Hunter Valley Coal Network Access Undertaking
2021 Annual Compliance Assessment

ATTACHMENT 1: Hunter Valley Network Operating Costs

Submission To

Australian Competition & Consumer Commission

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PUBLIC VERSION

ARTC

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1. INTRODUCTION

This document contains additional information and analysis relating to ARTC's Network operating costs for the 2021 calendar year. It is intended to supplement the information contained in ARTC's submission to the ACCC for the assessment of compliance with ARTC's Hunter Valley Access Undertaking (**HVAU**) during the 2021 period.

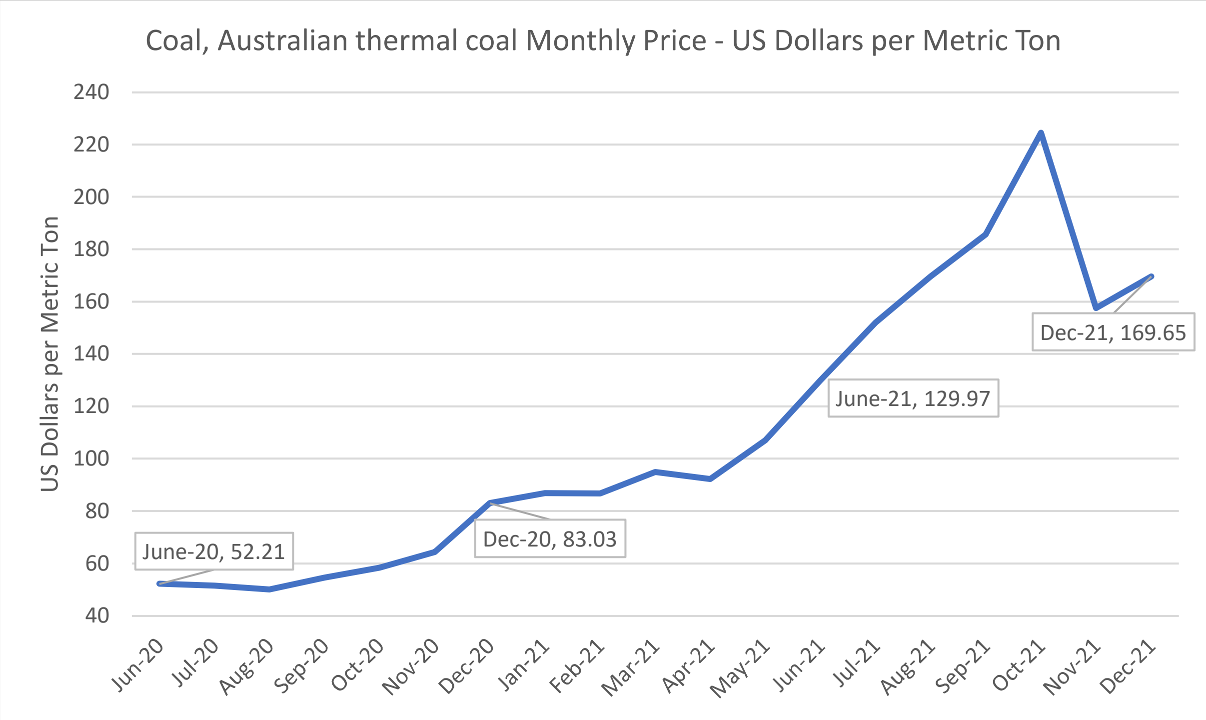
The increased demand and recovering coal price seen through 2021 reflected the increased confidence in financial and consumer markets as the economy adapted to the continuing impacts of the COVID-19 pandemic. With coal prices gradually rising to reach a record high of $225 per metric tonne at the back end of 2021, to ensure they capitalised on the increase in demand, customers communicated that ARTC's priorities should reflect network reliability and availability. Despite this sentiment and the recovering global markets, 2021 saw a significant number of external disruptions to the network in the form of severe flooding, continued inclement weather conditions and protestor events negatively impacting the network throughput result for the year.

Table 1: Hunter Valley Network Coal Gross Tonne Kilometres (GTK)

Pricing Zone	CY18 GTK ,000	CY19 GTK ,000	CY20 GTK ,000	CY21 GTK ,000	% Variance 2018 - 2021	% Variance 2019 - 2021	% Variance 2020 – 2021
Pricing Zone 1	27,296,875	28,608,590	27,405,381	26,976,698	(1.2%)	(5.7%)	(1.6%)
Pricing Zone 2	[redacted]	[redacted]	[redacted]	[redacted]	2.5%	(2.9%)	(1.8%)
Pricing Zone 3	[redacted]	[redacted]	[redacted]	[redacted]	(13.7%)	(9.6%)	(11.8%)
Total GTKs	**45,207,383**	**46,586,649**	**45,505,895**	**43,847,283**	**(3.0%)**	**(5.9%)**	**(3.6%)**

Note: Totals may not add due to rounding

Figure 1: Australian thermal coal Monthly Price – US$/ MT June 2020 – December 2021[1]



During 2021, the Hunter Valley Coal network achieved a total coal transportation volume (including domestic) of 167.7 million tonnes (Mt), a 2.4% decrease from total achieved tonnage volumes for 2020 of 171.9Mt. The overall total coal network Gross Tonne Kilometres GTK's decreased 3.6% between 2020 and 2021 with the volume profile varying at a zonal level. GTKs in Zones 1 and 2 decreased by 1.6% and 1.8% respectively, reflecting the impact of network disruptions. Although reducing slightly from the prior year, Zone 2's GTK throughput reflects the continued impact of the expansion of operations at the extremities of the zone. GTK's in Zone 3 peaked in 2017 before returning to stable contracted levels in 2020. Weather events across the Gunnedah Basin and Hunter Valley have impacted the coal customers operational productivity and severed road access to some Zone 3 mines for up to 2 weeks resulting in a lower production and reduced network availability causing the 11.8% cumulative reduction in GTK's between 2020 and 2021.

Figure 2 : Mine roads submerged in flood water just north of Boggabri [2]

[1] Source: Mundi Index

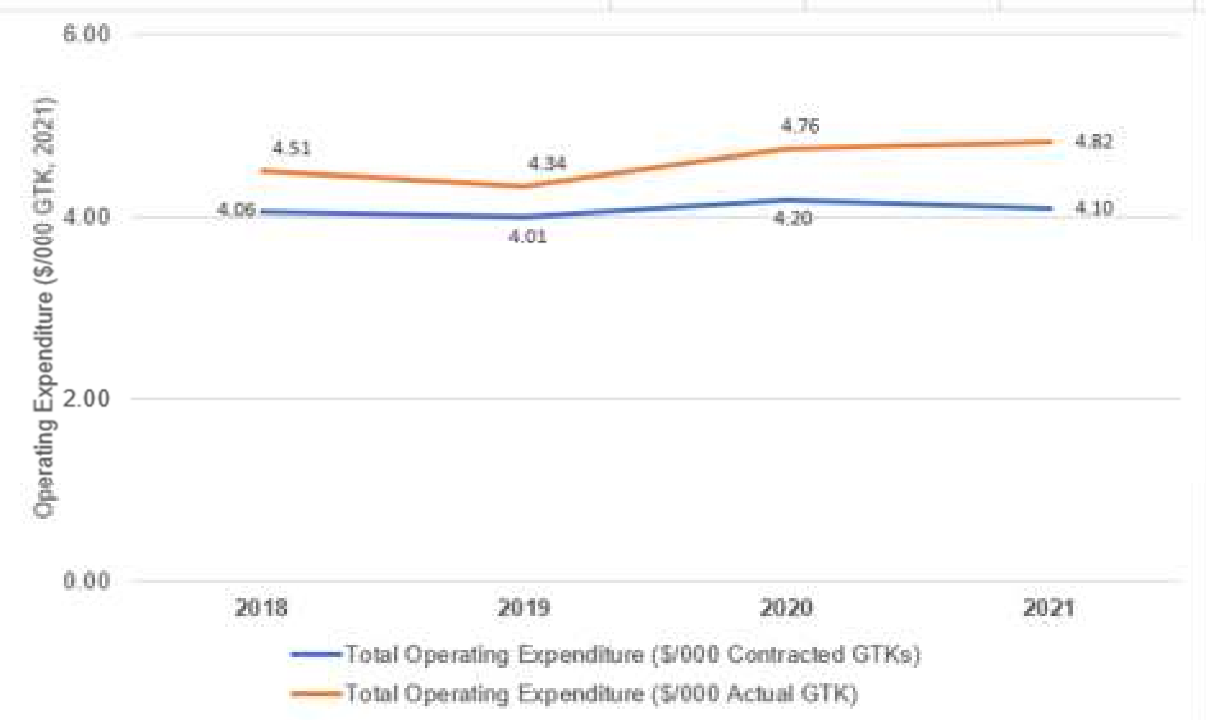
[2] Source: https://www.abc.net.au/news/rural/2021-11-27/photos-floods-north-west-nsw-weather/100653494?utm

Figure 3 below illustrates the Coal Network's year-on-year actual GTKs and compares this to Customer contracted volumes per Zone. The historical contracted and customer most likely profiles drive the volume assumptions used in building the forecasted maintenance plan. Actual GTK's achieved over the last 5 years have, on average, been 15% below customers most likely forecasted scenarios reflecting customers continued positive sentiment which has only been boosted further by the record coal prices seen in 2021.

Figure 3: GTK's per Zone

The trend of GTK's over time has an influence on cyclical maintenance requirements. Current customer contracted volumes and most likely GTK forecasts and contracted volumes show a declining 10-year volume profile. The efficiency and cost focus initiatives that ARTC have been focusing on in recent years are imperative to embed into our maintenance plans and operating cost outcomes. Notwithstanding, non-maintenance related operating costs (Overheads, Business Unit Management and Network Control costs) largely relate to full-time staff members. The ability to adjust these non-maintenance costs up and down in the short term in line with movements in actual GTK's is limited as it would lead to substantial recruitment costs, high staff turnover and significant loss of corporate knowledge. ARTC are continuously improving asset management practices in line with risk focused and condition-based principles, with forecasted and contracted GTK's received from Customers on an annual basis forming an integral part of this process. A significant component of ARTC's maintenance expenditure is fixed in nature due to contract terms agreed with suppliers to achieve cost efficiencies The categorisation of each type of maintenance activity is determined by the causal factors and cost drivers and also impacts the fixed yearly costs incurred by Customers.

Figure 4: Total Real Operating Expenditure per $‘000 Contracted and Actual GTK (real $2020), 2018 to 2021



The graph represented in Figure 4 above shows both Real Operating Expenditure per contracted and actual GTK’s. The trend in Real Operating Expenditure over actual GTK’s shows an increase of 7% from 2018 to 2021. The impact of the two flooding events in 2021 is apparent in the reduction of GTK’s from 2020 and impacts the upward trend seen in the 2021 figure for the current year as Real Operating Costs in of themselves reduced. When comparing real operating expenditure over contract GTK’s the trend is relatively flat, with a 1% increase for the same period. ARTC is continuously striving to become more efficient with managing both maintenance and non-maintenance expenditure noting that the sensitivity of real operating costs to GTK’s railed is inherently not a linear relationship.

The focus of Customers and ARTC has been to develop enhancements to the existing assets and processes that will result in increased efficiency of the network without the need for significant capital expenditure. Several operational expenditure projects were implemented during 2021. The multi-faceted Asset Management Improvement Project (AMIP) continued to evolve, providing a more sophisticated asset management framework that focuses on improving how maintenance and projects are recorded, managed and planned in order to increase operational efficiency and resource optimisation. There were a range of improvement projects that stemmed from the initial AMIP projects that were completed in 2021. These included:

- Improved planning and scheduling of maintenance activities at Provisioning Centres.
- Enhanced train control reporting and the implementation of field mobility services.
- An accurate geometric model of the network incorporating track deficiencies and work being completed on track has been incorporated into the Geographical Information System (GIS). This allows for viewing of maintenance works and the improvement of predictive analysis in graphical form.
- Development systems which enable the recording of all project works within the asset management system.

Enabled by the development of AMIP in prior years, the Decision Support Platform (DSP), was successfully implemented in the second half of 2021. The DSP is an overarching system that captures data and makes it available for centralised analysis. It provides ARTC with improved track condition data, identifies early warnings signs of potential failures and enables timely determination of the root cause of defects allowing for more efficient and cost-effective planning of works programs. DSP was used daily throughout the last quarter of 2021 to determine network priorities in response to the November floods, identifying sections of the network with rapid deterioration as well as determining the maintenance effectiveness where sections of work has been completed but may require further intervention. The data centralisation and transparency that DSP has enabled allows short term and long-term decision making to have a more focused lens to determine key network priorities and ensures improved asset reliability for Customers.

The Weighbridge Data Capture Project was initiated in 2021 with the aim to deliver train weight data to customers and rail haulage providers from all five Hunter Valley weighbridges in a reliable and efficient manner. With work continuing until the commissioning date in 2022, the project aimed to reduce the need for customers to revert to nominal train weights, as dictated by their base Coal Supply Agreements, resulting in more accurate invoicing of their customers and revenue capture. Increasing the use and efficiency of internal labour has been a key priority and initiative to reduce overall maintenance expenditure for 2021 onwards.

A new Provisioning Centre has been refurbished and opened in Rutherford, creating a centralised work environment, and had enabled greater efficiencies for operational teams in the lower Hunter Valley. The facility co-locates several workgroups previously scattered throughout various Hunter Valley locations directly linking this site to the other four Hunter PCs.

In May 2021 a presentation was made to the RCG on ARTC's challenges and work to date in developing a Spoil Strategy. The presentation contained the ongoing monitoring and results from a Spoil Reuse Trial at Whittingham which was started in May 2020 where 3,500 Tonnes of structural material was prepared from spoil for use at the nearby Whittingham track reconditioning project. The material was selected carefully and met all ARTC's standards for structural fill. The trial site has a significant lead time until conclusive results are available and is currently being monitored for performance to assess the longer-term effectiveness of the repurposed material. However, current short-term observations indicate that track performance is consistent with normal track degradation levels.

The 2021 calendar year saw a decline in performance of infrastructure loss outcomes, with the 2021 annual losses reported as 1.69% against a 2020 result of 1.28%. The increases in the reliability losses compared to the prior year were primarily due to Rail Breaks and Signalling and Points. Rail breaks accounted for approximately 38% of all infrastructure losses in 2021. There was also a significant infrastructure reliability loss attributed to the Muscle Creek Bridge settlement in late November with the site impacted by rainfall resulting in a 0.26% loss.

There was a total of 42 rail breaks in the Hunter Valley in 2021, a slight increase compared to 38 rail breaks in 2020. Although the increase in the number of rail breaks compared to 2020 is not significant, the impact in terms of train cancellations and infrastructure losses (0.65%) is higher compared to 2020 (0.17%) due to the complexity and location of the breaks resulting in the large disruptions and impacts on performance of the network. A notable disruption was a single rail break in Zone 1 at Grasstree in September 2021 which contributed to 18% of all rail break losses for the year. This rail break caused 22 train cancellations and resulted in a 0.11% reliability loss. The dominant type of rail break in 2021 was welds which made up of 50% of all rail breaks. There has been focus on weld improvement processes in recent years and there will be on-going focus in 2022 on weld quality inspections and testing, however noting there are still legacy welds on the network. The use of DSP as the basis of monitoring to assess the condition of insulated joints will increase as well as the testing of a rail break prediction tool developed by the University of Newcastle in conjunction with the Hunter Valley Reliability team in 2021. ARTCs rail defect removal strategy was an area of focus in 2020 due to rail breaks being the leading cause of RCG reportable infrastructure losses in 2018 and 2019. The continued effectiveness of this preventative maintenance strategy is evident in 2021 with the number of rail breaks remaining relatively consistent and rail defect infrastructure losses reduced from 0.16% in 2020 to 0.02% in 2021.

In 2021, signalling and points related failures resulted in a 0.50% reliability loss, an increase compared to the 0.36% loss in 2020 and equivalent to 30% of all infrastructure losses in 2021. Notably there were signalling delays in relation to track circuit failures at Sandgate both in the March and November 2021 floods. However, the number of signalling failures decreased 15.2% compared to 2020. Figure 5 below shows the overall decrease in both the number of failures and the associated delay noting that the delay in hours is the lowest it has been since 2016. The divergence in the two above results stems from the location in which the signalling failure occurs and volume of traffic which traverses that section of track. As reported to the RCG, from July 2019 to July 2021, 276-point failures have been prevented by the Points Conditioning Monitoring (PCM). Over the same period, ARTC experienced 184 unprevented failures on points equating to a 60% failure prevention rate. The remaining installation of the PCM machines will be completed by June 2023 bringing the total number of monitoring machines to 253 across the entirety of the network.

Figure 5: Signalling Related Failures and Delays

Various external events throughout 2021 have presented numerous incidents and external challenges for ARTC which have had a direct impact on network performance and overall maintenance costs.

Continual severe wet weather impacted the network throughout 2021 with multiple flooding events impacting daily operations. The network wide flooding events in March and November led to areas of the network showing increased signs of degradation and in some cases severe accelerated deterioration of track geometry. During the November 2021 closedown, a slip was identified on the Murrurundi side of the Ardglen range which has resulted in $0.9m of incidents costs. The slip occurred on the upside of the track, impacting track geometry which required immediate containment measures which were critical to stabilise the embankment to avoid any potential catastrophic failures. The drenching of the network that was seen prior to the November closedown also caused significantly high-water levels at Muscle

Creek. A site inspection of the Muscle Creek Bridge identified that an abutment had rotated, indicating a partial failure of the timber substructure which ultimately resulted in the closure of the network. Critical temporary repairs were completed to ensure services were maintained until the replacement of the bridge in May 2022. The 2021 weather events have resulted in the increased monitoring of the network, constrained access to the rail corridor due to access roads and causeways being inaccessible, additional mobilisation and demobilisation costs and unplanned maintenance to address track condition. ARTC has taken a purposeful approach to maintain the integrity of the network by focusing on areas with the highest risk.

Figure 6: Muscle Creek Bridge abutment failure

Forming part of the Infrastructure Maintenance costs for 2021, there were numerous extraordinary incidents that occurred on the network. In addition to the embankment slip at the Ardglen Range in November 2021 mentioned above, the ARTC Hunter Valley network was targeted with sustained trespassing and protest activities. [redacted]

ARTC continued to adapt its work practices throughout 2021 to be able to effectively respond to the ongoing COVID-19 environment. During this time the NSW government imposed 'stay at home orders' on the residents of Local Government Areas (LGA's) which had a high occurrence of the virus. ARTC office staff were again required to work from home and recorded high absenteeism due to isolation requirements and were subject to a vigorous daily COVID testing regime once allowed to return to the office. The stay-at-home orders in effect limited the movement primarily of Sydney and Hunter Valley residents to 5km out of their LGA unless they were deemed an 'essential worker'. It was determined that the work performed by ARTC's Network Control staff, maintenance field teams and external contractors was 'essential' to the continued running of the network. External medical providers were engaged to support this work and Rapid Antigen Tests made available at all sites to support the continued safe operation of ARTC Networks. Internal resources were required to decipher and implement stringent governmental controls which resulted in significant changes to staff interactions. Additional planning and management was required to implement changes to worksites, manage shift rotations in Network Control, update travel policies for workers from affected LGA's and ensure corporate controls included the proactive engagement of local councils and service providers across the region. Internal and external workers travelling between two different LGA's required evidence of negative COVID-19 tests within 7 days of commencement of work, approved COVID-19 safe site control plans and demonstration that social distancing was in place for accommodation and meals to ensure safe interaction with local communities. Particularly in zone 3, the difficulties that resulted in securing contractor personnel from locked down LGA's and access to accommodation for the August Closedown works resulted in increased costs and a portion of the closedown scope being deferred until restrictions were lifted and the risk of COVID-19 had reduced. ARTC prioritised the safety of its employees and communities whilst remaining agile and tenacious to ensure compliance to regulations and the uninterrupted running of the Hunter Valley coal supply chain.

The April closedown being postponed immediately prior to commencement of work due to the March floods and the August possession deferring scope due to COVID-19 restrictions had a significant impact on the timing and cost of maintenance work completed throughout the year. Additionally, due to the major delays experienced in the month of November, coupled with the desire of customers to capitalise on the record coal prices, ARTC consolidated and delayed the PMP's scheduled for December 2021 completing only essential maintenance works to ensure maximum throughput. These measures however necessary, created a reduction in maintenance scope, inefficiencies in scheduling and increases in de-mobilisation and re-mobilisation costs for site works which were directly postponed or delayed.

The ARTC Network Control Optimisation (ANCO) project was initially developed to increase network capacity through deferral and avoidance of capital infrastructure investment and efficiency by addressing the existing inefficiencies that had become systematically embedded in the coal chain's daily planning and operations. In the 2019 and 2020 Joint Compliance Submission, ARTC reported that the primary tangible benefits as outlined in the ANCO business case, being the increase in track utilisation and the avoidance and/or deferral of capital expenditure in the form of track infrastructure had been delivered. Productivity gains from dynamic train management has resulted in the targeted reduction in train dwell being met and the improved data capture that was enabled by the technology has laid the foundation for more sophisticated network performance analysis. Additionally, from a customer perspective, by increasing the efficiency of real time train planning and execution, ANCO enabled 5% improved utilisation of the available track capacity resulting in an increase in saleable capacity (paths) for Pricing Zones 2 and 3. In addition to the capacity uplift, the delivery of the ANCO project, is more responsive to Customer's dynamic needs, and created a supply chain that now has the technological capability to be integrated throughout.

In addition to the main capital and capacity objectives that were achieved by the implementation of ANCO, the initial business case conveyed that the project would deliver Business as Usual cost reductions. During the implementation of ANCO, complexities arose when it became evident that the need for Network Control resources were required to remain in place to support the transition and intensive training regimens of the business-as-usual operators. Specifically, there was a requirement for resources to remain within the network control function to assist with the increased data entry requirements in order to utilise the newly implemented system and further embed the broader supply chain opportunities that ANCO had enabled. Further work was required on the program's integration with supply chain partners to refine the planning process with additional data, including forecast loading times and above rail planned activities such as provisioning and transpositions.

The timing of the implementation of the foundational capabilities of ANCO coincided with the outbreak of the COVID-19 pandemic. As was experienced globally at the time, COVID-19 lockdowns, social distancing, and isolation requirements impacted the running and scheduling of the entire Network Control Function. The greater Network Control team is broken further into smaller teams which are scheduled on a rotational shift basis. At times, the COVID-19 regulatory requirements resulted in each sub-team being totally isolated from the other teams. With limited ability to cross fill for absences and the continued reality that whole teams of Network Controllers were isolating, resulted in other rotations having to fill those shifts. This created an unprecedented shortage in Network Controllers with team members working significant amounts of overtime and staffing shortages across the wider team experienced. The greater Network Control team (not only the Network Controllers) have been relied upon throughout the period of 2020 to 2022 to fill the gaps to ensure that the network has remained safe, reliable and running. No cost savings were realised by Network Control during the years of COVID-19 due to the reasons above, with ARTC acknowledging and being proud that the Network Control team were able to keep the network functioning safely and reliably throughout this challenging period.

During 2021, the continuation of COVID-19 impacts and the scarce labour market which had eventuated, led to ARTC challenging business assumptions and the original ANCO business case in relation to required staffing levels at Network Control. Network control competencies require a long lead time for each board. This is usually 6 – 12 months initially and up to years post this for competency on multiple boards. This lead time along with no transferable experience other than direct role transfer, resulted in these positions being extremely specialised, reinforcing to ARTC management that the impact of turnover in this function creates a significant risk to the safe and efficient running of the network. An ageing workforce along with the immediate issues of increased turnover and a tight labour market, emphasised the critical requirement to embed succession planning in the Network Control Function as a key focus for 2022 and moving into 2023. This new strategy is a key focus of discussion at the ANCO Oversight Committee.

Given the considerations above, ARTC has identified that a reduction in headcount of its critical function of Network Control would pose a significant risk to the network and the organisation. ARTC have made a conscious decision that the running and integrity of the network far outweighs any potential small cost savings in Network Control in the short term. The key focus and success of the delivery of the ANCO project was to deliver the technological infrastructure and systems to support the move from an inefficient and archaic paper-based planning system to a live dynamic environment making the progression toward an advanced integrated supply chain. ANCO expenditure in 2021 remained consistent with 2020. As conveyed in prior submissions, the implementation of the ANCO project has resulted in ongoing annual costs in the form of external support services, additional licence fees to enable the hosting and integration of external data sources and a backup operating environment to facilitate continuity and parallel live implementation, testing and training.

The significant increase in Business Unit Management costs is largely attributed to a review of the accounting treatment of various cloud-based engineering software. Complexities in accounting for, and lack of guidance for this type of expenditure from Accounting Standard Bodies resulted in an internal review to ensure the appropriate classification between capital and operating expenditure was in line with current Accounting Standards. The findings of this review resulted in $4.5m of the overall software spend being classified as operating expenditure. The Decision Support Platform (DSP) which has been developed over recent years to provide a centralised system that allows condition monitoring data to be displayed in one location was the largest contribution to this movement making up 82% of this cost.

Corporate overheads costs remained consistent with 2020. One area of increased costs was the Safe Work Improvement Program (SWIP) that was developed to increase network safety. This project comprised eight separate projects to be implemented between 2020 and 2023. The three-year program continued to progress throughout 2021, establishing a consistent approach to ARTC's safe working systems and practices whilst continuing to promote an improved safety culture. Another area of increased costs was the result of continuing extreme meteorological events across the Network which has continued to put upward pressure on insurers. The global insurance industry is continually evaluating and reducing the events they are prepared to insure for resulting in unavoidable costs for ARTC by way of both significant increases in insurance premiums and associated excess's payable in the event of successful insurance claims.

Table 2 sets out a comparison of the total operating costs in 2020 against 2021 for the Hunter Valley Coal Network. An explanation for the movement in costs is the following sections.

Table 2: Hunter Valley Coal Network Operating Expenditure $'000

	2020 (a)	**2021 (b)**	**% Variance (b)/(a)-1**
Infrastructure Maintenance	126,169	119,012	(5.7%)
Loss on Disposals	11,467	10,135	(11.6%)
Expensed Project Costs	-	4,437	n/a
Network Control	20,188	19,919	(1.3%)
Business Unit Management	36,090	40,534	12.3%
Corporate Overheads	24,833	24,930	0.4%
Less Non-Coal Allocation	(2,823)	(7,555)	167.6%
Total Operating Expenditure	**215,923**	**211,413**	**(2.1%)**

Note: Totals may not add due to rounding

2. INFRASTRUCTURE MAINTENANCE

Infrastructure Maintenance includes Major Periodic Maintenance (MPM) and Routine Corrective and Reactive Maintenance (RCRM) work programs.

MPM is typically major cyclical or planned activities that maintain the operating performance and asset life of operational infrastructure and aim to reduce the level of defects and corrective maintenance. These activities are largely delivered within the network closedowns and are predominantly outsourced.

RCRM is typically minor 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.

Figure 7: Infrastructure Maintenance Expenditure (real $)

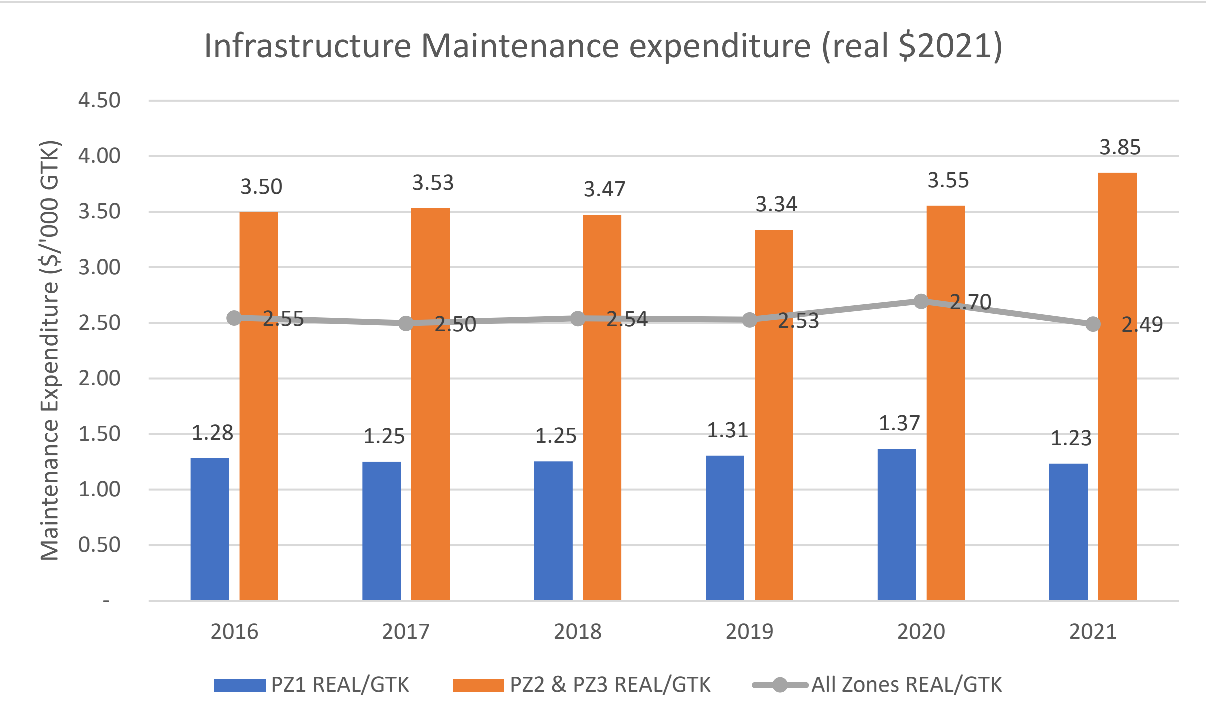


Figure 7: Infrastructure Maintenance Expenditure for the HV Coal Network excluding incident costs. HV Coal Network Gross Tonne Kilometres (GTK) including non-coal traffics.

Source: ARTC, confidential financial model 2021; Australian Bureau of Statistics, ***Consumer Price Index - Table 5 CPI: Groups/ Index Numbers by Capital, Sydney* 2016 - 2021**

Figure 8: Infrastructure Maintenance Expenditure MPM and RCRM (real $)

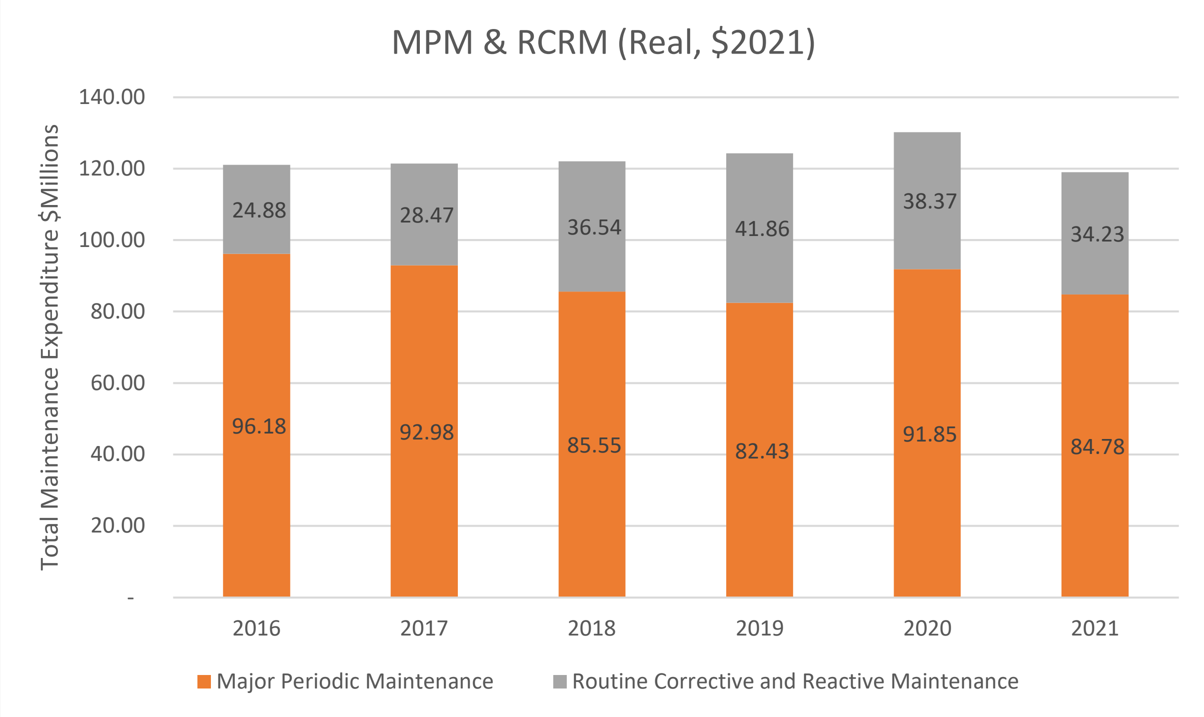


Figure 8: Infrastructure Maintenance Expenditure for the HV Coal Network excluding incident and indirect costs
Source: ARTC, HVAU 2021 Att 5.1 Opex Data – MPM RCM Summary CONFIDENTIAL; Australian Bureau of Statistics, ***Consumer Price Index - Table 5 CPI: Groups/ Index Numbers by Capital, Sydney* 2016 - 2021**

In 2021, infrastructure maintenance expenditure has reduced 5.7% since the peak of 2020 where cost increases occurred due to deferral of works from the 2019 bushfires, and the continued heated contractor labour market. Whilst the demand for contracted specialist resources remained high during 2021, ARTC was able to mitigate some of the impacts of these costs through accelerated training and staff retention programs that have been a focus for ARTC since 2018. However, various non-ARTC large infrastructure projects on the East Coast of Australia have recently started construction with additional major external projects being announced for commencement in future periods resulting in the already scarce resource of civil and signalling skilled workers becoming a greater challenge to employ going forward.

The second half of 2021 saw a marked increase in various costs throughout the supply chain. Major contributors to the increased costs seen throughout the sector include the rising price of fuel, higher labour costs from suppliers and increased costs of materials and equipment. In particular the cost of hot rolled coil steel on the global market increased 83% from the beginning of 2021 to a high September 2021. As ARTC buy rail in advance the full impact of the rise in steel prices was not seen until later periods. In response to the increase in steel prices, in August of 2021 ARTC selected several locations to trial a higher-grade rail being 370-grade rail. It is forecasted that the higher-grade rail will reduce the severity of defects that are occurring between rail grinding cycles on the Ulan Lines tight radius curves. ARTC note that the results of this trial will have a lead time of approximately four years and will report back to the RCG when they are available.

Both MPM and RCRM activity costs have fallen during 2021. The main decrease in RCRM costs relates primarily to rail defect removals which have reduced $3.3M or 50.2% from 2020 to 2021. In 2018, ARTC started a holistic review of welded track stability and rail stress risk management which has continued into 2021. This holistic review included rail defect removal, rail stress adjustment and design alignment corrections of predicted risk sites. A peak of rail defect removals occurred in 2020 in response to the culmination of improved diagnostic techniques and asset management processes which identified a significant number of sites which needed preventative maintenance intervention. The large volume of scope completed in 2020 was successful in significantly reducing the number of rail breaks that occurred during the year. This success in 2020 came at increased costs due to internal resources being exhausted and the need to employ external contractors to meet the demand of work. In 2021, the identified rail defect removal scope reduced significantly having a two-fold effect, being a direct cost reduction as well as the impact of reduced labour costs by being able to place less reliance on external contractors and complete the majority of the activity with internal resources.

The intense flooding and rainfall in March and November 2021 has resulted in the emergence of various rapidly deteriorating sites resulting in an increase in the required management, monitoring and maintenance seen in the activities of Full Track Reconditioning and Cutting, Embankment Maintenance & Geotechnology.

ARTC has provided details of the top 10 maintenance activities by value in 2021 at a Network level in Table 3A. A zonal break down of these top 10 maintenance activities is provided in Table 3B to Table 3D below. The required maintenance activities can vary year to year, particularly where there are discrete projects, and cost variations are to be expected. Commentary has been provided on the key drivers for the movement in costs for the top 10 maintenance activities.

The amounts reflect the underlying maintenance costs for each activity before allocating a share of incremental maintenance to the non-coal traffics.

Also contained in Table 3A to Table 3D is the summary of Other Activities not contained in the top 10 maintenance activities. In 2021 there has been a significant reduction in the overall Other Activities down 13.0% from 2020. The main cause of this decrease is in bridge related activities of Bridge Transoms and Steel Underbridge repairs. The driver of the increased costs in 2020 was due to a larger scope of works driven by the condition-based monitoring of the bridge structures compared to 2021.

Table 3A: Top 10 Hunter Valley Maintenance Activities $'000 Nominal

Activity	MPM/RCRM	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Ballast Cleaning	MPM	[redacted]		12.0%
Rail Grinding	MPM			4.2%
Full Track Reconstruction	MPM	7,812	10,546	35.0%
Maintenance Resurfacing	MPM	8,621	8,628	0.1%
Turnout Steel Component Replacement	MPM	9,012	8,520	(5.5%)
Turnout Resurfacing	MPM	4,307	4,588	6.5%
Inspection and Minor Repairs of Points	RCRM	4,136	3,888	(6.0%)
Ballast Undercutting	MPM	4,450	3,557	(20.1%)
Turnout Grinding	MPM	4,026	3,328	(17.3%)
Rail Defect Removal	RCRM	6,480	3,230	(50.2%)
Top 10 Total		**74,293**	**73,891**	**(0.5%)**
Top 10%		**58.9%**	**62.1%**	
Other Activities	MPM/RCRM	51,876	45,122	(13.0%)
Total Maintenance		**126,169**	**119,012**	**(5.7%)**

Infrastructure Maintenance Summary $'000 Nominal

Activity	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Major Periodic Maintenance	88,990	84,780	(4.7%)
Routine Corrective and Reactive Maintenance	37,179	34,233	(7.9%)
Total Maintenance	**126,169**	**119,012**	**(5.7%)**

Note: Totals may not add due to rounding

Table 3B: Top 10 Hunter Valley Maintenance Activities Pricing Zone 1 $'000 Nominal

Activity	MPM/RCRM	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Ballast Cleaning	MPM	[redacted]		(100%)
Rail Grinding	MPM			20.6%
Full Track Reconstruction	MPM	3,361	5,483	63.2%
Maintenance Resurfacing	MPM	2,431	3,170	30.4%
Turnout Steel Component Replacement	MPM	6,495	5,545	(14.6%)
Turnout Resurfacing	MPM	2,881	3,291	14.3%
Inspection and Minor Repairs of Points	RCRM	2,709	2,642	(2.5%)
Ballast Undercutting	MPM	2,905	2,441	(16.0%)
Turnout Grinding	MPM	2,475	1,938	(21.7%)
Rail Defect Removal	RCRM	4,442	2,202	(50.4%)
Top 10 Total		**36,579**	**32,786**	**(10.4%)**
Top 10%		**59.0%**	**60.7%**	
Other Activities	MPM/RCRM	25,414	21,247	(16.4%)
Total Maintenance		**61,993**	**54,033**	**(12.8%)**

Infrastructure Maintenance Summary $'000 Nominal

Activity	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Major Periodic Maintenance	41,386	34,003	(17.8%)
Routine Corrective and Reactive Maintenance	20,608	20,030	(2.8%)
Total Maintenance	**61,993**	**54,033**	**(12.8%)**

Note: Totals may not add due to rounding

Table 3C: Top 10 Hunter Valley Maintenance Activities Pricing Zone 2 $'000 Nominal

Activity	MPM/RCRM	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Ballast Cleaning	MPM	[redacted]		N/A
Rail Grinding	MPM			(17.2%)
Full Track Reconstruction	MPM	984	2,453	149.2%
Maintenance Resurfacing	MPM	1,039	1,391	34.0%
Turnout Steel Component Replacement	MPM	1,061	1,254	18.2%
Turnout Resurfacing	MPM	519	530	2.2%
Inspection and Minor Repairs of Points	RCRM	398	374	(5.8%)
Ballast Undercutting	MPM	536	86	(84.0%)
Turnout Grinding	MPM	524	672	28.2%
Rail Defect Removal	RCRM	951	412	(56.7%)
Top 10 Total		**10,148**	**10,598**	**4.4%**
Top 10%		**51.6%**	**60.4%**	
Other Activities	MPM/RCRM	9,506	6,943	(27.0%)
Total Maintenance		**19,654**	**17,541**	**(10.8%)**

Infrastructure Maintenance Summary $'000 Nominal

Activity	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Major Periodic Maintenance	14,341	13,589	(5.2%)
Routine Corrective and Reactive Maintenance	5,313	3,952	(25.6%)
Total Maintenance	**19,654**	**17,541**	**(10.8%)**

Note: Totals may not add due to rounding

Table 3D: Top 10 Hunter Valley Maintenance Activities Pricing Zone 3 $'000 Nominal

Activity	MPM/RCRM	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Ballast Cleaning	MPM	[redacted]		55.3%
Rail Grinding	MPM			6.9%
Full Track Reconstruction	MPM	3,467	2,610	(24.7%)
Maintenance Resurfacing	MPM	5,151	4,067	(21.1%)
Turnout Steel Component Replacement	MPM	1,456	1,721	18.2%
Turnout Resurfacing	MPM	907	766	(15.6%)
Inspection and Minor Repairs of Points	RCRM	1,029	872	(15.2%)
Ballast Undercutting	MPM	1,010	1,031	2.1%
Turnout Grinding	MPM	1,027	718	(30.1%)
Rail Defect Removal	RCRM	1,088	616	(43.4%)
Top 10 Total		**27,566**	**30,507**	**10.7%**
Top 10%		**61.9%**	**64.3%**	
Other Activities	MPM/RCRM	16,956	16,932	(0.1%)
Total Maintenance		**44,521**	**47,439**	**6.6%**

Infrastructure Maintenance Summary $'000 Nominal

Activity	2020 (a)	2021 (b)	% Variance (b)/(a)-1
Major Periodic Maintenance	33,263	37,188	11.8%
Routine Corrective and Reactive Maintenance	11,259	10,251	(9.0%)
Total Maintenance	**44,521**	**47,439**	**6.6%**

Note: Totals may not add due to rounding

The following sections provide an explanation for the key drivers for the movements in maintenance activities across the network.

2.1 Ballast Cleaning

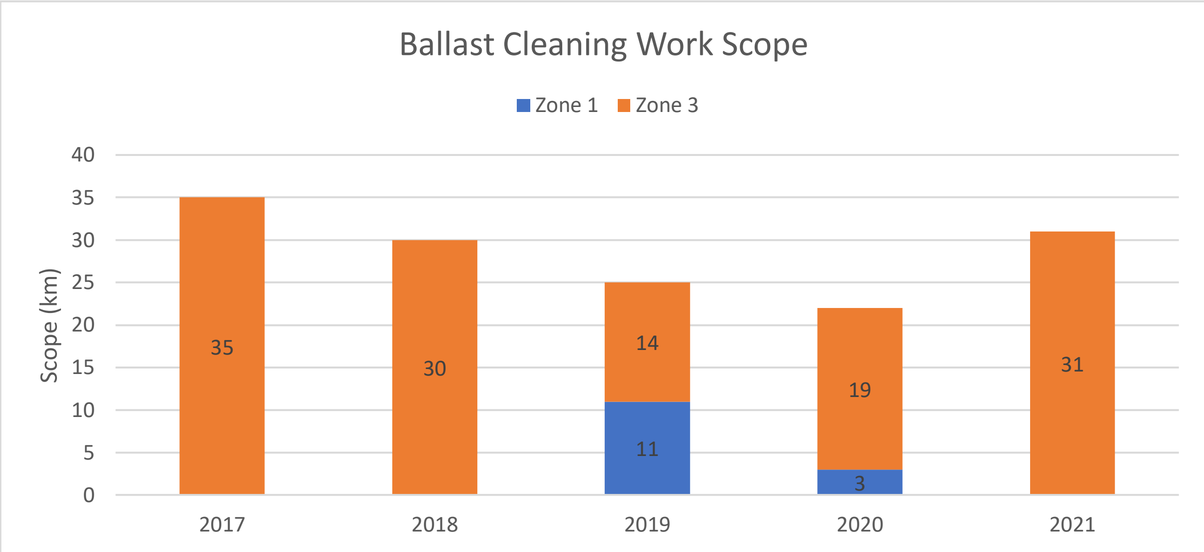
Ballast cleaning is the mechanical excavation of deteriorated track ballast up to 500mm below the bottom of the sleeper across the entire track cross-section. The activity's purpose is to reinstate the function of the ballast as a free-draining medium, holding the track to its correct geometry under the passage of trains. Ballast cleaning is a cyclical maintenance activity across the network, with timing driven by the cumulative tonnages over specific segments of track. It is a large component of the recurrent operating costs at an aggregate level, recognising that the activity will move through the zones across a number of years. The ballast cleaning activity is outsourced through the engagement of specialised plant. Unit rates fluctuate year on year dependent on contract rates, ballast reclamation levels, ballast age and maintenance possession scheduling.

The Ballast Cleaning strategy is based on a preventative maintenance intervention cycle, using accumulated line tonnage. The theoretical ballast cleaning cycle for the Hunter Valley has been developed based on industry standards and considers the uniqueness of the Hunter Valley tracks. The frequency for the different tracks on the network can range from 8 years in Zone 1 to 32 years in Zone 3 based on their tonnage profiles. Concurrently to the theoretical cycle, ARTC's strategy is also to ensure all of the coal network has been ballast cleaned at least once. Some large areas on the network, primarily Zone 3, still have not undergone a complete ballast clean since their original construction in late 1800s with approximately 63.1 km (24% of Zone 3) remaining to be completed for the first time.

The current ballast cleaning strategy is achieved through the utilisation of a single Ballast Cleaning machine over the six major annual possessions. The program has also considered customer feedback regarding their tolerance in relation to total cost of the ballast cleaning program and the outage requirements required to achieve scheduled scope. Considering the assessment of industry standards, track condition, historical cleaning activity and stakeholder feedback, ARTC's current strategy, which was implemented in mid-2017, is to deliver approximately 30km of ballast cleaning scope each year packaged in 5km bundles completed per possession. However, there are certain key contributors that influence the actual scope achieved by the ballast cleaner in any given period which include the condition of the ballast, ballast cleaning machine performance, material handling logistics (e.g. importing fresh ballast to each location) and interaction with fixed infrastructure such as level crossings. In order to assess track condition to refine the scope, ARTC utilises condition-based data which includes the Ballast Fouling Index (as measured by the Ground Penetrating Radar (GPR)) which indicates the level of ballast deterioration, and the Top Moving Sum which indicates the general track performance and is measured by the AK Car.

In 2018, ARTC commenced a five-year single supplier contract with a two-year extension option, to complete ballast cleaning in the Hunter Valley. The initial procurement of this contract was conducted through an open market international tender specifically seeking a multi-year agreement to ensure the supplier and the associated specialised equipment needed for ballast cleaning was secured for a longer term. The contract is inclusive of the ballast cleaning machine, spoil wagons, resurfacing and regulating activities with the ballast itself acquired directly by ARTC through various quarries, and, depending on the location of the ballast cleaning activity, delivered using both ballast trains and trucks. The schedule of rates of the contract contains both fixed and variable cost components with the fixed rates being related to the general operation of the ballast cleaner in the Hunter Valley and the variable rates are calculated based on the length of the closedown, achieved scope and required supporting resources. Due to the significant nature of this maintenance activity, ARTC is continually assessing the overall strategy and approach to ballast maintenance, accounting for any changes in network context with a full review scheduled to be conducted prior to the conclusion of the current contract.

Figure 9: Ballast Cleaning Work Scope - 2017 - 2021 in km



The total scope of the ballast cleaning activity increased 38% in 2021 with 31.0km completed up from 22.5km in 2020. The increase in scope across the two years was primarily due to COVID-19 restrictions in place in 2020 which resulted in the cancellation of 5km of annual planned scope in the April 2020 Closedown. Throughout 2021, the ballast cleaner was solely utilised in Pricing Zone 3 across all 6 closedowns whereas in 2020, out of the 5 utilisations completed, 4 were in Zone 3 and 1 was in Zone 1. Historically production rates in Zone 1 have been relatively lower than Zone 3 where more complexity exists due to multi-track locations and challenges managing resulting spoil.

Table 4: Ballast Cleaning Unit Rates 2018 – 2021 Cost ($)/Scope (m) and Number of Closedowns per Zone

[redacted]

The completion of all six closedowns on favourable geographical sections of the network has resulted in significantly better ballast cleaning returns and has contributed to achieving the highest scope since 2017. In particular, the 86-hour closedown in November allowed for approximately 7km of scope to be completed near Curlewis, being 2km more than the planned scope for that closedown. Additionally, open spilling of spoil in the Zone 3 corridor and a decrease in fixed asset interactions which require fewer cut in and cut outs, has also resulted in increased production.

2.2 Rail Grinding

Rail grinding is the periodic grinding of rail to manage its profile and stress-related rail defect growth. Grinding improves wheel and rail interface to reduce rail and wheel wear and propagation of rail defects. Rail grinding also provides a safety function by ensuring the rail is able to be tested for internal defects and other external defects that can trigger broken rails. Surface conditions on the rail can result in shielded rail that is impenetrable for the probes used during ultrasonic inspection and can prevent the detection of internal defects.

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. Rail grinding is a cyclic activity where the required frequency is determined by a combination of factors.

A baseline grinding program is prepared based on frequencies defined in the engineering standards for the following attributes:

- rail steel type;
- track alignment (curvature).
- traffic type ; and
- gross tonnage

To refine the Annual Works Plan for grinding, consideration is given to:

- surface condition; and
- maintenance possession timing.

Although generally comparable year on year due to a relatively stable tonnage profile and minimal configuration change to the network, there is still a cyclic dimension of the grinding activity that necessarily results in some fluctuation in the volume that becomes due. Additionally, the Hunter Valley rail grinding activity forms part of the ARTC National Grinding Program. This program is primarily delivered by a single high production rail grinding machine as part of a multi-year agreement. The planning of rail grinding scope in the Hunter Valley is reliant on the availability of the machine and alignment with this National Grinding Program.

In order to develop a program that addresses the assets grinding requirements, prior to each year the appropriate number of rail grinding shifts are allocated to the Hunter Valley Business Unit. The shifts allocated include a mix of standalone Rail Grinding Possessions, as well as shifts scheduled within the Hunter Valley Major Closedown. This ensures that the program is adequate to deliver the scope volume required, as well as minimising network downtime and customer disruption. However, due to the Australia wide grinding program, generally if the program experiences a disruption and planned scope is unable to be completed, this will normally result in a lost opportunity and the scope will not be able to be completed in the year, ultimately resulting in a reduction in achieved scope volumes and higher unit rates driven by the fixed cost component of the grinding contract.

Table 5: Rail Grinding Unit Rates 2019 – 2021 Cost ($)/Scope (km)

[redacted]

In 2021, total rail grinding costs increased by 4.2% ($0.5m) and completed scope reduced by 1% (12km) compared to 2020, resulting in an overall 5.0% increase in the rail grinding unit rate. 2020 fixed costs were also less than in 2021 due to the late delivery of the new grinding machine in February 2020, resulting in ARTC not being required to pay January's contracted costs.

The unit rate of rail grinding varied across the Zones in 2021, however the overall increase in Hunter Valley costs was primarily driven by the increase in costs in Zone 1. Although the achieved scope for Zone 1 increased by 4.8% (28km) in 2021, costs also increased by 20.6% resulting in unit rates within the zone increasing 15%. This can be attributed to low production rates achieved in the North Fork area due to significant amounts of rail milling required, which involves removal of larger amounts of rail material to address more severe surface defects. Additionally, lower unit rates and higher costs were experienced due to the majority of rail grinding throughout Zone 1 having been completed outside of the major closedowns, requiring additional Safeworking controls, impacting both productivity and cost.

In Zone 2, the rail grinding costs decreased by 17% ($0.7m) and the scope by 10% (36km) resulting in an overall reduction in unit rate of 8% between 2020 and 2021. Some reduction of scope between the years can be attributed to the considerably high amount of rail grinding completed in 2020 when mid-cycle shifts peaked. Additionally, Zone 2 grinding throughout the early part of 2020 (February and March) also involved abnormally high levels of corrective / defect grinding to address surface conditions that had developed due to the lack of maintenance caused by total fire bans during 2019. This involved substantially greater grinding effort (usually some combination of more passes and / or slower speeds) and results in less scope completed during a shift, with a commensurate adverse impact on unit rates.

In Zone 3, there was a 7% ($0.2m) increase in costs and a 1% (3km) decrease in scope in 2021. This was due to the flooding event in March which resulted in rail grinding shifts in both Zone 1 and 3 being cancelled; on this occasion, additional shifts were able to be scheduled in April and July to complete the required scope, therefore there was no reduction in total scope volumes achieved during the year as a result of this event. Additionally, ARTC did experience some costs associated with the cancelled shifts for stand-by and machine transfers, however these are relatively minor compared to the cost of a delivered shift.

Figure 10: Rail Grinding Work Scope and Expenditure – 2017 - 2021 in km (real, $2021)

[redacted]

2.3 Full Track Reconstruction

The majority of Hunter Valley track formation was constructed between 100-150 years ago using relatively uncompacted locally available materials to suit the axle loads of traffic at that time. This material has consolidated over the years however the original formation would be considered unsuitable for the current operational task. As a result of this aging network, there are sites across the Hunter Valley where the formation is failing and can also no longer be efficiently managed by other maintenance activities, such as tamping and undercutting.

The track reconditioning activity involves the removal and reconstruction of the track formation to effectively manage the risk to rail operations from track geometry deterioration. Track reconditioning includes subgrade treatment, the installation of structural earthworks, a capping layer and new ballast, followed by track and drainage restoration. It should be noted that sites that are 200m or more in length are treated as capital track upgrades and included in the annual Sustaining Capital Program. Key indicators of the requirement for reconditioning include overall deterioration rates, geotechnical risk investigations, temporary speed restriction performance, maintenance effectiveness intervals and formation configuration.

The strategy used to develop the AMP for the Hunter Valley (for both the MPM and Sustaining Capital activities) uses a multi-criteria condition-based analysis to identify scope in the earlier years, with allowances based on historical scope for later years. Due to the dynamic nature of the drivers behind track reconditioning, some sites emerge after the development of scope and are identified by accelerated degradation of track condition. This accelerated deterioration can occur at known or unknown locations, meaning the scope forecast beyond the first three years of the AMP cannot be accurately relied on, however, allowances are made in the scope development to ensure an indicative amount for the overall volume required is considered.

As the track reconditioning scope is heavily dependent on the formation condition and resulting track performance, the amount of scope completed each year may vary significantly. The scope variations seen year-on-year can often be attributed to the susceptibility of the network to wet weather in that period. Inconsistencies between different track reconditioning sites in terms of the excavation depth and transport of material costs (construction and spoil) drive large variances in unit rates which render comparison difficult and ineffective.

Relative to 2020, the overall expenditure for track reconditioning in 2021 increased by 35% ($2.7m). This was due to an increase in overall scope of 22% year on year and by the extreme flooding events in March and November after years of a relatively stable track formation due to a prolonged drought. The postponement of closedowns due to the wet weather and COVID-19 created demobilisation and mobilisation costs as well additional costs associated with sourcing scarce resources during Local Government Area (LGA) shutdowns and expenditure caused by Government social distancing and isolation laws.

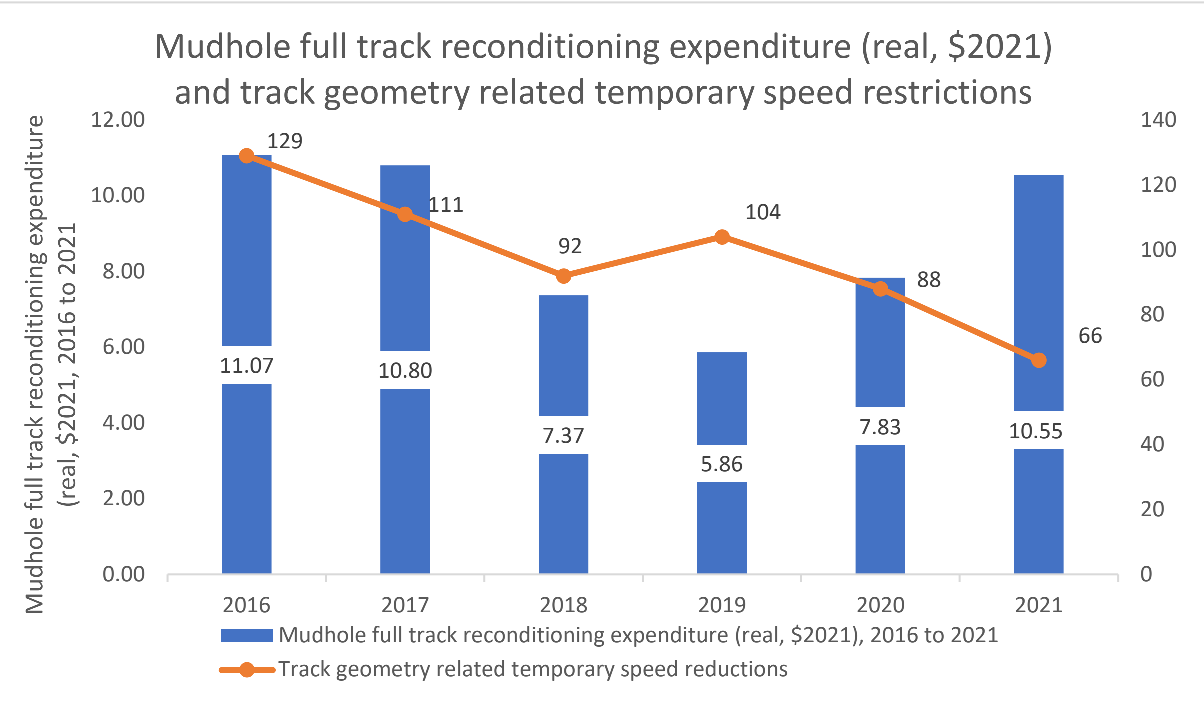
The variation at zonal level was driven by asset condition and complexity of scope. In Zone 1, the costs increased by 63% ($2.1m) with scope remaining relatively in line with 2020. Two sites at the Wallis Creek Bridge and Metford Bridge yielded a higher unit rate as they are relatively shorter in length than most reconditioning sites, however incur the same level of mobilisation and demobilisation costs coupled with access issues and site complexity. Track reconditioning which occurred at Metford included the preparation, removal and installation of wayside equipment creating significantly more complexity than a standard track reconditioning site. Additionally, due to the alignment of the October Major and Mains closedowns to reduce operational impact and to enable the safe execution of works that would ordinarily encroach the adjacent live lines; increased costs were experienced due to the availability of resources given the timing coincided with both the October long weekend and a closedown on the adjacent Sydney Trains network.

In Zone 2, the costs for track reconditioning increased by 149% ($1.5m). This is directly in line with the 200% increase in scope compared to 2020. Track reconditioning costs per site in Zone 2 generally have higher costs than the other zones due to the difficult terrain, access issues and complexity of work. In 2021, additional costs were incurred at the Denman reconditioning site which included level crossing works and at Baerami where the track reconditioning project was substantially impacted by access issues resulting in triple handling of materials, additional rock hammering and the site required an alternate construction technique that utilises a rock mattress formation to manage ground water issues.

In Zone 3 costs decreased by 25% ($0.9m) whist the scope increased 19% from 2020 to 2021. The variance in costs is driven largely by the complexity of sites completed in 2020 where track reconditioning works included complex sites such as Boggabri Bridge. A notable complex site that was completed in 2021 which created substantial maintenance focus was the track reconditioning in the Ardglen Tunnel.

The benefit of the track reconditioning works is evidenced in 2021 with the overall decreasing trend in incidence of TSRs of 25% as shown in Figure 11 below.

Figure 11: Mudhole Full Track Reconditioning Expenditure (real, $2021) and Track Geometry Related Temporary Speed Restrictions



[1] *Coal Up Direction Only with TSR PZ1 <80km; PZ2 <60km; PZ3 <60km*

Source: ARTC, HVAU 2021 Attachment 1: Hunter Valley Network Operating Costs; Australian Bureau of Statistics, ***Consumer Price Index - Table 5 CPI: Groups/ Index Numbers by Capital, Sydney 2016 - 2021***

2.4 Maintenance Resurfacing

Track maintenance resurfacing (tamping) restores the track geometric parameters of top, line, superelevation and curvature by mechanised on-track machinery to the “as designed” condition of the track. Similar to ballast cleaning, the accumulated gross tonnage over the line segment determines the anticipated volume of resurfacing scope. Tamping cycles have been determined for each line segment from historical data and considers factors such as track performance and track configuration. Benchmarking data suggests that tamping is required every 50 to 120 MGT, however the actual requirement is significantly influenced by other factors such as rainfall, track structure, track condition, axle load and speed.

The trigger for maintenance resurfacing is an out-of-tolerance geometric parameter or if the track quality is below, or approaching, the maintenance intervention limit. The key factors that drive the changes in maintenance resurfacing cycles are the configuration, strength and stiffness of the track bed (formation). Traffic during times of high rainfall results in movement of the formation and directly leads to the need for more tamping. It is important to note that in the majority of the Hunter Valley, particular north of Muswellbrook, track formation remains in its original construction from the late 1800s to early 1900s. While the track bed consists of un-engineered and poorly compacted materials, the rolling stock and track superstructure has been upgraded to suit heavy haul requirements. As expected, the high frequency maintenance resurfacing required on this old formation is reflected in the low MGT resurfacing cycles.

At the start of the delivery year, maintenance resurfacing scope is identified as allowances per line segment from the tonnage-based tamping cycles, with no specific start and end locations. The actual scope is determined and refined in the delivery year based on geometry defects, condition data from the AK Car and ICW and input from inspections from Provisioning Centres. The process of identifying actual scope involves manual analysis of available data and local knowledge.

The maintenance resurfacing activity is undertaken in the major closedowns in alignment with other maintenance activities and carried out using a combination of ARTC and contractor owned equipment. The maintenance resurfacing contract was awarded to five contractors during 2019 following an open market tendering process. The total duration of the current contract term is five years and will end in June 2024. The awarded tender focused on a move to improved technology which would involve a change in the mix of machines used to generate higher quality results to increase the effectiveness (or longevity) of the completed tamping. The new strategy and contract focus on condition-based works, and the improved quality of the tamping, although increasing the unit rate, has reduced scope and frequency of cycles. In 2021, ARTC continued to operate under the condition-based scope strategy which saw the overall tamping scope reduce compared to 2020.

Whilst ARTC entered into a leasing agreement and subsequently acquired a high-speed tamper in early 2020, the lower unit rates have not yet been realised. There are usually up to 20 track machines deployed across the Hunter Valley network to perform maintenance resurfacing at each closedown. Therefore, as majority of these machines are contracted, the lower unit rates achieved by the ARTC machine has not had a major impact on the total program costs. ARTC will continue with the Heavy Plant Strategy and bring online an additional two high-speed tampers in 2024 and 2025, which will increase the ratio of ARTC to contractor owned machines, further leveraging the lower unit rates achieved by the ARTC equipment.

Table 6: Maintenance Resurfacing Unit Rates 2019 - 2021 Cost ($)/Scope (km)

Year	2019 ($)	2020 ($)	2021 ($)
Unit Rates - Zone 1	10,872	11,857	19,685
Unit Rates - Zone 2	20,205	14,100	20,039
Unit Rates - Zone 3	14,501	15,217	13,439
Unit Rates - TOTAL	**13,808**	**13,968**	**16,185**

In 2021 the unit rates for plain track tamping increased by 16% relative to 2020. The increase in unit rates has been driven by a decrease in overall achieved scope with no reduction in network costs for this activity which have remained constant since 2019, with only a 0.1% increase between 2020 and 2021.

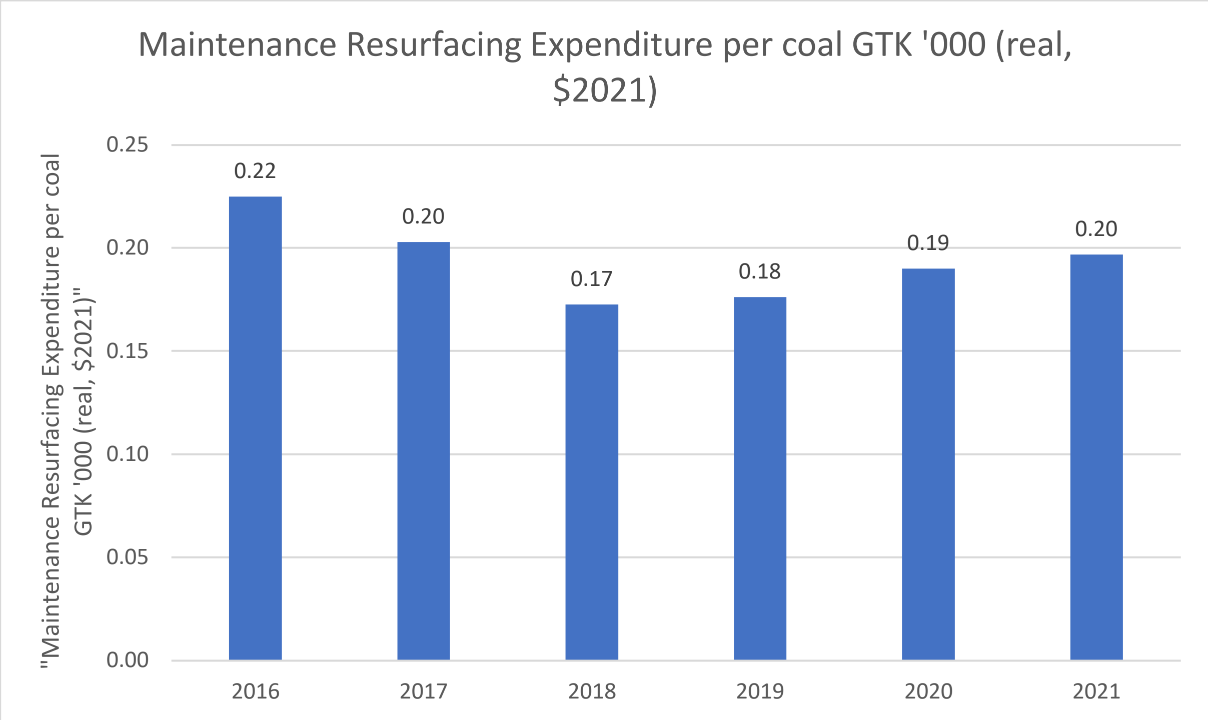
The 2021 costs and scope has been impacted by a number of factors. Additional resources were required at times due to scheduling issues such as track blocks, resulting in increased costs. There has also been a reduction in the number of shifts utilised on high production tamping due to smaller specific sites requiring tamping based on condition. Impacts to production were experienced due to the location of worksites on the network requiring additional travel and smaller scope of projects in general. ARTC has also encountered resourcing issues, unable to double shift throughout the workday and into the night due to the availability of experienced crews which has further reduced ARTC's ability to increase targeted scope. A combination of these above and specific zonal factors has resulted in the increase in unit rates for this activity in 2021.

In Zone 1, the unit rate increased by 66% in 2021 relative to 2020. This is due to a 30% ($0.7m) increase in costs and a 22% decrease in scope. The decrease in Zone 1 scope reflects the change in the network level strategy to target condition-based scope instead of on-the-face tamping. This has also created challenges in efficiently traversing the track machines around and through multiple worksites and around track blocks to access targeted sites. The overall unit rate in Zone 1 was further impacted by work completed on Hexham Relief Road to remove a TSR which occurred on a Coal Road Possession to accommodate train stabling during the closedowns which yielded an extremely high unit rate due to the complexity of the site. Lower production machines with innate higher unit rates have been utilised heavily in Zone 1 as the higher production machines are more effective in larger sites with more continuous sections of track as is seen in Zone 3.

In 2021, there was a 42% increase in unit rates in Zone 2 for this activity driven by almost double the number of high production machines being utilised in this zone compared to the previous year. This allocation of machines was driven by scope requirements, primarily track reconditioning and upgrade sites that require machines with higher capabilities including a dynamic stabiliser. However, these fixed worksites essentially create track blocks making the machines less productive. Overall scope has reduced by 6% in Zone 2 however the costs associated to utilising the high production machine has increased costs by 34%.

Zone 3 has utilised higher production machines which have been able to cover the larger non-complex sites seen throughout the zone. This has resulted in costs and unit rates decreasing significantly throughout 2021.

Figure 12: Maintenance Resurfacing Expenditure per Coal GTK '000 (real, $2021)



Source: ARTC, HVAU 2021 Attachment 1: Hunter Valley Network Operating Costs; Australian Bureau of Statistics, ***Consumer Price Index - Table 5 CPI: Groups/ Index Numbers by Capital, Sydney* 2016 – 2021**

2.5 Turnout Steel Component Replacement

Replacement of worn and defective turnout steel components reduces the risk of turnout rail component failure and therefore potential derailment. Replacement is required when components are damaged beyond the extent to which defects can be addressed by turnout grinders, hand grinding teams or wire feed welding repair (or build up) activities. Sites are identified through regular inspections by field staff who perform a condition assessment. Other condition-based datasets, such as vertical acceleration responses from the Instrumented Coal Wagon (ICW) are also used to highlight critical components, such as crossings, that are trending towards requiring intervention.

Although this activity is classified as an MPM activity, it is somewhat reactive in nature. This is due to the different types of turnouts in operation in the Hunter Valley each with their own corresponding lifespans, maintenance regimes and components that need to be replaced. Individual component performance varies due to track formation, design issues, drainage and tonnage. The planning of the Turnout Steel Component Replacement scope considers various factors relating to rail performance, including history of broken rails and internal defects, ability to install and maintain optimal profiles and advanced surface conditions or untestable rail. Unit costs of turnout components also vary considerably creating unit rate anomalies in the delivery of this activity and comparison year on year.

In recent years, the delivery model for this activity has changed from the use of contract staff to an in-house team that is supplemented by contractors as required. However, as the internal competencies are still being developed a reliance remains on contractor resources. In the Hunter Valley, one commercial partner has been engaged to deliver the scope under a one-plus-one year contract where it must provide two teams in support of major closedowns. The long-term view is for ARTC to continue to increase development and use of in-house resources for the delivery of this activity to provide better value for money outcomes for our customers.

Most of the scope delivered under this activity can be classified as one of three categories; build ups, switch and stock rail replacement or crossing replacement, with the cost of each varying substantially depending on a range of factors. Whilst there are other turnout components that are replaced and captured under this activity, they make up approximately 2% of the total work performed and do not result in significant expenditure. Examples of these types of components include the replacement of insulated joints within a turnout and the replacement check rails and check rail carriers.

A build up is where one or more defects within a turnout are ground down to remove damaged or cracked metal. The ground area is then built back up via a wire fed welding process. The area is then profile ground to restore the original profile of the component. The main variables that impact the unit rate for build ups are the size and number of defects and therefore the effort required to repair. The location relative to other required scope and the delivery (planned or unplanned) of this work can also impact the overall costs. This work is outsourced to a specialist service provider that are typically engaged on a fixed day rate agreement. Therefore, if the scope and location allow multiple jobs to be completed within a shift, the unit rate will be much lower than a location where multiple shifts are required to repair the components. Typically, the unit rate for a build-up will vary between $3,000 and $15,000 depending on these variables.

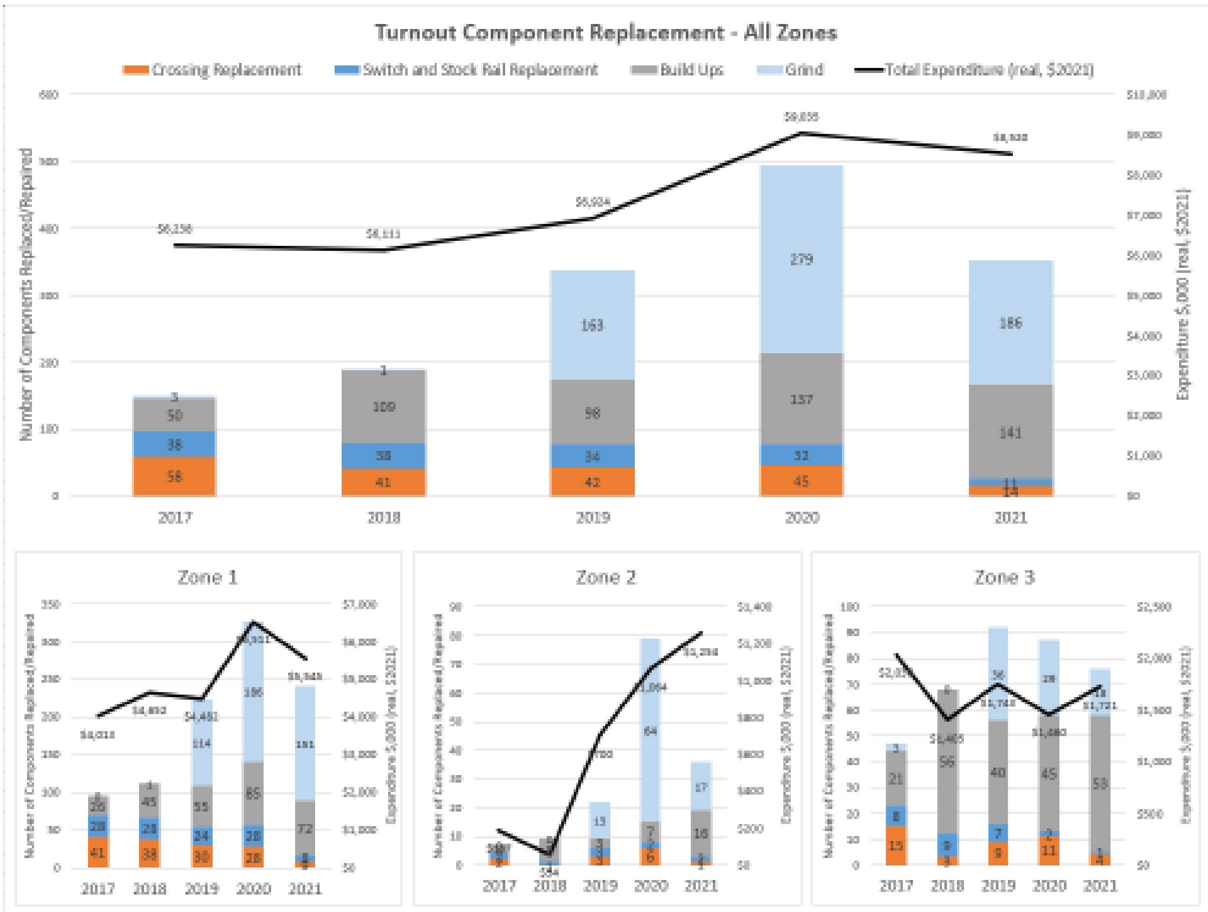
A switch and stock rail replacement refers to the replacement of either the left or right switch and stock rail assembly. To achieve this, the signalling equipment on the turnout must first be disconnected from the components to be removed, the assembly is then cut and removed from the turnout. The new component is then lifted into place and welded back into position. Following this the signalling equipment is then reinstated and certified back into use. There are many variables that impact the unit rate for this type of scope, these include:

- The cost of the new component which can vary substantially based on the type and size of the turnout.
- The location of the works and the cost delivering the component to site. The size of the component and site access may require a crane to perform the lifting activities versus whether an excavator is sufficient.
- Whether the scope is delivered through internal or external resources; or
- Whether there are other works required as part of the scope, such as additional closure rails.

Typically, the unit rate for a switch and stock rail replacement will vary from about $15,000 for a low cost, easy access component delivered by internal resources, up to about $100,000 for a high value, complex component delivered by external resources.

Crossing replacements are the most significant scope type performed under this activity. They are typically the highest wearing component of a turnout and for the larger turnouts on the ARTC network, are the most expensive component to replace. There are two types of crossings within the Hunter Valley, swing nose crossings and fixed nose crossings. Swing nose crossings are more complex in nature and include signalling equipment to control a switch blade within the crossing. Fixed nose crossings do not have any moving components and therefore have no signalling equipment. The process of replacing a crossing is in line with replacing a switch and stock rail assembly with the variables that affect the unit rate being same as detailed above. Typically, the unit rate for a crossing replacement will vary from around $25,000 for a low cost, easy access component delivered by internal resources (e.g. rail bound manganese insert), up to about $400,000 for the replacement of a large swing nose crossing.

Figure 13: Turnout Component Replacement - All Zones, 2017 - 2021 (real, $2021)



In 2021, the overall costs for Turnout Steel Component Replacement decreased by 6% ($0.5m) in the Hunter Valley. The network level decrease was driven by Zone 1 where most of the Turnout Steel Component Replacement scope was completed.

The 15% ($1M) decrease in costs in Zone 1 was due to a combination of factors including an overall reduction in crossings replacements required during the year, this has in turn reduced the volume of post installation grinding, as shown in Figure 13. Additionally, there was a 26% decrease in contractor costs in Zone 1 between 2020 and 2021 for this activity due to better alignment with Provisioning Centres using internal resourcing for this activity.

The variance between costs in 2021 compared to 2020 was also partially driven by the inflated turnout steel replacement costs seen in the prior year both locally and those manufactured overseas due to the COVID-19 pandemic. As some overseas components almost doubled in cost in 2020, this had a significant impact on the total cost of the program during the year.

In Zone 2, there was an 18% ($0.2m) increase in costs compared to 2020. Most of the costs were incurred in the first half of the year and majority of the costs were related to five specific turnouts. A turnout project at Coggan Creek required extensive work over three closedowns due to poor condition. The magnitude of the scope and complexity of this turnout was identified over time as work progressed which resulted in increased costs. The replacement of a high-cost swing nose crossing also contributed to the increased costs for the zone.

Similar to Zone 2, the Zone 3 costs also increased by 18% ($0.3m) in 2021. This increase was largely due to the upkeep and eventual replacement of a series of crossings near Gunnedah, that had been experiencing accelerated degradation due to a design issue with the crossing ramp rates. This resulted in increased build-up costs at short notice to maintain the crossings in an operational state, until such time as the crossing could be replaced with an improved product from the OEM. Overall, there was a 5.6% increase in contractor costs in Zone 3 between 2020 and 2021 for this activity which contributed to the increased in costs.

2.6 Turnout Resurfacing

Turnout resurfacing (tamping) restores the geometric parameters of top, line and superelevation by mechanised on-track machinery. Geometric parameters have a heavy influence of dynamic loading through turnouts which in turn influences the propagation of rail defects and formation loading. Turnout components also interface closely with signalling assets and can impact network reliability through signalling equipment failures if left in poor condition. Turnouts are generally tamped on a time-based cycle which are derived from tonnage and turnout performance, with factors such as drainage effectiveness and turnout geometric design also having an impact. Some turnouts have a high tamping requirement, for example three times a year for high traffic areas around Hexham, while other turnouts may only require a tamp every two years.

Turnout resurfacing work is carried out under the same contract as the maintenance resurfacing activity. Following an open market tendering process, a multi-year contract (5-year term) was awarded to five contractors which focused on the deployment of an improved technology solution via the use of a Unimat Tamper in lieu of the less effective Jackson Tamper. It was anticipated that this decision would result in an increased unit rate in the first instance, due to higher cost machines, despite higher production rates. However, the higher quality output will enable the extension of time between tamping cycles, and therefore require less scope over time. The contract is based on a schedule of rates where all shift rates are fixed, however include variable components for extra hours or shifts, mobilisation and demobilisation, or additional resourcing requirements as requested by ARTC.

Table 7: Turnout Resurfacing Unit Rates 2019 - 2021 Cost ($)/Scope (km)

Year	2019 ($)	2020 ($)	2021 ($)
Unit Rates - Zone 1	16,269	12,804	11,838
Unit Rates - Zone 2	26,235	28,833	17,097
Unit Rates - Zone 3	19,824	17,113	19,641
Unit Rates - TOTAL	**17,572**	**14,551**	**13,184**

The overall costs for turnout resurfacing increased 7% ($0.3M) in the Hunter Valley in 2021 while the scope increased by 18% (52 turnouts). This resulted in a 9% reduction to the unit rates.

The cost and scope increased in both Zones 1 and 2 relative to 2020 due to overdue scope from previous years and scheduled time-based cyclic scope being planned. The disproportionate increase in scope relative to cost, was also due to efficiencies gained through opportune tamping of turnouts within the Maintenance Resurfacing worksites, and the availability of four additional turnout tamping machines.

In Zone 3, there was a 15.6% decrease in costs which directly related to the 26% (14 turnouts) decrease in scope due to the high utilisation of tamping machines in Zones 1 and 2 in 2021 and the longer cycle times required in Zone 3 for this activity.

2.7 Inspection and Minor Repairs of Points

This activity relates to the minor, routine maintenance of the point machines and their moving parts. The performance of the point machines can be impacted by the vibrations of moving trains and environmental factors. Environmental factors include wet weather, the large differential in temperature between night and day, as well as sand, dust and coal debris generated from trains operating in the rail corridor. To keep the point machines in working order, they need to be regularly inspected for maintenance which can include cleaning, lubrication, adjustment, repair and/or replacement of life expired components. The points assembly must also be tested to ensure it is operating as designed and is safe to be in service. There are different types of inspections and testing performed at different intervals on the point machines. As this is an RCRM activity, a portion of work captured under this activity is routine and occurs at intervals specified within ARTCs Engineering Standard and form part of our statutory obligations under our Safety Management System. Additionally, a portion is either corrective or reactive and is triggered as conditions arise or failures occur during the year.

The costs for this activity decreased by 6% ($0.3M) in 2021 compared to 2020. The costs in 2020 reflected the reliance on signalling contractors engaged to backfill permanent positions while accreditation of internal resources continued. The competitive labour market for skilled signalling workers has continually resulted in the need for a high use and cost of signalling contractors. The scarcity of this resource still remains in 2021, however due to internal accelerated accreditation training and retention effort, ARTC has been able to considerably decrease the use of external resources in Zones 1 and 3 in this activity.

2.8 Ballast Undercutting

Ballast undercutting addresses localised ballast defects on track sections typically less than 100m in length, it involves a small crew using an excavator and cutter bar to remove a mud-hole and/or area of highly fouled ballast which impedes drainage. Often these sites deteriorate to a condition where temporary speed restrictions are required to ensure operational safety is maintained until the condition is repaired. Additionally, while in a degraded state, rail break risk is significantly increased due to additional stresses exerted on the rail under dynamic loading conditions, emphasising the need for prompt intervention.

Although this activity is classified as an MPM activity, it is somewhat reactive in nature. Allowances are made in the AMP based on historical scope requirements and the current asset condition. The actual scope locations are determined within the live year, usually during the closedown planning cycles. These locations are primarily detected through maintenance inspections and identified as deteriorating areas that require maintenance intervention to reduce the need for temporary speed restrictions and lowers the risk of rail breaks on the network.

While ballast cleaning is considered very effective in addressing fouled ballast over large sections of track, it is not financially or practically feasible for smaller sections due to the mobilisation and movement of the large on-track machinery. Ballast undercutting is therefore utilised as a more efficient method for addressing localised ballast fouling in smaller track sections. It is often a short-term solution deployed before full track reconditioning is required to improve the track condition.

Ballast undercutting is delivered by both internal and external resources. The contract for the ballast undercutting activity is based on a schedule of rates and was awarded through a competitive open tendering process. During 2019 a shift in strategy was introduced to improve the quality of ballast undercutting performed to increase the longevity of the work and reduce the required scope over time. This included a strategic move to increase the utilisation of geotextiles between the existing formation and the clean ballast which is installed to reduce the rate that fine material from within the formation migrates into the ballast which causes the subsequent fouling. In addition to this, the new strategy introduced tamping each undercutting site with a track machine, whereas traditionally this was performed with an excavator tamper resulting in a lower quality outcome increasing the risk that temporary speed restrictions would remain in place following the works. It was anticipated the change would result in an increase to undercutting unit rates, however, this also achieved improved reliability outcomes and improved long term maintenance requirements.

In 2021, the overall undercutting costs for the Hunter Valley decreased by 20% ($0.9m). This was driven by a 16% ($0.5M) decrease in Zone 1 and 84% ($0.5M) decrease in Zone 2 compared to 2020. Some of this variance across all zones was driven by a greater focus on improving the quality and performance of work completed by contractors through better understanding of scope.

In Zone 1, the scope completed in 2021 reduced by 16% which also had a proportional impact on the costs. There has been little change in unit rates between the 2020 and 2021 period and for most part the complexity of sites has also remained unchanged.

In Zone 2, much of the undercutting scope was combined with drainage works under a new initiative and therefore only one undercutting team was required. As only one closedown was completed in Zone 2, the overall scope for the zone also decreased compared to 2020 which resulted in lower costs.

There was marginal increase in cost for Zone 3 in 2021. The scope in this zone is usually much smaller due to more fixed assets (such as level crossings, turnouts and culverts) that are skipped by the ballast cleaner and require undercutting instead. Generally, shorter undercutting sites yield a higher unit rate as majority of the undercutting contract rates are fixed and therefore the shorter sites result in relatively high mobilisation and demobilisation costs.

2.9 Turnout Grinding

Turnout grinding is the periodic grinding of turnouts to manage rail profile and stress generated rail defect growth. Grinding improves the interface between the wheel and the rail reducing wear on both surfaces and slows the propagation of rail defects, in turn, minimising premature steel replacement and improving whole of life costs. Hand grinding is also undertaken to maintain the shape of steel components, such as switch blades or crossing noses, that cannot be ground by a turnout grinder. In determining the optimal grinding frequency, a detailed assessment and review of turnout performance is undertaken annually for all turnouts. Turnout grinding cycles are determined based on the requirements of the asset and the logistical considerations in terms of delivering the program. These cycles vary from four times per year through to once every four years.

ARTC has consistently engaged with two contracting partners at each stage of the turnout grinding process to provide a cost-efficient delivery of its scope. A key risk to the program is that there is a very limited pool of prospective suppliers available to deliver this type of work due to its specialised nature. During 2020, procurement for the turnout grinding contract was awarded following an open tender process to secure these scarce resources.

In 2021, the overall cost and scope for turnout grinding decreased by 17% ($0.7m) and 8% (54 units) respectively, compared to 2020. The decrease in expenditure can be directly attributed to the decrease in scope in Zone 1 and Zone 3. The variance in scope between 2020 and 2021 is driven by the uncharacteristically high scope achieved in 2020 as ARTC worked to catch up on the scope deferred from 2019 bushfires. There was also a greater focus on hand grinding by the Maintenance Services team in 2020 which increased the costs incurred that year but had minimal impact on scope as this hand grinding scope is not captured. Scope achieved in 2021 is in line with plan.

In addition to this the overall decrease in costs across the network for turnout grinding can also be attributed to a new negotiated contract where the mobilisation and demobilisation costs were reduced. This especially impacts Zone 1 costs where more productive grinders are mainly utilised due to the clustering of turnouts at some sites enabling their potential to be realised.

2.10 Rail Defect Removal

Rail defect removal is the removal of surface or internal defects through replacing and welding in of a new length of rail, generally 6-8 metres in length. The activity is undertaken to eliminate the risks associated with a range of rail defects as well as ensuring the rail is of sufficient strength and integrity to carry the axle load reliably and safely at the design track speed.

Rail defect removal is a condition-based corrective maintenance activity where defects are identified through visual or ultrasonic inspections. The planning of the scope also considers various factors relating to rail performance, including the history of broken rails or internal defects, surface condition, untestable rail, poor weld condition and corrosion; additionally, for certain defect types, ARTCs Engineering Standards require the rail to be replaced before it reaches its safety limits. Response timeframes to internal rail defects are published in ARTCs Engineering Standards and form part of our statutory obligations under our Safety Management System.

This activity is generally undertaken using internal resources, with the scope mostly delivered 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 specialised rail head repairs, with quotations sought in each instance and compared against the cost of replacement.

ARTC's rail defect removal strategy is aimed at improving network reliability and reducing network losses associated with rail breaks or the development of emergency internal defects that require extensive, unplanned intervention. In 2018 and 2019, rail breaks were the leading cause of RCG reportable infrastructure losses, requiring a strategic focus in this area to improve outcomes.

In 2021, the Zone 1 costs reduced considerably by 50% ($2.1m) compared to 2020. Similarly, in Zone 2 and Zone 3, the costs decreased by 57% ($0.5m) and 43% ($0.5m) respectively. This notable variance between 2020 and 2021 costs is largely due to an exceptionally high expenditure for this activity in 2020. This was in response to the high number of rail defects that attributed to RCG reportable infrastructure losses in 2018 and 2019. The number of rail breaks resulting from these defects, and the related losses, over the 2018 and 2019 period was high also. As a result of the effort in 2020, the losses due to rail defects and rail breaks combined decreased considerably from 0.68% in 2019 to 0.33% in 2020.

Actual number of rail breaks over the two years has remained mostly unchanged, with 38 rail breaks in 2020 and 42 in 2021, refer to Table 8 below.

Table 8: Total Rail Breaks per year 2014 – 2021

Rail Breaks	2014	2015	2016	2017	2018	2019	2020	2021
Number	128	87	80	91	75	61	38	42

Figure 14 below shows the number of rail related defects removed and rail defect removal expenditure by year and Pricing Zone. As there are a number of other factors that affect the cost of removing a rail defect, such as the mix of internal and external resources, outage type which effects productivity rates, the type of defect and the methodology to repair, the expenditure and scope in each zone can differ.

Note: Figure 14 below shows the rail related defects that have been closed in each calendar year in Ellipse. As discussed in the 2019/2020 Compliance Submission, prior to 2018, the rail defect data in Ellipse was sparse and inconsistent due to the system issues identified and addressed by the Asset Management Improvement Project (AMIP). Therefore, although the chart below does not reflect a true trend for all rail defects overtime, the quality of the defect data has improved each year after the implementation of AMIP. Additionally, it is important to note that this dataset is relative given that some rail defects are not exclusively removed through the Rail Defect Removal activity. Whilst relatively a smaller proportion of the overall, some rail defects will have been removed as part of larger Rerailing and Rail Grinding programs and these numbers will vary year to year.

Figure 14: Number of Rail Related Defects Removed and Rail Defect Removal Expenditure (real, $2021) by Year and Zone

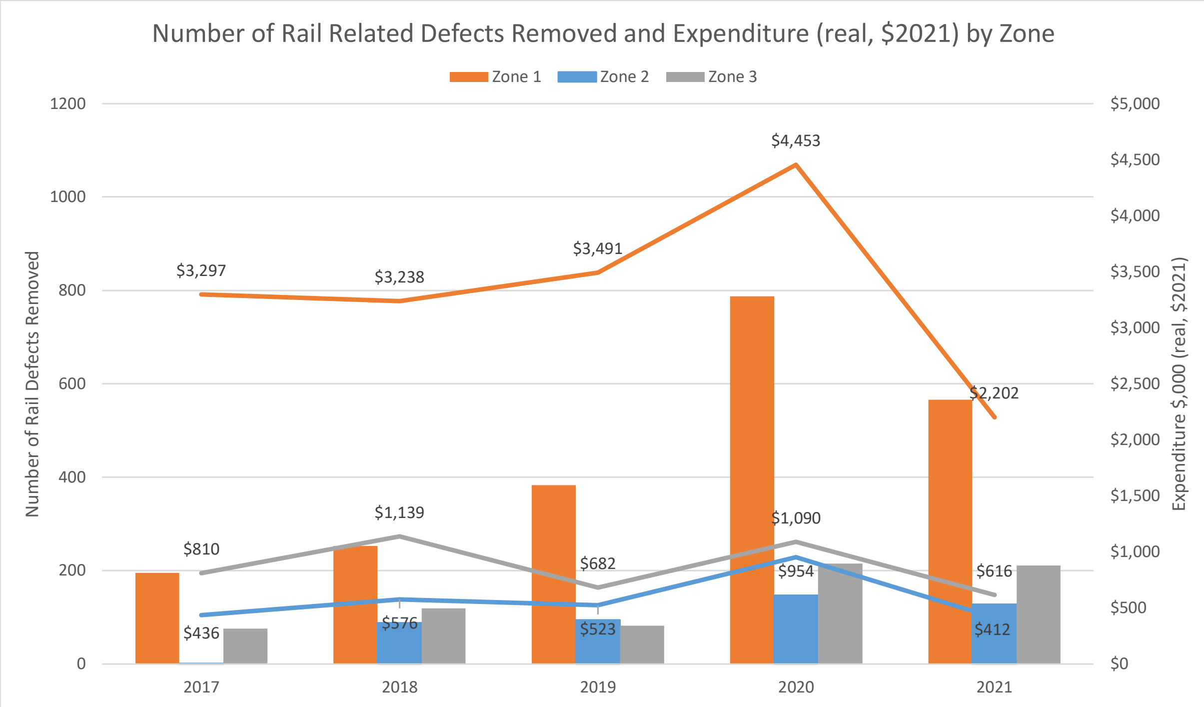
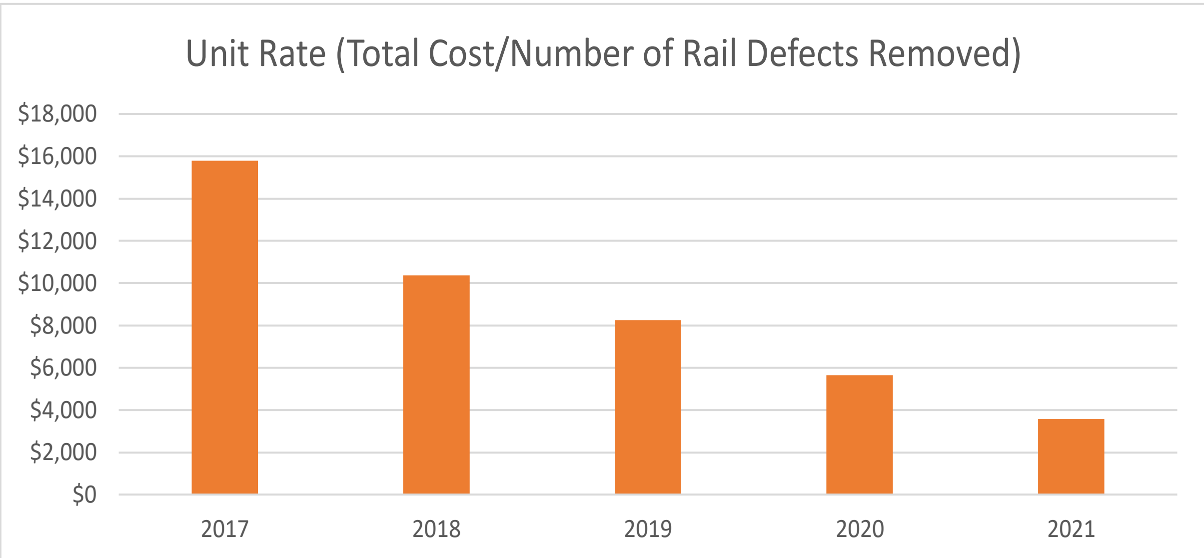


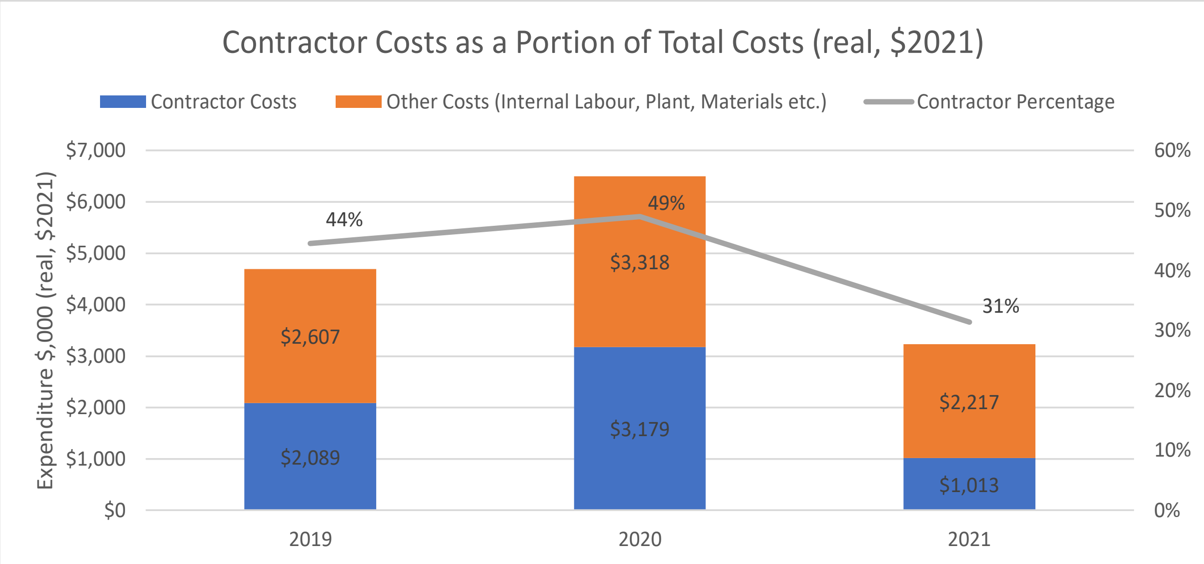
Figure 15 below shows the average unit rate for rail defect removal over the last five years. ARTC notes that unit rates for rail defect removal are not an entirely sound method to analyse costs, due to inaccurate work records prior to 2018, variability in scope type and the fact that not all rail defects are addressed through maintenance costed to the Rail Defect Removal activity. The graph shows that over the last five years, the average cost per removed rail defect has continued to reduce. With 2021 having the lowest unit rate to date.

Figure 15: Rail Defects Unit Rate



Unit rate reductions, particularly between 2020 and 2021 can largely be attributed a reduced reliance on contract resources to perform rail defect removal works. Figure 16 below shows the proportion of costs associated with contract resources, the graph shows that contractor costs peaked in 2020, both in terms of total value and as a percentage of the programs value. This is representative of the increased effort during the period to address the high-volume rail defects across the network to curb failures and related losses. Whereas in 2021, the total number of defects removed reduced, as well as the total value of contractor costs and percentage it contributes to the overall program.

Figure 16 : Number of Rail Related Defects Removed and Rail Defect Removal Expenditure (real, $2021) by Year and Zone



3. LOSS ON DISPOSALS

Section 6 of the 2021 Compliance Submissions set out the process for determining the loss on disposal for assets being removed from the regulated asset base (RAB). Table 9 summarises the loss on disposal amounts by zone relating to Expansion Capital Project works and Sustaining Capital projects.

Table 9: 2021 Disposals $

Expansion Capital Projects	**Written Down RAB Value**	**Net Disposal Proceeds**	**Net Loss on Disposal**
Pricing Zone 1	-	-	-
Pricing Zone 2	-	-	-
Pricing Zone 3	-	-	-
Total	**-**	**-**	**-**

Sustaining Capital	**Written Down RAB Value**	**Net Disposal Proceeds**	**Net Loss on Disposal**
Pricing Zone 1	5,608,414	684,805	4,923,609
Pricing Zone 2	4,066,258	350,800	3,715,458
Pricing Zone 3	1,687,795	191,624	1,496,171
Total	**11,362,467**	**1,227,229**	**10,135,238**

All Disposals	**Written Down** RAB Value	**Net Disposal Proceeds**	**Net Loss on Disposal**
Pricing Zone 1	5,608,414	684,805	4,923,609
Pricing Zone 2	4,066,258	350,800	3,715,458
Pricing Zone 3	1,687,795	191,624	1,496,171
Total	**11,362,467**	**1,227,229**	**10,135,238**

Note: Totals may not add due to rounding

Loss on disposals decreased $1.3m during the year from $11.4m in 2020 to $10.1m in 2021. The major contributor of this reduction relates to loss on disposal for Track Strengthening activities which reduced $2.8m (93%) from 2020. This is in line with the significant reduction in the overall scope in the capital commissioned for this activity for the same period reducing by 85% across the network. All zones in 2020 had significant track reconstruction projects with the most notable movements in Zone 3 at the Emerald Hill Track Slew which created a loss on disposal in 2020 of $2.0m. The scope reduction between the years ranged from 16km in 2020 compared to a 1.5km in 2021. Additionally, due to numerous costly swing nose turnouts replaced in 2020 primarily in zone 1, there was a decrease in loss on disposal for turnout renewal activities by $0.4m.

The above reductions in loss of disposals were offset against an increase in the loss on disposal on several projects across various other activities. The replacement of the bridge at Bridge Street Muswellbrook was completed in 2021 resulting in a loss on disposal of $0.2M. The completion of the Waratah to Sandgate re-signalling project in 2021, where aging and unreliable signalling infrastructure was replaced to improve the safety, operational flexibility and reliability on the network resulted in an additional $0.6m loss on disposals.

Loss on disposal values in relation to rerailing are highly dependent on the replacement cycle for the specific segments of rail where the renewal and disposal is occurring. In 2021 the loss on disposal for rerailing increased 11.2% from 2020, however the rerailing scope decreased by 18.2% resulting in a unit rate increase from $170 per train metre in 2020 to $231 per train metre in 2021. The main drivers of the increase were rail replacements in Zone 2 between the track sections Sandy Hollow to Wilpinjong, which has a higher replacement turnover due to the geographical nature of the line with tight curvature and steep inclines and in Zone 3 from Willow Tree to Werris Creek.

Disposal proceeds and asset recovery rates vary across years and Pricing Zones due to several factors including:

- The location and nature of the RAB asset being disposed and the RAB written down value attached to the applicable Segment;
- The nature of the capital projects/activities and scope being undertaken in each year;
- The nature of the asset or material being disposed of (e.g. rerailing and turnout projects have scrap rail, whilst concrete culverts have unsaleable and non-reusable scrap materials); and
- The market value for the scrap material.

For the 2021 calendar year, the overall asset recovery rate increased by 4% on the prior year. This was largely due to the change in the nature of the capital projects and activities undertaken during 2021, coupled with the increase in the recovery price of steel. Global average scrap prices increased from $204 in 2020 to an average price of $332 for the first half of 2021 increasing further to an average of $415 by the last half of 2021. This increase was due to tight supply and increased demand of steel makers. Lower economic activity and strict social distancing measures in 2020, alongside severe weather conditions in 2021, curbed scrap generation and collection. The resumption of idled steel mills and increased production from other industries also contributed to the significant increase in demand for scrap steel. The quantity of scrap steel disposed decreased from approximately 3,963* tonnes in 2020 to 3,293 tonnes in 2021.

*Noting there was a typing error in the 2020 compliance return which noted that the quantity of scrap steel was 2,963 tonnes however the trend analysis and narration was correct. The correct figure was 3,963 tonnes.

4. EXPENSED PROJECT COSTS

Expensed projects reflect the development cost of capital projects (as endorsed by the RCG) that have since been determined will no longer be required. The amount expensed represents the value of work in progress up to the point at which the project was suspended. For the 2021 compliance period, there were 3 expense projects totalling $4.4m as represented in Table 10 below.

Table 10: 2021 Expensed Projects

Location	Expensed Projects
Widden Creek Loop	$ 2,175,103
Kooragang Departure Roads 7 & 8	$ 1,356,868
Whittingham Down Relief Hub	$ 904,958
Total Expensed Projects	**$ 4,436,929**

Widden Creek Loop (Attachment)

The initial project was initiated to address the capacity constraints in the Baerami to Kerrabee section of Zone 2 and was modelled to increase capacity on the Ulan line by 3.8million tonne per annum. Phases 1 and 2 of the project were completed and expensed in prior compliance periods. In November 2021, ARTC and the RCG met to discuss the project status, cost and schedule and importantly, the improved utilisation rate that Zone 2 has achieved through other means since the inception of this expansion capital project. The outcome of consultation was that the Widden Creek Loop projects would no longer be required with the RCG no longer supporting this expansion capital project. It was determined that work would cease midway through Phase 3 of the project and that the already expended Phase 3 costs of $2.2m would form part of the operating costs in the 2021 Compliance Period.

Kooragang Departure Roads 7 & 8 (Attachment)

This project was established in January 2012 to increase the operational flexibility of Kooragang Coal Terminal (KCT) departure roads by providing in excess of two departure roads for each dump station and a third shared departure road for each dump station. Phases 1-3 of the project were endorsed and completed. In December 2013. The next phases were presented to the RCG but were not endorsed to proceed. In November 2021, the RCG were presented with a Submission for Information which detailed that $1.3m would be expensed in the 2021 period as there was no endorsement to proceed and these costs will never result in the construction of an asset.

Whittingham Down Relief Hub (Attachment)

The project commenced in late 2012 to construct a Relief facility at Whittingham to provide parking for unloaded trains on their return journey to their load points. This would reduce network constraints by allowing the Terminal departure roads to be kept clear and ultimately increase overall capacity. Phase 1 and 2 were completed, however, further assessment of the capital cost to construct the Hub and the softening change in Customer’s volume requirements has resulted in the project not progressing. In November 2021, $0.9m was expensed in as it was determined that these costs will never result in the construction of the asset.

5. NON-MAINTENANCE OPERATING ACTIVITIES

Non-maintenance operating activities are categorised as Network Control, Business Unit Management or Corporate Overheads.

In 2021 the basis for the allocation of Non-Segment Specific costs was Schedule I.

Table 11 sets out a year-on-year comparison of the costs for each of the non-maintenance operating cost categories.

The movements in non-maintenance operating costs between 2020 to 2021 are driven by a combination of:

- The change in the relative values for each allocator between Hunter Valley and Interstate; and
- Increases or decreases in the underlying costs associated with Network Control, Business Unit Management or Corporate Overhead activities.

Table 11: Non-Maintenance Operating Cost $'000

	2020 (c)	2021 (c)	Variance % (b)/(a)-1
Network Control	20,188	19,919	(1.3%)
Business Unit Management	36,090	40,534	12.3%
Corporate Overheads	24,833	24,930	(0.4%)
Total	**81,110**	**85,384**	**5.3%**

Note: Totals may not add due to rounding

The drivers for the cost movements are considered further in the following sections.

6. NETWORK CONTROL

Network control includes costs associated with ARTC's Network Control Centre North (located at Broadmeadow). The control centre controls the train movements for the entire Hunter Valley business unit including the coal network and non-coal segments that adjoin the coal network. The network is controlled by a series of 'Network Control Boards' (NC Boards) which manage defined areas. Twelve of the thirteen NC Boards (11 directly related to coal) are required to be operationally staffed 24 hours per day, 365 days a year.

Network control expenses include labour and materials associated with the delivery of the following functions:

- train control and signalling both on the main line and within the coal terminals;
- train planning and programming;
- operations and operational customer interface;
- incident management; and
- communication costs.

Table 12: Network Control Cost $'000

	2020	2021	Variance $ 2020 - 2021
Network Control Cost	20.2	19.9	(0.3)

Table 13: Network Control Movement of Cost Drivers $'000

	2021
Labour Costs	0.3
Train Communication Systems	0.4
Utilities- Electricity Accrual	(0.7)
Other Costs	(0.2)
Total Cost Movement from Prior Year	**(0.2)**
Allocator Movement	(0.1)
Total	**(0.3)**

Note: Totals may not add due to rounding

Network Control costs decreased by $0.3m compared to 2020. The major drivers of the cost movement in the 2021 period compared to 2020 included:

- $0.3m increase in labour costs as a result of Enterprise Bargaining Agreement annual award increases.
- $0.4m increase due to the reversal and correction of an accrual in the 2020 compliance submission in relation to services provided for the support and maintenance of critical train communication systems. Due to the adjustment in 2020, 2021 has increased, however is in line with prior years costs trend for this service.
- $0.7m decrease in utilities expenditure was due to a significant over accrual of electricity costs at the Network Control Centre North (NCCN) in prior periods which was corrected in 2021 based on the receival of revised utility contracted terms.

- $0.1m decrease in the allocator movement due to the redistribution between coal and non-coal activities of the Terminal Coordinator Board, increasing the percentage allocated to non-coal.

In 2020, the ANCO network-wide technological infrastructure was commissioned and became operational creating the ability for an end-to-end integrated Hunter Valley Coal supply chain. In 2021, operating expenditure relating to ANCO in the category of Network Control Cost remained consistent with 2020 representing ongoing annual IT service agreements including licence fees associated with the right to use the technology, leasing of required infrastructure and external support services to facilitate the ongoing maintenance of the technology.

7. BUSINESS UNIT MANAGEMENT

Business unit management costs comprise Hunter Valley direct costs and encompasses four functions:

- Hunter Valley Customer Service and Operations;
- Hunter Valley Asset Delivery, including the Provisioning Centres;
- Hunter Valley Asset Development; and
- Hunter Valley Management and Support.

Table 14: Business Unit Management Cost $'000

	2020	2021	Variance $ 2020 - 2021
Business Unit Management	36.1	40.5	4.4

Table 15: Business Unit Management Movement of Costs Drivers $'000

	2021
Professional Fees - Commercial	(0.8)
Engineering Software Platforms	4.5
Engineering - Restructure	0.8
Software Hosting Service Fees	0.5
Professional Fees – Engineering (SOC)	(0.3)
Other Costs	0.5
Total Cost Movement from Prior Year	**5.2**
Allocator Movement	(0.8)
Total	**4.4**

Note: Totals may not add due to rounding

In 2021 Business Unit Management costs increased $4.4m compared to 2020.

The major drivers of the cost movements are:

- $0.8m decrease in commercial professional fees due to additional costs incurred in the 2020 period relating to the renewal of the Hunter Valley Coal Network Access Undertaking (HVAU) Version 8 and additional resourcing required to assist with the accelerated lodgement of historical compliance submissions.

- $4.5m increase in costs relate to a review of the accounting treatment of various cloud-based software related projects. Historically, to access software packages, ARTC would purchase associated hardware and application software licenses which would be used from computers on business premises enabling control over the Intellectual Property (IP). In recent years the introduction of cloud-based computing services has become the most prominent form of software development and purchase. This has enabled the delivery of flexible, on-demand computing services over the internet including the services of data storage, databases, servers, analytics, intelligence and application software. The pace of change in software development and source of service delivery, has occurred at such a rate, that businesses are now realising the complexities and ambiguities in the evaluation of the appropriate accounting treatment relating to this type of expenditure. When applying basic accounting principles, the main source of contention when considering the classification of any expenditure on an asset is determining whether an entity has exclusive use and ownership of the intellectual property rights. Many of the new cloud-based software products, and even in house IP developments, are now hosted and managed by external providers creating uncertainly on who has ultimate control of the product and associated data. To date, IFRS has not issued explicit guidance on accounting for cloud-based arrangements or the associated costs to implement them. This has required ARTC to research and seek external advice and apply various applicable Accounting Standards to determine the appropriate accounting treatment for the Research, Development and Operation lifecycle stages of technology related projects.

Acknowledging these complexities, during 2021 an internal review was undertaken on all ARTC projects containing software development or purchase components with the purpose to evaluate and confirm the accounting classification between capital and operating expenditure. The findings of this review determined the appropriate cost treatment for these projects and identified various projects which were previously incorrectly classified as capital expenditure. The internal project review was completed through a structured and consistent process, evaluating each individual component of each project against a ‘classification decision tree’ developed by an external accounting firm. The decision tree ultimately evaluated whether ARTC has control of the software, whether the projects included an upgraded functionality a future economic benefit for ARTC will occur. The evaluation process often resulted in different components of the same project eventuating in a combination of both operating expenditure and capital classification. The findings of this review recommended that for 2021 $15.3m was to be classified as corporate capital expenditure and $4.5m to be classified as operating expenditure.

The main technology projects contributing to the $4.5m increase in operating expenditure for 2021 are as follows:

Software	2021 BUM $	Opex Classification Driver	Project Description
Decision Support Platform (DSP)	$4.2m	DSP was classified as operating expenditure in 2021 on the basis that the project is recognised in the decision tree as Software as a Service (SaaS). Under this arrangement, the cloud provider hosts and manages the associated underlying infrastructure and provides updates and maintenance services for a subscription-based service fee. ARTC have exclusive rights to use the software, however the organisation does not have any ability to control the use of the software and therefore no asset can be identified. The expenditure incurred is to be expensed over the term of the contract. Of the $4.2m expensed in 2021, $0.6m relates to engineering associated salary costs being capitalised onto the corporate asset register in the prior period.	The DSP is the centralised software system that allows ARTC's condition monitoring data to be displayed in one location and improves the visualisation of key data streams, allowing for real time data to support asset management decisions. DSP's condition monitoring and data was used extensively at the back end of 2021 to identify deteriorating track conditions. The prioritisation matrix enabled by DSP, allows for proactive decision making to be made which targets and directs works that will result in the removal TSR'S increasing the efficiency and throughput of the network. The ability of the system to locate the most critical areas requiring maintenance improves short term and long-term work plans, reduces the risk of asset failure and ensures the integrity of the track.
Weighbridge Data Capture Project (WDC)	$0.2m	The expenditure for the WDC project relates to feasibility costs incurred during the research phase of the project. As per the decision tree, up until the selection of a technology solution is made any expenditure will be classified as an operating cost. As the project moves beyond the feasibility stage, the costs will be reassessed to determine the treatment of expenditure for those future periods. In 2021 $0.2m was expensed in relation to the WDC Project. The WDC was completed in 2022.	The WDC's objective is to deliver train weight data to coal producing customers and Rail Haulage Providers from all 5 Hunter Valley Weight Bridges, in a reliable and efficient manner with minimal intervention.
Ellipse Project Upgrade	$0.1m	The upgrade to this project was recognised as part of the internal review as an Infrastructure as a Service (IaaS) project, where similar to the DSP, although ARTC have exclusive rights to use the software, the organisation does not have any ability to control the use of the software, requiring the $0.2m to be expensed in the 2021 year.	Ellipse is the primary Enterprise Asset Management System (EAMS) used to store the asset register, known conditions and maintenance work orders for the rail network assets. Upgrade to Version 9 of ARTC's asset was completed in 2021.
Total	**$4.5m***		

*Totals may vary due to rounding

- $0.8m increase due to the restructure in the Hunter Valley business unit. In 2021 the Major Projects team was disbanded in line with the corridor capacity strategy now no longer requiring significant expansion capital going forward. Concurrently the Asset Planning Hunter Valley (APHV) team was established to provided value for our customers by leveraging ARTC assets and focusing on improving operational efficiencies. These above changes included the centralisation of the asset planning team, changes to the leadership structure and numerous staff movements in the Maintenance Services, Corridor Works and Contracts teams. These changes were made to align further with Integrated Scheduling and to enable the transfer of the strengths and knowledge across the asset and maintenance disciplines building on ARTC's core maintenance competencies to improve and sustain reliability and availability of the asset. The costs in relation to the restructure primarily relates to staff termination cost and the employment of specialised positions to fulfill roles in the new delivery unit.

- $0.5m increase in software hosting service fees relates to a monthly fee for the implementation of the DSP project which includes the cloud provider hosting and managing the associated underlying infrastructure and providing system updates and maintenance services as required.

- $0.3m decrease in engineering professional fees due to the requirement in 2020 for the engagement of a specialist consultant to assist with the redesign of the existing Signalling Statement of Competency (SOC) to assist with the shortage of signalling and other critical resources needed to maintain network infrastructure.

- $0.8m decrease in the allocator movement due to significantly higher non-coal GTK allocator values driven by higher grain volumes following the breaking of drought conditions in central north-western NSW.

The balance of the cost movements is attributed to minor cost movements and annual salary increases across various business unit activities.

8. CORPORATE OVERHEADS

Corporate overheads include costs associated with the following ARTC wide functions:

- Executive;
- Finance;
- People;
- Corporate Services and Safety; and
- Strategy.

Table 16: Corporate Overheads Cost $'000

	2020	2021	Variance $ 2020 - 2021
Corporate Overheads	24.8	24.9	0.1

Table 17: Corporate Overhead Movement of Cost Drivers $'000

	2021
Safe Work Improvement Program (SWIP)	0.5
Insurance	0.6
TMS	0.2
Other Costs	0.5
Total Cost Movement from Prior Year	**1.8**
Allocator Movement	(1.7)
Total	**0.1**

Note: Totals may not add due to rounding

The Procurement Transformation Project (PTP) was a multi-year project which produced a road map to advise ARTC on the strategy and implementation of the transformation required to ensure functional uplift to the procurement function. Noting that procurement costs in 2021 were consistent with the prior year, ARTC provided an update on the goals achieved and benefits seen throughout this period stemming from the initial PTP.

ARTC has continued throughout 2021 to utilise the PTP roadmap to implement system changes and processes to further unlock efficiencies in procurement activities across the business. One of these key initiatives, was the advancement to the next stage of the Procure to Pay system being the configuration of the Phase 1 Approach to Market (ATM) within ARTC's Finance System. This first phase was essential to unlock the benefits ultimately realised in 2022 under Phase 2 ATM which required additional change management in the form of training and updates to the finance module. The benefits that the ATM projects unlocked once completed in 2022 was increased efficiency and transparency of procurement activities across the business with all stakeholders able to access further information in the finance system in real time and the provision of improved business to business tools linking ARTC directly to their suppliers.

The focus on Supplier Data Validation and Inventory Catalogue Classification continued in 2021, with continuous improvement and automation of inventory processes mapped in 2020. Business as usual improvements to the cleansing and standardisation of products has resulted in further accuracy in ordering the correct level of stock on hand reducing the risk of obsolescence. Accurate identification of inventory has also been essential in improving stock availability for planned and emergency maintenance and reducing delays on the network due to unavailable parts.

A key initiative of the procurement team in 2021 stemmed out of SWIP, being the release to market of a tender to establish a Panel of Safe Working Providers from which ARTC will source safeworking providers in the future. The project's purpose is the establishment of a consistent framework for which Safe Working Personnel are managed and to ultimately provide a pool of approved safe working resources for worksite protection. Under the framework there can be two types of external organisations authorised to provide safeworking services. The first engagement involves being a Member of the Safeworking Services Panel whereby by the organisation is authorised to provide worksite protection to ARTC or their contractors. The second type of arrangement involves Self-Performer Organisations who are authorised to use safeworkers that they themselves employ, and that hold a Primary Rail Industry Workers registration. Both types of organisations must have demonstrated that they possess both the capability and capacity to provide safeworking services to meet ARTC's business and project requirements. This initiative will support ARTC to enhance the safety of track workers by improving the quality of contract safeworkers used in the rail corridor.

In response to the rising costs of quarry materials used on the network, in October 2021 ARTC endorsed the future use of a direct negotiation procurement model to engage the quarry market. This will be completed in phases by establishing regional panels to bid for the right to supply quarry products, with the Hunter Valley to be the first regional panel established. The regional panels will aim to introduce processes and oversight to ensure competitive tension and commercial value exists in the procurement of quarry products. The finalisation of the panel will be finalised by mid-2023.

In September 2021, ARTC endorsed the release to market of a multi-year Hunter Valley Track Reconditioning and Earthworks procurement tender. This process progressed throughout 2022, with the procurement model providing ARTC with a selection of suppliers that will compete for work packages as they are released and creating secondary commercial tension, thereby delivering a cost-effective strategy for ARTC and its customers.

ARTC will continue to utlise the PTP roadmap to work towards the ultimate goal of providing a collaborative and robust procurement and inventory service that delivers sustainable value for money for ARTC and its stakeholders.

Corporate Overhead costs increased by $0.1m compared to 2020.

The major drivers of the cost movement for the 2021 period compared to 2020 included:

- $0.5m increase in expenditure relating to the Safe Work Improvement Program (SWIP). Several safe working near miss and incident events on the ARTC network over the two years prior to December 2019 led to an internal and external review of the effectiveness of the safe systems of work and the effectiveness of associated safety controls. This review highlighted areas for improvement as well as opportunities for ARTC to further develop effective frameworks to ensure the safety of all trackworkers entering the ARTC network.

In response to this review, a detailed analysis of safe working near miss and incident events was undertaken using a 'root cause analysis' approach which included developing systematic solutions to create a safer environment for ARTC workers and prevent recurrence of these events. This analysis resulted in the establishment of the SWIP, a three-year program of work containing eight interdependent projects designed to deliver sixteen solutions, to be implemented between 2020 and 2023. SWIP is designed to dedicate resources and establish integrated plans to bring about lasting improvement in ARTC's safe working systems and practices by developing a single approach across ARTC to safety.

Continued implementation of the SWIP Program continued throughout 2021 with the successful achievement of the following Program milestones:

- Implementation of the ARTC Network Control Communication Standard which defines safety critical communications for rail safety workers including the structure and protocols to be used, the skills needed for competent performance and the use of the 'Professional, Accurate, Clear and Concise (PACC) Principles.' These principles are now used by all stakeholders on the network and have established consistent, company-wide communication protocols and confirm a minimum standard of safety critical communications for rail safety workers. This required consistency has empowered network controllers to insist on safe working practices and has significantly improved emergency communications.

- The Deployment of eTAP(NSW) was also successfully achieved as part of the Communications Program milestone which involved the implementation of an electronic track work transaction tool to mitigate human factors associated with the previous manual process. The eTAP system supports the electronic issuing and notification of; Track Occupancy Authorities (TOA's), Look out Working Low (LOW) and Work in Corridor (WIC). The eTAP application provides location assurance, improving safety control for Track Workers. Reinforcing the principle that planned work is safer work, eTAP ensures that unplanned work will not be approved and associated workers will not be granted access to track or rail corridor.

- A review and update of the core technical knowledge requirements for Protection Officers was undertaken with ARTC's registered Training Organisations (RTO). As the key personnel in control of pre worksite safety briefs, work location and communication directly with Network Control, the training was aimed at ensuring that all Protection Officer's (PO's) used on the ARTC network have sufficient knowledge and training to ensure the safe implementation of safety procedures and the protection of rail and track workers.

- Defined the New Hierarchy of Protection for the application to the whole ARTC Network which involved the development of principles and a road map to deliver a standardised application of track work protection across ARTC.

- The development of an enterprise asset management system which has replaced the paper-based issuing of work activities with a mobile application. The application provides equipment and location data which allows for the real time management of work and enables more accurate and timely decision making in the field.

  - Update to pre-work briefs and worksite protection plans, templates and procedures providing clear definitions of roles and responsibilities and the requirement to provide dual confirmation of worksite track location. This included ensuring that the site supervisor role is separate to the PO role on all worksites to ensure that both roles are able to focus on their core roles and responsibilities.

  SWIP continues to have a primary focus on the long-term reduction in risk and improvement to safety culture and application of safe working systems at the frontline. The Office of National Rail Safety Regulator (ONRSR) has sought assurance that ARTC is committed to make changes to increase the effectiveness of safe working controls through an Enforceable Voluntary Undertaking (EVU) which requires monthly reporting into the ONRSR.

- $0.6m increase relates to the continued rise in insurance costs. Continual severe weather throughout 2019, 2020 and in particular 2021, triggered significant flooding across the network. This has resulted in the revaluation of the risk profile for major infrastructure in Australia and around the world by insurance providers. With global weather-related events increasing in number and severity whilst also becoming less predictable in regard to location and timing, the effect on the insurance market has been a hardening of the market cycle and has resulted in continual increases in insurance premiums and deductibles. Further to this, insurers are looking more closely at risks they are prepared to insure and on what basis they will offer coverage, if at all, resulting in a decrease in competition across the industry in certain sectors.

  ARTC has attempted to mitigate these risks through its provision of detailed information, commercial approach to incident cost recovery, and continued professional management of major liability and asset claims. The quality of the ARTC underwriting information continues to ensure premium increases are kept to a minimum; but the continuing hardening of the market and the premia-rates ratio has continued to drive an unavoidable increase in insurance costs over the period.

- $0.2m increase in Track Monitoring System (TMS) costs, primarily due to the increase in costs associated with Hook and Pull costs. Hook and Pull activities involve the manual coupling and uncoupling of rail cars by rail workers and in this case external contractors. The increase in Hook and Pull contractors was driven by the additional cost incurred in managing off site accommodation for these workers to adhere to protocols implemented in response to COVID-19 restrictions.

- $1.7m decrease in the allocator movement due to the significant impact of higher non-Hunter Valley allocator values resulting in a reduction in the share of costs being allocated to the Coal Network.

The balance of the cost movements is attributed to minor cost movements and annual salary increases across various business unit activities.

9. VARIABLE COSTS

Table 18 sets out the variable charges attracted by various groups of traffic within the Hunter Valley network.

Table 18: 2021 Variable Costs $'000

	Maintenance and Loss on Disposal	Capital Charges	Total
Constrained Group of Mines	35,005	69,743	104,747
Pricing Zone 3 Traffics	29,556	14,213	43,769
Other Unconstrained Coal	399	-	399
Non-Coal Traffics	7,555	-	7,555
Total	**72,514**	**83,956**	**156,470**

Note: Totals may not add due to rounding

9.1 Pricing Zone 3 Incremental Costs in Pricing Zone 1

In the interests of transparency, sets out the Pricing Zone 3 incremental costs in Pricing Zones 1 and 3. Note that under the ACCC approved methodology, incremental capital charges are not applied in Pricing Zones 2 or 3.

Table 19: 2021 Pricing Zone 3 Incremental Costs $'000

	Maintenance and Loss on Disposal	Capital Charges	Total
Pricing Zone 1	4,469	14,213	18,681
Pricing Zone 3	25,087	-	25,087
Total	**29,556**	**14,213**	**43,769**

Note: Totals may not add due to rounding

10. NON-COAL ALLOCATION

Under the HVAU, all traffic including non-coal traffics are required to contribute revenue sufficient to meet the Floor Limit. The Floor Limit as applies to non-coal traffics is the variable maintenance cost attributable to them based on GTK or Train Km, as applicable to each maintenance activity.

The non-coal variable maintenance cost attributed to non-coal traffics in 2021 was $7.6m.

The non-coal allocation has increased 168% from 2020 due to the increase in non-coal GTKs driven by the higher grain volumes being transported on the network.

These amounts are deducted from the costs that are allocated between coal traffics in the Hunter Valley Network, as shown in Table 2.