AURIZON

George Passmore
Director – Business Performance
Queensland Competition Authority
Level 27, 145 Ann Street
Brisbane QLD 4001

2 March 2022

Dear George,

Aurizon Network – Establishment of Ballast Asset Class and Asset Life

Please find enclosed Aurizon Network's Establishment of Ballast Asset Class and Asset Life submission to the Queensland Competition Authority (**QCA**).

The regulatory asset life for ballast was outlined within the Financial Year 2023 Annual Review of Reference Tariff (FY2023 ARRT) submission to the QCA on the 28 February. This submission is an appendix to the FY2023 ARRT as it supports the revenues outcomes. Aurizon Network is seeking a QCA determination on the Ballast asset life as part of its decision on the FY23 Annual Review of Reference Tariffs

Outlined within this submission is a proposal for the ballast asset class, specifically the asset life resulting from the QCA Final Decision on the 2017 Access Undertaking in 2018, which decided to capitalise ballast undercutting (mainline and turnout) renewals expenditure from FY2020 onwards.

Detailed calculations supporting the ballast asset life along with the evidence supporting the assumptions are included within the submission. Should you have any queries, please do not hesitate to contact Sandra Xia at Sandra.Xia@aurizon.com.au

Kind regards,

Jon Windle
Manager Regulation
Aurizon Network Pty Ltd

Aurizon Network - Establishment of Ballast Asset Class and Asset Life

Purpose

This paper seeks the Queensland Competition Authority's (**QCA**) approval of an endorsed life of 8 years for the ballast asset class for the Central Queensland Coal Network (**CQCN**). This proposal has been necessitated following the QCA's final decision on the 2017 Access Undertaking (**UT5**), which required that Aurizon Network capitalise ballast undercutting (mainline and turnout) renewals expenditure from FY2020. This expenditure was previously recoverable through the maintenance cost allowance.

Aurizon Network notes that as part of its UT5 final decision[1], the QCA approved a transitional life of one (1) year and two (2) years for ballast undercutting expenditure incurred in FY2020 and FY2021 respectively. Upon QCA approval of the ballast asset life proposed in this submission, Aurizon Network will apply this on a forward-looking basis from FY2022 onwards, with all ballast assets within the Regulatory Asset Base (**RAB**) Roll-forward and to the forecast Capital Indicator when determining Aurizon Network's Allowable Revenues for each year.

Background

What is Ballast?

Ballast refers to the small, angular rocks that are laid underneath, between and around the railway sleepers. This aggregation of the ballast forms the track bed and interlocks to form a resilient, stable base to support the track. It also helps with drainage and the prevention of vegetation growth. The ballast is packed up to, between and around the sleepers, with a 'shoulder' of ballast piled up at either end of the sleeper to prevent horizontal movement of the track.

New ballast contains approximately 40-45% voids and has the size, shape, density and grading requirements specified to suit the operational requirements and environment. The frequency of ballast maintenance is linked to the ballast condition, which changes continually due to the generation of fine particles (fouling) caused by ballast attrition and external contaminants. In the CQCN, most of the ballast fouling is by coal infiltration and ballast breakdown from heavy axle loads.

As the quality of the ballast reduces:

- ballast loses its angularity, which reduces its ability to interlock and support the track; and
- the spaces between the ballast (voids) fills with fouling material such as coal fines and subgrade material. The fouling material sinks to the bottom of the ballast and builds up over time.

The consequences of fouled ballast can be described as below:

- prevents effective drainage and the movement of particles through the ballast;
- leads to the formation of mud and clay holes;
- constrains the resiliency of the track and can cause damage to adjacent assets such as formation, sleepers, fastenings and rollingstock;

[1] QCA final decision (December 2018) summary 3.3. (b) and analysis 3.3.3.
Aurizon Network's 2017 draft access undertaking (qca.org.au)

- reduces resistance against vertical, lateral and longitudinal forces;
- increases speed restrictions; and
- reduces track stability and consequently increases the risk of derailments.

In light of the above, Aurizon Network undertakes ballast renewal activities each year to manage ballast condition through its ballast undercutting program. This in turn helps to improve operational performance by minimising unplanned disruption and reducing the risk of derailment or consequential damage to (or premature replacement of) adjacent rail infrastructure.

What is Ballast Undercutting?

Ballast Undercutting is the process through which ballast is excavated, screened and replaced to remove contamination; thereby reinstating optimal track stability and drainage characteristics. This task is carried out through a combination of methods, including:

- the Ballast Cleaning Machine (BCM) - which mechanically excavates and screens contaminated ballast;
- Excavators - which are typically used for turnouts and short sections of track (<1km); and
- Manual Labour - used in locations where access by heavy plant is difficult, e.g. bridges.

Depending on the ballast condition, undertaking ballast cleaning may not result in complete replacement of all ballast at each individual site. If conditions allow, Aurizon Network will seek to screen ballast and, where the existing ballast meet the requirements, it will return a proportion of used ballast to track. This approach has the advantages of:

- reducing the time required to undercut long sections of track;
- reducing overall production costs; and
- extending the operational life of that ballast.

However, in some instances, conditions will prevent the use of screened ballast, resulting in a complete replacement of the ballast material.

Nevertheless, it should be noted that screening may not completely restore the track to the original designed asset life. As outlined within this submission, Aurizon Network's analysis has taken this into consideration as it is important to establish appropriate operational asset lives to reflect the assets created through Ballast Undercutting.

Aurizon Network uses a volume-based measure called Percent Void Contamination (**PVC**) to measure the extent to which ballast voids are filled with fouling material. If the fouling level exceeds the intervention threshold (i.e. Aurizon Network's asset policy is based on a 38% PVC threshold), the deterioration in asset condition is likely to be rapid and unpredictable, particularly in wet conditions, with the potential to cause:

- permanent damage to the formation – formation repairs are typically expensive and have a high impact on network capacity;
- loss of track strength and consequent track stability (vertically and laterally) with subsequent rapid breakdown in the track structure including the ability to control lateral track buckles resulting in safety issues; and
- premature asset replacement.

Aurizon Network prioritises and plans its annual ballast cleaning program having regard to the intervention threshold, taking into account data sourced via Ground Penetrating Radar (GPR) and local condition data sourced from field-based teams. GPR programs are run approximately every two years and provide locational snapshots of the PVC levels throughout the CQCN. The locations with a PVC greater than the intervention threshold along with reliability data from field teams, is used to inform the annual ballast undercutting program.

Proposal

Like rail assets, ballast is affected by the coal volumes railed in each Coal System, expressed in million net tonnes (**MNT**). The utilisation of Rail Infrastructure in each Coal System will vary depending on the location and level of production of mines located throughout the rail corridor. For example, Rail Infrastructure located at the extremities of a Coal System will typically see lower utilisation (and hence, a lower rate of fouling) than Rail Infrastructure that is located closer to the coal export terminals. It is not practical, to set a multitude of different ballast lives for individual line sections throughout the CQCN. Similarly, the volume profile between each of the individual Coal Systems, which collectively comprise the CQCN, is significantly different from one another.

For Moura, the lowest volume system with approximately 7% of annual CQCN volume and roughly 2% of total annual ballast undercutting scope, the calculated ballast asset life would be far beyond the ballast design asset life. The calculated Moura ballast asset life would be minimum 43 years. On the other hand, Goonyella has approximately 49% of total annual CQCN volume and c. 49% of total annual ballast undercutting scope. The calculated Goonyella ballast asset life would be 5 years.

In light of these variances, Aurizon Network proposes to apply a weighted average approach for determining the ballast asset life for the CQCN as this results in a more stable and consistent outcome for both Aurizon Network and its customers. Based on the annual CQCN weighted average coal volume, the calculated weighted average ballast asset life for the CQCN is between 7 and 9 years. In light of this, Aurizon Network is seeking QCA approval of an 8 year ballast asset life, which reflects the mid-point of the derived range.

The rationale for the annual CQCN weighted average coal volume assumption is explained in section 4 below.

Rationale for proposed Ballast Asset life

There are four key assumptions to determine the Ballast operational asset life. Specifically:

1. The fouling Intervention threshold;
2. The residual PVC% level after ballast cleaning activities;
3. The fouling rate; and
4. The annual CQCN weighted average volume.

Aurizon Network has outlined each key assumption below.

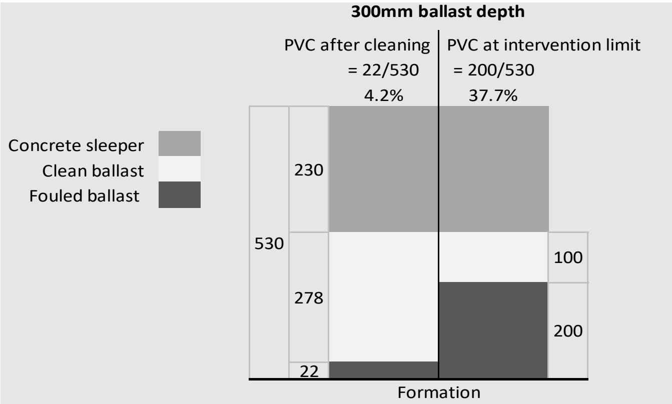
1. The fouling intervention threshold (the Threshold)

The intervention threshold of 38% PVC is used as a best practice policy which represents 100mm clean ballast below the bottom of the sleeper to maintain good drainage[2]. Contamination above this level is known to reduce the free drainage properties of ballast and leads to track structure deterioration.

[2] CMT (2015), Queensland Competition Authority, Aurizon Network Review of Ballast Undercutting Scope and Costs, 20 November 2015, page 8

Aurizon Network's current standard ballast depth under the base of a concrete sleeper is 300mm. This results in an Intervention Threshold of 38% PVC which is illustrated in figure 1.

Figure 1 – Calculation of the 38% PVC Intervention Threshold



Numbers in figure 1 above are in mm unless expressed otherwise

Aurizon Network utilises the GPR PVC data and 38% PVC threshold as a key quantitative criterion to identify the locations across the CQCN where ballast undercutting may be required, however, it is important to note that this is considered in conjunction with other qualitative criteria when determining the specific scope locations for the annual ballast undercutting program. These qualitative data sets include but are not limited to, past mechanised resurfacing (maintenance) interventions, track geometry measurements, maintenance effort and track inspections.

Aurizon Network develops the ballast renewal program as early as 24 months before the actual delivery of the scope via the high production ballast cleaning machine (RM902). This is to integrate ballast undercutting scope within the planned coal supply chain outages to minimise disruption to train services. The planned scope in each year must also have regard to the annual customer approved budget. It should be noted that the lag between scoping and execution of works can mean that the PVC level at the point of completing the ballast undercutting scope can be greater than 38% PVC if ballast fouling mechanisms continue to contaminate the ballast between scoping and delivery.

An engineering analysis has been performed by Aurizon Network's Civil Asset Team to determine the empirical ballast intervention threshold. This engineering analysis was based on data collected from sites where ballast undercutting had been performed between July 2020 and May 2021. This provided data on approximately 99 kilometres of renewed ballast across both Blackwater and Goonyella. The PVC measurement from the most recent GPR survey results taken before ballast renewal activities, were used to analyse the average PVC at locations renewed during this period. For the locations included in the sample, the empirical PVC prior to ballast renewal was determined to be 46% PVC on average. The detail data selection assumptions and analysis can be found in **Appendix A.**

2. Residual PVC level after Ballast Cleaning

Approximately 140km of mainline ballast undercutting and over 45 turnouts are completed across the CQCN each year. The ballast cleaning program is performed either by a BCM (approximately 122kms each year) or by excavators (approximately 18km per year). The delivery methodology will differ depending on location, for example, the size of the BCM means that it is physically unable to complete undercutting in certain constrained locations.

The BCM undercuts the fouled ballast from under the track structure (rail and sleepers) to the formation level. This fouled ballast is either:

- screenable ballast - passed over screens on the BCM to remove fouling material, then deposited back on the track structure; or

- unscreenable ballast – transferred to spoil wagons coupled to the BCM or placed next to the track for future disposal.

Aurizon Network's current BCM, the Plasser RM902, was commissioned in FY2022. Results from the RM902 indicate that the current average screenable ballast return rate is at 80% and the remaining 20% is topped up by new or recycled ballast. Currently, approximately 20% of the annual ballast undercutting scope is completed by total excavation, where all fouled ballast is disposed and replaced by new ballast.

As the annual Ballast Cleaning program returns existing screened ballast at most undercutting sites, the PVC % level does not always return to 0% after the ballast cleaning activity. This is justified by:

1. The fouled ballast has gone through the BCM with the screened ballast being returned to the track. The screened ballast has a residual PVC of 4.2% on average. This conclusion has been formed through a manual spot PVC % test program conducted by Aurizon Network's Civil Asset Team, who complete testing immediately after the Ballast Undercutter. Refer to the test results in **Appendix B**.
2. The ballast material replaced within the track after the undercutting activity (either by BCM or excavator) contains an average 64% screened and 36% recycled ballast or new ballast to top up the ballast to required depth and volume. Analysis of the top-up ballast indicates a 0.3% PVC once on track. Refer to the test results in **Appendix B**.

The weighted average variance to the intervention level after undercutting is calculated in Table 1.

Table 1 – Residual Fouling level assumptions

Residual Fouling level	Screened Ballast	New/Recycled Ballast
Residual PVC level after undercutting	4.2%	0.3%
Average ballast material mix in operations	64%	36%
The weighted average residual Fouling level	**2.8%**	
Equivalent to fouled ballast level (mm)	**15**	

The rate at which the contamination in the cleaned ballast reaches the Threshold will determine the operational life of the ballast asset. This rate of deterioration is referred to as the fouling rate.

3. The fouling rate (%PVC/100MNT)

Aurizon Network tests and analyses the ballast condition for the CQCN using GPR data. GPR surveys are generally completed every two years and the PVC measurements provide valuable data to assist with the analysis of key measures, like the fouling rate.

In support of this submission, Aurizon Network's Civil Asset Team analysed the data from the last two GPR runs (in calendar years 2018 and 2020). The methodology and key assumptions underpinning the fouling rate analysis are summarised below:

- Using only the centre-line GPR data (from a possible selection of left, right and centre);
- Using Route IDs for the main trunk routes in each system as these trunk lines carry the most coal tonnages and therefore have more reliable data;
- Removal of any PVC values over 80% as potential GPR data inaccuracies;

- Removal of any PVC values captured over bridges, turnouts, crossings, or track undercut/resurfaced between the 2018 and 2020 GPR runs;
- For each one metre of track, allocate the maximum PVC sample value from the four data points collect per lineal metre;
- To identify the Million Gross Tonne's (MGT), tonnages between turnouts for each track section is identified between the last two GPR runs and those tonnes are assigned to each metre of track; and
- Remove any PVC values less than 5 MGT to eliminate any errors due to low traffic volumes.

The calculation of the fouling rate for each metre as the PVC change per 100 Million Net Tonnes (MNT), and averaged over the Route ID. The conversion factor for MGT to MNT is 1.6[3].

$$The\ fouling\ rate\ (\%PVC/100MNT) = \frac{(PVC\ 2020 - PVC\ 2018)}{(MGT/100/1.6)}$$

On the basis of the above formula, the average ballast fouling rate for the CQCN is 6% PVC per 100MNT. Results for each Coal System are outlined in Table 2 below.

Table 2 – Fouling Rate summary

System	PVC% / 100MNT
Blackwater Avg	4
Goonyella Avg	13
Moura Avg	1
Newlands/GAPE Avg	7
CQCN Avg	**6**

The detailed analysis of the CQCN Ballast Fouling Rates 2018 – 2020 is referenced in the Civil Engineering Report included in **Appendix C**

4. The annual CQCN weighted average volume

Aurizon Network proposes to use current annual volume forecast included in the FY2022 Annual Review of Reference Tariffs (ARRT). This forecast represents the most recent QCA-approved volume forecast at the time of this submission.

The annual CQCN weighted average volume is calculated in table 3 below.

Table 3 – The annual CQCN weighted average volume

System	FY22 ARRT volume Forecast	System volume to total CQCN volume
Moura	14	6%
Newlands incl GAPE	33	14%
Blackwater	63	28%
Goonyella	118	52%
Total annual CQCN weighted average volume forecast (MNTs)	227	

[3] Refer to Appendix B in Civil Engineering Report – CQCN Ballast Fouling Rates 2018 – 2020, 29 September 2021

The annual CQCN weighted average volume (MNTs)	84

Calculation of Ballast asset lives

In determining the proposed ballast asset life, Aurizon Network has applied the following values.

Assumptions:

- ✓ The intervention threshold (Threshold PVC%): 38% PVC (best practice), 46% PVC (empirical threshold)
- ✓ The weighted average residual Fouling level (Residual PVC%): 2.8%, refer to Table 1
- ✓ The CQCN average fouling rate is 6% PVC per 100MNT, refer to Table 2
- ✓ Annual CQCN weighted average volume (MNTs): 84, refer to Table 3

The ballast asset life for the CQCN is calculated as follows, with the results outlined in Table 4 below:

$$\frac{(\text{Threshold PVC\%} - \text{Residual PVC\%})}{\text{the fouling rate (PVC\%/100MNT)}} \text{X } (100 \text{ / annual CQCN weighted average volume (MNTs/year)})$$

Table 4 – Calculated ballast asset life for the CQCN

Assumptions	Best practice	Empirical threshold
The intervention limit (Threshold PVC%)	38.0	46.0
The weighted average residual Fouling level (Residual PVC%)	2.8	2.8
The weighted average variance to the intervention level after undercutting (PVC%)	35.2	43.2
The CQCN average fouling rate (%PVC/100MNT)	6	6
The annual CQCN weighted average volume (MNTs)	84	84
The weighted average Ballast operational asset life (years)	**7**	**9**

The above ballast asset life calculation provides a range from 7 years to 9 years. Aurizon's accounting asset life for mainline ballast is 8 years, which falls within the above calculated range. Therefore, Aurizon Network considers that an 8-year regulatory asset life for ballast asset is reasonable.

Recommendation

On the basis of the analysis above, and consistent with Aurizon's accounting standards, Aurizon Network seeks QCA approval of an eight (8) year asset life for ballast undercutting renewal expenditure for all Coal Systems comprising the CQCN.

Effective date

Aurizon Network proposes that the ballast asset life be applied to all relevant capital expenditure approved for inclusion in the RAB from 1 July 2021.

Appendix A

Engineering analysis of Percentage Void Contamination prior to ballast undercutting

V1.2, by William Schuh, 15 February 2022

Appendix B

Civil Engineering Report – Percentage Void Contamination (PVC) Testing After Ballast Cleaning

Rev 3, 16 September 2021


AURIZON
Civil Engineering Report
Percentage Void Contamination (PVC) Testing After Ballast Cleaning

Appendix C

Civil Engineering Report – CQCN Ballast Fouling Rates 2018 - 2020

29 September 2021


AURIZON
Civil Engineering Report
CQCN Ballast Fouling Rates 2018 - 2020

Reference

QCA - Aurizon Network Review of Ballast Undercutting Scope and Costs by CMT

20 November 2015