

The business and operating requirements of each rail corridor must be considered in the development of Asset Class Strategies and the subordinate Activity Strategies.

Table 1 provides an overview of the key configuration details for each of the Rail Corridors (Pricing Zones), how they are utilised and the connectivity with different corridors and interfaces.

Table 1: Overview of Zonal Configuration and Key Differences

	Zone 1	Zone 2	Zone 3
COVERAGE	**Newcastle to Muswellbrook (Bengalla)** 333 mainline track kilometres 130 corridor length (route kilometres)	**Muswellbrook (Bengalla) to Ulan** 142 mainline track kilometres 142 corridor length (route kilometres)	**Muswellbrook and Turrawan** 261 mainline track kilometres 261 corridor length (route kilometres)
PEAK ANNUAL TONNAGE	240MGT	80MGT	35MGT
TRACK CONFIGURATION	**Newcastle to Maitland:** Quad track comprising dedicated double track 'coal lines' and shared double track non-coal "mainlines". **Maitland to Muswellbrook:** A shared (coal, freight, agriculture and passenger) double track line with some significant stretches of third track. **Muswellbrook to Bengalla:** A shared (coal and freight) single line with passing loops.	**Bengalla to Ulan:** A shared (coal and freight) single line with passing loops.	**Muswellbrook and Turrawan:** A shared (coal, freight, agriculture and passenger) single line with passing loops.
INTEROPERABILITY	**Kooragang Island and Port Waratah:** Multiple coal and non-coal tracks provide connectivity to port infrastructure. **Islington Junction (Newcastle) and North Coast Junction (Telarah)** provide linkage to the NSW Sydney Trains and ARTC Interstate Networks respectively (where coal load and unload points are also situated). **Multiple mainline junctions** provide linkage to private mine rail loops across the length of the corridor.	**The Ulan Line** provides linkage to the ARTC Central and North West corridor and to Zone 1 export and domestic unload points. **Multiple mainline junctions** provide linkage to private mine rail loops across the length of the corridor.	**Turrawan** provides linkage to the ARTC Central and North West corridor and to Zone 1 export and domestic unload points. **Werris Creek** provides linkage to the ARTC Central and North West corridor and to the NSW Trains managed Country Regional Network (CRN). **Multiple mainline junctions** provide linkage to private mine rail loops across the length of the corridor.

2.6 Asset Population

In addition to the zonal characteristics in Table 1, each zone has varying numbers of assets that require maintenance. The table below provides an overview of the track and civil asset quantities. Additionally, numerous signalling and communications assets also support the whole rail network.

Table 2: Hunter Valley Coal Network, Track and Civil Asset Quantities 2024

Asset Type	Zone 1	Zone 2	Zone 3
Track Assets (in service)			
Main line (km)	334	142	261
Grade > 1in100 (km)	33 (10% of Z1)	60 (42% of Z2)	66 (25% of Z3)
Loop track (km)	9	23	37
Sidings (km)	13	3	25
Yard (km)	17	0	4
Crossover (km)	5	0	1
Individual Assets (in service)			
Underbridge (concrete)	48	6	102
Underbridge (steel)	9	10	9
Overbridge	7	2	1
Footbridge	3	0	1
Culvert	220	472	395
Communication Towers	11	15	10
Level Crossing (public)	8	25	58
Level Crossing (private)	9	66	31
Level Crossing (service)	13	2	3
Tunnel (qty)	0	4 (total 3,492m)	1 (513m)
Turnouts (mainline only)	172	33	96
Turnouts (non-mainline)	35	1	49

2.7 Historical Legacy (Age and Progressive Development)

The Coal Network was not originally purpose built for its current heavy haul coal traffic. Since the original construction in the 1850's, it has endured an evolution which has seen its purpose grow from a passenger and light axle load freight network, to a mixed traffic heavy axle load network. Progressive capitally efficient expansion and upgrades have occurred in line with coal demand resulting in the network becoming an integral part of the world's largest coal export supply chain.

While the Coal Network has seen significant upgrades to the track superstructure and signalling asset classes since its original construction, the network is still largely dependent upon the original track substructure. The Coal Network is built on a track alignment with steep grades and tight radius geometry necessary to traverse the challenging terrain at numerous locations. Due to the varying characteristics across its corridors, the maintenance approach required for different parts of the network also varies.

Figure 2-5 shows the development of the Hunter Valley Coal Network since it was first built and further detail for the configuration of each zone is provided below.

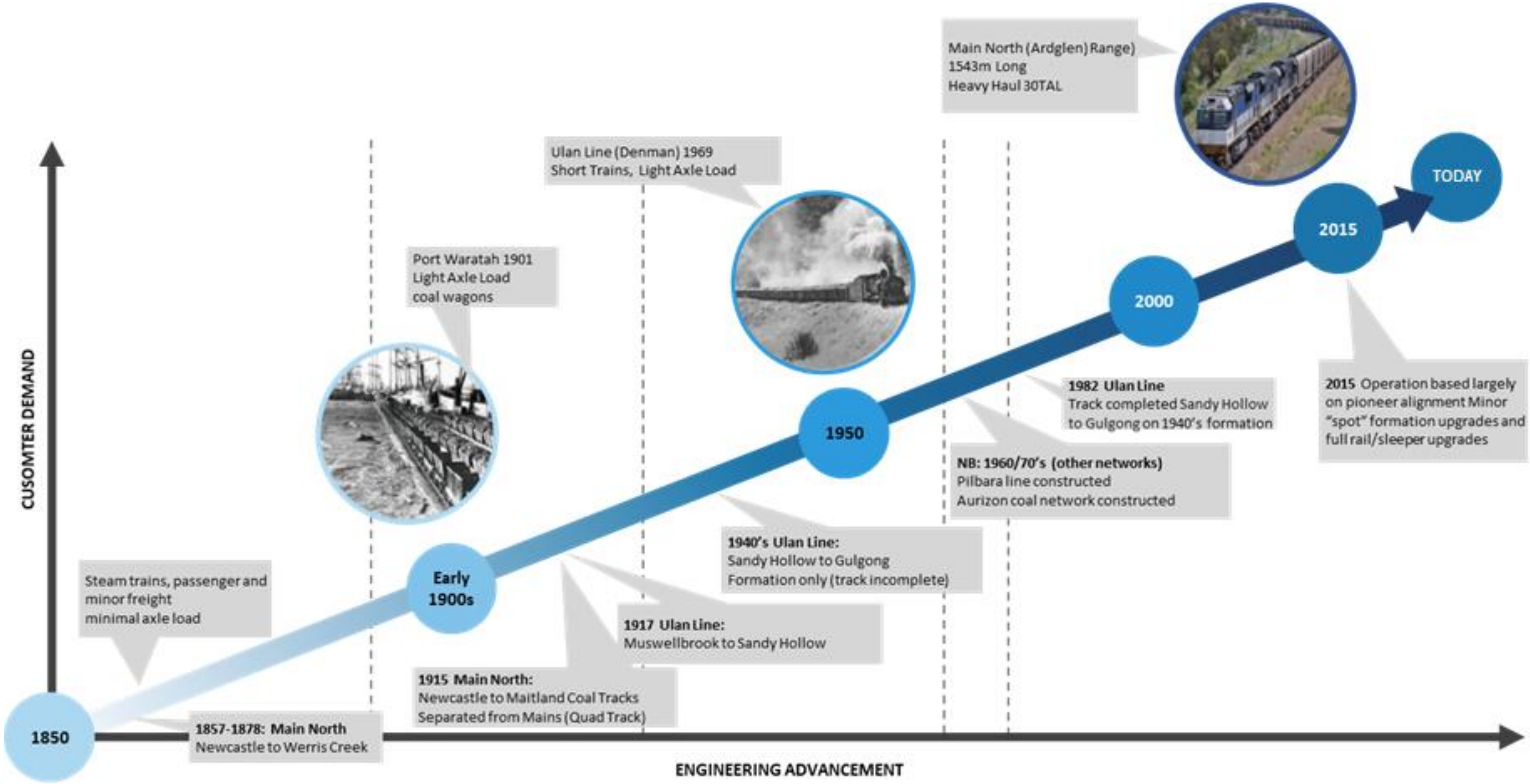


Figure 2-5: Hunter Valley Network Development

2.8 Asset Considerations

The following table and diagrams provide a summary of the asset considerations and track alignments for each Pricing Zone.

2.8.1 Zone 1 Rail Corridor

Table 3: Zone 1 – Asset Considerations

	Zone 1 - Asset Considerations
ASSET AGE	• Majority constructed in late 1800's to early 1900's, with track segments around Hexham constructed on swampland. • Since initial construction, several capital expansion programs have duplicated or triplicated track sections.
CORRIDOR ALIGNMENT	• The track traverses through numerous townships and mixed terrain including steep track grades at Allandale, Minimbah and Nundah (Camberwell).
ASSET CONTEXT	• No end-to-end strengthening of old formation has been undertaken to compensate for axle load increases and trebling of network line tonnages since the early 1990's. • A gradual upgrading of structures continues, however reliance on many old steel structures remains.
TYPICAL ASSET CONDITION CONSIDERATION	• High volumes and large asset populations closer to port (e.g. Turnouts). • Wear-and-tear at major junctions due to tight geometric arrangements and high congestion. • High volume causes stress on old steel bridges and some culverts. • Track Pumping/Geometry problems created by formation issues (e.g. Hexham-Sandgate swamp). • Flooding risks Hexham-Sandgate. • Aging and obsolete signalling infrastructure.

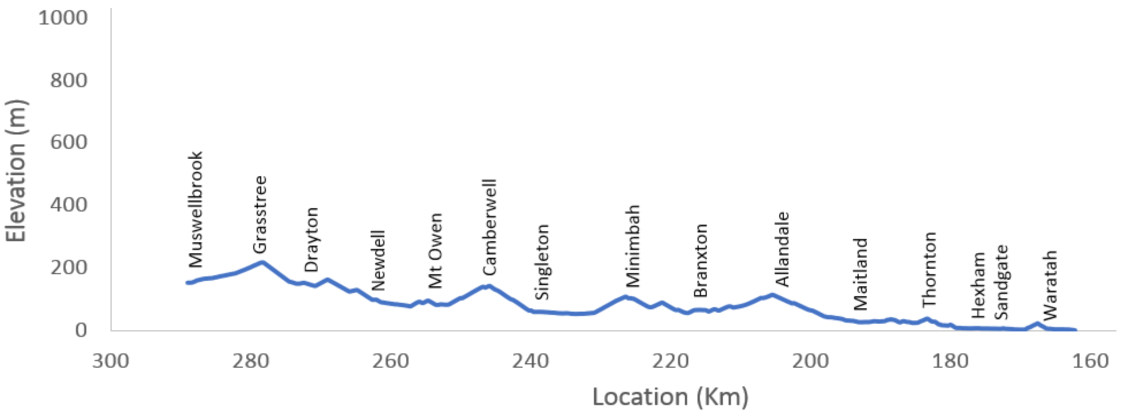


Figure 2-6 and Figure 2-7: Zone 1 Track Alignment and Gradient

2.8.2 Zone 2 Rail Corridor

Table 4: Zone 2 – Asset Considerations

	Zone 2 – Asset Considerations
ASSET AGE	• Track formation constructed between 1915-1950 on top of sections of an existing ~100-year-old roadway with track superstructure only completed to Sandy Hollow at the time. • Unused beyond Sandy Hollow until the early 1980's, when track superstructure laid on old formation to transport coal from mine sites in the Ulan area.
CORRIDOR ALIGNMENT	• The track traverses through numerous townships and a range of topography, with four tunnels on the higher-grade sections of track and many tight radius curves that increase rail wear.
ASSET CONTEXT	• This zone's complex terrain and remoteness of infrastructure are key asset management challenges.
TYPICAL ASSET CONDITION CONSIDERATION	• Rail wear on tight radius curves. • Tunnel maintenance requirements including, structural, formation and drainage. • Steel Bridge and Culvert Maintenance and upgrade requirements. • Geotechnical challenges including cuttings and escarpments. • Bulk of volume from the outer reaches of the zone creating a long length of asset exposure. • High utilisation of available corridor capacity creates heightened focus on reliability.

Figure 2-8: Zone 2 Track Alignment

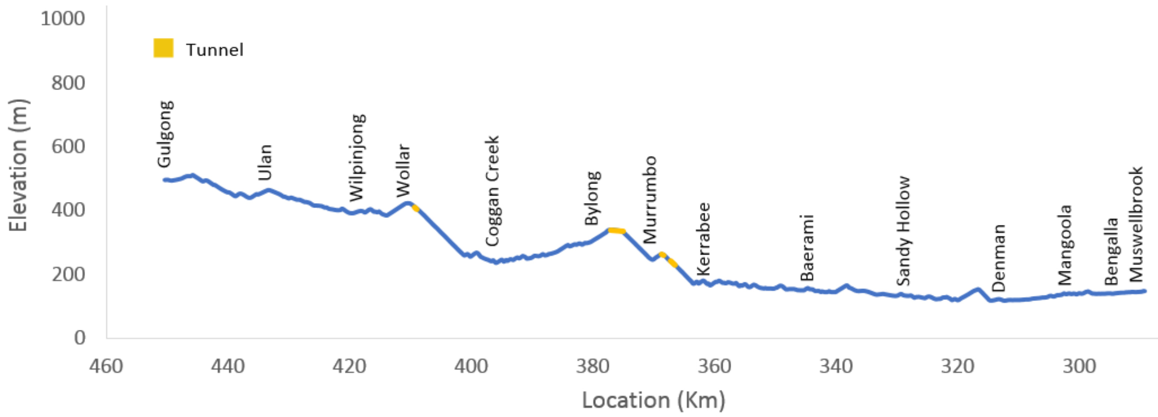


Figure 2-9: Zone 2 Track Gradient

2.8.3 Zone 3 Rail Corridor

Table 5: Zone 3 – Asset Considerations

	Zone 3 – Asset Considerations
ASSET AGE	• Constructed in the late 1800's. • Minor enabling works for 30 TAL trains completed in January 2015 to meet customer demand (track superstructure only).
CORRIDOR ALIGNMENT	• The track traverses through numerous townships and a range of topography, with a tunnel on the higher-grade section at Ardglen. Banker engines are required over Liverpool range (*between Chillcott's Creek and Ardglen). The grades ease once the alignment reaches the western plains.
ASSET CONTEXT	• A gradual upgrading of structures continues, however reliance on many old steel structures remains.
TYPICAL ASSET CONDITION CONSIDERATION	• Rail wear caused by tight radius curves due to steep grades on the Liverpool Range at Ardglen. • Geometry and formation integrity issues due to the presence of highly reactive black soils on the Liverpool Plains. • Steel Bridge and Culvert Maintenance and upgrade requirements.

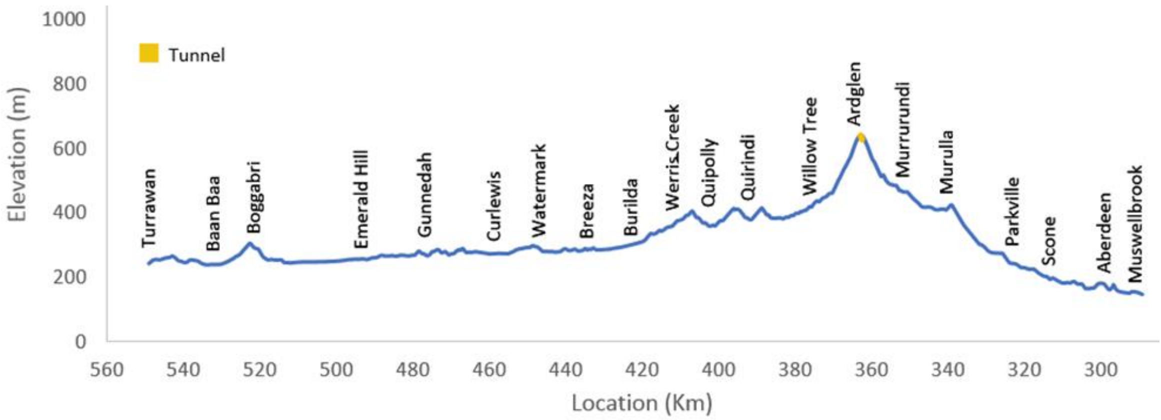


Figure 2-10: Zone 3 Track Gradient

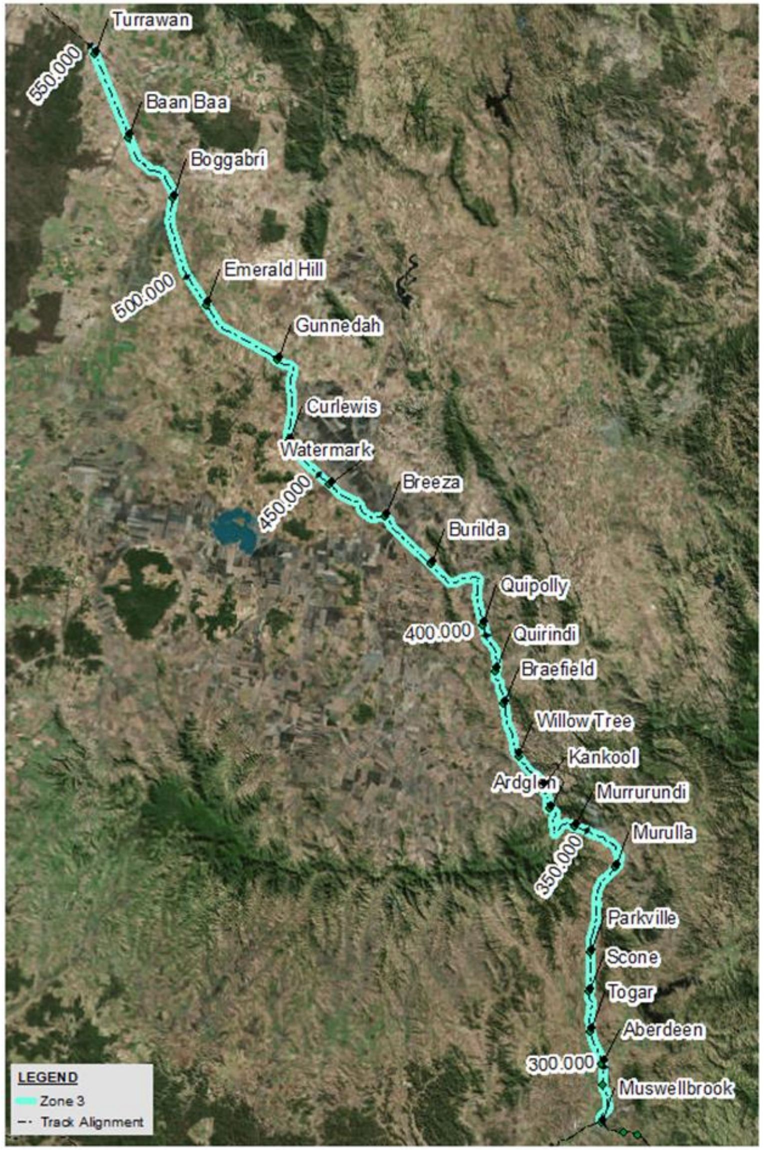


Figure 2-11: Zone 3 Track Alignment

2.9 Provisioning Centres

The Coal Network has five Provisioning Centres (PCs). Four of these PC's have been strategically positioned to provide maintenance to designated geographical areas. These PC's servicing the Coal Network are located at Gunnedah, Muswellbrook, Maitland and Port Waratah. Each PC provides a base for ARTC maintenance employees, minor plant and emergency material inventory for the delivery of the Routine Corrective and Reactive Maintenance program and activities. The PC located at Rutherford is not designated to a geographical area and is the base for the Maintenance Services Team which provides maintenance services to the whole of the Coal Network.

The Provisioning Centres operate 5 days per week on a day work basis, with on-call arrangements to service response to breakdowns outside of these hours.

Figure 2-12 shows the Provisioning Centre locations and indicative boundaries.

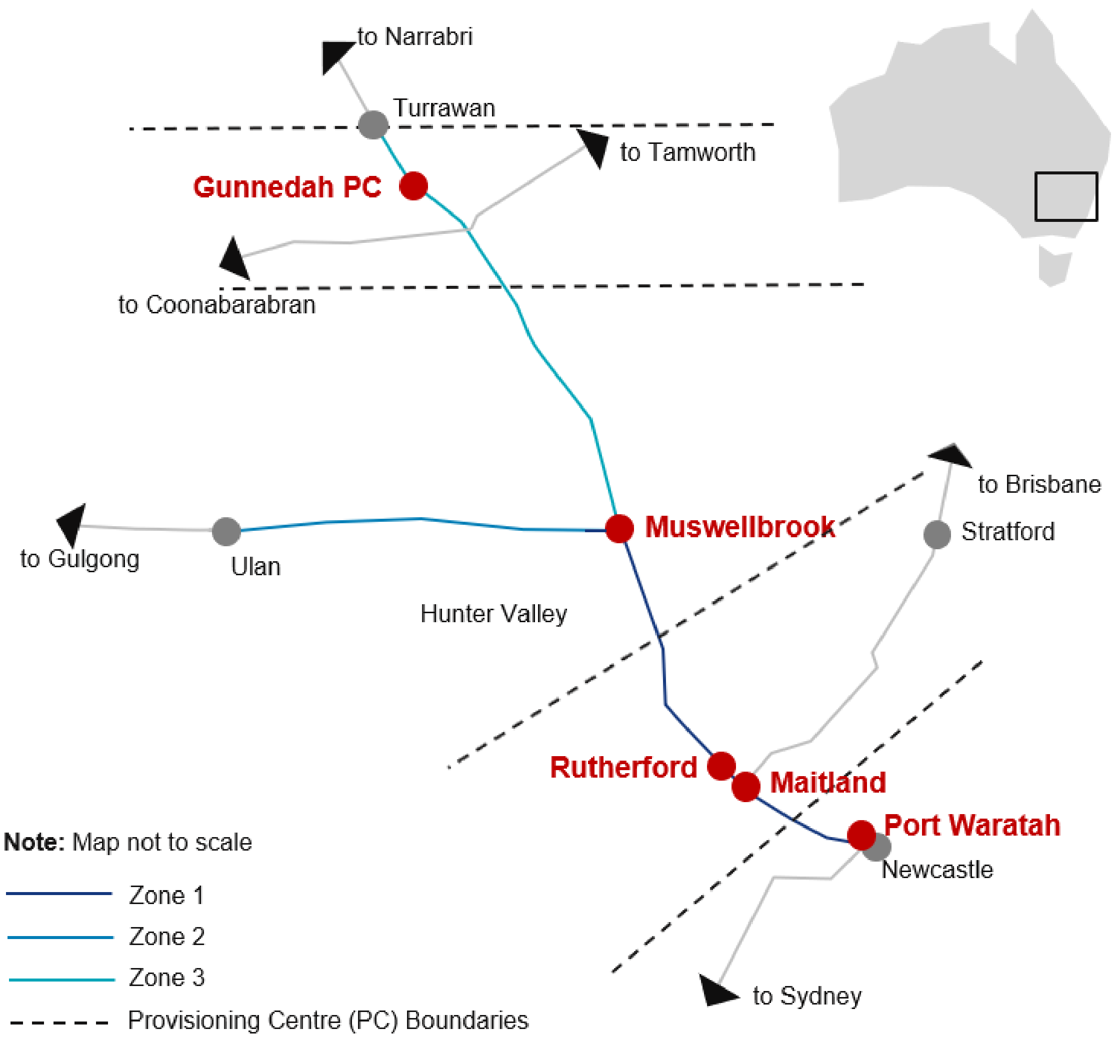


Figure 2-12: Schematic of the Hunter Valley Provisioning Centre Locations and Boundaries

3 Customer & Regulatory Obligations

ARTC's approach to maintaining the network is shaped by the need to uphold the safety and reliability of the network, and to meet Customers needs and the Coal Customers contracted demand. This includes meeting ARTC's requirements under its lease with the NSW Government and Rail Safety National Law.

3.1.1 NSW Lease

On 5 September 2004, the Australian Rail Track Corporation (ARTC) commenced a 60-year lease of the Hunter Valley rail lines in New South Wales. The lease includes condition requirements relating to:

- Track geometry (top moving sum, track quality);
- Speed restrictions;
- Bridges;
- Signals; and
- Maximum allowable speed and axle load combinations.

Risk and liability under the lease sit with ARTC as if it owned the assets. This includes liability for both lands and contamination, and in some cases also the pre-existing contamination. At the end of the lease, ARTC is required to return the leased assets in a working condition as determined by the lessor.

3.1.2 Rail Safety National Law

The Office of the National Rail Safety Regulator (ONRSR) applies the Rail Safety National Law.

Management of rail safety is based on a co-regulatory model with the regulator accrediting ARTC's Safety Management Systems (SMS). ARTC must also meet required technical standards for building and maintaining the track. This includes the types and frequencies of inspections to be carried out.

ARTC is accredited as a Rail Infrastructure Manager (RIM) and a Rolling Stock Operator (RSO) for the purposes of operating rolling stock for maintenance.

3.1.3 Coal Customer Needs

ARTC is obliged to maintain the Coal Network so that Customers, through their above rail operators, can utilise their contracted train paths. ARTC plans and undertakes maintenance with the objective that Customers can use their pathing entitlements, that Coal Network outages are coordinated with other outages in the Hunter Valley Coal Chain and adjoining rail networks and that maintenance costs are efficient.

The HVAU requires ARTC to publish network performance indicators relating to network performance and track condition (such as transit times, ARTC attributed train path cancellations and track quality measured by index). ARTC also routinely reports a range of measures to the RCG in the monthly report regarding network condition, asset management outcomes and delivery of maintenance work.

The monthly reported KPI measures are set by ARTC as part of HVCCC's annual capacity declaration process and also reflected in the calculation of ARTC's network capacity.

The target values are updated in January each year and are included in the monthly report.

Table 6: Hunter Valley Coal Network KPI's

Network Reliability
1. Total ARTC Reliability Loss (% of declared throughput)
• ARTC Infrastructure Loss
• ARTC Network Control Loss
2. ARTC Access Loss

Table 7: Hunter Valley Network Condition

Network Condition
1. Asset Performance KPI's - Zone 1, 2 and 3
• Temporary Speed Restriction – TSR (Number)
• TSR Time Loss (Minutes)
• % Track with TMS > 300
• Rail Breaks (Numbers)
• Signalling and Points Failures (Numbers)

Notes:
TSR – (Number & Minutes) is based on the "open" TSR's at the end of the period.
TMS – A measurement of track quality based on the last Track Geometry Recording.
Rail Breaks and Signalling and Points – (Number) is based on the total for the period.

3.1.4 Projected Gross Tonnage Demand

In July of each year, coal Customers provide forecast tonnage volumes on an individual basis for each of their load points for a most likely and high scenario. Non coal volumes are provided by the ARTC Interstate strategy team. The volume forecasts are utilised each year to inform the development of the Hunter Valley Corridor Capacity Strategy and Asset Management Plans.

Typically, the aggregated Customer provided forecast results in tonnages much higher than current actual volumes. To ensure that the forecasted asset management requirements are not excessive, ARTC undertakes analysis that also has regard to prior year actuals, Customer contract volumes, and HVCCC coal chain throughput estimates to derive an informed anticipated volume profile and associated Million Gross Tonnes (MGT) projection for the asset management team.

Photo: Loaded coal train on up relief road

4 Budget Structure

4.1 Asset Work Program Definitions

The annual asset management program is divided into three main areas of expenditure; Routine Corrective and Reactive Maintenance (RCRM), Major Periodic Maintenance (MPM) and Sustaining Capital (CAP). The RCRM and MPM programs are an operating expense (OPEX). The CAP program of works is subject to the RCG consultation and endorsement process under the HVAU.

Table 8 below summarises the classifications.

Table 8: RCRM, MPM and Sustaining Capital 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. These activities aim to reduce the level of defects and corrective maintenance required.
CAP	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. It can be minor works that sustain existing capacity, for example asset replacement, cost reduction or safety related projects.

There is an inter-relationship between Sustaining Capital activities and maintenance expenditure and other operating costs. From a Sustaining Capital perspective, asset renewal activities are undertaken where an asset is approaching end-of-life or where maintenance intervention is no longer a cost-effective way of sustaining asset performance. Where Sustaining Capital activities, such as asset renewals, do not take place as per planned timelines, higher levels of maintenance will likely be required.

4.2 Budgeting and Maintenance Cost Elements

ARTC's business operates on an Australian financial year (FY) basis, with all internal budgeting, planning and financial information reported for financial year ending 30 June. The contracting and financial model under the HVAU however is aligned to a calendar year (CAL) and effectively amalgamates two six-month periods from adjoining financial years.

ARTC prepares a budget and corporate plan for the forward 10-year period. ARTC's Budget Investment Committee (BIC), Board and Federal Government Shareholder review and approve the annual budget and corporate plan.

The following table describes the elements that make up ARTC's maintenance costs:

Table 9: ARTC Maintenance Cost Elements

Cost Element	Description
Internal labour	Direct labour and employee on-costs for maintainers, signal electricians and project delivery teams are charged to maintenance projects.
External contractor resources	Costs associated with procured external maintenance services and equipment.
Materials	Materials (such as ballast or rail) from inventories or directly procured to maintenance projects.
National Plant	ARTC's National Plant team, in conjunction with Provisioning Centres (PC's), manage and control the maintenance and operation of approximately 500 ARTC owned plant items, including tamping machines, excavators, ballast regulators and various small plant items housed within PC's, for example forklifts and compressors. National Plant unit rate charges are costed to maintenance projects at nil margin.
Consumables/Other	Travel and accommodation, project delivery motor vehicle costs, freight, waste disposal.

Overhead costs relating to the Provisioning Centres (e.g. management, equipment, motor vehicles) and asset management strategy and planning functions form part of Business Unit Management costs for the Hunter Valley and are separate to the Maintenance Plan and Capital works budgets.

Photo: Bengalla Track Upgrade delivered by external contractors, internal resources & national plant

4.3 Treatment of Maintenance Costs under the HVAU

The costs identified in the Maintenance Plan contribute to the pricing budget which is used to determine the customer access fees. The budgeted maintenance costs are fully recoverable via the access fees. Actual costs are subject to the ACCC annual compliance submission process and may result in a "true up" of the fees due if costs differ from the budget and are deemed prudent.

Maintenance costs are typically Segment Specific Costs and directly identifiable with a particular segment or group of segments. Under the HVAU, maintenance costs are further classified as either Variable Maintenance Costs or Fixed Costs based on an assessment of the extent to which the maintenance costs vary with usage of a segment. The variability is based on an engineering assessment in accordance with the principles in section 4J.5 of the HVAU having regard to the purpose, causal factors and cost drivers for the maintenance cost / activity.

This approach adopts the methodology utilised by the ACCC's consultant WIK for the 2013 Compliance Assessment decision and maintained through subsequent Compliance Assessment submissions as approved by the ACCC.

The distinction between Variable Maintenance Costs and Fixed Costs is important as it determines which Access Holders contribute to the respective costs (including the Floor Contribution), the calculation of the Economic Cost of a Segment and which component of the Access Charge recovers the cost. Table 10 below summarises the treatment:

Table 10: Variable and Fixed Maintenance Cost Classifications

Maintenance Classification	Cost Contribution / Economic Cost	Access Charge Component
Variable Maintenance Cost	• All Access Holders (coal and non-coal) contribute to the Variable Maintenance Costs of a Segment based on their actual usage of that Segment. Actual usage will be either actual GTK or Train Km depending on the cost driver of the maintenance activity. • The Economic Cost of a Segment will exclude the Variable Maintenance Costs imposed by non-coal Access Holders and Access Holders who are not Constrained Coal Customers for that Segment.	• Recovered through the Non-TOP component of the Access Charge based on actual usage on a $/GTK basis.
Fixed Costs	• For Segments that form part of the Constrained Network, maintenance Fixed Costs are allocated to the Constrained Coal Customers that utilise that Segment. * Non-coal and Access Holders who are not Constrained Coal Customers do not contribute to the Fixed Costs of Segments that form part of the Constrained Network. • Maintenance Fixed Costs for unconstrained Segments do not form part of the Economic Cost of the Constrained Network.	• Recovered through the TOP component of the Access Charge based on contracted volume on a $/Train KM basis.

Notes: The variable proportion and cost drivers for the Key Maintenance Activities are referenced in the Annual Maintenance Plan[2].

[2] Further information regarding the assessment of variability of maintenance activities can be found in WIK-Consult TÜV - Consultant report for 2013 Annual Compliance (PUBLIC).pdf (accc.gov.au) and HVAU 2014 Compliance Assessment Submission Attach 4 Bull Head Services Report.pdf (accc.gov.au).

4.4 Treatment of Capital Costs under the HVAU

Once the commissioning of an RCG fully endorsed asset is complete, the costs associated with commissioning the asset are added to the Regulatory Asset Base (RAB) or RAB Floor Limit. As negotiated in the HVAU, the RAB Opening Balance is escalated by CPI annually and the return on assets contained in the RAB is calculated on the Average RAB Floor Limit for any given year by applying a real pre-tax Rate of Return (RoR). On and from 1 July 2021, the real pre-tax Rate of Return is 4.6%. The RAB is depreciated on a straight-line basis with the useful life of all assets deemed to be 21 years commencing 1 July 2021.

5 Asset Management Strategy

5.1 ARTC Asset Management System

ARTC's Asset Management System 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 effective management of infrastructure assets to maintain their condition and optimise their life cycle. To achieve this, the Asset Management System 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.

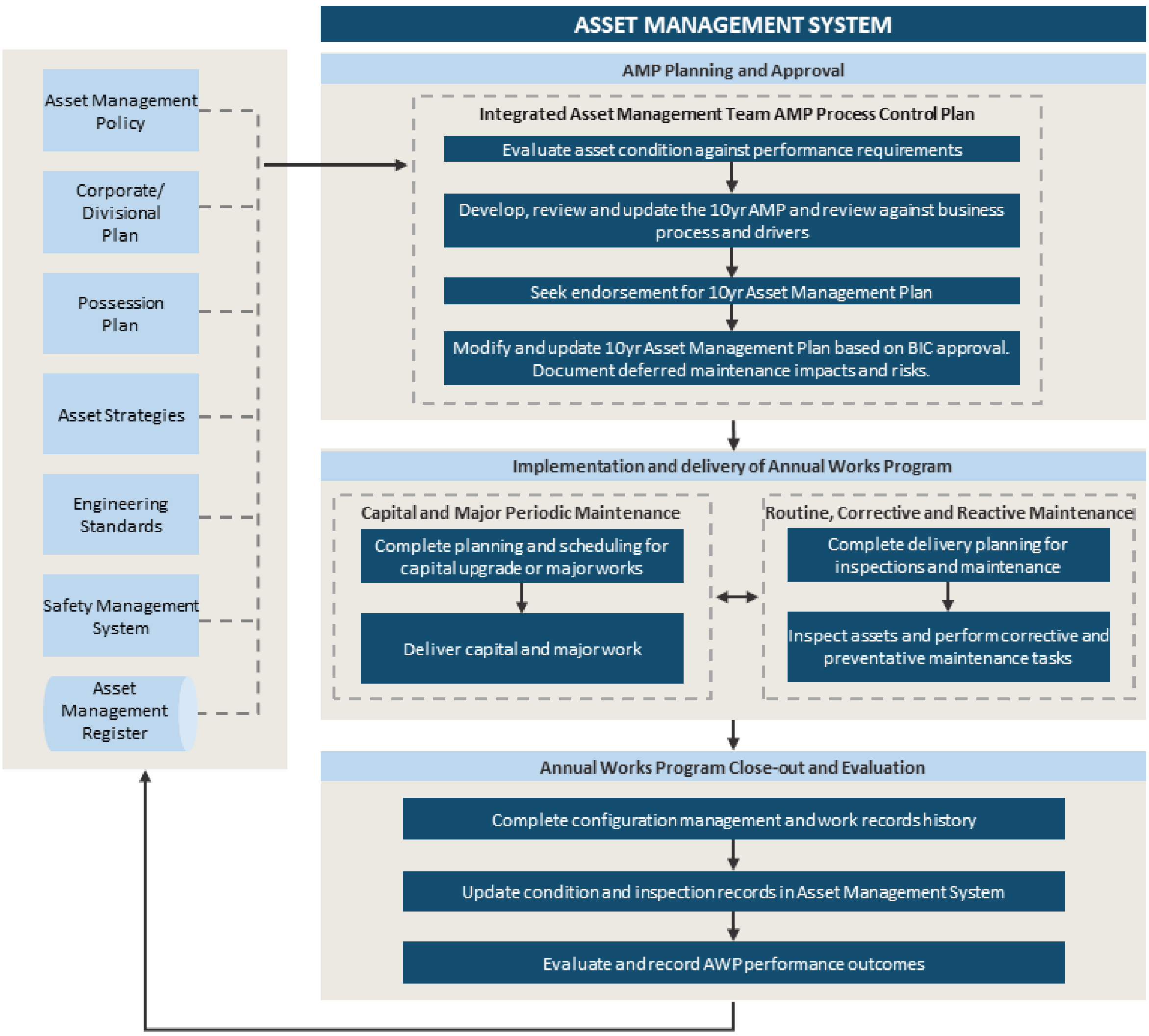


Figure 5-1: Asset Management System in ARTC's Safety Management System

5.2 Asset Management Strategy and Objectives

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

- **Safety:** to minimise rail infrastructure risk through compliance to ARTC's Safety Management System, including engineering standards and risk management framework.
- **Network Condition and Reliability:** to maintain rail infrastructure condition and reliability in accordance with its Lease and Access Undertaking obligations in order to minimise disruptions including performance measures and Temporary Speed Restrictions (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 guide development and delivery of the rail infrastructure asset management plans.

Photo: Hunter Valley Coal Network

5.3 Asset Management 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 Sustaining 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 are calculated based on previous years' actuals and changing external factors such as operational conditions and staffing which establish the forecast RCRM plan and budget. As such, the forecast and budget for RCRM activities are reasonably consistent from year to year, accounting for some price escalation. 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 budget for specific maintenance activities and projects across the network. The level of detailed forecasting for the first one to three years of the 10-year plan may vary for each maintenance activity as it is dependent on the activity strategies, different scope drivers and the data available at the time of planning. Figure 5-2 outlines ARTC's overall asset management planning process.

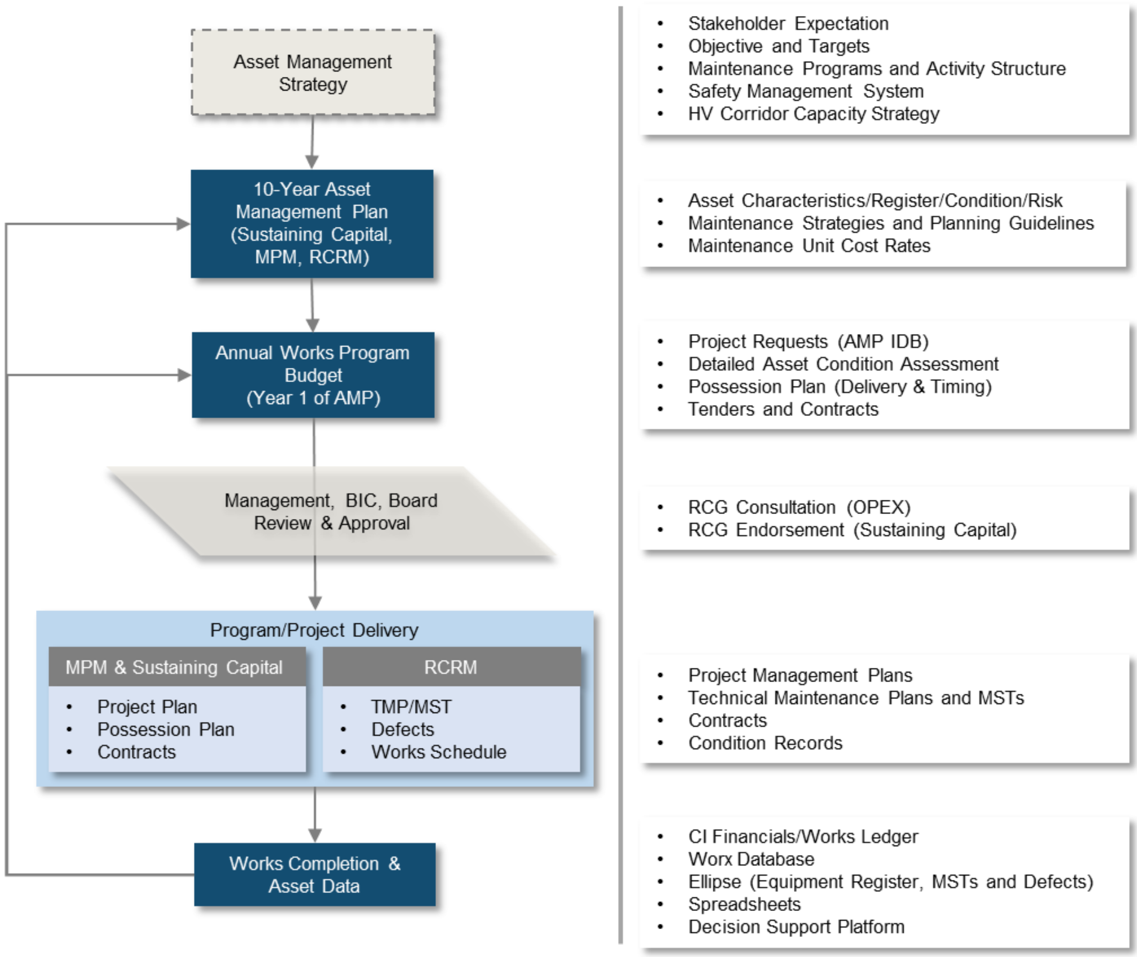


Figure 5-2: ARTC Asset Management Planning Process

Key stages in the asset management planning process include:

- **Asset Management Plan (AMP) or the 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 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 (AWP) and Budget:** For year 1 of the AMP, ARTC's Annual Works Program validates and refines the scope, cost and timing of specific CAP and MPM projects. Input through this validation process typically includes;
    - detailed asset condition assessments (e.g. mechanised inspection results, ballast fouling indices, etc.), inspections and site visits by the Provisioning Centre staff, reliability engineers and subject matter experts, likely contracting arrangements 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.

- **Internal Review and Approval:** Review and approval of the Annual Works Program and budget involves several ARTC stakeholders including the Hunter Valley Management Team, Business Investment Committee (BIC), Executive Committee, Board and Shareholder.
- **RCG Consultation:** RCG consultation and endorsement of the Sustaining Capital program, and consultation on the Maintenance Plan as part of the annual access charge setting process.
- **Program and Project Delivery:** Delivery of the approved Annual Works Program involves parallel activities to develop and execute detailed work plans for the CAP, MPM and RCRM programs. For the CAP and MPM program, this can include:
    - Detailed site investigation and refinement of scope and cost estimates
    - Preparation of activity-based and, if warranted, project-specific management plans
    - Tendering, contestable market and value for money assessments and management of CAP and MPM activity contracts
    - Integrated scheduling and coordination of work completion within the overall annual possession program for the network.
- **Program and Project Completion:** On completion of the work, ARTC Ci Financials and Works Ledger records the 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.

Given the age, characteristics and dynamic loads on the network, the asset management planning process is not static. The asset management and maintenance processes aim to prevent failures, ensure rapid response to defects, coordinate closedowns and possessions across the network and align with the coal chain. There is ongoing review of asset condition information, work scopes and priorities post the setting of a budget to deliver a contextualised response to maintain the safety and reliability of the network and meet Customer network availability needs.

Photo: Hunter Valley AWP project worksite

5.4 Maintenance Model Fundamentals

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.

The figure below shows the general Maintenance Model and process followed by ARTC in developing and delivering projects on the Coal Network. The three inter-related stages in the model are Scope Generation, Scope Validation and Scope Delivery. This model is adapted for each maintenance activity and may have different inputs contributing at each stage.

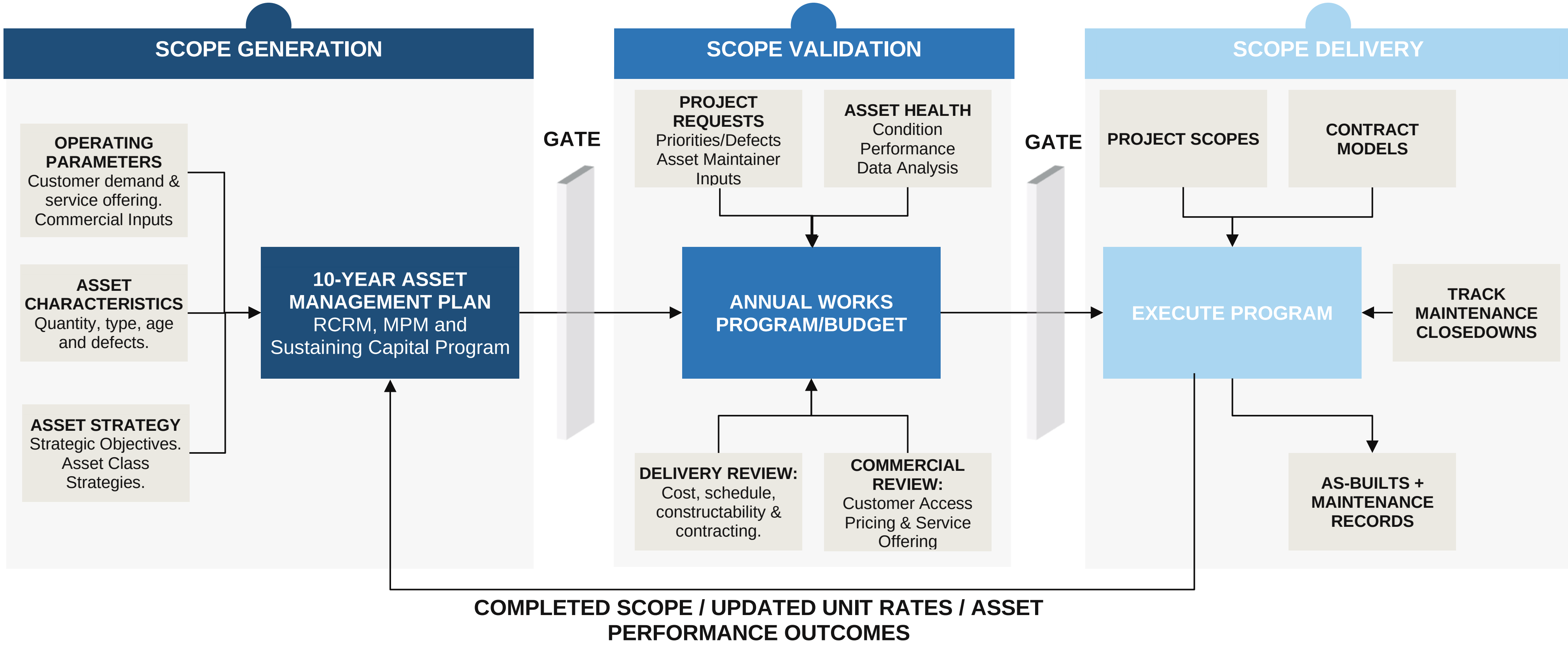


Figure 5-3: Maintenance Model

5.5 Asset Management Decision Framework

The development of the Hunter Valley Asset Maintenance program involves a detailed process using a number of asset data inputs and analysis methods to arrive at a program of works that is considered to deliver the ARTC customer requirements of a safe and reliable network in the most efficient manner. Figure 5-4 outlines the basis of the process. ARTC is continuing to manage its assets based on a Risk and Condition approach and moving away from a Time and Tonnes approach where appropriate. ARTC is continuing to enhance the available condition related data sets through use of technology to provide objective reference points for condition related information.

ARTC's asset lifecycle decision making framework incorporates the Plan-Do-Check-Act (PDCA) cycle and considers:

- **Acquisition** – ensures evidence-based decision-making through business cases, feasibility and lifecycle considerations before acquisition, including consideration of spares.
- **Reliability and performance** – covers risk management, criticality and tactical decision-making for maintenance based on an assessment of available condition-based information.
- **Asset maintenance** – a 'Plan, Do, Check, Act' cycle to plan for, undertake, review and continually improve maintenance activities.
- **Asset assurance** – the processes to identify, analyse and develop actions for failures that may occur, and feed this back into the planning and reliability processes.

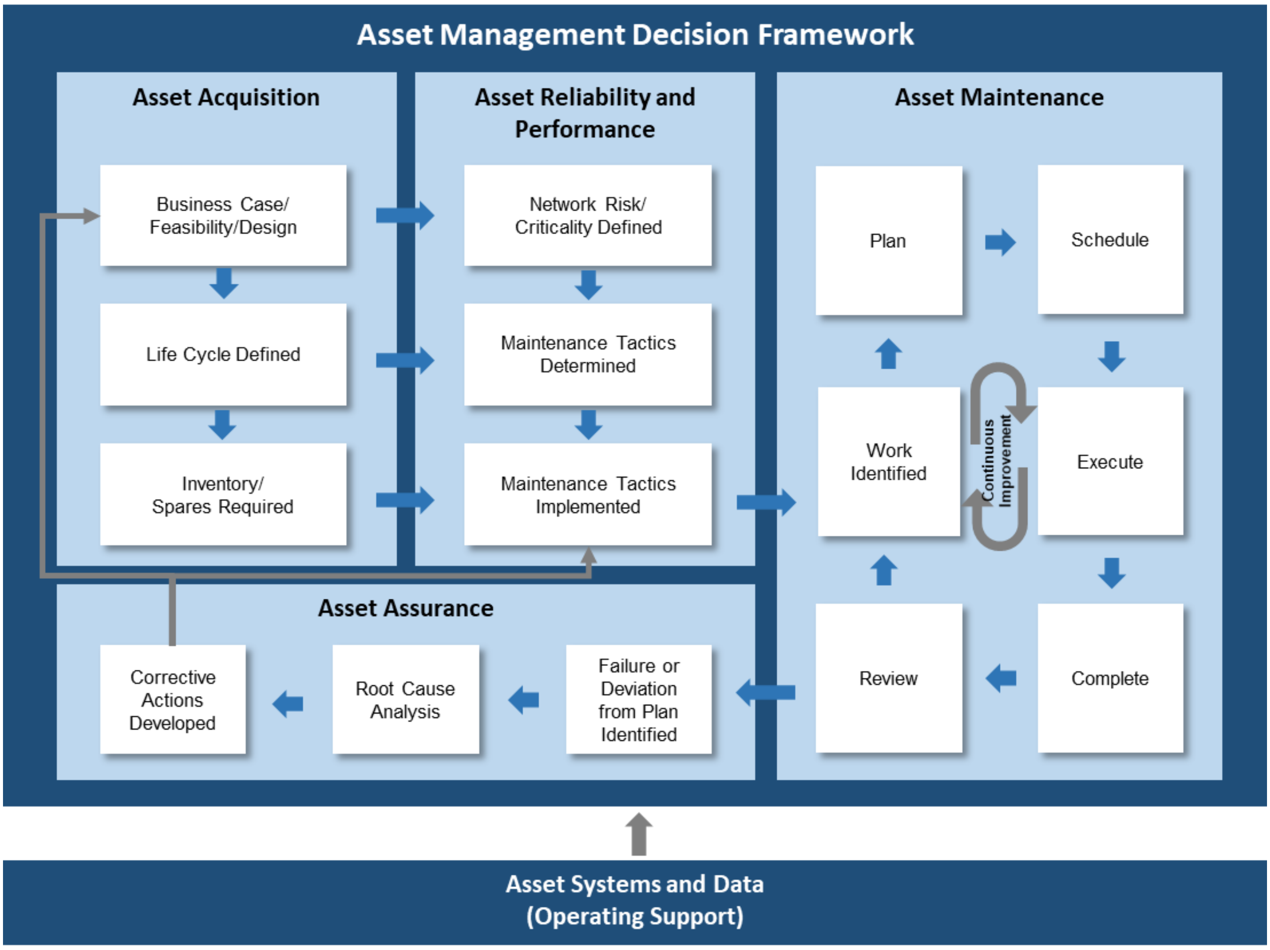


Figure 5-4: Asset Management Decision Framework

5.6 Key Asset Management Systems

5.6.1 Enterprise Asset Management System (EAMS)

Ellipse is the primary Enterprise Asset Management System (EAMS) used to store the asset register, known conditions (defects) and maintenance work orders for the rail network assets.

Whenever work is undertaken on the asset, the information contained in Ellipse shall be reviewed and updated as appropriate.

While Ellipse is the primary system, ARTC also maintains and uses other systems to manage aspects of the rail network assets.

5.6.2 Inspections and Monitoring

ARTC conduct both mandatory inspections and discretionary monitoring to best deliver the safety and operational efficiency of the network.

The mandatory inspections for ARTC's critical assets are specified in the Technical Maintenance Plan (TMP) which forms a part of the Safety Management System (SMS).

The discretionary monitoring has been implemented using various technologies to strengthen the understanding of asset condition and therefore further the safety, reliability and operational efficiency of the network. The asset condition knowledge provided by the monitoring systems supports the development of targeted AMP scope of works.

5.6.3 Technical Maintenance Plan (TMP)

The ARTC TMPs set out the routine inspection policy and requirements in terms of mandatory inspection tasks and inspection intervals, which are scheduled in Ellipse as Maintenance Schedule Tasks (MST's). It references ARTC's engineering standards for asset requirements.

The Technical Maintenance Plan (TMP) specifies:

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

While being prescriptive in nature, the requirements can be increased or decrease based on risk and condition. Any decreases require an Engineering Waiver in accordance with ARTC Procedure EGP-02-01 Engineering Waiver Management, while permanent changes to the TMP are subject to regulatory approval.

ARTC measures compliance to the mandatory requirements and take a risk and condition approach when proposing changes to the plan.

5.6.4 Asset Performance Monitoring

In addition to the inspection regime, the following suite of monitoring tools are used as key inputs to the asset strategy, planning and maintenance processes. The relevance of each tool to specific asset classes is described in the specific asset class and work activity strategies.

<u>List of Monitoring Tools:</u>

- Track Recording Vehicle (AK Car)
- Ultrasonic Inspection Car (UIC)
- Instrumented Coal Wagons (ICW)
- Ground Penetrating Radar (GPR)
- Digital Mapping (LiDAR)

- Real Time Bridge Monitoring
- Points Condition Monitoring (PCM)
- Level Crossing Monitoring
- Decision Support Platform (DSP)
- Geographic Information System (GIS) Visualisation

Descriptions of each monitoring tool are provided below:

Track Recording Vehicle (AK Car)

The AK car provides for both mandatory inspection and additional condition monitoring and runs approximately every four months. The vehicle provides track geometry measurements, rail profile measurements, digital video and LiDAR. ARTC is also investigating the potential to fit GPR equipment to the vehicle and hence providing greater GPR data frequency for condition trend analysis.

Ultrasonic Inspection Car (UIC)

The Ultrasonic Inspection Car provides mandatory ultrasonic rail testing to identify internal rail flaws. The frequency of testing is set out in the Civil TMP and is based on tonnage demand, rail break frequencies and rail flaw frequencies. ARTC are investigating the replacement of the current low speed testing platform with a high-speed technology that will reduce the impact of ultrasonic testing on the operational network.

Instrumented Coal Wagons (ICW)

ARTC have four ICW units operating on the Hunter Valley Coal network. The ICW platform delivers; daily track condition data; notifications to relevant stakeholders for urgent repairs; allows for identification and early intervention of track condition issues; data analysis with long and short-term trends monitored to optimise planned maintenance programs; and assists in avoiding unnecessary maintenance.

Ground Penetrating Radar (GPR)

Inspection process using ground penetrating radar equipment to detect Ballast Fouling Index, free draining layer, ballast pockets, fouled ballast, mud spots and wet track beds. The data produced from this process is a key input to decisions and justification for formation and ballast maintenance work. The GPR currently runs once every two years and ARTC is investigating the feasibility of operating more frequently using the current machine or using new options (see Track Recording Vehicle).

Digital Mapping (LiDAR)

The AK Car is fitted with LiDAR equipment. The use of this data is currently focussed on clearance infringement checks and track centre measurements however its purpose may be expanded in the future. Future uses may include using digital terrain contour data for concept planning and estimating purposes. Further uses may also include level crossing sighting checks and for the validation of asset locations.

Real Time Bridge Monitoring

ARTC have installed bridge mounted electronic monitoring systems on several critical steel bridges on the Hunter Valley Network. The electronic monitoring systems will provide real-time monitoring and flag issues by way of exception reports for detailed investigation by the structures team.

Points Condition Monitoring (PCM)

Points failures are the second biggest contributor to infrastructure reliability issues (after rail breaks). PCM will provide detailed diagnosis of points machine behaviour; drive proactive maintenance interventions thereby reducing the number of failures; and will allow our asset management teams to aggregate data sets to identify deeper insights into required maintenance. These may include identification of track, civil or signalling issues.

Level Crossing Monitoring

Level crossing monitors are installed at actively protected level crossings and provide alarms and in most cases remote diagnostics for faulty lamps, booms, batteries and signalling logic. The alarms and data allow emergency response teams to diagnose problems before attending site and hence allowing for the fastest possible return to service. Failure records also assist in the prioritisation of longer-term work programs.

Geographic Information System (GIS) Visualisation

The Geographic Information System (GIS) is a framework for gathering, managing, and analysing data spatially. ARTC collects and maintains large datasets necessary to manage the asset. ARTC also uses datasets produced by various government organisations. In order to make effective use of this data, it must be available to users in a clear, accurate and consistent manner, ARTC's GIS Platform provides this function.

5.6.5 Decision Support Platform (DSP)

The DSP rationalises the many models and data sources on the asset into a single analysis system, thereby enabling efficient, reliable, objective and robust asset management decision-making.

This includes data from inspections, monitoring systems and work activity history to deliver more efficient maintenance and improve asset reliability. The DSP has been utilised to identify and refine scope for activities such as tamping, ballast cleaning, grinding and track upgrades. Additionally, the DSP is also utilised daily to determine network priorities and identify sections with rapid deterioration, as well as determining the maintenance effectiveness of sections where work, such as tamping, has been completed but may require further intervention. A sample of one of the DSP visuals is provided in Figure 5-5.

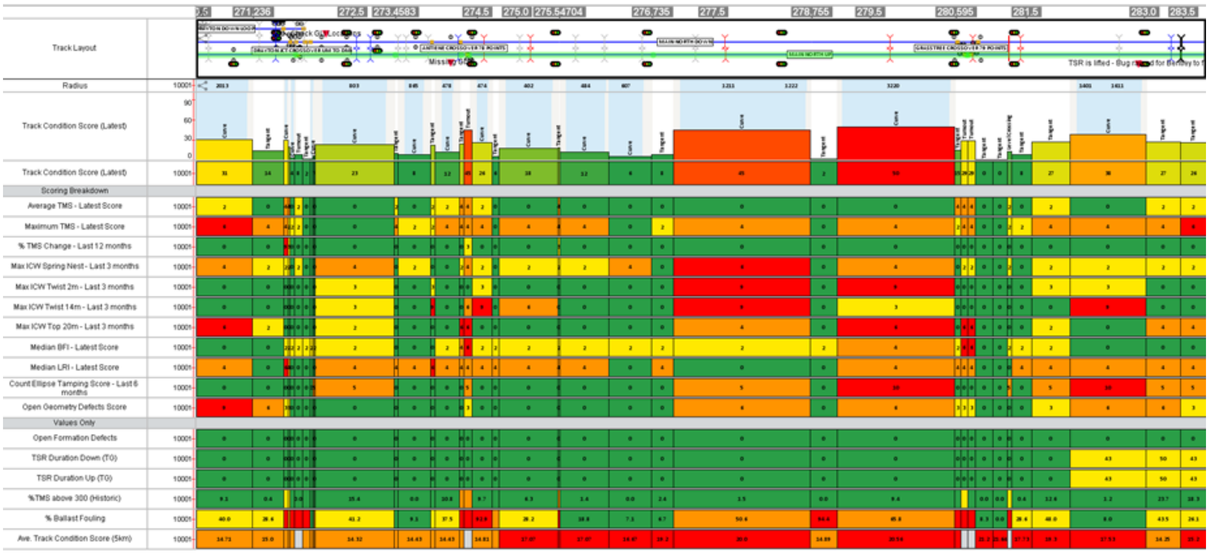


Figure 5-5: Sample DSP visual for track condition

5.7 Asset Management and Maintenance Program Delivery

There are two key factors that influence the asset management and maintenance program delivery – access to the track (possessions) and resourcing.

5.7.1 Structure of Maintenance Possessions

Track work authorities or possessions are required to enable maintenance work to be safely undertaken on or adjacent to the track. A key tenet of the cooperative supply chain model employed for the Hunter Valley Coal Chain is the alignment of maintenance planning and delivery throughout the chain to minimise the cumulative outage time for Customers.

ARTC's initial Annual Possession Plan, produced by the end June for the following calendar year, becomes the base from which HVCCC works with the terminals and load point owners to create a system-wide plan. The output from this process is a 12-month coal chain major maintenance plan, which has clear alignment between track and major terminal closedowns, and some smaller maintenance events and load points.

Modelling and analysis by HVCCC has supported the system-wide closedowns as the most effective way to align major maintenance. The current regime typically utilises six major aligned closedowns of around 62-72 hours driven by terminal stockpile levels and the critical path for the required asset management activities. This is supplemented by other planned possessions between these major closedowns. The number and duration of these possessions are reviewed regularly as network conditions change. Consultation is undertaken with Customers and coal chain stakeholders in circumstances where closedown duration or timing needs to be revised.

Outside of the six major closedowns, other planned possessions included in the Annual Possession Plan are required for:

- Rail Flaw Detection Car (Ultrasonic Inspection Car) – These possessions enable clear paths for rail mounted equipment to test the rails ultrasonically for internal defects.
- Ballast and Rail Set Deliveries – These possessions are planned to enable delivery of ballast and rail sections by rail wagons to key locations in preparation for works during the major closedowns.
- Rail Grinding, Turnout Grinding and Resurfacing – These possessions are planned for grinding and resurfacing works that cannot be undertaken during the major closedown due to location conflicts with other closedown works or where grinding is required either more frequently or within a short period after new rail is installed.
- Routine Maintenance (RM) Possessions – These possessions provide dedicated time windows to target compliance inspections, improve reliability in key locations where access to the track in live run operations is difficult due to rail traffic density (e.g. the fortnightly Preventative Maintenance Possessions in Zone 1) and rectification of defects following ultrasonic testing. If no defects are identified, then the paths are made available for train running.

Figure 5-6 shows an example of a month's excerpt from the Annual Possession Programme.

For the purpose of future maintenance plans and cost phasing, it is assumed that the possession regime will generally be consistent with the description provided above and in the Annual Possession Programme diagram.

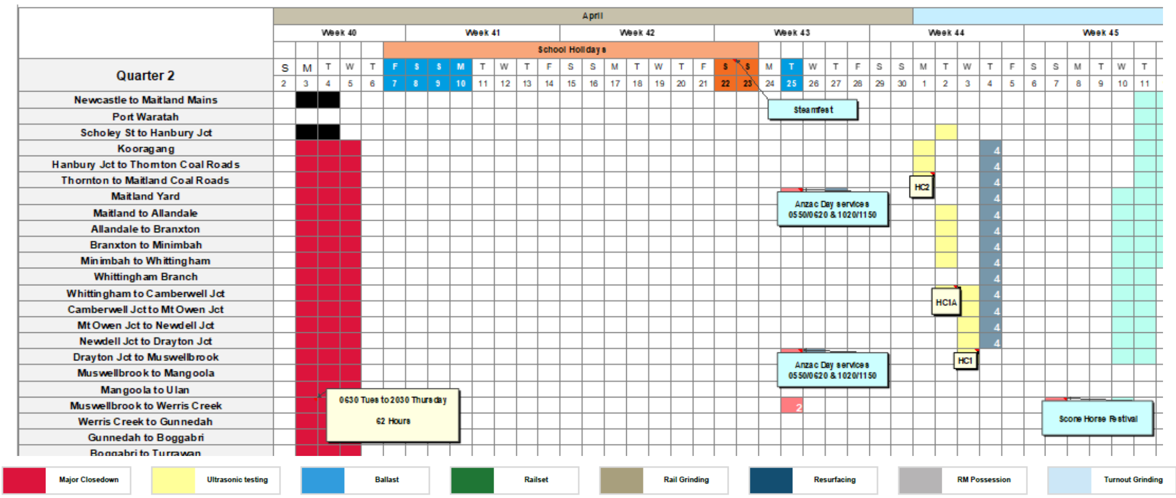


Figure 5-6: Example Annual Possession Programme

Beyond the planned possessions in the Annual Possession Programme, ARTC still needs to enable track access for breakdown and emerging defect rectification maintenance. ARTC's Network Integration team coordinates timing for these shorter notice possessions on a week-to-week basis and integrates with customer railing requirements to provide effective time on track for maintenance requirements while preserving the capacity of the Hunter Valley Network.

ARTC achieves this, in consultation with HVCCC, by integrating multiple track access related activities that have the potential to impact network train flow into shortened overall time periods. The integration process seeks to maximise the use of existing planned possession windows, consider network operational requirements (including demand) and external alignment opportunities across the Hunter Valley Network. Work is scheduled in the shadow of other activities in a controlled and aligned manner to minimise the cumulative impact of maintenance on pathing.

5.7.2 Resourcing

ARTC's RCRM program and activities are typically delivered by ARTC employed maintainers, with some external support for specialised activities (e.g. ultrasonic rail testing, vegetation control) and specialist equipment. Where required, contract labour is utilised to provide coverage when internal resources are not available (for example due to vacancies) to ensure responsiveness and performance of the network is maintained.

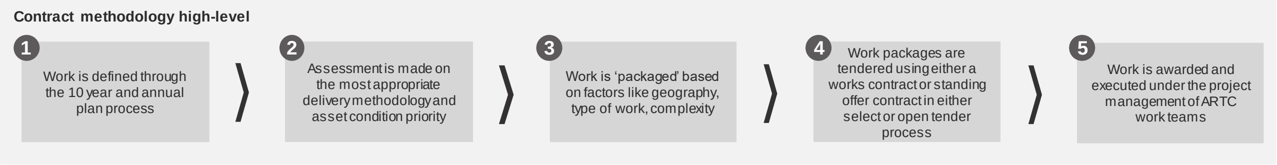
Currently, CAP and MPM work is primarily conducted in the six major closedowns and therefore creates a heavily 'peaked and troughed' outcome in terms of resource requirements throughout the year. The six-closedown strategy effectively concentrates the annual CAP and MPM program into approximately 18 days of track time in alignment with other supply chain fixed infrastructure maintenance, with peak resourcing in the order of 1,000 to 1,500 people working on the Coal Network during each closedown to deliver the work program. Due to the large amount of work delivered concurrently, CAP and MPM activities are generally contracted out to external service providers following a market testing process.

ARTC staff provide project management, engineering, design, supervision, scheduling, environment, community and stakeholder engagement functions to support CAP and MPM activities.

5.8 Approach to Procuring Suppliers

ARTC employs an enterprise level, integrated, risk and value driven framework for the procurement function across the business, including the Coal Network, to safely and cost efficiently meet the changing business context and customer needs.

The process used to test the market is scalable with various engagement options available to deliver Customer value commensurate with the risk, priority, market and complexity of the work. The following diagram illustrates the high-level approach:



Other considerations in the procurement process include:

- Original Equipment Manufacturer (OEM) purchases and other engagements where IP is protected (e.g. Train control systems)
- The need to exhaust specific market supply to support campaign maintenance (e.g. sourcing multiple resurfacing machines for Hunter Valley Closedowns)
- Highly specialised resources or equipment where a security of supply risk is required to be actively managed over a long period of time (e.g. procurement of 120-Stone Rail Grinder).
- Where volume (quantity) of plant and labour required to complete work would be cost prohibitive to own and operate (e.g. large earthmoving fleet)
- Multi-year contracts for large scale programs of work where the basic requirement is reasonably predictable (e.g. Track Formation Reconstruction, Rerailing, Maintenance Resurfacing etc.), providing ARTC with a larger point of leverage in developing competitive market tension, security of supply, agility in responding to changing network context.

6 Key Activity Strategy Summary

This section and Table 11 provide an overview of the key maintenance and capital works activities including:

- Activity descriptions
- Contributing Factors
- Scope development
- Procurement
- Cost estimation.

The summary information provided here is underpinned by the more in depth ARTC Safety Management System and Asset Strategy suite of documents including:

- Technical Maintenance Plans
- Engineering Standards
- Asset Class Strategies
- Activity Strategies

Table Notes:

Direct Tonnage Relationship – Tonnage volumes are a key input to the calculations used to determine the activity scopes. The calculations are based on a well-established understanding of the tonnage and asset condition relationship.

Indirect Tonnage Relationship – Tonnage volumes will have an impact on the activity scope, but it is not a direct calculation. The impacts of tonnage for these activities are based on condition monitoring and forecasts are a prediction on the likely outcomes. Other factors such as asset age, condition and environmental factors may also determine scope outcomes for these activities.

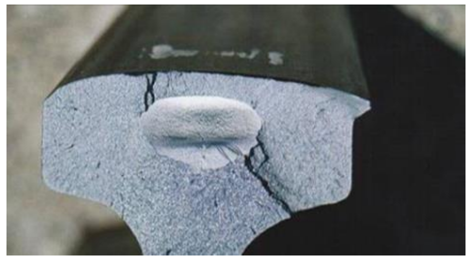
No Tonnage Relationship – Tonnage volumes do not have an influence on these activities.

Asset Reliability Driver – May include a combination of asset reliability, asset availability, minimise reactive asset maintenance, minimise impact on other assets and minimise TSR's.

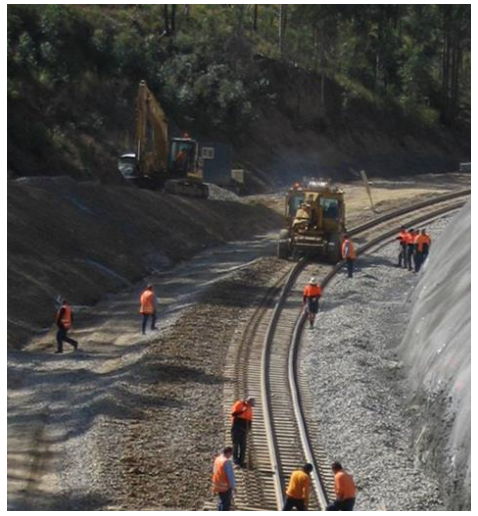
Table 11: Key Activity Strategy Summary

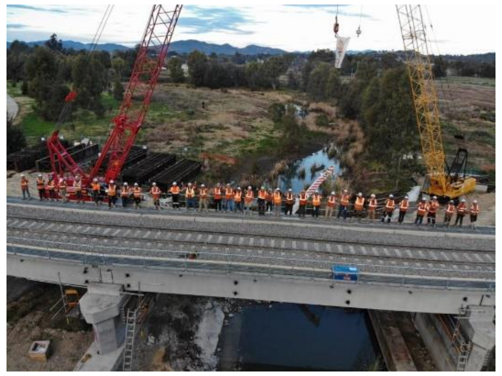
Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Ballast Cleaning (MPM) 	***The work:*** Ballast Cleaning is the mechanical excavation and replacement of deteriorated track ballast up to 500mm below the bottom of sleeper and across the entire track cross section. ***Asset Benefits:*** • Reliability	Contributing Factors are: • Ballast fouling and attrition • Poor drainage • Lower quality crushed rock • Lower quality ballast grading • Soft formation and track deflection • Mechanised track resurfacing • Track geometry and speed ***Tonnage Relationship*** • Indirect	Scope locations have historically been prioritised by: • Operational criticality • Track performance • Ballast age and attrition • DSP and historical data, condition trends and maintenance patterns • Resurfacing effectiveness With the ballast cleaning contract concluding, an engineering assessment was completed to determine the optimum means of maintaining future ballast condition, balancing cost effectiveness and reliability benefits of each option. The assessment has determined that the ballast cleaning program for the Hunter Valley would be paused across all zones for the 10-year forecast.	Single supplier via an open market international tender. Multi-year agreement to secure specialised equipment long term. The 5-year contract commenced in 2017 with an options to extend. The contract is due to expire mid-2025. Includes fixed and variable costs for the Ballast Cleaning machine, spoil wagons, resurfacing, regulating and support staff. Ballast is supplied directly by ARTC and is delivered by train and truck. ARTC also provide an automated ballast train to the project.	Annual budgets are built up from: • Historically achieved unit rates • Scope • Severity of ballast fouling • Delivery and Procurement consultation regarding potential changes and risks going forward. •
Rail Grinding (MPM) 	***The work:*** Rail Grinding is the periodic removal of the rail surface damage induced by wheel contact and restoration of the rail profile to ensure favourable wheel/rail interface conditions. ***Asset Benefits*** • Reliability • Prolonged useful life of rail asset	Cyclic maintenance activity in accordance to engineering standards with frequency dependent upon: • Rail and traffic type • Line tonnages • Track geometry In determining the optimal Rail Grinding frequency a detailed analysis of rail performance is undertaken to maximise rail life and minimise the development of rail defects. ***Tonnage Relationship*** • Direct	The long term (10-year plan) scope is primarily based on the preventative grinding cycles; however Provisioning Centre inspections and monitoring tools are also used to refine the annual scope. The use of DSP allows further refinement based on parameters such as: • ICW Vertical acceleration data • Rail defect information • Ultrasonic test data • Grind Quality Index	Scope predominantly delivered by one plain track grinding contractor utilising a single 120-stone machine under a multi-year contract. This machine is utilised by ARTC across Business Units following a National Grinding Program. Some scope is delivered by other contractors utilising smaller grinders or milling machines. This is generally during shutdowns and typically in geographic areas such as Kooragang Island or Port Waratah where the 120-stone grinder is relatively inefficient.	Annual budgets are built up from: • Historically achieved unit rates • Scope forecast derived from DSP based on cycles for each track segment and tonnage profile • Number of grinding shifts allocated • Provision for utilisation of other machines for certain Line Segments • Delivery and Procurement consultation regarding potential changes and risks going forward. •
Maintenance Resurfacing (MPM) 	***The work:*** Maintenance Resurfacing, or Plain Track Tamping, is the restoration of the track geometric parameters to the 'as designed' condition using mechanised on-track machinery. Benchmarking data suggests that Maintenance Resurfacing is required every 50 to 120 MGT, however, actual requirement is significantly influenced by other factors. ***Asset Benefits*** • Safety • Reliability	Contributing factors Include: • Ballast condition • Formation condition • Overall track Stiffness • Line tonnage, axle load and speed • Track / geometry performance ***Tonnage Relationship*** • Direct	Tonnage-based tamping cycles are determined based on historical performance. The scope is identified as allowances per line segment. During the delivery year, the actual scope is determined using condition data including: • Top Moving Sum (TMS) • ICW data • Geometry Defects • Provisioning Centre inputs A multi criteria Track Condition score is produced in the DSP to help prioritisation.	The Maintenance Resurfacing contract was awarded to six contractors with a contract term between 2.5 and 5 years and will all end in June 2024. The multi-year contracts ensure value for money and secures the supply of plant, labour and professional services. The contracts are based on a schedule of rates where all shifts are fixed and inclusive. The variable component of the contract is related to extra hours or shifts, mobilisation and demobilisation, and any additional resourcing requested by ARTC.	Annual budgets are built up from: • Historically achieved unit rates • Consultation with Project Managers on likely unit rates • Scope volume •

Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Track Formation Reconstruction (MPM & CAP) 	***The work:*** Track Formation Reconstruction is the reconstruction of the track formation. It includes subgrade treatment and installation of structural earthworks, capping layer and new ballast, followed by track and drainage restoration. Sites are generally between 80m to 199m lineal metres long. Sites >200m long are included in the capital program of work. ***Asset Benefits*** • Safety and Reliability • Reduced maintenance	Contributing factors include: • Non engineered formation • Breakdown cement stabilised formation (Mix 3) • Poor drainage and water ingress into the formation • Ballast fouling and coal spillage ***Tonnage Relationship*** • Indirect	Scope is identified with: • Type and rate of failure • Track performance • Maintenance effectiveness • Geotechnical configuration • Operational requirements • Site specific features • Resources and closedown opportunities • Coordination with other maintenance activities • Asset Management Plan • MCA for formation failure sites with DSP information • Strategic areas with multiple sites	Multi-year construction agreements with a panel of contract partners. Sites are bundled as separable portions of work for competitive tender. Contracts are fixed lump sum price with a schedule of rates for latent conditions encountered. Utilising multiple construction companies allows multiple sites during track closures. The largest risk for track formation construction remains the management of spoil for each site. This is dependent on handling requirements, haul routes, transportation costs, spoil treatment (e.g., acid sulphate soil), stockpiling space, spoil re-use or recycling and cost of disposal.	Annual budgets are built up from: • Historically achieved unit rates • Consultation with Project Managers on likely unit rates • Geotechnical Investigations • Scope and complexity of work • Spoil management Scope can vary significantly from project to project resulting in differing unit rates between Pricing Zones and from year-to-year. The difference in the depth of excavation and transport of material costs (construction and spoil) can also drive large variances between sites.
Turnout Steel Component Replacement (MPM) 	***The work:*** Turnout Steel Component Replacement is the in-situ replacement of the turnout steel components through either the installation of a new item or the building-up of existing components through wire feed welding. ***Asset Benefits*** • Reliability • Safety	Contributing factors include: • Asset condition and wear of steel components • Corrosion • Configuration of the turnout and complexity of track geometry at the turnout location • Maintenance effectiveness including frequency and effectiveness of grinding and steel repairs. ***Tonnage Relationship*** • Indirect	Scope is identified with: • Historic data review • Condition assessment and review of defects with field validation • Decision Support Platform (DSP) data review. The DSP is essential in the assessment of component performance to detect trending performance issues and patterns of maintenance intervention. • Tonnage forecasts • Track possession availability • Risk review of possible failure outcomes.	Internal and external resources complete this activity. This approach provides greater control of scope completion. For the scope outsourced one commercial partner is engaged under a one plus one year contract for the provision of two teams per track closure. This activity also requires supply agreements for: turnout components; signalling; rail head repairs and safe working.	Annual budgets are built up from: • Based on historical costs at program level. • Tonnage forecast. • Consultation with Area Managers on broad scope requirements •
Ballast Undercutting (MPM) 	***The work:*** Ballast Undercutting is a mechanical method of removing highly fouled ballast and/or the impacts of mud holes and formation failure. This is used to address localised defects on smaller track sections (typically <100m) where it is impractical and expensive to carry out Ballast Cleaning. ***Asset Benefits*** Safety and reliability	Contributing factors include: • Ballast fouling and attrition • Poor drainage • Soft formation – mud hole • Fractured cementitious layer in the formation (Mix 3) • Failing rock subgrade ***Tonnage Relationship*** • Indirect	Scope is identified with: • Reports and advice from the Area Provisioning Centres during the live year. • Visual condition assessments • Track performance data • Review of weather forecasts. Wet weather periods causes mud holes sites to deteriorate	In 2022, a contract agreement divided into two zones (north and south of Muswellbrook) was sought to support undercutting, drainage and other specialised activities. The contract is a single year term with an option to extend for another year at ARTC's discretion based on supplier performance.	An allowance is allocated to each zone based on historical scope and unit rates. Consultations with the Project Manager are carried out throughout the year to capture any potential changes or risks to unit rates.

Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Rail Defect Removal (MPM) 	***The work:*** Rail Defect Removal involves the localised replacement of rail by cutting out a short section and installing rail of equivalent length. Rail Defect Removal also includes defect removal undertaken by 'building up' the rail through a wire feed welding process to restore its profile. ***Asset Benefits*** Safety and reliability	Contributing factors are: • Tonnage – cyclic live loading • Rail and component wear • Poor wheel to rail interface • High weld population in the rail • Corrosion • Internal defects • Surface defects ***Tonnage Relationship*** • Indirect	Scope is identified with: • Field inspection reports • Track performance data • Historical data • Monitoring and surveillance of rail and weld condition data	The Rail Defect Removal activity is undertaken using internal resources, with the scope mostly identified and undertaken by the Provisioning Centres and supplemented with external resources (welding, testing, etc.) on an as-required basis. Within the context of this activity, ARTC also works with commercial partners for the delivery of rail head repairs, with quotations sought in each instance and compared against the cost of replacement.	Annual budgets are built up from: • Based on historical costs at program level. • Tonnage forecast • Consultation with Area Managers on scope requirements •
Cess & Top Drain Maintenance (MPM) 	***The work:*** Cess and Top Drain Maintenance is a preventative maintenance activity that involves cleaning, installation and/or re-grading of cess, top and mitre drains to redirect surface water away from the track. ***Asset Benefits*** • Safety and reliability	Contributing factors include: • Asset condition • Track performance • Blockages • Vegetation • Ballast cleaning ***Tonnage Relationship*** • None	Scope is identified with: • Field inspection reports • Track performance data • Historical data • Cyclic maintenance program	In 2022, a contract agreement divided into two zones (north and south of Muswellbrook) was sought to support undercutting, drainage and other specialised activities. The contract is a single year term with an option to extend for another year at ARTC's discretion based on supplier performance. Drainage is also completed as a supplemental activity to Ballast Cleaning.	Annual budgets are built up from: • Historically achieved unit rates • Consultation with Project Managers on likely unit rates • Scope •
Ballasting (MPM) 	***The work:*** Ballasting is the replenishing of ballast after repeated Plain Track and Turnout Resurfacing activities, which cause the ballast to lose its angularity and become worn, broken and contaminated. ***Asset Benefits*** • Reliability	Contributing factors include: • Mechanised tamping • Cyclic train loading • Poor track performance • Track geometry I.e. high superelevation ***Tonnage Relationship*** • Indirect	Scope is identified with: • Condition assessments and field reports • Historical data on ballast supply for mechanised resurfacing operations	Ballast is procured using established supply agreements with quarries.	Annual budgets are built up from: • Cost of materials • Cost of delivery by road or rail • Scope Note that Ballasting does not include the Resurfacing cost.

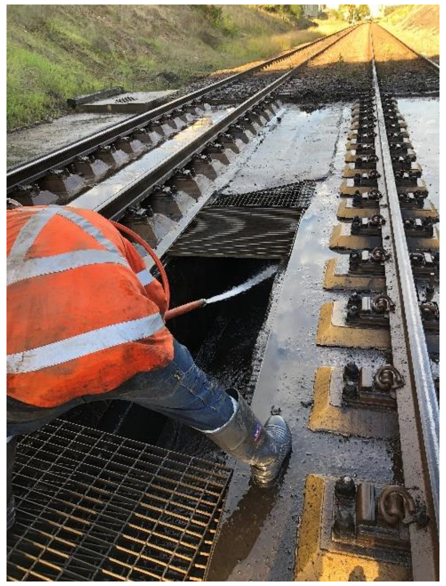
Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Steel Underbridge Repairs (MPM) 	***The work:*** To repair defects or replace or strengthen aged or defective steel bridge components and bearings. This may include cleaning debris from steel spans. Other activities include installation of remote monitoring systems and scaffolding. ***Asset Benefits*** Reliability	Contributing factors include: • Asset condition and wear of components • Corrosion • Configuration of the structure Maintenance effectiveness including frequency of steel repairs and inspections. ***Tonnage Relationship*** • Indirect	Scope is identified with: • Value engineering and options assessment • HV Steel bridges MCA prioritisation • Condition assessment and field validation by structural inspections • Member fatigue analysis • Prioritisation of defects • Monitoring system results • Ultra-sonic or magnetic particle testing • Maintenance intensity • Track possession availability • Risk review of possible failure outcomes	Site works construction agreements with selected contract partners via competitive tender. Sites are awarded as separable portions of work with a fixed lump sum price and a schedule of rates scope variations. The largest risk for this activity is limited skilled steel bridge resources.	Annual budgets are built up from: • Historically scope • Design scope which varies significantly from site to site • Cost of materials and delivery • Temporary works costs for bridge access The nature of the scope varies from minor steel underbridge components to large components. Hence, scope and unit rates are incomparable at a program level.
Turnout Replacements (CAP) 	***The work:*** In-situ replacement of existing turnouts or crossovers with new turnouts complete with new points motors and signalling as designed. Often includes formation renewal under the turnouts. ***Asset Benefits*** • Reliability • Safety • Reduced on-going reactive maintenance	Contributing factors are: • Asset age and condition • Axle loading and component wear • Corrosion • Surface condition and profile • Internal defects • Configuration and componentry • Soft formation • Maintenance effectiveness ***Tonnage Relationship*** Indirect	Scope is identified with: • Operation requirements • Asset Management Plan • Turnout specific Multi Criteria Analysis with the DSP • Historic data and defect review • Network capacity, criticality and speed requirements • Strategic drivers e.g. environmental • Tonnage forecast • Value engineering and design • Track possession opportunities • Resource availability	Multi-year construction agreements with a panel of site work contract partners. Sites are bundled as separable portions of work for competitive tender. Contracts are fixed lump sum price with a schedule of rates for latent conditions encountered. For quality and lead time reasons turnout components are typically procured by ARTC with pricing offers for manufacture and supply are quoted and evaluated	Annual budgets are built up from: • Historically achieved unit rates • Consultation with Project Managers on likely unit rates • Geotechnical investigations • Design scope and complexity of work • Spoil disposal
Transom Replacement (MPM) 	***The work:*** • Replacing worn timber transoms • Replacing track jewellery and transom fixings with new pads. • Installation of scaffolding • Replacing abutment bump plates • Re-aligning the track geometry ***Asset Benefits*** • Safety and reliability • Reduced maintenance • Reduced long term maintenance cost by installing FFU synthetic transoms.	Contributing factors are: • Timber transom wear from cyclic loading and exposure to extreme weather conditions • Componentry wear and corrosion • Track and structure configuration ARTC forward strategy is to install longer life synthetic transoms or FFU (Fibre reinforced foamed urethane transoms). The outcome is FFU transoms will see out the life of the structure with only small parts such bolts requiring replacement. ***Tonnage Relationship*** • Indirect	Scope is identified with: • Condition and defect monitoring. Annual review for transom condition, degradation rates and the set re-transom cycles. Re-transom cycles vary for each structure between 6 and 15 years. • Asset Management Plan discrete sites (for earlier years of the 10yr plan) – • Condition and defect monitoring • Historical in-situ in-service life cycle of hardwood timber transoms on the HV Network.	Site works construction agreements with selected contract partners via competitive tender. Sites are awarded as separable portions of work with a fixed lump sum price and a schedule of rates scope variations. Depending on lead time and availability of materials ARTC may procure the timber transoms and componentry and offers for manufacture and supply are quoted and evaluated.	Annual budgets are built up from: • Historically achieved unit rates • Consultation with Project Managers on likely unit rates • Scope and complexity of work • Scaffolding costs • Actual FFU supply costs •

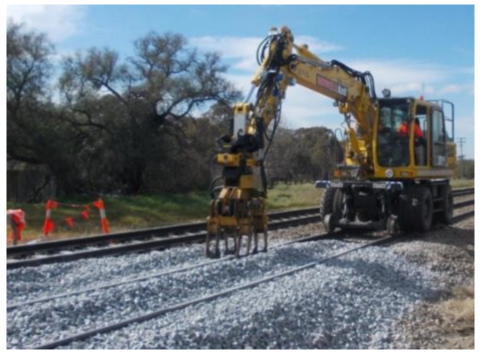
Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Cutting, Embankments Maintenance (MPM) 	***The work:*** Stabilising cutting and embankment batter slopes by: • Clearing loose rocks • Felling overhanging trees and trees in the batter causing root jacking • Laying back steep batter slopes • Clearing and establishing cess and top drain pathways ***Asset Benefits*** • Safety and reliability	Contributing factors are: • Erosion and scouring • Vegetation • Rock falls • Poor drainage ***Tonnage Relationship*** • None	Scope is identified through: • Asset Management Plan sites • Condition monitoring • ARTC Geotechnical Database with risk review and reports • Geotechnical investigation or field validation	Site works construction agreements with selected contract partners via competitive tender. Sites are awarded as separable portions of work with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Consultation with ARTC Geotechnical Engineer • Geotechnical investigations • Scope and complexity of work • Environmental Requirements •
Cutting & Embankments Works (CAP) 	***The work:*** Stabilising cutting and embankment batter slopes by strengthening with either: • Retaining wall • Rock buttress • Sheet piling • Rock bolting • Shotcreting with mesh • Earthworks widening ***Asset Benefits*** • Safety and reliability	Contributing factors are: • Steep batter slopes and non-engineered embankments • Weathering of cutting face • Erosion and scouring • Vegetation • Poor drainage and water ingress • Shear failure ***Tonnage Relationship*** • None	Scope is identified through: • Type and rate of failure • Condition monitoring • Maintenance effectiveness • Geotechnical investigation and configuration • Site specific features • Resources and closedown opportunities • Asset Management Plan sites • ARTC Geotech Database with risk reviews and reports	Site works construction agreements with selected contract partners via competitive tender. Sites are awarded as separable portions of work with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Consultation with ARTC Geotechnical Engineer • Geotechnical investigations • Design scope and complexity of work • Environmental Requirements •
Rerailing (CAP) 	***The work:*** Replacing rail before its life expiry with new rail including rail jewellery. ***Asset Benefits*** • Safety and reliability	Contributing factors are: • Wheel rail interaction • Metal removal by grinding • Rail fatigue • Ineffective rail lubrication • Corrosion • Track curvature • Rail wear limits • Poorly maintained wheels on rollingstock ***Tonnage Relationship*** • Direct	Scope is identified through: • ARTC HV Rail Wear Model • Desktop and field review • Provisioning Centre requests • DSP data correlation with rail profile analysis and grinding plan to confirm annual scope prioritisation • Rail wear rate and rolling contact damage • Internal defect rate • History of broken rails and GIJs • Weld density • Operational parameters • Resource availability • Track closedown opportunities • Coordination with other activities •	Supply agreements with selected suppliers of rail and rail sets. Multi-year contracts exist with contracting partners that deliver packages of scope. New contracts are being developed for July 2023 onwards.	Annual budgets are built up from: • Historical scope and unit rates • Scope • Cost of materials and delivery •

Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
<u>Bridge End Track Upgrade (CAP)</u> 	***The work:*** Strengthening bridge end formation approaches with transition slabs on reconditioned reinforced formation 20m behind the abutment. Includes installation of sub surface drainage. Asset Benefits • Reliability	Contributing factors are: • High dynamic live load forces at the bridge end transition • Poor drainage and water ingress • Steep stiffness transition • Ballast attrition • Excessive tamping • Loss of shoulder ballast ***Tonnage Relationship*** • Indirect	Scope is identified through: • Track performance and rate of failure • Maintenance effectiveness • Geotechnical configuration • Site specific features • Resources and closedown opportunities • Coordination with other maintenance activities • Asset Management Plan • MCA for formation failure sites with DSP information • Strategic areas with multiple sites	Multi-year construction agreements with a panel of contract partners. Sites are bundled as separable portions of work for competitive tender. Contracts are fixed lump sum price with a schedule of rates for latent conditions encountered.	Annual budgets are built up from: • Historically achieved unit rates • Consultation with Project Managers on likely unit rates • Geotechnical investigations • Scope and complexity of work • Spoil management •
<u>Bridge Renewal or Upgrade (CAP)</u> 	***The work:*** • Replacing aged bridges with new concrete ballast top structures • Upgrading parts of existing structures to strengthen them such as span replacement or pier and abutment strengthening. • Tunnel structure strengthening ***Asset Benefits*** • Safety and reliability • Reduced maintenance • Flood immunity	Contributing factors are: • Asset age and condition • Fatigue and component wear • Corrosion • Flooding and poor hydraulic performance • Track condition and profile • Structure configuration • Foundation failure • Low maintenance effectiveness ***Tonnage Relationship*** • Indirect	Scope is identified through: • Structural inspections • Value engineering and options assessment • Engineering investigations and design • Operational requirements and tonnage forecasts • Environmental and hydrology requirements • Sensitivity to TSRs • Condition monitoring and review of the HV Bridges MCA priorities with DSP information • Asset Management Plan and discrete sites	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Engineering investigations and design scope • Complexity of the work • Cost of materials and delivery •
<u>Culvert Upgrade (CAP)</u> 	***The work:*** • Replacing defective or under capacity culverts • Upgrading parts of existing culverts to strengthen them such new wingwalls or full relining of the interior ***Asset Benefits*** • Reliability • Reduced maintenance • Flood immunity	Contributing factors are: • Asset age and condition • Inadequate load capacity • Fatigue and component wear • Corrosion • Inadequate hydraulic capacity • Structure configuration • Foundation settlement • Low maintenance effectiveness ***Tonnage Relationship*** • Indirect	Scope is identified through: • Risk based Multi Criteria Assessment • Condition assessment • Tonnage forecast • Structural inspections • Engineering investigations and design • Asset Management Plan and discrete sites	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Design scope • Cost of materials and delivery •

Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Level Crossing Maintenance (MPM) 	***The work:*** • Clearing vegetation for improved sight lines • Cleaning drainage through the crossing • Crossing panel minor repairs or replacement • Minor asphalting on the road • Track resurfacing ***Asset Benefits*** • Safety and reliability	Contributing factors are: • Asset condition • Component and surface wear • Foundation settlement • Poor drainage • Safety requirements ***Tonnage Relationship*** • Indirect (for track) • None (for other)	Scope is identified through: • Safety assessments such as sight line assessments and Road Safety Audits • Tonnage forecast • Routine visual inspections • Condition monitoring with DSP reviewing historical track geometry defects	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Scope • Cost of materials and delivery •
Level Crossing upgrade (CAP) 	***The work:*** • Road crossing track panel replacement • Pedestrian crossing panel replacement and new maze construction • Road re-profiling with new formation and asphalt surface • Road line markings and signage • Signalling system renewal • Installation of boom gates • Track resurfacing ***Asset Benefits*** • Safety • Reliability	Contributing factors are: • Asset condition • Component and surface wear • Foundation settlement • Poor drainage • Safety requirements ***Tonnage Relationship*** • Indirect (for track) • None (for other)	The scope is identified through: • Safety assessments such as sight line assessments and Road Safety Audits • Tonnage forecast • Routine visual inspections • Condition monitoring with DSP reviewing historical track geometry defects • Engineering investigation and design	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Engineering design scope and complexity of the work • Cost of materials and delivery •
Signalling System Upgrades (CAP) 	***The work:*** • Power supply upgrades • Location Box upgrades • Communication system upgrades • Signal control circuit upgrades • New signal posts / masts / lamps • Conditioning monitoring alarm, pt and CCTV • New access ladders • Signalling system upgrades ***Asset Benefits*** • Safety and reliability	Contributing factors include: • Asset age • Asset Obsolescence • Environmental factors These factors may result in recurring loss of signalling and communications performance, which poses a risk to the safe operation of trains, reduced operational performance or reduced maintenance effectiveness. • ***Tonnage Relationship*** • None	Scope is identified through: • Asset condition and monitoring • Asset Management Plan Sites (for earlier years of the 10yr plan) – discrete locations identified using the Multi Criteria Analysis in the DSP • Strategic Sites – driven by environmental or other risk factors and have the potential of adversely impacting many customers • Emerging Sites – usually identified during the live year through visual observations and current condition data	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Engineering design scope and complexity of the work • Cost of materials and delivery •

Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Tunnel Maintenance (MPM) 	***The work:*** • Repairing structural defects • Strengthening tunnel lining • Drainage system clean • Sump pump servicing ***Asset Benefits*** • Reliability • Reduced maintenance	Contributing factors include: • Asset age • Drainage blockages • Pump failure • Ground movements • Floor or wall displacement ***Tonnage Relationship*** • Indirect (for track) • None (for other)	Scope is identified through: • Condition assessment • Cyclic survey scans • Routine and cyclic structural inspections • Cyclic drainage and pump cleaning	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Engineering investigations and design scope • Complexity of the work •
Culvert Structural Repairs (MPM) 	***The work:*** • Replacing failing components • Repairing defects • Cleaning out sediment and debris blockages • Clearing approach channels ***Asset Benefits*** • Reliability • Reduced on-going reactive bridge and track maintenance • Flooding immunity	Contributing factors are: • Asset age and condition • Component wear • Corrosion • Blockages • Structural displacement • Environmental ***Tonnage Relationship*** • Indirect	Scope is identified through: • Risk based Multi Criteria Assessment • Condition assessment • Routine structural inspections	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Design scope • Cost of materials and delivery •
Concrete or Masonry Underbridge Repairs (MPM) 	***The work:*** • Replacing failing components such as cracked wingwalls and bearing plinths • Repairing defects such as spalling or repointing brick work ***Asset Benefits*** • Reliability • Reduced on-going reactive bridge and track maintenance	Contributing factors are: • Asset age and condition • Component wear and cracking • Insufficient structural capacity • Structural displacement • Environmental • Soft formation behind abutments Track loading and geometry ***Tonnage Relationship*** • Indirect	Scope is identified through: • Risk based Multi Criteria Assessment • Condition assessment • Tonnage forecast • Routine visual inspections • Cyclic engineering inspections	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Design scope • Cost of materials and delivery •

Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
Subsurface Drainage Maintenance (MPM) 	***The work:*** • Replacing failing components • Repairing defects • Cleaning out sediment and debris blockages ***Asset Benefits*** • Reliability • Safety • Reduced on-going reactive bridge and track maintenance • Flooding immunity	Contributing factors are: • Asset age and condition • Pipe and pit wear • Blockages • Inadequate load capacity • Pipe displacement • Environmental ***Tonnage Relationship*** • Indirect	Scope is identified through: • Condition assessment • Routine visual inspections • CCTV/Scans of sub surface drainage systems • Cyclic drainage system cleaning	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Cost of materials and delivery •
Noise Abatement Walls (CAP) 	***The work:*** Construction of new noise abatement walls and gates. Typical post and panel wall with Hebel panels and steel columns planted in a reinforced concrete foundation. ***Asset Benefits*** • Environmental • Corridor Security	Contributing factors are: • Environmental factors • Noise monitoring programs • Security ***Tonnage Relationship*** • None	The scope is identified through: • Noise monitoring • Community consultation • Engineering design	Site works construction agreements with selected contract partners via competitive tender. Contracts awarded with a fixed lump sum price and a schedule of rates scope variations.	Annual budgets are built up from: • Historically scope and unit rates • Design scope • Cost of materials and delivery •
Complex Projects 	***The work:*** Upgrading aged assets that involve staging and multiple disciplines: • Junction upgrades with turnouts and crossovers • Earthworks, track and signalling works • Larger bridges replacements requiring staging • New loops and loop extensions • Siding and yard upgrades • Sites with multiple assets being upgrades as part of an area master plan ***Asset Benefits*** • Safety and reliability • Increase capacity • Flood immunity	Contributing factors are: • Insufficient network capacity and reliability • Insufficient hydraulic capacity • Safety and environmental issues ***Tonnage Relationship*** • Various depending on project	Scope is identified through: • Value Engineering • Engineering pre concept designs and option assessment • Cost estimating • Stakeholder consultation • Operation requirements • Safety objectives • Environmental conditions • Risk assessment	Site works construction agreements with selected contract partners via competitive tender or Design and Construction Contracts.	Annual budgets are built up from: • Historically scope and unit rates • Engineering design scope • Cost of materials and delivery •

Work Activity	Description	Contributing Factors	Scope Development	Contract & Procurement	Cost Estimation
<u>Inspection and Minor Repairs of Points (RCRM)</u> 	***The work:*** • Field inspections, measurements and reporting • Hi-rail patrols • Remove obstacles • Minor part replacement ***Asset Benefits*** • Safety and reliability	Contributing factors are: • Cyclic train loads • Turnout condition • Track and turnout geometry • Mechanised resurfacing • Civil works • Flooding ***Tonnage Relationship*** • Indirect	Scope is identified through: • Technical Maintenance Plan • Turnout age • Field inspection reports and defects register • Historical information • DSP Track Condition Score	Inspection and site work undertaken by ARTC track maintenance crews.	Annual budgets are built up from: • Based on historical costs at program level.
<u>Reactive Track Correction (RCRM)</u> 	***The work:*** • Installation of closure rails • Excavator tamping and minor geometry adjustments • Minor track defect removal • Track jacking • Monitoring and surveillance ***Asset Benefits*** • Safety and reliability	Contributing factors are: • Wear and tear from cyclic train loading • Rail and sleeper condition • Ballast fouling • Poor drainage • Mudholes • Flooding ***Tonnage Relationship*** • Indirect	Scope is identified through: • Technical Maintenance Plan • Field inspection reports and defects register	Inspection and site work undertaken by ARTC track maintenance crews.	Annual budgets are built up from: • Based on historical costs at program level.