# Ballast Asset Life in the Central Queensland Coal Network

| To | Sandra Xia | From | William Schuh |
|---|---|---|---|
| CC | John Windle, Michael Bray, Luke Gibbons | Date | 15 February 2022 |

**Subject:** Engineering analysis of Percentage Void Contamination prior to ballast undercutting

Dear Sandra,

Please find below the results of an engineering analysis, to study the empirical Percentage Void Contamination (PVC) prior to Ballast Undercutting within the Central Queensland Coal Network (CQCN). These results aim to facilitate the regulatory asset life of ballast under the management of Aurizon Network.

## Background

It is well understood that Ground Penetrating Radar (GPR) Surveys is used by Aurizon Network to provide PVC measurements for the CQCN to efficiently assess and prioritise the ballast renewal program.

The intervention threshold of 38% PVC is used as a best practise policy which represents ballast which only has the equivalent of 100mm of clean ballast underneath the sleeper. Contamination above this level is known to reduce the free drainage properties of ballast and leads to track structure deterioration.

Aurizon Network utilises the GPR PVC and 38% PVC threshold as a key quantitative criterion to determine ballast renewal scope, however, Aurizon also uses other qualitative criteria to determine scope. These qualitative data sets include but is not limited to, past mechanised resurfacing count, 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 the scope within the coal supply chain outages. Therefore, the empirical intervention threshold for ballast cleaning is understood to be greater than 38% PVC if ballast fouling mechanisms continue to contaminate the ballast between scoping and delivery.

## Empirical Ballast Intervention Threshold

To determine an accurate ballast asset life within the Central Queensland Coal Network, an engineering analysis has been performed to determine the empirical PVC prior to ballast undercutting.

The results of this analysis do not represent the adopted intervention threshold of Aurizon Network asset management strategies. The positive and negative consequences of this empirical PVC value is not well understood, and the impacts of maintenance performed between scoping and ballast renewal has not been accounted for.

## Analysis Assumptions and Constraints

This engineering analysis has been performed via data queries, combining the past ballast undercutting delivery dates between July 2020 and May 2021, with the latest GPR survey results before ballast renewal.

The below assumptions and constraints have been applied to enable this analysis:

- Aurizon Network's typical algorithm has been applied to the GPR PVC results to summarise the centre, left and right radar measurements. The algorithm takes the average between the centre channel and the maximum of the left and right channel.

- For each ballast renewal scope, the SAP notification is subdivided into smaller work items to reflect the RM902 movements, such as cut in cut out locations as well as operational rosters. The 80$^{th}$ Percentile PVC value has been used to represent each work item, then a weighted average (based on item length) has been used to represent the entire renewal scope. The decision to use the 80$^{th}$ Percentile PVC was based on the process to develop efficient high production ballast cleaning scopes which combine a distribution of ballast fouling conditions. Within the CQCN, coal fouling is the primary fouling mechanism and does not uniformly contaminate track (see figure 1).

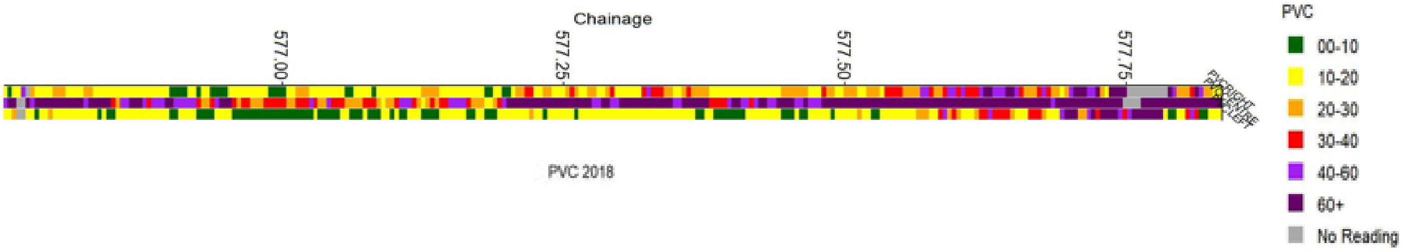


**Figure 1: An example of GPR PVC results demonstrating the random distribution of ballast contamination along a scope length**

- Aurizon Network has completed GPR surveys of the CQCN in 2014,2016,2018,2020 and recently in 2021 (uncalibrated). This analysis determined the empirical PVC threshold by using the most recent GPR PVC prior to the ballast renewal date (see Appendix 1 for detailed summary). Aurizon has historically performed GPR surveys every two years, and due to this interval, the analysis is limited in its capability. There will be some inaccuracy of the GPR PVC due to the time difference between the GPR survey and the ballast renewal date. However, it is believed that this inaccuracy is mitigated by the quantity of scope analysed in this investigation.

- 34 ballast renewal scopes, summating to 99km of ballast renewal between July 2020 and May 2021 have been analysed. All scopes within this analysis were constrained to the Blackwater and Goonyella Systems.  Data integrity issues impacted this analysis when reviewing historical ballast renewal scopes and further data cleansing is required to improve this dataset.

- Aurizon uses multiple data sources and inspections for ballast renewal scoping to compliment the below GPR analysis assumptions:
    - GPR measures the depth of clean ballast and assumes a design ballast depth (typically 300mm) for calculating a PVC value.
    - Ballast particles are standard sized (Grade A) and the void space is filled with fouling materials (coal fouling and ballast breakdown).
    - The accuracy of GPR PVC ranges between ± 5-15% PVC depending on the severity of fouling present.
- The root cause of the ballast renewal scope was not considered in this analysis. The reason for performing a ballast renewal scope can include, coal fouling, ballast attrition, excessive ballast depth and fouling from debris via flooding.

**Analysis Results**

The results of the data analysis are listed below:

- Ballast renewal scopes ranged in length from 110 metres to 7770 metres, the average distance was 2918 metres. The total length analysed was 99.226km
- The 80th Percentile PVC for each ballast renewal locations ranged from 17% PVC to 84% PVC. See figure 2 below and Appendix 1 for detailed summaries.
- The empirical PVC prior to ballast renewal was determined to be 46% PVC, this was determined by averaging the 80th Percentile PVC for each ballast renewal location. This value helps to inform the assessment of the regulatory asset life of ballast in the CQCN.

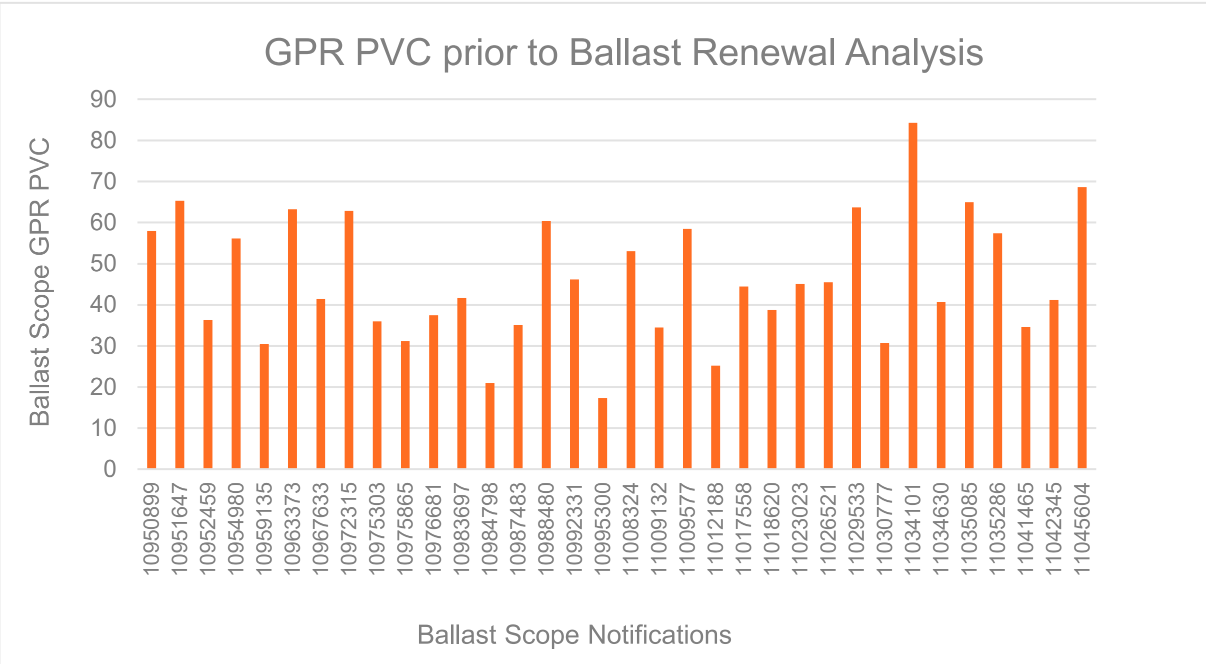


**Figure 2: GPR PVC results per Ballast Renewal Scope in FY21**

Sincerely,

*Douglas Schuh*

William Schuh
RPEQ 19004
Civil Asset Team Leader
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## Appendix 1 – Ballast Renewal PVC Summary

| Notification | Linear ref pattern | Basic finish date | GPR year | GPR PVC (80th Percentile) | Length (metres) |
|---|---|---|---|---|---|
| **10950899** | GA-02ML | 3/07/2020 | 2018 | 58 | 3133 |
| **10951647** | GA-01ML | 5/07/2020 | 2018 | 65 | 600 |
| **10952459** | GA-01ML | 3/08/2020 | 2020 | 36 | 5854 |
| **10954980** | GA-02ML | 21/07/2020 | 2018 | 56 | 7770 |
| **10959135** | GA-01ML | 15/09/2020 | 2020 | 31 | 2901 |
| **10963373** | GA-02ML | 13/08/2020 | 2020 | 63 | 2552 |
| **10967633** | GA-03ML | 15/09/2020 | 2020 | 41 | 3221 |
| **10972315** | GA-01ML | 14/09/2020 | 2020 | 63 | 1354 |
| **10975303** | BW-01ML | 24/09/2020 | 2020 | 36 | 454 |
| **10975865** | BW-03ML | 13/01/2021 | 2020 | 31 | 2357 |
| **10976681** | BW-06ML | 30/09/2020 | 2020 | 37 | 3812 |
| **10983697** | BW-04ML | 24/10/2020 | 2020 | 42 | 2411 |
| **10984798** | BW-02ML | 3/02/2021 | 2020 | 21 | 6371 |
| **10987483** | BW-03ML | 4/12/2020 | 2020 | 35 | 2134 |
| **10988480** | BW-03ML | 10/11/2020 | 2020 | 60 | 3904 |
| **10992331** | BW-03ML | 22/11/2020 | 2020 | 46 | 5799 |
| **10995300** | BW-04ML | 6/12/2020 | 2020 | 17 | 6507 |
| **11008324** | BW-01ML | 2/02/2021 | 2020 | 53 | 896 |
| **11009132** | BW-01ML | 16/01/2021 | 2020 | 34 | 1696 |
| **11009577** | BW-03ML | 19/01/2021 | 2020 | 58 | 1603 |
| **11012188** | BW-04ML | 31/01/2021 | 2020 | 25 | 1724 |
| **11017558** | BW-03ML | 12/02/2021 | 2020 | 44 | 2472 |
| **11018620** | BW-04ML | 15/02/2021 | 2020 | 39 | 1321 |
| **11023023** | BW-04ML | 1/03/2021 | 2020 | 45 | 5608 |
| **11026521** | BW-03ML | 15/03/2021 | 2020 | 45 | 4073 |
| **11029533** | GA-03ML | 8/05/2021 | 2020 | 64 | 3560 |
| **11030777** | GA-02ML | 30/03/2021 | 2020 | 31 | 2980 |
| **11034101** | GA-02ML | 8/05/2021 | 2020 | 84 | 1434 |
| **11034630** | GA-01ML | 12/04/2021 | 2020 | 41 | 110 |
| **11035085** | GA-02ML | 30/04/2021 | 2020 | 65 | 622 |
| **11035286** | GA-02ML | 15/04/2021 | 2020 | 57 | 1959 |
| **11041465** | GA-02ML | 7/05/2021 | 2020 | 35 | 3324 |
| **11042345** | GA-02ML | 11/05/2021 | 2020 | 41 | 3046 |
| **11045604** | GA-01ML | 20/05/2021 | 2020 | 69 | 1664 |
| **Average** | | | | 46 | 2918 |
| **Sum (metres)** | | | | | 99226 |