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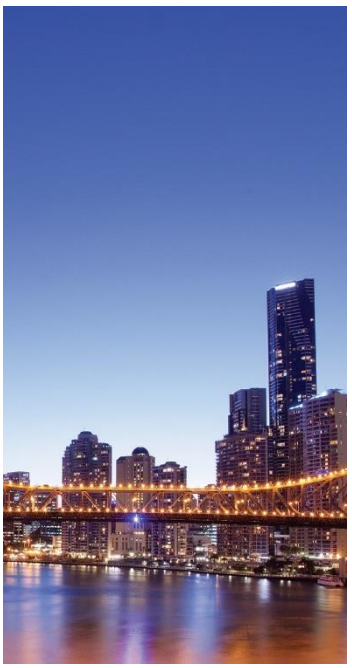

Review of the Prudency and Efficiency of Aurizon Network's Proposed UT5 Maintenance Expenditure

Queensland Competition Authority

15 November 2017

GHD

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1. Introduction

This report summarises GHD's (our) assessment of the prudency and efficiency of Aurizon Network's proposed UT5 (Financial Year 2017-18 (i.e. FY2018) to FY2021) maintenance costs. We also provide an overview of Aurizon Network's below-rail infrastructure, known as the Central Queensland Coal Network (CQCN). Our detailed analysis prudency and efficiency of Aurizon Network's proposed UT5 maintenance costs is provided in the Appendices to this report.

1.1 QCA's role

The QCA is responsible for the economic regulation of Aurizon Network. As part of its role, the QCA must assess draft access undertakings (DAUs) that Aurizon Network submits to it for consideration. DAUs contain proposed terms and conditions for access, including below-rail tariffs for the five CQCN systems, comprising Newlands, the Goonyella Abbot Point (GAP) interconnection between the Newlands and Goonyella systems, Goonyella, Blackwater and Moura.

1.2 Our engagement for the QCA

In assessing DAUs, the QCA must have regard to section 138(2) of the QCA Act, which makes reference to, among other things, the efficient operation and use of the below-rail infrastructure and the pricing principles.

It is against this background that we have assessed the prudency and efficiency of Aurizon Network's UT5 maintenance-cost proposal. As requested in the QCA's Terms of Reference (ToR), our analysis considers the following key themes (see Table 1).

Table 1 – Themes for review

Underlying themes	Title
Efficiency and prudency	The extent to which Aurizon Network's proposals are efficient and prudent.
Achievability	The extent to which the proposals are practically achievable.
Measurability	The extent to which the proposals provide a platform for measuring performance.
Transparency	The extent to which the proposals clearly articulate and commit to a set of outputs.
Accountability	The extent to which Aurizon Network is accountable for its performance.

In accordance with the ToR, we have undertaken the following in carrying out our review:

- We have, where the data are available, considered all tasks on a rail system-by-rail system basis, as well as with respect to the aggregate of all systems:
  - In addition, as applicable to the task, we have considered the UT3 period (FY2010 to FY2013), UT4 period (FY2014 to FY2017) and UT5 period (FY2018 to FY2021) on both a yearly and aggregate basis
- We have considered the tasks in the context of the need to prioritise maintenance cost categories and their associated maintenance products. This prioritisation informs the depth of analysis we have undertaken for a particular maintenance cost category and its associated maintenance products.

1.3 Central Queensland Coal Network

The Central Queensland Coal Network (CQCN) is an integrated and interconnected narrow gauge (1,067 mm) heavy haul (26.5 tonne axle load (TAL)) rail transport network which links more than 40 mines to five export coal terminals, using over 2,800 km of track, as listed in Table 2. These systems are further detailed in the subsequent sections.

Table 2 – CQCN characteristics

System	Length (km)	Aurizon Network UT5 FY2018 forecast (mtpa)
Blackwater	1,171	70
Goonyella	1,021	120
Moura	315	10
Newlands	242	9
GAPE[1]	69	16
Total[2]	2,818	226

Figure **1** (below)[3] sets out the layout of Aurizon Network's CQCN.

Figure 1: CQCN

[1] Goonyella to Abbot Point Expansion (GAPE) is typically coupled with Newlands

[2] Number differs from the sum of throughput across the individual systems due to rounding

[3] http://www.aurizon.com.au/what-we-deliver/network#central-queensland-coal-network--cqcn-

Allowable axle loads and speeds on branch lines vary as described below.

1.3.1 Blackwater system overview

Table 3 presents below-rail data for the Blackwater system (including for the Wiggins Island Rail Project (WIRP)).

Table 3 – Blackwater system data[4]

Asset type	Length/Total
Total track	1,171.361 km including yards, sidings and passing loops
Duplicated track	296.950 km
Passing loops	27.298 km (16 passing loops)
Sidings	14.371 km (35 sidings)
Electrified track	1,122.527 km including yards, sidings and passing loops
Access roads	979.895 km including left and right side of track
Level crossings	228 crossings
Lubricators	40 sites
Crew change facilities	87 sites
Turnouts	447 turnouts (main line and yards)

The main trunk route from Blackwater to Gladstone is mostly 60 kg/m rail with concrete sleepers. Bridges allow the passage of 106 tonne (26.5 TAL) wagons at 80 km/h, with a typical train length of 1,800 m.

1.3.2 Goonyella system overview

Table 4 presents below-rail data for the Goonyella system.

Table 4 – Goonyella system data[5]

Asset type	Length/Total
Total track	1,021.319 km including yards, sidings and passing loops
Duplicated track	182.773 km
Passing loops	35.506 km (15 passing loops)
Sidings	10.535 km (34 sidings)
Electrified track	1,014.842 km including yards, sidings and passing loops
Access roads	669.079 km including left and right side of track
Level crossings	275 crossings

[4] Aurizon Network, *Blackwater System Information Pack*, issue 7.0, March 2017

[5] Aurizon Network, *Goonyella System Information Pack*, issue 7.0, March 2017

Asset type	Length/Total
Lubricators	33 sites
Crew change facilities	130 sites
Turnouts	424 turnouts (main line and yards)

The track on the main trunk route from Hay Point to North Goonyella is generally 60 kg/m rail with concrete sleepers. Bridges allow the passage of 106 t (26.5 TAL) wagons at 80 km/h, with a typical train length of 2,080 m.

1.3.3 Moura system overview

Table 5 presents the below-rail data for the Moura system.

Table 5 – Moura system data[6]

Asset type	Length/Total
Total track	315.094 km including yards, sidings and passing loops
Duplicated track	0 km
Passing loops	25.111 km (14 passing loops)
Sidings	2.048 km (11 sidings)
Electrified track	13.700 km including yards, sidings and passing loops
Access roads	216.797 km including left and right side of track
Level crossings	149 crossings
Lubricators	22 sites
Crew change facilities	44 sites
Turnouts	128 turnouts (main line and yards)

The narrow-gauge track on the main trunk route from Byellee Flyover to Moura Mine is generally 60 kg/m rail with concrete sleepers. Bridges allow the passage of 106 t (26.5 TAL) wagons at 80 km/h, with a typical train length of 1,500 m.

[6] Aurizon Network, *Moura System Information Pack*, issue 7.0, March 2017

1.3.4 Newlands system (including Goonyella Abbot Point infrastructure) overview

Table 6 presents below-rail data for the Newlands system (including for the Goonyella Abbot Point (GAP) infrastructure)).

Table 6 – Newlands system data[7]

Asset type	Length/Total
Total track	311.416 km including yards, sidings and passing loops
Duplicated track	14.107 km
Passing loops	23.025 km (12 passing loops)
Sidings	4.449 km (11 sidings)
Electrified track	0 km including yards, sidings and passing loops
Access roads	260.873 km including left and right side of track
Level crossings	82 crossings
Lubricators	13 sites
Crew change facilities	46 sites
Turnouts	76 turnouts (main line and yards)

1.4 Maintenance categories

Aurizon Network subdivides its maintenance activities into nine categories (see Table 7).

Table 7 - Aurizon Network's maintenance categories for UT5 and proposed UT5 expenditure

Maintenance category	Description	Total UT5 expenditure ($FY2015)[8]
Ballast undercutting[9]	Removal, cleaning and replacement of ballast	274,232,255
Resurfacing	Mechanised lifting, alignment of track and tamping of ballast.	95,627,646
Rail grinding	Mechanised removal of metal from the head of the rail to reshape the rail head and remove defects.	70,884,017

[7] Aurizon Network, *Newlands System Information Pack*, issue 7.0, March 2017

[8] Maintenance UT5 Cost Build. Total NMP

[9] Includes track ballast undercutting, which is captured in “General maintenance” by Aurizon Network

Maintenance category	Description	Total UT5 expenditure ($FY2015)[8]
General maintenance	Maintenance activities not captured in other categories such as fire and vegetation management.	185,645,797
Signalling	Maintenance of track signals, level crossings, weighbridges and monitoring equipment	97,887,698
Traction Power	Maintenance of overhead traction infrastructure	38,587,055
Telecommunications	Telecommunications infrastructure maintenance	19,002,082
Structures	Maintenance of structures such as rail over road crossings, road over rail crossings, drainage under track	15,382,027
Maintenance planning and support (MPS)	Planning and support services to the maintenance categories of ballast undercutting, resurfacing, grinding, general maintenance, signalling, traction, telecommunications and structures	17,573,320
Total	n/a	**814,821,897**

Aurizon Network's UT5 maintenance-cost proposal amounts to $814.8 M ($FY2015) over four years. Given the scale of the UT5 maintenance-cost proposal, in agreement with the QCA, we have adopted a prioritisation and sampling approach for our assessment of the prudency and efficiency of Aurizon Network's maintenance costs.

1.5 Volume forecasts

In determining the prudent maintenance scopes for the UT5 period, we considered the volume forecasts provided by both Aurizon Network and the QCA. Aurizon Network's forecast is 225.8 mtpa in FY2018 and plateaus at 228.5 mtpa from FY2019 to FY2021. By contrast, the QCA's volume forecasts are higher, with increasing variance to Aurizon network's forecasts from year to year (see Table 8).

Table 8 QCA's proposed UT5 volume forecast[10]

Volume (mtpa)	FY2018	FY2019	FY2020	FY2021
Blackwater	68.4	69.6	70.6	70.6
Goonyella	128.3	132.0	133.8	133.8
Moura	14.1	17.3	18.3	18.3
Newlands	11.7	14.2	14.2	14.2
GAP	15.9	18.9	23.9	28.9
Total (QCA)	**238.3**	**251.9**	**260.7**	**265.7**
Total (Aurizon Network)	**225.8**	**228.5**	**228.5**	**228.5**
% difference (QCA minus Aurizon Network)/Aurizon Network	5.5%	10.2%	14.1%	16.3%

[10] Forecasts provided by QCA staff as at 28 June 2017. Where QCA-staff forecast volumes are provided in the mini reports, they refer to the forecasts provided as at 28 June 2017/

2. Our approach

In accordance with the requirements of the TOR, we have undertaken the following in our analysis for this report:

- Articulated our approach for determining the prudence and efficiency of Aurizon Network's UT5 maintenance-cost proposal
- Reviewed Aurizon Network's detailed costing methodologies, including indexation
- Reviewed Aurizon Network's productivity and undertaking cost benchmarking
- Presented overall conclusions and recommendations.

This section describes our overarching approach for assessing the prudency and efficiency of Aurizon Network's proposal. It also sets out our prioritisation and sampling approach, followed by a discussion of the information constraints we faced and how we endeavoured to overcome them.

2.1 Prudency

A prudent expenditure is one that is needed for the entity to deliver necessary regulated services and one that is supported by a regulatory (customer mandated, economic, technical, financial or environmental) driver. Such drivers include:

- Meeting growth (with respect to capex)
- Service improvement (usually requiring explicit or tacit customer approval, through an access agreement or system operating parameters that the entity has published)
- Replacement and refurbishment of assets to maintain foreseeably required capacity and to ensure conformance with performance standards contained in customers' access agreements
- Compliance with applicable legislation (e.g. for rail, Transport (Rail Safety) Act 2010 (Qld) (TRSA Act) and Transport (Rail Safety) Regulation 2010 (Qld) (TRSA Regulation), Aurizon Network's Safety Management System (SMS), the Professional Engineers Act 2002 (Qld) and mandatory standards and operating licences
- Maintenance of the utilities' regulated assets to achieve planned service life (typically on a least life cycle cost basis hence allowing for capital expenditure and maintenance/operating expenditure trade-offs) and to comply with technical regulatory standards such as safety.

We have had regard to these drivers in undertaking our assessment of prudency of scopes and expenditure.

2.2 Efficiency

This is a two-part test:

- The first part assesses whether the regulated entity (Aurizon Network) has selected the right (most efficient on a life-cycle cost basis) option for meeting the expenditure need, in keeping with that which a knowledgeable, prudent and efficient operator would have selected.
- The second part of this test is to assess whether the costs are: the least costs (taking into account asset lifecycle cost); in keeping with market rates; comparable to industry benchmarks (taking into account locational and operating factors that may impact on costs); and are in keeping with those costs that a knowledgeable, prudent and efficient operator would have incurred.

We note that in previous Aurizon Network access undertaking reviews, the QCA has adopted prudency of scope, prudency of standard and prudency of cost as being the regulatory tests to apply for capital

expenditure. However, we also note that both tests are comparable in nature and approach hence the difference is more one of nomenclature than substance.

In undertaking the assessment of reasonableness of costs, it is necessary to take account of the interplay between the different key cost elements of Aurizon' Network's business of capital expenditure, maintenance expenditure and, to a lesser degree, operating expenditure. In particular, when assessing maintenance costs, we understand the need to appreciate Aurizon Network's distinction between what it classifies as maintenance expenditure over capital expenditure, which is often volume driven. An example being replacement of sleepers where, below a defined number, Aurizon Network classifies the expenditure as being related to a maintenance activity whilst if the number replaced is equal to or greater than that defined number, the expenditure is classified as capital expenditure.

Recognising this distinction and the need to fully understand it are particularly important given that maintenance costs are regulated ex ante whilst capital costs are regulated ex post. Hence, there is the potential for Aurizon Network to double recover certain costs if, during a regulatory period, it allocates costs that have previously been allocated to maintenance in the establishment of the AU, to capital costs incurred during the period of that particular AU.

We have had regard to the above in undertaking our assessment of the efficiency of maintenance practices (e.g. the extent of productive use of shift time and possession time, speed of machinery) and expenditures (i.e. via bottom-up cost building blocks for mechanised-maintenance categories, where data allowed that analysis to occur). In undertaking the above, we also gave consideration, data permitting, to the following factors:

- Achievability
- Transparency
- Measurability
- Accountability.

2.3 Prioritisation and sampling approach

2.3.1 Prioritisation approach

Where a maintenance category accounts for at least 7.5% of total maintenance expenditure over UT5, we undertook a detailed review either of: all the sub-categories making up that category expenditure; or a sample of the sub-categories making up the category, if the number of sub-categories exceeds five. Where the category accounts for less than 7.5% of total maintenance costs, we undertook a preliminary review.

We have moved 'Mechanised Track Costs', comprising 'Ballast Undercutting (Other)' and 'Ballast Undercutting – Turnout - Minor' from the General Maintenance category, to the Ballast Undercutting category. This approach keeps all ballast-undercutting-related tasks within the Ballast Undercutting category. Our prioritised list, including the percentage of total expenditure covered by this list, is set out below.

2.3.1.1 Detailed review (category accounts for at least 7.5% of total maintenance costs[11])

Categories that undergo a detailed review are: (% of total maintenance)

- Ballast undercutting (33.7%)
- Resurfacing (11.7%)

[11] Assessment undertaken in nominal, rather than real, terms.

- Rail grinding (8.7%)
- General maintenance (22.8%)
- Signalling (12%).

We have also reviewed MPS cost category being 2.2% of overall costs as this represents a new category.

2.3.2 Sampling

To manage the large amount of sub-categories within some maintenance cost categories, we adopted a sampling approach. A sub-category was included in our sample for detailed review if it:

- accounted for at least 10% of costs within a category; and/or
- presented year-on-year changes from FY2018 to FY2021 or changes from FY2015 to FY2018, in real terms, of at least 20%.

We formed our sample at a network (not system-by-system) level (see Real > 'Total NMP' tab in Aurizon Network's UT5 model). We established a sample of sub-categories that accounted for at least 50% of a category's costs. Where we were unable to achieve at least 50% coverage by adding sub-categories representing greater than 10%, or where the sub-category has a greater than 20% real year-on-year delta, we added sub-categories (by magnitude of cost contribution) to the sample until we achieved the 50% coverage requirement. Based on this approach, where data allowed, our sample of items reviewed reflected the following:

- Ballast undercutting – sample-size coverage of 100% of total costs:
    - C01 – RM900 (69%)
    - C14 – Excavator (15%)
    - C13 – Turnouts (8%)
    - C02 – Ballast Undercutting (Other) (8%)
    - C03 – Ballast Undercutting – Turnout – Minor (close to 0%).
- Resurfacing – sample-size coverage of 100%:
    - C19 – Mechanised Resurfacing (83%)
    - C23 – Mech Resurfacing – Turnouts (17%)
    - C49 – Stoneblowing was excluded because this sub-category accounts for no costs over UT5
- Rail grinding – sample-size coverage of 100%:
    - Grinding (mainline and turnout) (100%)
- General maintenance (Mechanised Track and General Track) – sample-size coverage of 53.9%:
    - C54 – Rail Repair (14.7%)
    - C44 – Fire & Vegetation Management (12.6%)
    - C50 – Track Inspections (12.3%)
    - C42 – Maintenance Ballast (7.5%)
    - C47 – Rail Stress Adjustment (6.8%)

- Other sub-categories are excluded because they were not needed to achieve a 50% sample coverage

- Signalling – sample-size coverage of 77%:
  - T29 – corrective signalling field maintenance (42%)
  - T28 – preventative signalling field maintenance (34%)
  - Other sub-categories were excluded because they each account for less than 10% of the Signalling category's costs and are not needed to achieve a 50% sample coverage.

In FY2015 dollars, Aurizon Network's maintenance cost proposal amounts to $814.8 million over the UT5 period. Our detailed-review approach yields a coverage of **75.5%** of total maintenance costs (i.e. $615.5 million out of $814.8 million), based on the following contributions to total maintenance costs:

- Ballast undercutting (33.7%) – $274.2 million
- Resurfacing (11.7%) – $95.6 million
- Rail grinding (8.7%) – $70.9 million
- General maintenance (12.3%) – $99.9 million
- Signalling (9.2%) – $74.9 million.

Finally, we included MPS costs in our detailed review.

2.4 Comments on the information-gathering process

We commenced our review of Aurizon Network's proposal in late February 2017. In the first eight weeks of the project, we shaped several requests for information (RFIs) in collaboration with QCA staff to extract detailed productivity-related, cost-related and qualitative evidence from Aurizon Network about the underpinnings of its maintenance-cost proposal.

During the RFI process, it became apparent to QCA staff and GHD that Aurizon Network staff required greater amounts of time than envisaged to respond to the RFIs. We considered that Aurizon Network's, initial responses were lacking or incomplete. To address this, on 10 April 2017, the QCA issued an information notice to Aurizon Network under section 185 of the QCA Act, with the objective of promoting a timely and structured approach for obtaining the information required to undertake the UT5 assessment. Over that period, QCA staff instructed us to adopt a 'pens down' approach until 12 May 2017 (the QCA's nominated deadline for Aurizon Network).

On 15 May 2017, QCA staff shared Aurizon Network's RFI responses with us. Over a number of weeks, we investigated Aurizon Network's data, which were voluminous, sometimes not accurately reported and sometimes conflicting. To address this, and to seek clarification on the information received, we derived a set of further questions in partnership with QCA staff. The questions formed the basis of nearly 10 meetings with Aurizon Network staff, along with QCA staff, as listed below:

- Ballast-undercutting productivity-related parameters and scopes – 12 July 2017
- Ballast-undercutting costs – 13 July 2017
- Safety Management Systems (including safety-related legislation) and the Network Strategic Asset Plan models – 26 July 2017
- Procurement-related matters – 27 July 2017

- Resurfacing productivity-related parameters, scopes and costs – 28 July 2017
- Rail-grinding contract arrangements and costs – 3 August 2017
- Rail-grinding productivity-related parameters and scopes – 8 August 2017.

At the end of the meetings, action items were assigned and agreed to by Aurizon Network staff. While we consider that Aurizon Network staff had been generally forthcoming and had worked in a collaborative manner with us, we do not consider that sufficient resourcing and quality assurance had been dedicated to closing out our follow-up questions by Aurizon Network. Against this background, QCA staff asked us to advise Aurizon Network that we would cease to consider new information from 18 August 2017. Nevertheless, where possible, we have tried to accommodate information provided to us by Aurizon Network after 18 August 2017.

The lack of structure in, and accuracy of, the information that Aurizon Network provided coupled with the time taken for Aurizon Network to provide necessary information and resolve our clarifications about data inconsistencies or errors has made the undertaking of the maintenance cost review problematic. In addition, part of the issues with the data provided to us by Aurizon Network was the *structure* of the information. For example, it became clear at the "Ballast-undercutting costs" meeting on 13 July 2017 that Aurizon Network had prepared for the meeting with the apparent purpose being to display its *cost-capture procedures*, rather than the *structure of the information* itself.

The information provided was more in keeping with an accountancy audit process rather than a regulatory prudency and efficiency of expenditure review. An example of this was that, through our analysis, we were able to determine the amount spent on bottled water but not the hourly labour rate of workers or quantity of ballast consumed during operations.

In the lead up to the UT6 process for Aurizon Network, we recommend that the QCA establish an annual regulatory-information-notice (RIN) type of arrangement for Aurizon Network. We note that the Australian Energy Regulator (AER) uses a RIN process to support a review of the prudence and efficiency of electricity networks' opex *ex ante* proposals and *ex post* materialisations. A significant part of the RIN development process will be the identification of cost structures required to satisfy such a review's objectives.

The RIN process will be a platform for Aurizon Network to inform QCA staff and stakeholders, in a regular and credible manner, about its ability to achieve maintenance practices and scopes and to what degree of cost effectiveness. This needs to be done well in advance of Aurizon Network making its UT6 submission to the QCA. Such a process would also assist stakeholders (e.g. CQCN above-rail operators and coal producers) with maximising their ability to review and comment on Aurizon Network's DAU submissions. For example, RIN type submissions can be included as part of the reporting sections in the draft UT5 proposal. We urge the QCA to consider our recommendation.

2.5 Quality of information received

Our review of the prudency and efficiency of Aurizon Network's UT5 maintenance-cost proposal has been impacted due to the low quality of key information from Aurizon Network, including the poor timeliness associated with receiving this information. In response to that and to prepare this report, we have had to make numerous assumptions and have had to introduce many caveats in shaping our analysis.

In this context, we acknowledge that:

- stakeholders may request that the QCA requests further information from Aurizon Network
- Aurizon Network may wish to submit further information to substantiate their UT5 submission.

2.5.1 Limitations

Key examples of information absence and deficiencies from Aurizon Network include:

- Ballast undercutting:
  - the reported speed (in writing) of 100 metres per possession hour (e.g. in an 11-hour possession, Aurizon Network's ballast-undercutting machine covers 1.1 km of undercutting) for the RM902 in Aurizon Network's business case was amended by Aurizon Network to 79.9 metres per possession hour in our meeting with them of 12 July 2017
  - the time-in-motion chart supplied for the RM900 machine did not include distances, even though this was requested on more than one occasion
  - the time-in-motion chart for the RM902 was not supplied
  - Productivity dynamics for the excavator (relevant for spot-ballast-undercutting and some mainline ballast-undercutting activities) were not provided
  - bottom-up cost models for ballast undercutting mainline and turnout activities were not provided for the UT5 period. This means that no bottom-up costs were available for us to estimate fuel consumption for the RM900/RM902 machines (and for supporting machinery) and to estimate consumables costs (e.g. ballast material).
- Resurfacing:
  - UT5 Maintenance Allowance presentation and business-case documentation said that the speed of MMA/B 503 to MMA/B 507 machines is 1,300 metres per production hour, but Aurizon Network staff said the figure should be 1,200 metres per production hour instead in its meeting with us on 28 July 2017
  - Reasons as to why Principal Delays, Traffic Delays, Daily Servicing and Pre-start durations in historical and planned shift and possession performance appear to be poor
  - Reasons as to why most of the mainline resurfacing works is not being performed by the MMA/B 503 to MMA/B 507 machines (i.e. Aurizon Network has not explained why it is still using a relatively large share of its old resurfacing fleet to deliver the scope, when all of its new fleet is available and capable to perform all the work).
- Rail grinding:
  - Aurizon Network did not provide the contract it has for rail-grinding services with Aurizon Operations. Aurizon Network also did not provide clear definitions and information of what the variable unit cost of grinding is over the UT5 period
  - Aurizon Network has not demonstrated that it administers the incentives and penalties reflected in the KPIs with Aurizon Operations.
- General maintenance:
  - Aurizon Network did not provide information concerning scopes for rail repairs, rail stress adjustment and maintenance ballast over the UT5 period. For track inspections, however, Aurizon Network advised that it undertook visual track inspections on a 96-hour cycle (i.e. a given length of track is inspected every four days).
- Signalling:
  - Aurizon Network did not provide scopes for preventative and corrective signalling maintenance not provided over the UT5 period.
- Maintenance and Planning Services (MPS):

- Aurizon Network did not provide sufficient evidence that MPS costs were not already masked by the maintenance-cost categories that we have not reviewed (e.g. telecommunications, traction and structures)
- Aurizon Network did not provide evidence that MPS costs are not being claimed via forecast operating costs over the UT5 period.

2.5.2 Overcoming the limitations

To overcome the limitations above, we have had to undertake the following:

- Ballast undercutting:
  - Use data from Evans & Pecks' (**confidential**) UT4-related report for Aurizon Network to inform our estimates of fuel and ballast-stone costs
  - Assume that the RM900/RM902 can perform all mainline work, since no historical productivity dynamics of the excavator were provided
  - Assume that the cost estimate for track-ballast-undercutting activities is prudent and efficient, in the absence of historical scopes for this activity and no information being provided by Aurizon Network on the historical productivity dynamics of the excavator used in this process.
- Resurfacing:
  - Assume that Aurizon Network's bar charts for the percentage of time for each activity required to undertake a resurfacing shift is comparable across all CQCN systems
  - Provided Aurizon Network the *benefit of the doubt* that 1,200 metres per productive hour for the overall resurfacing fleet for mainline resurfacing is appropriate, in comparison with the 1,300 metres per hour stated on page 22 of the UT5 Maintenance Allowance presentation.
- Rail grinding:

  [redacted]
- General maintenance:
  - Use historical UT4 costs as the basis for establishing whether costs for rail repairs, rail stress adjustment and maintenance ballast are prudent and efficient. We have had to do this because no scopes for those cost sub-categories have been provided for the UT5 period. For track inspections, we adjusted the scope of work to accommodate the Office of the National Rail Safety Regulator's allowed inspection rate of 192 hours. This means that Aurizon Network can undertake visual inspections of its track every eight days, instead of four.
- Signalling:
  - Use a top-down approach, with our industry knowledge, to estimate the number of signalling professionals per km of track. This is our measure to check whether Aurizon Network's proposed signalling costs for the UT5 period reflects prudent and efficient signalling-related maintenance practices for a rural and remote railway. We have had to do this because no scopes for preventative and corrective signalling maintenance exist in Aurizon Network's data.
- MPS:

– Assume that MPS costs are not already masked by the maintenance-cost categories that we have not reviewed (e.g. telecommunications, traction and structures)
– Assume that MPS costs are not being claimed via forecast operating costs over the UT5 period.

2.5.3 Other issues

A further issue is how Aurizon Network has split its UT5 cost proposal across CQCN systems and across the cost components of the MCI (i.e. labour, consumables, travel & accommodation, fuel, and depreciation). Because of the absence and deficiencies in the information that we received from Aurizon Network, we have had to consider the following in undertaking our analysis:

- In some cases, we could only assess Aurizon Network's proposal at a CQCN-level basis. The lack of granularity at a system-by-system level prevents us from undertaking a more detailed analysis that will seek to promote no cost cross-subsidisation across the CQCN systems
- In some cases, MCI cost-component breakdowns for the UT5 period did not align, in a material way, with the historical breakdown across the UT4 period. For example, in the signalling category, UT5 MCI cost components for labour were far lower than the UT4 actuals. Conversely, UT5 MCI cost components for consumables were far higher than UT4 actuals.

For our report to be updated in a way that meets the requirements of the QCA Act and stakeholder needs, Aurizon Network will have to provide precise and accurate further information to us; likely to be after the QCA's draft decision on Aurizon Network's UT5 proposal. Without this further information, the many assumptions and significant caveats we have proposed in arriving at our conclusions in this report will have to remain. And so will the associated findings.

3. Assessment of Aurizon Network's possession management

This section describes Aurizon Network's preventative maintenance strategy and discusses whether Aurizon Network's practices for possession management lead to efficient outcomes.

3.1 Analysis

Aurizon Network's UT5 proposal defines a "Possession" as follows:

> *"The temporary closure and/or occupation by Aurizon Network on part of the Rail Infrastructure (including closure of Track or isolation of any electrical overhead traction system) for the purposes of carrying out [a] Planned Possession, [an] Urgent Possession or [an] Emergency Possession on or in the proximity of the Rail Infrastructure which may affect the safety of any person or property."*[12]

The draft UT5 defines a "Planned Possession" as:

> *"A Possession that is entered into the [Master Train Plan] and may adversely impact upon the operation of Train Services and is notified to Access Holders at least twenty-one (21) days prior to taking effect and, for clarity, includes Maintenance Work."*[13]

Therefore, Possessions allow Aurizon Network to undertake preventative maintenance work on its infrastructure that cannot be undertaken when a train is running over a given section of track. As such, since Possessions provide a restriction on the operation of train services, it is important that Aurizon Network maximises the productive maintenance time during a given Possession.

However, we have observed that Aurizon Network does not exploit its possession times in a prudent an efficient manner. In particular, on some occasions, Aurizon Network is willing to let access holders' train services interrupt a Planned Possession at the expense of it being able to complete the planned maintenance task during that Planned Possession. In addition, our analysis has revealed that Aurizon Network does not make efficient use of its possession times. This occurs because of Aurizon Network's excessive allowances of time, in our view, for undertaking 'unproductive' activities, such as travel time, equipment-inspection time and preparation time, relating to delivering a maintenance activity.

Aurizon Network's practices, and associated assumptions for those practices, result in Aurizon Network achieving, on average, three hours of productive time only, during which the actual maintenance activity is undertaken, in an 11-hour Possession. Finally, we also note that Aurizon Network's practices may not accord with the Network Management Principles in the currently approved AU (i.e. 2016 AU); Subsection 3.2 discusses this matter.

[12] UT5: 287

[13] UT5: 287

3.2 Compliance with the network management principles

In the course of the engagement, we observed that some of Aurizon Network's maintenance practices, in particular resurfacing practices, are mismatched with network-management practices of a railway operator that employs a preventative-maintenance-based regime.

The *Network Management Principles* contained in Schedule G of the 2016 AU allow for Planned Possessions to be included in the Master Train Plan (MTP) at one to three months' notice. Clause 3.2 of Schedule G makes it clear that any MTP modification must not cause a Planned Possession to "not be met". That is, an MTP modification should not interrupt a Planned Possession, ensuring that the entire time of the Planned Possession is available for maintenance activities.

Clause 4 of Schedule G refers to Intermediate Train Plans (ITPs), which are a refinement of the MTP and are scheduled 48 hours prior to the day of operation. Daily Train Plans (DTPs) are the final step in the planning process for operations; they are finalised in the day before the day of operation. Clause 5.5 (a) of Schedule G states that, as with MTP variations, a DTP variation may not interrupt a Planned Possession.

Given the above, our interpretation of Schedule G of the 2016 AU is that any alteration to the MTP, ITP and DTP **must not cause a Planned Possession to be interrupted (i.e. a Train Service in the CQCN should never take priority over a Planned Possession)**. This requirement is consistent with the practices of a railway operator that employs a preventative-maintenance regime efficiently and prudently.

However, from our analysis, we have observed that Aurizon Network does not always ensure that a Planned Possession is not interrupted by Train Services. This results in 13%[14] of shift time being lost to Train Services (and likely to be more than 13% impact on Possession times); this observation was corroborated in our meetings with Aurizon Network staff, who indicated that Train Services are sometimes prioritised over mainline and turnout resurfacing activities (which would be in Planned Possessions) on the day of operation.

In response to our queries about its practices of prioritising Train Services over Planned Possessions, Aurizon Network said that "*healthy/unhealthy[15] possessions are treated the same as train services*". Aurizon Network's response addressed our queries in the context of the discretion that the Train Controller has in the day of operation.

In particular, Aurizon Network identified the provision in Schedule G that allows the Train Controller to give preference to late Train Services (caused by below-rail delays) over on-time Train Services, which would include Possessions as per Aurizon Network's statement above, if the Train Controller believes that giving such preference:

> *"would be consistent with 'critical objectives of the (late) Trains in question, and that it will result in less aggregated consequential delays to other Trains than otherwise would be the case."*[16]

From Aurizon Network's response, we consider that Aurizon Network's position is contrary to what Schedule G of the 2016 AU seeks to achieve for Planned Possessions. In our view, it is clear that Schedule G provides that Planned Possessions should not be interrupted by Train Services. As discussed above, the MTP, ITP and DTP cannot be amended to accommodate changes in the times or number of Train Services if doing so means a Planned Possession is interrupted.

[14] See Appendix C

[15] 'Healthy' means on time, while 'unhealthy' means late, with respect to starting and completing a Possession

[16] E-mail response from Aurizon Network staff to QCA staff and GHD, 7 August 2017

By allowing Planned Possessions to be interrupted, Aurizon Network's resurfacing costs are higher than those Aurizon Network would incur if it complied with Schedule G. This is because Aurizon Network has to undertake more Planned Possessions to achieve its annual resurfacing scopes, and associated activities, for mainlines and turnouts than would be the case if it did not allow a Planned Possession to be interrupted by a Train Service.

Aurizon Network transitions from a planning phase to an operational phase once the day of operation commences. We note that Schedule G of the 2016 AU requires that Aurizon Network's MTP, ITP and DTP be developed in a manner that accommodates the restriction of Planned Possessions not being interrupted by Train Services. We consider that this restriction should be carried forward to the operational phase, consistent with the plans developed during the planning phase. In short, Aurizon Network should not allow Train Services to interrupt the maintenance activities that it has planned to take place during Planned Possessions in the day of operation.

Finally, we do not accept Aurizon Network's practice that a Planned Possession be treated in the same way as Train Services in the day of operation. Rather, we consider that Train Services should be scheduled around Planned Possessions. Even if a Planned Possession has commenced late due to below-rail delays or due to other reasons, Aurizon Network has the discretion, from our interpretation of Schedule G, to change the timing of Train Services to accommodate Planned Possessions.

4. Summary of GHD's recommended costs against Aurizon Network's proposal

We have set out in Table 9 Aurizon Network's proposed UT5 expenditure and our assessed prudent and efficient UT5 expenditure (in $FY2015). Details of our assessments of prudency of scope and efficiency of expenditure (and productivity of operating practices) are provided in the appendices of this report.

Table 9 - Aurizon Network's maintenance categories for UT5[17]

Maintenance category	Aurizon Network's proposed total UT5 expenditure ($FY2015)[18]	GHD's assessed total UT5 prudent and efficient expenditure ($FY2015)	Cost difference (GHD minus Aurizon Network) ($FY2015)
Ballast undercutting[19]	274,232,254	223,090,674	-51,141,580
Resurfacing	95,627,646	60,445,160	-35,182,486
Rail grinding	70,884,017	70,884,017	0
General maintenance[20]	185,645,797	174,594,213	-11,051,584
Signalling	97,887,698	97,887,698	0
Traction	38,587,055	38,587,055	0
Telecommunications	19,002,082	19,002,082	0
Structures	15,382,027	15,382,027	0
Maintenance planning and support (MPS)	17,573,320	14,062,188	-3,511,132
Total	**814,821,897**	**713,935,115**	-100,886,782

Aurizon Network's proposed UT5 maintenance expenditure is $814.8 million ($FY2015). In comparison, our assessed prudent and efficient expenditure is $713.9 million ($FY2015), which is $100.9 million lower than Aurizon Network's proposal. This change represents a 12.4% reduction in Aurizon Network's expenditure proposal over the UT5 period ($FY2015 terms).

[17] Figures may not reconcile to Aurizon Network's maintenance-cost proposal due to rounding

[18] Maintenance UT5 Cost Build, Total NMP

[19] Includes track-ballast undercutting, which is included in "General maintenance" by Aurizon Network

[20] Track-ballast undercutting costs have been removed from the General Maintenance category, as the costs have been included in ballast undercutting.

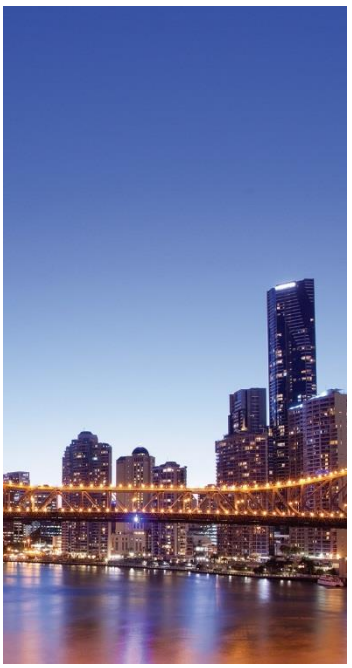
The main factor driving the differences between our assessed prudent and efficient expenditure and Aurizon Network's proposed UT5 maintenance expenditure is that we have assessed Aurizon Network's productivity rates for the ballast-undercutting and resurfacing machines to be lower than what can be achieved by adopting efficient operating practices. Moderate changes have also been proposed to the General Maintenance and MPS categories. For details of our analysis, refer to the following appendices:

- Safety (Appendix A)
- Ballast undercutting (Appendix B)
- Resurfacing (Appendix C)
- Rail grinding (Appendix D)
- General maintenance (Appendix E)
- Signalling (Appendix F)
- Maintenance and planning support (Appendix G).

GHD Advisory

Appendices

GHD Advisory



Appendix A - Safety

Mini Report for the Queensland Competition Authority

15 November 2017

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Disclaimer

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1. Summary of findings

Rail safety is controlled by a number of items of legislation. These include specific Rail Safety Acts and regulations and a number of others, which are more general in nature, such as Work Health and Safety, the Electricity Regulations and Professional Engineers Act.

Until 2017 the Rail Safety Acts and Regulations were Queensland legislation, as Queensland Rail Safety Unit operated as a division of the Department of Transport and Mains (Qld), rather than a part of the Office of the National Rail Safety Regulator, ONRSR. However the legislation was closely modelled on the legislation of the Office of the National Rail Safety Regulator, (ONRSR).

Since 1 July 2017, Queensland rail safety is now within the remit of the ONRSR, and the original Queensland legislation amended to now be:

- Rail Safety National Law (Queensland) Act 2017
- Rail Safety National Law (Queensland) Regulation 2017

The principal legislation that determines control by the ONRSR is the Rail Safety National Law (Queensland) Act 2017, which is effectively the same Act as the previous Transport Rail Safety Act 2010 Queensland.

The legislation listed above in turn refers to the Rail Safety National Law which means the Rail Safety National Law, as in force from time to time, set out in the schedule to the Rail Safety National Law (South Australia) Act 2012 (SA).

Using the Act, the Regulator requires an Operator to be accredited to conduct rail operations, irrespective of whether they are regarded as an above- or below-rail Operator. Accreditation is awarded when an Operator satisfies the Regulator that the risks to the rail operations are adequately understood and the appropriate controls are in place via a Safety Management System (SMS). The SMS must be effective, continuously monitored and continually improved.

Part of the control for risks for infrastructure is the adoption of an appropriate maintenance regime. The nature and scale of works and allowable tolerances and standards are to be defined by the Operator, not the Regulator. The Operator will define such practices based on the nature and scale of the operations, including train speeds and tonnages carried.

The critical issue with relation to maintenance programs and budgets, is that these are not mandated or dictated by law, but are for the Operator to determine. Importantly, in our view, there are no grounds for Aurizon Network to imply that the scope and costs of maintenance to the network are dictated by rail safety legislation. The costs for establishing, maintaining and operating the SMS, including auditing with or without the Regulator, are to be borne by the Operator. Since the SMS is required to cover all risks and the controls for all aspects of the network, then the costs of administering the SMS should be placed under operating expenditure, rather than maintenance expenditure. This is because the SMS would cover the entire operation of the network, as opposed to maintenance functions alone.

It would be expected that the costs for Registered Professional Engineer of Queensland (RPEQ) for review and approval of maintenance work scopes under the requirements of the Professional Engineers Act 2002 (Qld) should be considered as an internal-management matter and the costs of such review and approvals be allowed as an operating expense.

The points made by Aurizon Network's UT5 submission in relation to maintenance, in particular the statement that "Aurizon Network's legislative obligations underpin decisions around safety & maintenance tasks", in itself, is correct. However, the Operator is responsible for determining the specific works required, using the standards and policies within its approved SMS and tonnage/performance requirements.

The fact that Aurizon Network has developed an Asset Maintenance and Renewals Policy (AMRP) document with specific maintenance intervention rates, based on tonnages, reflects the outcomes of Aurizon Network's SMS process (which covers the RPEQ-related approvals), not that of legislative obligations.

Accordingly, Aurizon Network's RPEQ-related requirements are considered to be an internal-management matter, not a requirement of the rail safety legislation.

In summary, it is the tonnage and performance standards, rather than any legislated requirement, that define the scopes of maintenance works required and the associated costs.

Any inference on the part of Aurizon Network that the nature and scale of specific maintenance works are defined in the legislation is not accurate. Rather, in our view, it is for the Operator to determine the appropriate scope and scale of maintenance works based, on the safety and performance needs of the Operator's network and the requirements defined in the Operator's approved SMS.

2. Objective of this report

2.1 Purpose

The Queensland Competition Authority (QCA) has engaged GHD to review Aurizon Network's proposed maintenance costs for UT5 (2017-18 to 2020-21).

The purpose of this mini report is to assess whether Aurizon Network's proposed maintenance works are mandated by legislated requirements or whether the works to be undertaken are driven predominantly by the service levels that Aurizon Network is contracted to provide its customers.

The principal legislation that addresses railway safety in Queensland are:

- Transport Infrastructure Act 1994
- Transport (Rail Safety) Act 2010 and Transport (Rail Safety) Regulation 2010
- Professional Engineers Act, Queensland Legislation, 2002

Other legislation also applies to safety including work health and safety legislation and electrical safety. Finally, we consider the QCA's role in relation to Aurizon Network's maintenance practices, scopes and costs.

2.2 Structure

Our report is structured as follows:

- Requirements of the legislation (Section 3)
- Aurizon Network's safety-related positions for UT5 (Section 4)
- Conclusion (section 5).

3. Requirements of legislation

It is crucial to note that whilst the Acts and relevant guidelines in Australia do impose a duty of care on transport operators, they are not usually as prescriptive as those that can be found in overseas jurisdictions. Australian legislation, like most Common Law jurisdictions has a jurisprudence tradition that focuses on outcomes as opposed to exacting or prescriptive standards. This emphasis can often lead to conflict when dealing with the requirements of a country that relies on Civil Statute, where building codes or standards are often highly prescriptive.

In Australia, the progression of Common Law Liability comprises the following elements:

Breach of duty of care: The care that must be shown by all to "Ones' Neighbour," described in Donoghue v Stevenson. Statute, Common Law or Proximity may give rise to a duty of care.

If breached, the law asks "was harm reasonably foreseeable?" This is known as the objective test, although it asks the question of a 'reasonable individual.' This definition can vary in context. Where engineering design is concerned, a reasonable individual would be held to be a suitably qualified and accredited Engineer. The RPEQ legislation does impose a duty on Aurizon Network to have designs and maintenance schedules approved by RPEQ qualified engineers.

Aurizon's choice to maintain RPEQ staff on a full-time basis is not imposed by legislation. The engineers must simply foresee and mitigate harm, irrespective of whether they are employed as contractors or permanent staff. This duty extends to all engineers everywhere in Australia.

Standards are also often proven to be fallible and the common law does not afford them overt reliance in order to prevent service providers from claiming blanket exemptions to liability. Again, Aurizon cannot claim that its costs are imposed by legislation. It, as monopoly Operator of the CQCN, is charged with maintenance of CQCN assets to an acceptable standard. It is expected to exercise judgement that fulfils this duty and it cannot claim it has been singled out. An argument that a party should be granted relief from following the law is void unless it can be shown that the costs of following the law, or of mitigating the harm are unreasonable.

If Aurizon chooses to pass the costs of a "best-practice maintenance program" through to third parties as part of the DAU, it must do so in a transparent and legible manner. Aurizon must demonstrate these costs are also prudent and efficient, to justify the additional expenditure. GHD is not advocating wanton cutting of costs.

3.1 Transport Infrastructure Act 1994

The objectives of the *Transport Infrastructure Act 1994* are defined in the Preliminary of the Act as:

> *(1) The overall objective of this Act is, consistent with the objectives of the Transport Planning and Coordination Act 1994, to provide a regime that allows for and encourages effective integrated planning and efficient management of a system of transport infrastructure.*
>
> *(2) In particular, the objectives of this Act are—*
>
> *a. to allow the Government to have a strategic overview of the provision and operation of all transport infrastructure; for rail—to establish a regime that:*

(i) contributes to overall transport effectiveness and efficiency; and

(ii) provides for the safety of railways and persons at, on or near railways; and

(iii) contributes to lower transport costs by allowing the maximum flexibility in rail transport operations consistent with achieving safety objectives; and

(iv) allows railway managers and operators to make decisions on a commercial basis;

Of significance is the statement within the Act at Part 2 Section 14, which refers to government-supported rail infrastructure. We note that Aurizon Network is not government-supported nor does it, in any substantive way, form part of a public transport network. Given this, it could be argued that the Act does not apply to Aurizon Network's operations. However, we do note that since part of the Blackwater system caries long-distance passenger trains, this section of the network may be considered to fall under the Act. In any case, the Act does not prescribe any particular maintenance activities or frequency of such activities and has no impact on determining specific maintenance actives on Aurizon Network's below-rail infrastructure.

In summary, the *Transport Infrastructure Act 1994* does not have any specific rules (e.g. activities and associated frequencies) for how Aurizon Network should maintain the below-rail infrastructure.

3.2 Rail Safety National Law (Queensland) Act 2017 and Rail Safety National Law (Queensland) Regulation 2017

The *Rail Safety National Law (Queensland) Act 2017* and *Rail Safety National Law (Queensland) Regulation 2017* are the principal statutory instruments that define railway-safety requirements.

The legislation listed above in turn refers to the Rail Safety National Law which means the Rail Safety National Law, as in force from time to time, set out in the schedule to the Rail Safety National Law (South Australia) Act 2012 (SA).

The specific intent is given in the Preliminary to the Rail Safety National Law, which states:

Objects

(c) to make provision for a national system of rail safety, including by providing a scheme for national accreditation of rail transport operators in respect of railway operations; and

(d) to provide for the effective management of safety risks associated with railway operations; and

(e) to provide for the safe carrying out of railway operations; and

(f) to provide for continuous improvement of the safe carrying out of railway operations; and

(g) to make special provision for the control of particular risks arising from railway operations; and

(h) to promote public confidence in the safety of transport of persons or freight by rail; and

(i) to promote the provision of advice, information, education and training for safe railway operations; and

(j) to promote the effective involvement of relevant stakeholders, through consultation and cooperation, in the provision of safe railway operations.

The Act refers to work health and safety legislation. It also refers to electrical safety regulations and requires compliance with such legislation as a component of the compliance with the Act. The Act does not therefore overrule the requirements of other safety legislation and it can be said that, in conducting its business, Aurizon Network has the same general safety duties as would apply to another other entity, but with the added requirements of rail safety legislation.

The principal control that the Act applies is the use of an accreditation system for both above- and below-rail owners and operators, without which an organisation may not conduct rail operations. Removal of accreditation is therefore the ultimate sanction that may be employed if the Rail Safety Regulator (Regulator) considers an Operator to be in breach of its rail safety obligations.

The overarching requirement for awarding of accreditation is the adoption of a safety management system (SMS), which must consider all the risks to the proposed rail operations and the measures to control such risks. Guidance provided by the Regulator[1] defines 27 aspects that must be included in the SMS, as set out below.

Table 1 – SMS areas

SMS Topics	
Safety policy	Safety performance measures
Safety culture	Safety audit arrangements
Governance and internal control	Corrective action
Management responsibilities, accountabilities and authorities	Management of change
Regulatory compliance	Consultation
Document control arrangements and information management	Internal communication
Review of the SMS	Training and instruction
Risk management	Human factors
Procurement and contract management	General engineering and operational systems safety requirements
Process control	Asset management
Safety interface coordination	Management of notifiable occurrences
Rail safety worker competence	Security management
Emergency management	Health and fitness
Drugs and alcohol	Fatigue risk management
Resource availability.	Other matters as appropriate

The Act does not define any specific maintenance activities or the frequency of the activities. It does not, for example, define the frequency of inspections, resurfacing programs, re-railing or any maintenance activity. The Operator or owner is required to define the works and controls, standards and procedures it believes are required to safely operate the railway, having regard to the risks identified and methods of control to be applied.

[1] https://www.onrsr.com.au/

It is then for the Operator to demonstrate and satisfy the Regulator that the provisions, standards and procedures included in the SMS will allow the railway to be operated in a manner that reflects an appropriate standard of safety. In doing so, the level of traffic, forecast demands and operating parameters will need to be taken into account in developing the Operator's SMS.

The system must allow for continual monitoring and improvement, and is subject to annual audit by the Regulator. The Operator must ensure that the SMS is effective, continuously monitored and regularly updated. The SMS must also make provision for the review and revision of the adopted standards and procedures. Auditing will also include any aspect the Regulator considers is necessary to be satisfied that the safety management is effective. This may include physical confirmation that repairs and maintenance requirements, identified by the Operator, are timely and effective to maintain the safety of operations.

The SMS is developed by the Operator, which is required to ensure it has suitable and adequate controls, having considered the proposed operations and potential risks associated with railway operations, including setting out an approach for how these are to be managed. The Regulator will review the SMS following submission and will determine whether it is adequate to ensure the operations can be undertaken safely.

Part of the SMS should define track-related items, including acceptable operating tolerances and limits. The recommendation of such tolerances is for the Operator to define and will, generally be based on the level of services to be provided, previous experience, national standards and other recognised practices.

A below-rail system, such as that operated by Aurizon Network, carrying heavy haul traffic of relatively high volumes and high axle loads would require a higher standard of track maintenance than, for example, a heritage rail Operator using light axles at low speed with minimal rail traffic. The major control of risks is thus related to the scale of Aurizon Network's infrastructure, tonnages and line speeds, which determine the level of maintenance required and the costs. The level of maintenance of the CQCN below-rail infrastructure is therefore for Aurizon Network to determine based on its required service levels. It is not prescribed in legislation nor provided by the Regulator.

If the Regulator determines at any time that safety is compromised due to the Operator non-compliance with the approved SMS, the Act makes provision for the issue of Prohibition Notices under the Act. A Prohibition Notice must include details of the activity or breach and why it is considered unsafe. It is not required to define a corrective action. From Aurizon Network's responses to section 1.3 of the QCA's RFI3, it is understood that the Regulator has never issued such notices to Aurizon Network.

Maintaining an SMS includes monitoring by an Operator to determine its effectiveness, reviewing and updating the SMS, providing annual and incident-based reports to the Regulator. It also includes assisting the Regulator to audit the SMS. These requirements will incur costs and likely require personnel whose sole function would be to ensure the SMS is maintained and is operating effectively. However, such costs, in our view, would fall under the ambit of operating expenditure, rather than maintenance expenditure.

3.3 Professional Engineers Act

It is a requirement of the Professional Engineers Act that professional engineering services in Queensland or for Queensland, are carried out by a Registered Professional Engineer Queensland (RPEQ), or alternatively by a person who carries out the services under the direct supervision of an RPEQ.

This requirement relates to design and other work, including maintenance. The wording of the Act defining professional engineering services is given below:

"***professional engineering service*** *means an engineering service that requires, or is based on, the application of engineering principles and data to a design, or to a construction, production, operation or maintenance activity, relating to engineering, and does not include an engineering service that is provided only in accordance with a prescriptive standard."*

Within a rail environment such services in relation to maintenance would include:

- Civil works (RPEQ Civil engineering)
- Track (RPEQ Civil or Mechanical engineering)
- Structures (RPEQ Structural engineering)
- Overhead wiring (RPEQ Mechanical or Electrical engineering)
- Signalling (RPEQ Electrical engineering)

The engineering disciplines that may be required to provide review and approval of maintenance work scopes would indicate four RPEQ qualified engineers may be required for any one track length depending on the works identified for review.

Aurizon Network states with the UT5 submission:

"The resulting scope is reviewed and approved by Registered Professional Engineer of Queensland (RPEQ) accredited engineers, who are held accountable, through their accreditation, for the appropriateness of the maintenance task."

We consider Aurizon Network's practices that are canvassed in the above statement to be confirmation that Aurizon Network operates in accordance with the Professional Engineers Act 2002 (Qld) in approving the scope of maintenance works required for forecast tonnages, but also note that the maintenance intervals for the infrastructure are defined in the Aurizon Network Asset Maintenance and Renewals Policy, (AMRP). Approval of the scope of works for all major maintenance operations should therefore be a case of confirming the proposed scope has been derived from the combination of forecast tonnage and AMRP intervention rate, or the use of a time interval if so defined in the AMRP, rather than an individual engineer's judgement.

Our review of the works scopes for UT5 presented by Aurizon for resurfacing, ballast cleaning and rail grinding suggests a direct relation between forecast tonnage and AMRP intervention rates. We do not therefore consider the approval of the maintenance work scopes to be a complex or difficult process.

We note that, in the development of the business cases for the purchase of ballast cleaning and resurfacing with an anticipated value in excess of $150 million, none of the documents presented by Aurizon Network's responses to RFIs includes an RPEQ. Our report assumes that, given the quantum of the investment referred to in the business cases, an RPEQ was, or should have been, involved in shaping the relevant analysis before the appropriate Delegated Authority signed off on the business cases.

4. Aurizon Network's safety-related positions for UT5

Aurizon Network's UT5 submission makes the statement that "Aurizon Networks legislative obligations underpin decisions around safety & maintenance tasks".[2] This section sets out the specifics of Aurizon Network's claims.

Aurizon Network's UT5 submission makes several statements related to safety and the maintenance and operation of the CQCN. In some cases, Aurizon Network makes particular reference to the Transport Rail Safety Act and Regulations.

1. On page 49 of its UT5 submission, Aurizon Network has made particular reference to the QCA potentially introducing conditions that may affect its ability to comply with its legislated safety obligations; except if such conditions are not endorsed by the Regulator. Aurizon Network's statement does not appear to indicate any particular condition that the QCA may have imposed but rather the potential for the QCA to do so.
2. On page 75 of its UT5 submission, Aurizon Network refers to a similar point with respect to an access dispute resolution that may be determined by the QCA. The specific issue raised is that the QCA cannot override any safety obligations imposed under legislation. At page 81 of its UT5 submission, Aurizon Network reiterates the point on access dispute resolution and emphasises that a copy of a decision on a safety matter determined by the Regulator under Section 132 of the Rail Safety Act must be distributed to all parties. The overall issue suggested by Aurizon Network is that an access determination cannot be inconsistent with statutory safety obligations imposed on Aurizon Network by the Regulator.

   The views of Aurizon Network set out in points 1 and 2 above that the QCA cannot override safety legislation is not disputed by GHD. However, it is within the QCA's powers under the QCA Act to consider Aurizon Network's proposed scale against the need for Aurizon Network to demonstrate prudency and efficiency of below-rail operations and associated costs (section 69E and section 168A(a) of the QCA Act).

   We consider this particular issue may relate to the reduction in ballast cleaning enforced by the QCA in UT4.[3] The reality for UT4 was that Aurizon Network did not achieve even the reduced scope determined by the QCA. In conducting our analysis of the scope of works for the various maintenance tasks considered for UT5, we have generally determined that the scope of works for each task is prudent, but have identified issues relating to the proposed productivity rates of the ballast-undercutting machines. In our view, the QCA has the discretion under the QCA Act to use the information above to decide whether to approve or not approve Aurizon Network's UT5 maintenance-cost proposal.
3. At page 152 of its UT5 submission, Aurizon Network confirms that the development of its maintenance task is in accordance with its SMS, using the standards and asset policies contained therein. On Page 155, this is expanded to suggest that SMS policies and procedures are developed with clear reference to specific legislative and regulatory requirements and that such scopes are reviewed and internally approved by RPEQ qualified staff.

   This confirms that Aurizon Network develops the tasks and scope of maintenance works, using its SMS and associated internal processes.
4. On page 162 of its UT5 submission, Aurizon Network says that if the QCA and its advisors are in dispute with Aurizon Network and then elect to determine Aurizon Network's scope of works, then the QCA and advisors are exercising engineering judgement. This would appear to suggest that the QCA and its advisors then take responsibility in the event of an infrastructure failure. This would appear to

[2] Appendix R.2 of UT5 explanatory submission, p. 315

[3] Volume IV of the QCA's final decision on UT4

follow the logic of safety in design legislation, where the last person to determine a design issue absorbs the relevant responsibilities.

In our view, this reiterates Aurizon Network's points 1 and 2, in that it suggests that if the QCA defines the scope, then it takes responsibility for infrastructure failure. In response, we consider that our analysis on Aurizon Network's scope of maintenance for UT5 generally aligns with what Aurizon Network has proposed for its network overall. However, we have expressed concern on the efficiency and, hence, costs on some maintenance categories. Additionally, we consider that Aurizon Network, as an experienced below-rail infrastructure operator, would undertake additional works, if required, to ensure the safety and performance of the CQCN and then seek the agreement of the QCA for additional costs reasonably incurred.

5. With respect to the rail safety legislation, Aurizon Network suggests that there will be further complexity in moving from one set of legislation to another. In that, Queensland will adopt national (rather than Queensland-based) rail safety legislation and, presumably, with associated costs in future. We understand that the Queensland and national legislation are very closely aligned. Therefore, they essentially contain the same requirements.

   Whilst there may be some administrative effort in Aurizon Network adopting the national rail safety legislation, we do not consider there is any fundamental change in the requirements that would, relative to the Queensland legislation (i.e. no change in the scale and nature of maintenance operations). In our view, any additional costs of administering, or modifying, the SMS as a result of the adopting the national legislation should be allocated to operating expenditure, not maintenance expenditure.

6. At Appendix R.2 to the UT5 submission, Aurizon Network details the relevant sections of the Transport Rail Safety Act and Regulations with which they must comply. Whilst the listing is comprehensive, the requirements detailed are the same that apply to any rail Operator, whether in an above- or below-rail capacity.

   This relates to the Aurizon Network listing of applicable rail safety legislation. Whilst we recognise that the applicable legislation has wide coverage, we consider that this wide coverages does not impose a greater burden on Aurizon Network relative to any other below-rail operator. As per our view on point 5, Aurizon Network's costs of complying with the rail safety legislation is better placed in the estimate of operating expenditure, not maintenance expenditure. We reiterate that, in our view, the rail safety legislation does not define specific maintenance tasks by nature or scope.

In summary, we consider that:

- there are no specific detailed tasks in relation to maintenance that are mandated in the railway legislation applying to Aurizon Network
- Aurizon Network's costs of complying with all rail safety legislation are better placed in operating expenditure, not maintenance expenditure.

5. Conclusion

Rail safety is controlled by a number of items of legislation. These include specific Rail Safety Acts and regulations and a number of others, which are more general in nature, such as Work Health and Safety, the Electricity Regulations and Professional Engineers Act.

The Rail Safety Act is administered by the Rail Safety Regulator (Regulator). The principal legislation that determines control by the Regulator is the Transport Rail Safety Act 2010. The Regulator requires an Operator to be accredited to conduct rail operations, irrespective of whether they are regarded as an above- or below-rail Operator. Accreditation is awarded when an Operator satisfies the Regulator that the risks to the rail operations are adequately understood and the appropriate controls are in place via a Safety Management System (SMS). The SMS must be effective, continuously monitored and continually improved.

In the above context, the Operator is responsible for determining the specific maintenance works required, using the standards and policies within its approved SMS and tonnage/performance requirements. We note that Page 155 of Aurizon Network's UT5 submission states the following with respect to the maintenance scope of works:

"The resulting scope is reviewed and approved by Registered Professional Engineer of Queensland (RPEQ) accredited engineers, who are held accountable, through their accreditation, for the appropriateness of the maintenance task."

The fact that Aurizon Network has developed an AMRP document with specific maintenance intervention rates, based on tonnages, reflects the outcomes of Aurizon Network's SMS process (which covers the RPEQ-related approvals), not that of legislative obligations. Accordingly, Aurizon Network's RPEQ-related requirements are considered to be an internal-management matter, not a requirement of the rail safety legislation.

Furthermore, it is the tonnage and performance standards, rather than the legislated requirement that define the scopes of maintenance works and the associated costs. Finally, we note that RPEQ process as defined by Aurizon Network is only a review and approval step.

This suggests that the scope is first defined by others and then reviewed and approved, and in our opinion forms part of an internal management process. Accordingly we consider any costs associated with discharging these processes are operating expenditures, not maintenance expenditures.

Level 9 145 Ann Street Brisbane QLD 4000 Australia
GPO Box 668 Brisbane QLD 4001 Australia

61 7 3316 3000
advisory@ghd.com

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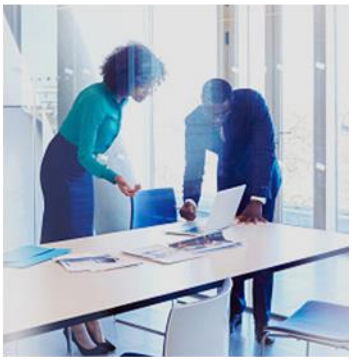

Appendix B - Ballast Undercutting

Mini Report for the Queensland Competition Authority

15 November 2017

GHD

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1. Summary

1.1 Objective

The Queensland Competition Authority (QCA) engaged GHD (us) to review Aurizon Network's proposed maintenance costs for the regulatory period covering 2017-18 (FY2018) to FY2021 (known as the UT5 period).

This mini-report assesses whether the ballast undercutting costs that Aurizon Network has proposed reflect prudent and efficient maintenance scopes and delivery practices. As requested in the QCA's Terms of Reference (ToR), our analysis considers the following key themes (see Table 1).

Table 1 – Analysis themes

Underlying themes	Title
Efficiency and prudency	The extent to which Aurizon Network's proposals are efficient and prudent.
Achievability	The extent to which the proposals are practically achievable.
Measurability	The extent to which the proposals provide a platform for measuring performance.
Transparency	The extent to which the proposals clearly articulate and commit to a set of outputs.
Accountability	The extent to which Aurizon Network is accountable for its performance.

In accordance with the ToR, we have undertaken the following in carrying out our review:

- We have considered all tasks on a rail system-by-rail system basis, as well as with respect to the aggregate of all systems. In addition, as applicable to the task, we have considered the UT3 period (FY2010 to FY2013), UT4 period (FY2014 to FY2017) and UT5 period (FY2018 to FY2021) on both a yearly and aggregate basis.
- We have considered the tasks in the context of the need to prioritise maintenance cost categories and their associated maintenance products. This prioritisation informs the depth of analysis we have undertaken for a particular maintenance cost category and its associated maintenance products.

In this report the terms ballast undercutting and ballast cleaning are used interchangeably.

1.2 Ballast undercutting activity categories

There are five categories of ballast undercutting undertaken by Aurizon Network as follows:

- Mechanised ballast undercutting:
  - C01 – RM900 (mainline-related)
  - C14 – Excavator (mainline-related)
  - C13 – Turnouts (turnout-related)
- Track ballast undercutting:
  - C02 – Ballast undercutting (other)
  - C03 – Ballast undercutting – turnout - minor.

In our analysis, we have grouped these categories into the following cost categories:

- Mechanised ballast undercutting – mainline

- Mechanised ballast undercutting – turnout
- Track ballast undercutting – mainline
- Track ballast undercutting – turnout.

1.3 Aurizon Network proposal

Ballast undercutting covers:

- Mechanised ballast undercutting for mainlines. This is performed by the RM900 in FY2018 and FY2019, and will be performed by the RM902 in FY2020 and FY2021
- Mechanised ballast undercutting for turnouts. This is performed by an excavator
- Track ballast undercutting. This is a spot, reactive undercutting activity which we have extracted from the General Maintenance category to keep all ballast-undercutting activities in one place for our assessment. We refer to this as 'track ballast undercutting', to avoid confusion with 'mechanised ballast undercutting'. Like mechanised ballast undercutting for turnouts, the excavator is also used for track ballast undercutting.

The scopes proposed by Aurizon Network are driven by a link between tonnage (volume) forecasts and ballast undercutting specification. Aurizon Network's volume forecasts are presented in Table 2.

Table 2 – Aurizon Network's proposed UT5 volume forecast

Volume (mtpa)	FY2018	FY2019	FY2020	FY2021
Blackwater	69.9	71.3	71.3	71.3
Goonyella	120.3	120.3	120.3	120.3
Moura	10.2	10.2	10.2	10.2
Newlands	9.2	9.2	9.2	9.2
GAP	16.2	17.5	17.5	17.5

In Aurizon Network's forecasts, Goonyella and Moura volumes, 120.3 million tonnes per annum (mtpa) and 10.2 mtpa respectively, will remain flat. Volumes for Blackwater and GAP will increase from FY2018 to FY2019 (6.9 mtpa to 71.3 mtpa for Blackwater, and 16.2 mtpa to 17.5 mtpa for GAP) and then remain flat over the rest of UT5. Overall, Aurizon Network has assumed that total tonnes across the CQCN will be 225.8 mtpa in FY2018, increase slightly to 228.5 mtpa, and then become flat for the rest of UT5.

Table 3 presents Aurizon Network's proposed mechanised ballast-undercutting scopes. While GAP volumes have been presented separately from those of the Newlands, we note that Aurizon Network has not presented its GAP scopes (see Table 3) separately from those of Newlands.

Table 3 – Aurizon Network's proposed UT5 ballast undercutting scopes[1]

Ballast Undercutting (Mainlines) CQCN	FY2018	FY2019	FY2020	FY2021	Total
Mainline Scope (km)	**140**	**140**	**149**	**149**	**578**
Blackwater (km)	60	60	50	50	**220**

[1] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells L13:EH14. NB: Numbers may not add due to rounding

Ballast Undercutting (Mainlines) CQCN	FY2018	FY2019	FY2020	FY2021	Total
Goonyella (km)	64	64	89	89	**306**
Moura (km)	2	2	4	4	**12**
Newlands (km)	14	14	7	7	**42**
Turnout Scope (no.)	**42**	**42**	**42**	**42**	**168**
Blackwater (no.)	17	17	19	19	**72**
Goonyella (no.)	17	17	18	18	**70**
Moura (no.)	1	1	2	2	**6**
Newlands (no.)	7	7	3	3	**20**

Aurizon Network's proposed scopes for mainline ballast undercutting are 140 km in FY2018 and FY2019, before rising to 149 km in FY2020 and FY2021. In comparison, Aurizon Network anticipates turnout-scope numbers to be 42 in each UT5 year.

Aurizon Network was unable to provide proposed scopes for the track-ballast-undercutting activities because the scopes for those activities are not measured or recorded, as the work tends to be small and reactive in nature. Track-ballast-undercutting is measured in metres, relative to ballast undercutting, which is measured in kilometres. We understand that the required functionality to report work for these scopes was included in the scope of Aurizon Network's Network Asset Management System (NAMS), which once fully implemented, is expected to improve Aurizon Network's reporting capability.[2]

Table 4 presents Aurizon Network's proposed track ballast-undercutting costs ($22.0 million ($FY2015) over UT5). There is a gradual increase in costs of approximately $200,000 in each year.

Table 4 – Aurizon Network's proposed UT5 ballast undercutting costs[3]

Track Ballast Undercutting	FY2018	FY2019	FY2020	FY2021	Total
Costs ($FY2015)	$5,208,296	$5,402,186	$5,596,075	$5,789,965	$21,996,522

Table 5 contains Aurizon Network's forecast mechanised ballast undercutting costs over UT4.

Table 5 – Aurizon Network's proposed UT5 mechanised ballast undercutting forecast ($FY2015)[4]

Ballast Undercutting – CQCN – ($FY2015)	FY2018	FY2019	FY2020	FY2021	Total
Mainlines	$56,000,000	$56,000,000	$59,600,000	$59,600,000	$231,200,000

[2] UT5 Maintenance Submission, p. 341

[3] *Maintenance UT5 Cost Build - Demonstrating Aurizon Network Efficient Costs_ v9_QCA_v2,* worksheet 'Total NMP', cell D10:G12

[4] *Maintenance UT5 Cost Build - Demonstrating Aurizon Network Efficient Costs_ v9_QCA_v2,* worksheet 'Total NMP', cell D6:G9

Ballast Undercutting – CQCN – ($FY2015)	FY2018	FY2019	FY2020	FY2021	Total
Turnouts	$5,258,933	$5,258,933	$5,258,933	$5,258,933	$21,035,733
Total	$61,258,933	$61,258,933	$64,858,933	$64,858,933	**$252,235,733**

Aurizon Network was not able to separate mainline scope into work done by the ballast cleaning machine and that done by the excavator in UT5 forecasts, although we note that this information is available on an historical basis. Given that the work undertaken by an excavator is less than 10% of all mechanised ballast undercutting, we have modelled the costs for mechanised ballast undercutting on the basis that the ballast cleaning machine will cover all of the mainline scope.

1.4 QCA's volume forecasts

The QCA's proposed volume forecasts for UT5 are set out in Table 6. We note that the QCA's forecasts are consistently higher than Aurizon Network's forecasts over the UT5 period, with increasing variance from year to year.

Table 6 – QCA's proposed UT5 volume forecast[5]

Volume (mtpa)	FY2018	FY2019	FY2020	FY2021
Blackwater	68.4	69.6	70.6	70.6
Goonyella	128.3	132.0	133.8	133.8
Moura	14.1	17.3	18.3	18.3
Newlands	11.7	14.2	14.2	14.2
GAP	15.9	18.9	23.9	28.9
Total (QCA)	238.3	251.9	260.7	265.7
Total (Aurizon Network)	225.8	228.5	228.5	228.5
% difference (QCA minus Aurizon Network)/Aurizon Network	5.5%	10.2%	14.1%	16.3%

1.5 Summary of analysis of ballast undercutting scope and costs

Our analysis of the scope is based on a review of intervention rates arising from tonnage hauled per annum.

[5] As provided by QCA staff on 28 June 2017

Our analysis of productivity for ballast undercutting is based on time available to undertake the work (possessions, shift hours, maintenance shut down, access windows and general logistical constraints) coupled with a review of the production rates (m per possession hour) of the ballast undercutting machine.

Aurizon Network provided very limited information underpinning its proposed costs for UT5 in its submission, the only underpinning cost data provided was a figure of $400,000/km escalated by the maintenance cost index (MCI) for ballast undercutting based on the UT4 final decision. In absence of a detailed scope and cost breakdown from Aurizon Network in its UT5 submission, we have undertaken our analysis of scope and costs through a bottom up approach drawing on limited information provided by Aurizon Network in response to our RFIs, in house cost data, engineering knowledge and previous modelling undertaken for the QCA. The provided scopes were converted into multiple quantities, such as number of shifts, shift hours and number of days required (e.g. for hire costs and accommodation costs). These quantities were multiplied by calculated unit rates to obtain annual costs for each 'cost item', consistent with Aurizon Network's maintenance cost categories.

Our assessment of costs for ballast undercutting for mainlines was more comprehensive than that for turnouts, due to the fact that more comprehensive information was provided by Aurizon Network for main lines than for turnouts. However, we encountered difficulty when attempting to calculate costs for consumables and fuel cost categories in particular as Aurizon Network provided insufficient information on consumables (particularly machine hire) and fuel and labour costs to enable us to accurately assess Aurizon Network's costs associated with these items. Depreciation was taken from the mini roll-forward depreciation models that QCA staff provided, and integrated into our cost modelling.

In our bottom-up costs model for the mechanised ballast undercutting of turnouts, we assumed an excavator productivity of 15 linear meters per hour on the basis of Aurizon Network's UT5 maintenance allowance presentation. This enabled us to model turnouts using the same method and calculations as for mainlines.

Depreciation was impossible to determine for turnouts, as the depreciation model provided by QCA staff was unable to identify which assets were associated with turnouts, whether that be exclusively or in a shared capacity. We therefore assigned all ballast undercutting-related depreciation to main lines.

1.5.1 Productivity of ballast cleaning equipment

Aurizon Network has invested in new ballast undercutting machinery based on the recommendations of their signed business case of November 2013. The signed business case provided approval for the purchase of a Plasser RM902 ballast cleaner with a capability of cleaning 400-630 m per hour of ballast, compared to the existing RM900 which has a capability of cleaning 220-350 m per hour. The justification for the expenditure was that Aurizon Network projected that it would need to have a ballast cleaning capacity in excess of 200 km per annum during UT5 (in FY2019 and beyond). However, Aurizon Network has in its submission, nominated an annual mainline ballast cleaning scope of 140 km per annum in FY2018-FY2019 and 149 km per annum in FY2020-FY2021.

In our opinion, Aurizon Network has purchased equipment with greater capacity than is needed for the UT5 period and, as such, a more prudent action may have been to defer purchase of the RM902 until it became evident that the greater capacity of the RM902 over the existing RM900 was required. However, we understand from Aurizon Network that the existing RM900 has reached the end of its economic life and requires replacement. We have insufficient information on comparative costs of the RM902 over the RM900 to advise whether or not it is appropriate for Aurizon Network to have purchased the RM902 rather than either refurbishing the RM900 or purchasing a replacement RM900 (if available).

1.5.2 Scopes

Aurizon Network has proposed to undertake 140 km or mainline track ballast undercutting in FY2018 and FY2019 and 149 km mainline ballast undercutting in each of FY2020 and FY2021. Aurizon Network has

projected an increase of 9 km above that for FY2018 and FY2019 in the two subsequent years on the basis that this 18 km quantity should have been included in UT4 scope. This increase in km per annum also aligns with the timing of arrival of Aurizon Network's larger ballast cleaning machine, the RM902 which has a higher ballast undercutting rate than Aurizon Network's current RM900 machine.

We have undertaken a high-level assessment of whether Aurizon Network's proposed scopes for mainline ballast undercutting are prudent. Our assessment is based on the projected tonnage (225.8 million tonnes per annum (mtpa) to 228.5 mtpa using Aurizon Network's volume forecasts, and 238.3 mtpa to 265.8 mtpa using the QCA's volume forecasts), track lengths and, as per Aurizon Network's Asset Maintenance and Renewal Policy June 2014 (AMRP), the mainline-ballast-undercutting intervention rate of 600 million net tonnes per annum (MNTA).

We note that Aurizon Network's proposed mainline ballast undercutting scope is 140 km per year in FY2018 and FY2019, while the figure is 149 km per year in FY2020 and FY2021. Our analysis, which is based on the 600 MNTA intervention rate, including associated assumptions for converting net tonnes to gross tonnes, reveals that a scope of about 152 km (using Aurizon Network's volume forecasts) to 183 per annum (using the QCA's forecasts) would have been prudent. However, our analysis needed to also account for the constraints of Aurizon Network's production process for mainline ballast undercutting. In particular, as set out in later sections of this report, the primary limitation on Aurizon Network achieving its prudent mainline ballast undercutting scopes is the capacity of its spoil wagons (and train) to remove spoil during a possession under its current operating regime of filling all wagons and then removing the spoil train as a single unit. We have not assessed what the impact of having additional spoil wagons on the productivity of Aurizon Network's mainline-ballast-undercutting processes would be. Rather, we have assessed Aurizon Network's proposal on the basis of the actual machines it has and on the machines that it expects to procure, not on what machines Aurizon Network should have.

In summary, given the maximum number of spoil wagons that Aurizon Network currently has and the process of spoil removal, we do not consider that Aurizon Network will be able to achieve annual scopes of greater than 150 km. Unless this capacity constraint is proposed to be rectified, we consider Aurizon Network's proposed mainline ballast undercutting scopes to be prudent. We have therefore based our assessment on Aurizon Network's forecast volumes rather than the QCA's.

On a related front, we note that it is difficult to compare required intervention rates for ballast cleaning between different rail systems due to, for example, differences in construction, wagon types, wagon design, annual tonnages and climatic conditions.

We note from Aurizon Network's Asset Maintenance and Renewal Policy that, following its employment of GPR to gain a greater understanding of the level and rate of contamination of ballast, Aurizon Network has reduced the intervention rate from 400 MNT to 600 MNT, thereby reducing the km of track required to be cleaned in any one year. From our experience, and noting this relaxation in intervention rate, we consider the 600 MNT intervention rate used by Aurizon Network to be reasonable.

In the context of 140 km per year of mainline undercutting, we also consider Aurizon Network's proposed 42 turnouts for undercutting per annum to be prudent. This is on the basis of the specified intervention rate, as well as an assumption of one turnout per 3.5 km of mainline track. Therefore, our assessment of prudency of scope aligns with Aurizon Network's proposed scope as shown in Table 7 below.

Table 7 – Recommended adjustments to Aurizon Network's proposed ballast undercutting scopes

Ballast Undercutting (Mainlines & Turnouts) - CQCN	FY2018	FY2019	FY2020	FY2021	Total
Aurizon Network Mainline Scope (km)	**140**	**140**	**149**	**149**	**578**
GHD Mainline Scope (km)	**140**	**140**	**149**	**149**	**578**
Blackwater (km)	60	60	50	50	**214**
Goonyella (km)	64	64	89	89	**295**
Moura (km)	2	2	4	4	**11**
Newlands (km)	14	14	7	7	**41**
Aurizon Network Turnout Scope (no)	**42**	**42**	**42**	**42**	**168**
GHD Turnout Scope (no)	**42**	**42**	**42**	**42**	**168**
Blackwater (no)	17	17	19	19	**72**
Goonyella (no)	17	17	18	18	**70**
Moura (no)	1	1	2	2	**6**
Newlands (no)	7	7	3	3	**20**

1.5.3 Productivity

In its business case for the purchase of the RM902, Aurizon Network has stated that the RM900 can achieve a ballast cleaning production rate of 49 m/h (metres per possession hour) and the RM902, when it comes on line in the later part of the UT5 period of approximately 103 m/h (metres per possession hour). Taking account of the duration of operation of each machine, this results in an average production rate of approximately 77 m/h (average over the possession period) over the UT5 period.

From our analysis of the capability of the mechanised ballast cleaning equipment employed, based on manufacturer's documentation and an efficient use of spoil wagons and possession hours is 109 m/h (average over the possession period) for both the RM900 and RM902. We have determined this as follows:

A machine capable of advancing 300 m per h (a point estimate between 220 m/h to 350 m/h quoted by Aurizon Network) with a spoil removal volume of 1 cubic metre per track metre, being 0.5 cubic metres of spent ballast plus 0.5 cubic metres of coal and other contamination, will produce 300 cubic metres of spoil per hour. Using a fleet of 30 MFS 40 spoil wagons of 1,200 m^3 total capacity, the RM900 could clean 1,200 metres of track in 4 hours, and produce 1,200 m^3 of spoil, filling the wagons. The RM900, working continuously for four hours until it

fills the spoil wagon will achieve a production rate over the entire 11 hour possession of 1,200 m/11 equalling 109 m/h (average over the possession period).

Assuming an 11-hour closure, the RM900 would work for four hours and then clear site with the spoil train. The remaining time within the closure would allow for 600 cubic metres of ballast replacement and tamping, and the hand back to operations. The RM 900 average production rate would therefore be 109 m per hour in screenable ballast with machine working for 4 hours only in the closure. The shift production rate given by Aurizon is 49 m per hour.

With the commissioning of the RM902 with a linear production rate of 500 m per hour, a spoil rate of 1 m^3 per track metre and a spoil train capacity of 1,200 cubic metres, this machine would work for 2.5 hours to fill the spoil capacity, and cover 1,200 metres of track.

The calculated production rate of 109 m per possession hour is comparable with Aurizon Network's business case estimate for the RM902 of 102.8 m per possession hour. We have therefore modelled mainline ballast cleaning costs based on the Aurizon Network production rate of 102.8[6] m per possession hour for both the RM900 and RM902 during the UT5 period as it is the spoil wagon capacity that dictates the production rate over the possession rather than the rate of the individual machines as compared to the average production rate of 77 m/h average from the possession time production rates for each machine quoted in the Aurizon Network's business case. This significant increase in the efficient productivity rate recommended by GHD drives much of the cost reduction determined from our modelling. In order, at a subsequent time, to take full advantage of the increased production capacity of the new RM902 over the RM900, Aurizon Network will either need to increase the number of spoil wagon trips per shift or increase the number of spoil wagons used per trip.

We have determined the efficient production rates for the RM900 and RM902 and ultimately, the efficient cost for ballast undercutting using a 'bottom up' modelling process. Conversely, we understand that Aurizon Network applied its UT4 ballast cleaning unit rate of $400,000/km to arrive at its proposed costs for UT5, not taking into account the increase in efficiency that would be gained by it employing a greater number of spoil wagons during UT5 than it did during UT4. As we demonstrate above, it is the overall capacity of the spoil wagon train that sets the production rate for both the RM900 and RM902.

1.5.4 Overall ballast undercutting costs

Our recommended costs at an aggregate level across all ballast undercutting maintenance categories are provided in Table 8.

Table 8 – Recommended adjustments to Aurizon Network's proposed total ballast undercutting costs[7]

Ballast Undercutting - CQCN	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$66,467,229	$66,661,119	$70,455,008	$70,648,898	**$274,232,254**
GHD Costs ($FY2015)	$53,554,378	$54,483,415	$57,585,712	$57,467,169	**$223,090,674**
Adjustment ($FY2015)	-$12,912,851	-$12,177,704	-$12,869,296	-$13,181,729	**-$51,141,580**

[6] Approximated to 103 m/hr in our model.

[7] Based on *Maintenance UT5 Cost Build – Demonstrating AN Efficient Costs v9_QCA_v2,* worksheet 'Total NMP', cell D6:G12.

Ballast Undercutting - CQCN	FY2018	FY2019	FY2020	FY2021	Total
Adjustment (%)	**-19%**	**-18%**	**-18%**	**-19%**	**-19%**

We have recommended a total efficient cost of $223.1 million ($FY2015), in comparison with Aurizon Network's proposal of $274.2 million ($FY2015). This amounts to a 19% cost reduction in Aurizon Network's proposal. Our commentary on the drivers for the reduction are explained from subsection 1.5.4.2 onwards.

For turnouts we have assumed that each turnout requires 25 m of track at most to be ballasted in our bottom up cost model. We have used Aurizon Network's excavator productivity rate to determine productive hours required per turnout. Costs have been developed on a bottom up basis in the same manner for mainline ballast undercutting as set out in Section 8.1.

1.5.4.1 Approach for depreciation

In arriving at the numbers set out in Table 8, we used depreciation data that were provided by the QCA. The QCA data reflect the following:

- The QCA's categorisation of Aurizon Network's maintenance kit for ballast undercutting into a roll-forward model. This has been based on a fixed asset register (FAR) that Aurizon Network provided the QCA
- Depreciation is based on depreciated actual cost (DAC), and has been provided in nominal terms only
- As directed by QCA staff, we have not expressed the DAC in $FY2015 terms. Hence, our recommendations, while they are presented in $FY2015 terms, includes the nominal DAC figures.

We have split the value of depreciation across the Blackwater, Goonyella, Moura and Newlands systems according to our derivation of the approach number of shifts in each system. We consider this method better represents the opportunity cost of the machine being 'stuck' in one system and the relative efficiency of each system.

Additionally, it is unclear if the maintenance assets for ballast undercutting are used for mainlines only, turnouts only or some combination of the two. The exception to this is the ballast cleaning machine(s) and the excavator, as these are used for mainlines and turnouts respectively. In our view, it is not important whether mainlines and turnouts have accurate depreciation values assigned to them, as long as depreciation costs are accurately captured at an *aggregate* level. Accordingly, we have decided to assign: the depreciation for the ballast cleaning machine(s) to mainlines; the depreciation of the excavator (and related items) to turnouts; and all remaining ballast-undercutting assets to mainlines.

1.5.4.2 Mainlines

Our recommended adjustments to Aurizon Network's proposed UT5 costs, at an aggregated level, are presented in Table 9.

Table 9 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs – CQCN

Ballast Undercutting (Mainlines) - CQCN	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)[8]	$56,000,000	$56,000,000	$59,600,000	$59,600,000	**$231,200,000**
GHD Costs ($FY2015)	$45,458,603	$46,444,756	$49,575,468	$49,552,194	**$191,031,021**

[8] Maintenance UT5 Cost Build: "Real Total NMP" (Cells D6:G7)

Adjustment ($FY2015)	-$10,541,397	-$9,555,244	-$10,024,532	-$10,047,806	**-$40,168,979**
Adjustment (%)	**-19%**	**-17%**	**-17%**	**-17%**	**-17%**

Over the UT5 period, our recommended costs for mainline ballast undercutting are 17% lower than Aurizon Network's proposal.

The main driver for the mainline-related outcome is that we have calculated that Aurizon Network's RM900 and RM902 can both achieve 102.8 m of mainline scope per possession hour and that four hours productive time per possession is achievable; Aurizon Network has implicitly assumed that the RM900 can achieve 49.9 metres per possession hour and that, combined, the RM900 and RM902 can achieve 77.0 m per possession hour over the UT5 period[9] with assumed productive hours per possession being only 3 hours. Our recommended productivity rate has lowered the number of shifts that Aurizon Network requires, consequently reducing all on-track labour costs, some accommodation-related costs and some consumables-related costs in our bottom up modelling (see Section 8.2).

Due to the top down budgeting approach adopted by Aurizon Network in developing its cost forecasts, Aurizon Network has only provided cost information on an aggregate level for each system for UT5 and not on a cost category level. We have been unable to generate Aurizon Network category level costs forecast using Aurizon Network's aggregate cost data and cost split by category from UT4 data as depreciation is not captured in the UT4 data and the fuel cost data in UT4 is inconsistent with machine requirements. As such we have been unable to undertake a category level comparison of costs.

Our recommendations on a system-by-system level, based on our bottom up cost model, are presented in the tables below.

Table 10 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs – Blackwater[10]

Ballast Undercutting (Mainlines) - Blackwater	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$24,555,675	$24,555,675	$19,076,002	$19,076,002	**$87,263,354**
GHD Costs ($FY2015)	$20,124,870	$20,522,669	$18,772,419	$18,764,633	**$78,184,592**
Adjustment ($FY2015)	-$4,430,805	-$4,033,006	-$303,583	-$311,369	**-$9,078,762**
Adjustment (%)	**-18%**	**-16%**	**-2%**	**-2%**	**-10%**

The majority of cost reductions for Blackwater that we have proposed for UT5 occur in FY2018 and FY2019. Aurizon Network has proposed $87.3 million of mainline ballast undercutting for UT5, while we have proposed $78.2 million. The reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the ballast undercutting plant hence lower number of shifts required, resulting in a 10% reduction in mainline ballast undercutting costs over the UT5 period.

[9] Based on the mid-point of the RM900 and RM902 speeds, from the publicly available Aurizon Network UT5 Maintenance Allowance Presentation document

[10] Maintenance UT5 Cost Build: "Real Blackwater" (Cells D6:G7)

Table 11 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs - Goonyella[11]

Ballast Undercutting (Mainlines) - Goonyella	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$24,845,512	$24,845,512	$36,335,706	$36,335,706	**$122,362,436**
GHD Costs ($FY2015)	$20,960,260	$21,371,945	$27,283,839	$27,270,008	**$96,886,052**
Adjustment ($FY2015)	-$3,885,252	-$3,473,567	-$9,051,867	-$9,065,698	**-$25,476,384**
Adjustment (%)	**-16%**	**-14%**	**-25%**	**-25%**	**-21%**

The majority of cost reductions for Goonyella that we have proposed for UT5 occur in FY2020 and FY2021. Aurizon Network has proposed $122.4 million of Goonyella mainline ballast undercutting in UT5, while we have proposed $96.9 million. Again the reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the ballast undercutting plant hence lower number of shifts required, resulting in a 21% reduction in Goonyella mainline ballast undercutting costs over the UT5 period.

Table 12 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs – Moura[12]

Ballast Undercutting (Mainlines) - Moura	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$1,161,785	$1,161,785	$1,382,655	$1,382,655	**$5,088,880**
GHD Costs ($FY2015)	$631,123	$695,835	$1,016,859	$1,016,279	**$3,360,096**
Adjustment ($FY2015)	-$530,662	-$465,950	-$365,796	-$366,376	**-$1,728,784**
Adjustment (%)	**-46%**	**-40%**	**-26%**	**-26%**	**-34%**

Aurizon Network has proposed $5.1 million of mainline ballast undercutting in UT5, while we have proposed $3.4 million, resulting in a recommended 34% reduction in Moura mainline ballast undercutting costs over the UT5 period. Again the reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the ballast undercutting plant hence lower number of shifts required.

Table 13 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs - Newlands[13]

Ballast Undercutting (Mainlines) - Newlands	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$5,437,027	$5,437,027	$2,805,637	$2,805,637	**$16,485,328**
GHD Costs ($FY2015)	$3,742,350	$3,854,307	$2,502,351	$2,501,274	**$12,600,282**
Adjustment ($FY2015)	-$1,694,677	-$1,582,720	-$303,286	-$304,363	**-$3,885,046**
Adjustment (%)	**-31%**	**-29%**	**-11%**	**-11%**	**-24%**

Aurizon Network has proposed $16.5 million of mainline ballast undercutting in UT5, while we have proposed $12.6 million, resulting in a 24% reduction in Newlands mainline ballast undercutting costs over the UT5 period. Again the reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the

[11] Maintenance UT5 Cost Build: "Real Goonyella" (Cells D6:G7)

[12] Maintenance UT5 Cost Build: "Real Moura" (Cells D6:G7)

[13] Maintenance UT5 Cost Build: "Real Newlands" (Cells D6:G7)

ballast undercutting plant and hence lower number of shifts required. We have accounted for GAP volumes on the Newlands network in reviewing the maintenance scopes and costs for the Newlands system.

1.5.4.3 Turnouts

Our recommended adjustments to Aurizon Network's proposed UT5 costs, at an aggregated level are presented in Table 14.

Table 14 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – CQCN[14]

Ballast Undercutting (Turnouts) - CQCN	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$5,258,933	$5,258,933	$5,258,933	$5,258,933	**$21,035,732**
GHD Costs ($FY2015)	$3,723,919	$3,666,803	$3,638,388	$3,543,119	**$14,572,230**
Adjustment ($FY2015)	-$1,535,014	-$1,592,130	-$1,620,545	-$1,715,814	**-$6,463,502**
Adjustment (%)	**-29%**	**-30%**	**-31%**	**-33%**	**-31%**

The main driver for our recommended reduction in costs for turnouts (i.e. 31% over the UT5 period) is our assumption that each turnout requires 25 m of track at most to be ballasted in our bottom up cost model. The reduction in cost is mainly due to lower ballast costs, lower on track labour costs and lower hire costs for turnouts as compared to Aurizon Network costs (determined through application of a UT4 cost component split to UT5 costs).

Our recommended cost adjustments on a system-by-system basis are located in the following tables.

Table 15 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Blackwater[15]

Ballast Undercutting (Turnouts) - Blackwater	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$2,128,616	$2,128,616	$2,379,041	$2,379,041	**$9,015,314**
GHD Costs ($FY2015)	$1,461,914	$1,437,148	$1,561,821	$1,529,951	**$5,990,834**
Adjustment ($FY2015)	-$666,702	-$691,468	-$817,220	-$849,090	**-$3,024,480**
Adjustment (%)	**-31%**	**-32%**	**-34%**	**-36%**	**-34%**

Aurizon Network has proposed $9.0 million of turnout ballast undercutting in UT5, while we have proposed $6.0 million, resulting in a 34% reduction in Blackwater turnout ballast undercutting costs over the UT5 period.

Table 16 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Goonyella[16]

Ballast Undercutting (Turnouts) - Goonyella	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$2,128,616	$2,128,616	$2,253,829	$2,253,829	**$8,764,890**
GHD Costs ($FY2015)	$1,533,063	$1,506,472	$1,590,592	$1,533,973	**$6,164,101**
Adjustment ($FY2015)	-$595,553	-$622,144	-$663,237	-$719,856	**-$2,600,789**
Adjustment (%)	**-28%**	**-29%**	**-29%**	**-32%**	**-30%**

[14] Maintenance UT5 Cost Build: "Real Total NMP" (Cells D8:G8)

[15] Maintenance UT5 Cost Build: "Real Blackwater" (Cells D8:G8)

[16] Maintenance UT5 Cost Build: "Real Goonyella" (Cells D8:G8)

Aurizon Network has proposed $8.8 million of turnout ballast undercutting in UT5, while we have proposed $6.2 million, resulting in a 30% reduction in Goonyella turnout ballast undercutting costs over the UT5 period.

Table 17 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Moura[17]

Ballast Undercutting (Turnouts) - Moura	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$125,213	$125,213	$250,425	$250,425	**$751,276**
GHD Costs ($FY2015)	$144,866	$144,726	$205,892	$203,519	**$699,002**
Adjustment ($FY2015)	$19,653	$19,513	-$44,533	-$46,906	**-$52,274**
Adjustment (%)	**16%**	**16%**	**-18%**	**-19%**	**-7%**

Costs proposed by Aurizon Network for turnout undercutting in Moura are small compared to other systems. GHD proposed costs approximately reflect those of Aurizon Network. Aurizon Network has proposed $0.75 million of turnout ballast undercutting in UT5, while we have proposed $0.70 million, resulting in a 7% reduction in Moura turnout ballast undercutting costs over the UT5 period.

Table 18 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Newlands[18]

Ballast Undercutting (Turnouts) - Newlands	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$876,489	$876,489	$375,638	$375,638	**$2,504,254**
GHD Costs ($FY2015)	$584,075	$578,458	$280,083	$275,676	**$1,718,292**
Adjustment ($FY2015)	-$292,414	-$298,031	-$95,555	-$99,962	**-$785,962**
Adjustment (%)	**-33%**	**-34%**	**-25%**	**-27%**	**-31%**

Our proposed cost reductions for turnout undercutting in Newlands come mostly in FY2018 and FY2019. Aurizon Network has proposed $2.5 million of turnout ballast undercutting in UT5, while we have proposed $1.7 million, resulting in a 31% reduction in Newlands turnout ballast undercutting costs.

1.5.4.4 Track ballast undercutting by excavator

Aurizon Network has not provided scope data for its spot track ballast undercutting activities by excavator either in its UT5 submission or in response to our RFIs. In the absence of data we therefore have not been able to develop a bottom up cost model to assess the prudence and efficiency of Aurizon Network's proposed track ballast undercutting costs.

In absence of information from Aurizon Network on scopes and unit rates for track ballast undercutting undertaken by excavator, we have assessed prudency and efficiency of Aurizon Network's proposed track ballast undercutting expenditure by comparing it with historic UT4 expenditure. Given that the increase in track length in the CQCN occurred during FY2017 of UT4, we do not consider that the 413 km increase in track length that occurred in FY2017 should result in a corresponding increase in track ballast undercutting for UT5 given the newness of these track sections. We also consider that, given the nature of the work, i.e. addressing small areas of track that are not suitable to be addressed through mechanised ballast undercutting, the work will vary year on year. As such, we consider that proposed UT5 expenditure should reflect average expenditure during UT4 (which we have assumed to be efficient given the nature of the work and in absence of other information). Table 19 and Table 20 below present Aurizon's ballast undercutting expenditure proposed for UT5 and historic UT4 expenditure respectively.

[17] Maintenance UT5 Cost Build: "Real Moura" (Cells D8:G8)

[18] Maintenance UT5 Cost Build: "Real Newlands" (Cells D8:G8)

Table 19 - Aurizon Network's proposed ballast undercutting by excavator costs for UT5[19]

Ballast Undercutting	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)	Average UT5 ($FY2015)
C02-Ballast Undercutting (Other)	3,382,403	3,376,293	3,390,182	3,384,072	**13,532,950**	**3,383,238**
Proposed C02 uplift	1,520,000	1,720,000	1,900,000	2,100,000	**7,240,000**	**1,810,000**
C03 – Ballast Undercutting – Turnout - Minor	305,893	305,893	305,893	305,893	**1,223,572**	**305,893**
Total	**5,208,296**	**5,402,186**	**5,596,075**	**5,789,965**	**21,996,522**	**5,499,131**

Table 20 - Aurizon Networks historic ballast undercutting by excavator expenditure (UT4)

Ballast Undercutting	FY 2014 ($FY2015)	FY 2015 ($FY2015)	FY 2016 ($FY2015)	FY 2017^ ($FY2015)	Total ($FY2015)	Average UT4 ($FY2015)
C02 – Ballast Undercutting (Other)	4,546,114	3,385,202	4,460,487	4,560,332	**16,952,134**	**4,238,034**
C03 – Ballast Undercutting – Turnout - Minor	112,555	44,646	84,057	294,032	**535,290**	**133,822**
Total	**4,658,669**	**3,429,847**	**4,544,543**	**4,854,364**	**17,487,424**	**4,371,856**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

Given that the 413 km increase in track length that occurred in UT4, e.g. for the Wiggins Island Rail Project, occurred in the last year of UT4, and is therefore relatively new, we do not consider that this increase in system track length should warrant an increase in the ballast undercutting by excavator cost allowance during UT5. Table 21 presents the comparison of expenditure for ballast undercutting by excavator between UT4 and the proposed UT5 expenditure. The suggested increase between periods of 26% would suggest the increase in track over the period would have similar magnitude, however this is not the case (the increase in track length during UT4 was approximately 14%). In absence of supporting information, and given the variable nature of the work, we consider it more appropriate to base proposed UT5 expenditure on the average of UT4 actual expenditure. Our proposed efficient costs for ballast undercutting by excavator are as provided in Table 22.

Table 21 - Comparison of Aurizon Networks UT4 and proposed UT5 expenditure for ballast undercutting by excavator

Ballast Undercutting	UT4 Average ($FY2015)[20]	UT5 Average ($FY2015)[21]	Increase (%)
C02-Ballast Undercutting (Other)	4,238,034	5,193,238[22]	23%
C03 – Ballast Undercutting – Turnout - Minor	133,822	305,893	129%
Total	**4,371,856**	**5,499,131**	**26%**

[19] Maintenance UT5 Cost Build: "Real Total NMP" (Cells D10:G12). NB: Numbers may not add due to rounding

[20] 170713 – RFI – UT5 Maintenance_AN: 1_Tab 1 (Cells DX21:EA23)

[21] Maintenance UT5 Cost Build: "Real Total NMP" (Cells D10:G12)

[22] Includes proposed C02 uplift

Table 22 - GHD's proposed efficient UT5 ballast undercutting by excavator expenditure

Ballast Undercutting	FY 2018 ($FY2015)	FY2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
C02 – Ballast Undercutting (Other)	4,238,034	4,238,034	4,238,034	4,238,034	**16,952,134**
C03 – Ballast Undercutting – Turnout - Minor	133,822	133,822	133,822	133,822	**535,290**
Total	**4,371,856**	**4,371,856**	**4,371,856**	**4,371,856**	**17,487,424**

1.5.5 MCI accounting-cost components

The table below shows Aurizon Network's proposed MCI breakdown of costs for ballast undercutting. We note that Aurizon Network's MCI breakdown does not include track ballast undercutting costs. Table 23 shows that consumables occupy two thirds of Aurizon Network's cost build up, with labour occupying nearly 20%.

Table 23 - Aurizon Network's proposed UT5 MCI accounting-cost component breakdown of ballast undercutting costs (excluding track ballast-undercutting costs)[23]

Ballast Undercutting – CQCN ($FY2015)	FY2018	FY2019	FY2020	FY2021	Total	% of Total
Labour	$11,295,087	$11,480,945	$11,480,945	$11,480,945	**$45,737,922**	**18.2%**
Consumables	$41,299,172	$41,048,989	$41,500,431	$41,323,336	**$165,171,926**	**65.7%**
Fuel	$848,804	$843,662	$877,710	$882,410	**$3,452,586**	**1.4%**
Travel & accommodation	$2,627,019	$2,611,105	$2,716,485	$2,731,030	**$10,685,639**	**4.2%**
Depreciation	$5,188,852	$5,274,233	$7,883,363	$8,041,213	**$26,387,660**	**10.5%**
Total	**$61,258,933**	**$61,258,933**	**$64,458,933**	**$64,458,933**	**$251,435,733**	**100.0%**

Our bottom-up estimate of total ballast-undercutting costs (excluding track-ballast-undercutting costs), in the context MCI cost component breakdown, is set out in Table 24 below.

Table 24 – GHD's proposed UT5 MCI accounting-cost component breakdown of ballast-undercutting costs (excluding track ballast-undercutting costs)

Ballast Undercutting (Mainlines) - CQCN	FY2018	FY2019	FY2020	FY2021	Total	% of Total
Labour	$14,311,336	$14,525,945	$16,296,474	$16,296,474	**$61,430,229**	**29.9%**
Consumables	$26,551,009	$26,183,516	$24,809,785	$24,809,785	**$102,354,095**	**49.8%**
Fuel	$1,432,415	$1,435,237	$1,604,937	$1,604,937	**$6,077,526**	**3.0%**
Travel & accommodation	$1,386,389	$1,410,500	$1,604,937	$1,832,444	**$6,461,778**	**3.1%**
Depreciation	$5,501,373	$6,556,361	$8,670,216	$8,551,673	**$29,279,622**	**14.2%**
Total	**$49,182,522**	**$50,111,559**	**$53,213,856**	**$53,095,313**	**$205,603,251**	**100.0%**

Consumables occupy just under a half of our recommended total costs, while labour occupies nearly a third. Our estimates of labour costs and fuel costs are higher than those of Aurizon Network. In comparison, our estimates of consumables costs, travel & accommodation and depreciation is lower than Aurizon Network's. We are unable to provide significant commentary on the differences between our estimate and Aurizon Network's estimate because, as noted in earlier parts of this report, our cost build up is done on a bottom-up basis, while Aurizon Network's proposal has been shaped on a top-down basis.

[23] *Maintenance UT5 Cost Build – Demonstrating AN Efficient Costs v9_QCA_v2,* worksheet 'BCD', cell B46:F52.

2. Documentation reviewed

The key documents and spreadsheets referenced in undertaking our assessment of prudency and efficiency of ballast undercutting are as follows:

- Aurizon Network's responses to QCA's RFIs 1-2
- Aurizon Network UT4 Submission
- Aurizon Network UT5 Submission
- Ballast-undercutting machine actual data (UT5 Maintenance_v8_QCA)
- Network Capacity and Maintenance-Renewals (MAWs and Shutdowns)
- Previous Maintenance Cost Reports
- UT5 Maintenance Allowance Presentation
- Business cases for purchase of RM902 machine.

3. Ballast undercutting description

Ballast undercutting occurs on Aurizon Network's main lines, including turnouts. Aurizon Network's cost categories for ballast undercutting are:

- Mechanised ballast undercutting:
  - C01 – RM900 (mainline-related)
  - C14 – Excavator (mainline-related)
  - C13 – Turnouts (turnout-related)
- • Track ballast undercutting:
  - C02 – Ballast undercutting (other)
  - C03 – Ballast undercutting – turnout - minor.

Track ballast undercutting represents only a small fraction of the total ballast undercutting activity. As such, our analysis of scope, productivity and costs focuses on mechanised undercutting costs.

3.1 Description of the ballast undercutting process

Ballast is a graded crushed rock material providing support to the sleepers in track. The intent of ballast undercutting, or more correctly ballast cleaning, is to ensure that the ballast supporting the track: provides sufficient capacity to ensure drainage of the track; adequately distributes the loading from trains to the formation; and holds the track in place.

Ballast degradation occurs for a number of reasons which can be grouped into three main categories.

- **Ballast degradation caused by the passage of trains and rail equipment**: Trains apply a loading to the ballast via the bottom of the sleepers will, over time, cause the ballast to abrade or crush, reducing the voids in the ballast. In addition, the use of track tamping machines and to some extent dynamic track stabilisers, which apply vibration and squeeze forces to the ballast during track stabilisation and realignment works, will also degrade the ballast.
- **Introduction of contaminants from above the track**: Ballast fouling can also occur with windblown contaminants or by material dropping from trains passing over the track. Aurizon Network has identified the introduction of contaminants, in particular, coal dust or small particles dropping from wagons in to the ballast, to be the principal reason for ballast degradation (fouling). There is potential for the introduction of contaminants from above track to be reduced through the use of wagons designed to minimise coal and coal dust spillage and through improvements in the loading process. However, this relates to above rail and customer practices and hence, to achieve this Aurizon Network would have to work in partnership with these stakeholders.
- **Introduction of contaminants from below the track:** The final form of ballast fouling is material entering the track from below due to formation failure, particularly during extended wet weather periods. If the formation is of weaker material, then, when wet, the passage of trains can punch the ballast into the formation. With a system such as the Goonyella network, built as a purpose-designed heavy coal system with appropriate earthworks and capping, this should not occur. Conversely, a system such as the Newlands and Moura networks using an original track alignment constructed for only modest axle loading may be more susceptible to this form of ballast degradation or fouling.

When undertaking ballast undercutting, the degree of contamination or degradation will determine whether the ballast is replaced in full or cleaned, and the material if complies with the ballast grading requirements is returned to track.

Aurizon Network indicates that ground penetrating radar (GPR) is planned to be used from FY2018 and 2019 to assist in determining the scope of works in FY2020 and FY2021. GPR has been adopted by a number of major

rail network owners as a means of identifying scope for ballast undercutting, as it can be undertaken relatively quickly compared with traditional test pits and provides a continuous reading through the work area. For extensive work areas, this is the only realistic method of defining the work.

However, there are several factors affecting the accuracy results from use of GPR, including the stone material forming the ballast, the radar wavelength, and moisture content within the ballast. Considerable judgement is required in determining the degree of contaminated ballast, the level that the effective formation level. Aurizon Network uses a specialist GPR contractor for this work.

3.2 Description of the production process

The process for ballast undercutting or cleaning for major works entails the use of a purpose-designed on-track machine, with appropriate support of ballast and spoil trains plus track tamping and a stabilisation unit. Aurizon Network currently uses a Plasser RM900 ballast cleaner for these works capable of completing 220 to 350 m of track per hour when operating continuously[24].

For smaller works such as under turnouts, or small isolated spot works, excavator-mounted horizontal cutter chains may be more appropriate. Production rates for such equipment are much lower than with heavy on track equipment, but can allow works to be undertaken in short track possessions. There is obviously a cost saving in terms of equipment costs and mobilisation for such smaller machines. Spoil would generally be disposed of locally for excavator equipment and ballast supplied by road vehicles.

Being able to tackle problem points in the track without waiting for a full track block possession may allow for the removal of speed restrictions at an early stage and thus may have cost benefits for train operations.

The operating sequence with the RM900 would be in a train consist with spoil train leading, ballast cleaner, new-ballast train, tamper and regulator if only limited recovered ballast is expected. If a reasonable ballast recovery rate is expected, it may be possible to have new ballast in place, following the cleaning process and first tamp operation.

Ballast undercutting production rates can be limited by a rail network operator's capacity to remove spoil during undercutting. This limitation may be overcome by using temporary spoil dumps if allowed. We understand, from meetings with Aurizon Network that a mixture of spoil dumps and spoil removal trains is used for the smaller networks and that only spoil removal trains are used for the larger networks.

3.3 Aurizon Network's overarching views on mechanised production assets

Aurizon Network has advised that due to the capital intensive nature of the mechanised production assets involved and the labour resources required to operate them, a significant proportion of the costs associated with these activities are fixed. Consequently, efficiency gains are realised by:

- improved coordination between the access requirements of coal traffic and maintenance teams
- improvements in fleet reliability
- improvements in the fleet's productive capability

Such improvements allow the mechanised plant fleet to maximise production within the allocated access time. This is paramount as access time, if missed, generally cannot be caught up without disruptions that impact on

[24] UT5 Maintenance Allowance Presentation

coal services. Furthermore, unit rate improvements can be realised by spreading the high proportion of fixed costs over greater output.[25]

Aurizon Network's investment in improving supply-chain coordination, fleet reliability and fleet productive capacity should lead to reduced maintenance shifts and labour hours. We have taken any such proposed investment into account in our analysis of prudency and efficiency of ballast undercutting scope and costs.

We have also assessed whether Aurizon Network's incremental costs of investing in the improvements are lower than the cost efficiencies anticipated to arise from those investments. For example, we have assessed if the incremental depreciation and machine-maintenance costs with the RM902 exceeds labour and accommodation cost savings.

[25] Aurizon Network's UT5 submission: 166

4. Aurizon Network UT4 ballast undercutting program

4.1 QCA approval of UT4

In its UT4 final decision on the scope of works, the QCA determined that a total scope of 402 km was prudent for 2015 to 2017 across the CQCN as compared to a scope of 420 km proposed by Aurizon[26].

The unit costs for UT4 for ballast cleaning were determined as $400,000 per km ($FY2012). We note that Aurizon Network proposes to retain this unit rate, with adjustment for the maintenance cost index (MCI), for the UT5 period[27].

4.2 UT4 forecast ballast undercutting scope

Aurizon Network's mechanised ballast undercutting scopes and costs shown in the tables below. Track ballast undercutting was not forecast by Aurizon Network in UT4, as this activity is minor and reactive in nature.

Table 25 – UT4 mechanised ballast undercutting scope

Mechanised Undercutting	FY2014	FY2015	FY2016	FY2017	Total
Mainline scope (km)	118	129	133	140	520
Turnout scope (no.)	41	40	40	40	161

Table 26 – UT4 mechanised ballast undercutting costs ($FY2012 million)

Mechanised Undercutting	FY2014	FY2015	FY2016	FY2017	Total
Aurizon Network Proposal[28]	55.3	64.9	65.9	66.4	252.5
QCA Final Decision[29]	52.2	58.0	59.3	62.4	231.9

4.3 UT4 performance

Table 27 displays the variance between forecast scope and actual performance for mechanised ballast undercutting in UT4.

[26] Final decision on Aurizon Network's 2014 DAU, Volume III

[27] Aurizon Network's UT5 explanatory submission: 159 (see Table 24)

[28] Aurizon Network 2014 Access Undertaking – Maximum Allowable Revenue

[29] Aurizon Network 2014 Access Undertaking – Maximum Allowable Revenue

Table 27 – Variance to scope mechanised ballast undercutting[30]

Mechanised Ballast Undercutting	FY2014	FY2015	FY2016	FY2017	Total
Mainline scope (km)	118	129	133	140	520
Mainline actual (km)	118	152	134	140	544
Variance actual to forecast km	0	23	1	0	24
Variance to forecast %	**0**	**17.83**	**0.75**	**0**	**4.62**
Forecast turnout scope (no.)	41	40	40	40	161
Turnout actual scope (no.)	41	48	58	40	187
Variance actual to forecast (no.)	0	8	18	0	26
Variance to forecast %	**0**	**20.00**	**45.00**	**0**	**16.15**

Forecast mainline scope was exceeded materially in FY2015, while turnout scope forecast was exceeded in both FY2015 and FY2016. This increase in scope over forecast is likely due to Aurizon Network seeking to catch up, in part, on ballast undercutting activities due to the underperformance of ballast undercutting in UT3 for the CQCN as an aggregate. During UT3 there was a shortfall of 88 km of mainline ballast undercutting compared to forecasts for mainlines and 221 fewer turnouts completed than forecast.

Similar analysis is conducted on a system-by-system basis in the tables below.

Table 28 – Variance to scope mechanised ballast undercutting - Blackwater[31]

Mechanised Ballast Undercutting - Blackwater	FY2014	FY2015	FY2016	FY2017	Total
Forecast Main line scope (km)	74	39	67	60	240
Main line actual (km)	74	43	58	60	235
Variance Actual to Scope km	0	4	-9	0	-5
Variance to forecast %	**0**	**10.26**	**-13.43**	**0**	**-2.08**

[30] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells DX13:EA18

[31] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells BA13:BD18

Mechanised Ballast Undercutting - Blackwater	FY2014	FY2015	FY2016	FY2017	Total
Turnout forecast scope (no.)	19	20	20	20	79
Turnout actual scope (no.)	19	19	27	20	85
Variance to forecast (No)	0	-1	7	0	6
Variance to forecast %	**0**	**-5.00**	**35.00**	**0**	**7.59**

Mainline forecast was not met in UT4, primarily due to a significant shortfall in FY2016. The effect in the changes in actual scope competed against forecast was 'smoothing', with scope exceeded in the year of lowest forecast (FY2015) and reduced in a higher forecast year (FY2016). Forecast turnout scope was exceeded in FY2016, likely to make up for UT3 turnout shortfall.

Table 29 – Variance to scope mechanised ballast undercutting - Goonyella[32]

Mechanised Ballast Undercutting - Goonyella	FY2014	FY2015	FY2016	FY2017	Total
Forecast Main line scope (km)	32	77	51	64	224
Main line actual (km)	32	89	53	64	237
Variance Actual to Scope km	0	12	2	0	13
Variance to forecast %	**0**	**15.58**	**3.92**	**0**	**5.80**
Turnout forecast scope (no.)	18	15	15	15	63
Turnout actual scope (no.)	18	19	26	15	78
Variance to forecast (No)	0	4	11	0	15
Variance to forecast %	**0**	**26.67**	**73.33**	**0**	**23.81**

Forecast was exceeded in both FY2015 and FY2016 for both mainlines and turnouts, as is reflected in the network at an aggregate level.

[32] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells W13:Z18

Table 30 – Variance to scope mechanised ballast undercutting - Moura[33]

Mechanised Ballast Undercutting - Moura	FY2014	FY2015	FY2016	FY2017	Total
Forecast Main line scope (km)	1	4	4	2	11
Main line actual (km)	1	10	12	2	25
Variance Actual to Scope km	0	6	8	0	14
Variance to forecast %	**0**	**150.00**	**200.00**	**0**	**127.27**
Turnout forecast scope (no.)	3	1	1	1	6
Turnout actual scope (no.)	3	8	3	1	15
Variance to forecast (No)	0	7	2	0	9
Variance to forecast %	**0**	**700.00**	**200.00**	**0**	**150.00**

Table 31 – Variance to scope mechanised ballast undercutting - Newlands[34]

Mechanised Ballast Undercutting - Newlands	FY2014	FY2015	FY2016	FY2017	Total
Forecast Main line scope (km)	12	8	11	14	45
Main line actual (km)	12	10	10	14	46
Variance Actual to Scope km	0	2	-1	0	1
Variance to forecast %	**0**	**25.00**	**-9.09**	**0**	**2.22**
Turnout forecast scope (no.)	1	3	3	3	10
Turnout actual scope (no.)	1	2	2	3	8
Variance to forecast (No)	0	-1	-1	0	-2

[33] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells CT13:CW18

[34] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells H13:K18

Mechanised Ballast Undercutting - Newlands	FY2014	FY2015	FY2016	FY2017	Total
Variance to forecast %	**0**	**-33.33**	**-33.33**	**0**	**-20.00**

The actual financial performance of ballast undercutting in UT4 is found in Table 32.

Table 32 – UT4 actual performance ($FY2015)[35]

Ballast Undercutting (Mainlines) - CQCN	FY2014	FY2015	FY2016	FY2017	Total
Main line actual (km)	118	152	134	140	544
Main line actual costs ($FY2015)	$47,616,207	$54,093,570	$62,596,540	$56,944,730	$221,251,047
Main line actual cost/km	$404,161	$355,879	$467,568	$406,719	$406,934
Turnout actual scope (no.)	41	48	58	40	168
Turnout actual costs ($FY2015)	$3,212,003	$4,175,464	$5,922,247	$5,517,009	$18,826,723
Turnout actual cost/turnout	$78,344	$86,989	$102,108	$137,925	$112,064

[35] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 1, Cells DX18:EA23

5. GHD assessment of proposed UT5 ballast undercutting scope

In undertaking our analysis of the proposed undercutting programme, we will have given consideration to:

- Physical scale and scope of CQCN infrastructure (e.g. account for length of infrastructure and track type (single line or duplicated))
- The extent to which renewing the asset, instead of maintaining the existing asset, can reduce corrective maintenance activities required
- Tonnage volume forecasts, which account for the extent, depth and intrusiveness of the required maintenance activity.

5.1 UT5 forecast coal volumes

QCA forecast coal volumes (tonnage) for each system and in aggregate are provided in in the table below.

Table 33 – QCA Forecast tonnage[36]

Forecast tonnage (million tonnes)	FY2018	FY2019	FY2020	FY2021
Blackwater	68.4	69.6	70.6	70.6
Goonyella	128.3	132.0	133.8	133.8
Moura	14.1	17.3	18.3	18.3
Newlands	11.7	14.2	14.2	14.2
GAP	15.9	18.9	23.9	28.9
Total	**238.3**	**251.9**	**260.7**	**265.7**

Aurizon Network forecast coal volumes (tonnage) for each system and in aggregate are provided in Table 34.

Table 34 Aurizon Network Forecast tonnage

Forecast tonnage (million tonnes)	FY2018	FY2019	FY2020	FY2021
Blackwater	69.9	71.3	71.3	71.3
Goonyella	120.3	120.3	120.3	120.3
Moura	10.2	10.2	10.2	10.2
Newlands	9.2	9.2	9.2	9.2
GAP	16.2	17.5	17.5	17.5

[36] As provided by QCA staff on 28 June 2017

Forecast tonnage (million tonnes)	FY2018	FY2019	FY2020	FY2021
Total	**225.8**	**228.5**	**228.5**	**228.5**

The difference in forecast tonnage between QCA's forecast and Aurizon Networks is shown in Table 35.

Table 35 Comparison between QCA and Aurizon Network's forecast tonnages

Forecast tonnage (million tonnes)	FY2018	FY2019	FY2020	FY2021
Total QCA forecast	238.3	251.9	260.7	265.7
Total Aurizon Network	225.8	228.5	228.5	228.5
% difference (QCA minus Aurizon Network)/Aurizon Network	**5.5%**	**10.2%**	**14.1%**	**16.3%**

We have undertaken our analysis using the tonnage (volumes) forecast by Aurizon Network for the assessment of scope for consistency with Aurizon Network's scope forecasts.

Of interest is that Aurizon Network project a flat-line tonnage, whereas QCA shows a growth in tonnage of 16% over the four year period.

5.1.1 Ballast undercutting scope determination methods

Figure 1 shows that Aurizon Network's proposed approach for determining ballast undercutting is GPR-based for the mainline and Network Strategic Asset Planning tool (NSAP)-based for turnouts.

Maintenance Activity	Scope Methodology	Costing Methodology	Consistent with UT4 Final Decision?
Direct Costs			
Ballast Undercutting			
Mainline	Ground Penetrating Radar (GPR)	$400,000 per km unit rate; escalated at MCI	Yes
Turnout	NSAP	QCA approved allowance for base year (FY2015), converted to unit rate; escalated at MCI	Scope - No; QCA used GPR. Difference immaterial (41 vs 42 turnouts per annum) Cost - Yes

Figure 1 – Aurizon Network's proposed approach for ballast-undercutting scopes and costs[37]

In UT4, we understand that Aurizon Network proposed its ballast-undercutting scopes using its NSAP model. The NSAP approach adopts a frequency of 600 MNT, based on assessment of ballast condition undertaken by GPR in 2012, with no allowance for >30 percent void contamination (PVC). Whilst Aurizon Network conducted GPR monitoring of ballast contamination up to 2014 as set out in their UT5 submission, the adoption of this 600 MNT intervention rate has not be subsequently adjusted from the later GRP undertaken. Previously, the intervention rate had been fixed at 400 MNT for Goonyella and 300 MNT on the other systems.

[37] Aurizon Network's UT5 submission: p159

GPR has been adopted by a number of major rail network owners as a means of identifying scope as it can be undertaken relatively quickly compared with traditional test pits and provides a continuous reading throughout the work area.

Network Rail, UK, uses the GPR method. In addition, there are a number of companies internationally providing this service. For extensive production lengths, this is the only realistic method of defining the work because the use of potholing (use of test pits) at various locations will not provide sufficient data to program an effective work scope.

However, there are a number of factors affecting the accuracy of the system, including the stone material forming the ballast, the equipment wavelength and the moisture content within the ballast. Considerable judgement is required in determining the degree of contaminated ballast and the formation level that is effective. It is preferred that some calibration between GPR and tests pits be undertaken to calibrate the GPR values.

5.2 Ballast undercutting scope analysis

5.2.1 Mainline scope

We understand that the approach adopted by Aurizon Network in developing the scope of ballast undercutting works for FY2015 and UT5 is to use the historical data from UT4 of a required annual rate of mainline ballast undercutting of 140 km in aggregate across the CQCN and that this rate may be modified during UT5 depending on the results of the GPR based and sample pit assessment of ballast condition. However, Aurizon Network has proposed that since the UT4 Aurizon Network scope was reduced by QCA by 18 km, it needs to catch up the lost 18 km during UT5, such that the required total scope over UT5 is 578 km rather than 560 km.

Table 36 sets out Aurizon Network's proposed scopes for mainline ballast undercutting.

Table 36 – Aurizon Network's proposed UT5 scopes for mainline ballast undercutting[38]

Ballast undercutting (Mainlines) - CQCN	FY2018	FY2019	FY2020	FY2021	Total
Mainline Scope (km)	**140**	**140**	**149**	**149**	**578**
Blackwater (km)	60	60	50	50	**220**
Goonyella (km)	64	64	89	89	**306**
Moura (km)	2	2	4	4	**11**
Newlands[39] (km)	14	14	7	7	**41**

Table 37 shows a breakdown of our calculation for projected ballast undercutting requirement of 152 km of mainline per annum in aggregate. This calculation is based on projections of 225.7-228.4 mtpa over UT5, an intervention rate set at 600 MNT, the track lengths for the various systems, the distribution of the tonnage over each system (to account for the distribution of mines along the track, and length of track duplication).

[38] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells L13:EH13

[39] No proposed undercutting on GAP was noted in Aurizon Network's UT5. It is assumed that GAP's new condition (opened in 2012) does not require undercutting.

Table 37 – GHD track length ballast undercutting scope calculation

Scope calculator	Blackwater	Goonyella	Moura	Newlands	Total
Tonnage (MNTA)	70	120	10	26	226
Intervention Rate (MNTA)	600	600	600	600	
Intervention Rate/Annum	0.1	0.2	0	0	
Total Length (km)	1,107	979	260	328	2,674
Factor duplication	1	1	1	1	
Factor distribution	2	2	1	1	
Program Annual Track (km)	55	97	0	0	152

We have undertaken a high-level assessment of whether Aurizon Network's proposed scopes for mainline ballast undercutting are prudent. Our assessment is based on the projected tonnage (225.8 million tonnes per annum (mtpa) to 228.5 mtpa using Aurizon Network's volume forecasts, and 238.3 mtpa to 265.8 mtpa using the QCA's volume forecasts), track lengths and, as per Aurizon Network's Asset Maintenance and Renewal Policy June 2014 (AMRP), the mainline-ballast-undercutting intervention rate of 600 million net tonnes per annum (MNTA).

We note that Aurizon Network's proposed mainline ballast undercutting scope is 140 km per year in FY2018 and FY2019, while the figure is 149 km per year in FY2020 and FY2021. Our analysis, which is based on the 600 MNTA intervention rate, including associated assumptions for converting net tonnes to gross tonnes, reveals that a scope of about 152 km (using Aurizon Network's volume forecasts) to 183 per annum (using the QCA's forecasts) would have been prudent. However, our analysis needed to also account for the constraints of Aurizon Network's production process for mainline ballast undercutting. In particular, as set out in later sections of this report, the primary limitation on Aurizon Network achieving its prudent mainline ballast undercutting scopes is the capacity of its spoil wagons (and train) to remove spoil during a possession under its current operating regime of filling all wagons and then removing the spoil train as a single unit. We have not assessed what the impact of having additional spoil wagons on the productivity of Aurizon Network's mainline-ballast-undercutting processes would be. Rather, we have assessed Aurizon Network's proposal on the basis of the actual machines it has and on the machines that it expects to procure, not on what machines Aurizon Network should have.

In summary, given the maximum number of spoil wagons that Aurizon Network currently has and the process of spoil removal, we do not consider that Aurizon Network will be able to achieve annual scopes of greater than 150 km. Unless this capacity constraint is proposed to be rectified, we consider Aurizon Network's proposed mainline ballast undercutting scopes to be prudent. We have therefore based our assessment on Aurizon Network's forecast volumes rather than the QCA's.

5.2.2 Turnout scope

The Aurizon Network AMRP allows for an intervention rate on turnouts for ballast cleaning of 600 MNT, the same as for mainline. We understand that this intervention rate is based on the rate of cleaning developed in UT4 and the number of turnouts dealt with in FY2016. Aurizon Network says it uses NSAP to determine the scopes for turnouts. However, from our evaluation, we consider that Aurizon Network's projection of turnout

ballast undercutting for UT5 is based on projected turnout undercutting used for UT4 adjusted for forecast UT5 tonnages and the 600 MNT intervention rate.

Aurizon Network has allowed for a fixed number of 42 turnouts per annum for the CQCN for UT5 (see Table 38).

Table 38 – Aurizon Network's proposed UT5 scopes for mainline ballast undercutting of turnouts[40]

Ballast undercutting (Turnouts) - CQCN	FY2018	FY2019	FY2020	FY2021	Total
Turnout Scope (no)	**42**	**42**	**42**	**42**	**168**
Blackwater (no)	17	17	19	19	**72**
Goonyella (no)	17	17	18	18	**70**
Moura (no)	1	1	2	2	**6**
Newlands (no)	7	7	3	3	**20**

The table below shows a breakdown of our calculation for projected ballast undercutting requirement of 41 turnouts per annum in aggregate based on projections of 225.7-228.4 mtpa over UT5, intervention rate set at 600 MNT and track lengths for the various systems.

Table 39 – Scope comparison calculation

Scope calculator	Blackwater	Goonyella	Moura	Newlands	Total
Tonnage (MNTA)	70	120	10	26	226
Intervention Rate (MNTA)	600	600	600	600	
Intervention Rate/Annum	0.1	0.2	0	0	
Total Turnouts (no.)	277	280	65	82	704
Factor duplication	1	1	1	1	
Factor distribution	2	2	1	1	
Program Annual Turnouts (no.)	13	28	0	0	41

It is reasonable to assume that if the mainline ballast is contaminated then the turnouts on the mainline are also contaminated given that the contamination rate for both from coal spillage will be the same, with, perhaps, increased coal fouling around the turnout due to increased train vibration over the crossing, hence resulting in coal dislodging from the rolling stock. On basis of approximately one turnout per 3.5 km of mainline and 140 km of mainline ballast undercut per annum, the required turnout ballast undercutting scope is of the order of 40 turnouts.

[40] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells L14:EH14

We therefore consider Aurizon Networks proposed scope of 42 turnouts ballast undercut per annum to be prudent.

5.2.3 Track ballast undercutting scope

We understand that track ballast undercutting (mainline and turnout) as captured in Aurizon Network's general maintenance category is small-scale works dealing with isolated spots and would not entail the use of heavy on track equipment. Because of the reactive nature of this work as opposed to preventative, Aurizon Network has not provided a scope of works for these activities for UT5, only a cost. We have therefore contrasted UT5 expenditure with UT4 expenditure to assess prudency and efficiency of UT5 proposed expenditure.

5.3 Scope delivery incentives and penalties

There currently appears to be no reclaim or penalties imposed on Aurizon Network in the event that the agreed scope for a particular year or UT period are achieved. It would also appear, conversely, that there is no compensation mechanism in place when Aurizon Network completes a greater scope than planned. We understand that UT4 allows for a revenue-cap adjustment process, where maintenance underspends or overspends are indirectly or partially addressed. However, we note that the review of UT5 is subject to the QCA Act, not the existing UT4 provisions. Therefore, there is no regulatory obligation for Aurizon Network to compensate customers if it fails to meet maintenance scopes, nor is there additional revenue for Aurizon Network if it performs more maintenance than planned.

The funding agreed for UT5 will be based on an agreed scope, which in itself is derived from a forecast of projected tonnage. We note that tonnage forecasts are estimates for periods up to four years in the future. Given this, it would be reasonable to consider an adjustment mechanism that redefines scopes and anticipated costs in the event that actual forecasts are significantly different from the original forecast.

6. GHD review of UT5 ballast undercutting productivity

In this section we discuss the productivity of the ballast undercutting machines that will be employed during UT5. The resulting productivity values are used, among other inputs, to drive our determination of efficient costs.

6.1 Ballast undercutting plant

Aurizon Network currently uses the RM900, which it owns, to deliver its mainline ballast undercutting program for the CQCN. For the UT5 period, Aurizon Network intends to introduce a new ballast undercutting machine, the RM902, which it also owns, supplied by Plasser Australia from February 2019[41].

The RM902 has a capacity of 430 to 600 m per productive hour and will replace the existing RM900 ballast cleaner which has a capacity of 220 to 350 m per productive hour. The introduction of the RM902 will result in a productivity gain of 80%, based on the two machines' maximum continuous output of 600 m per hour for the RM902 compared with 350 m per hour for the existing RM900. Aurizon Network owns the RM900 and will own the RM902.

Productivity rates for both machines were given by Aurizon Network in the UT5 presentation to the QCA as show in Figure 2.[42]

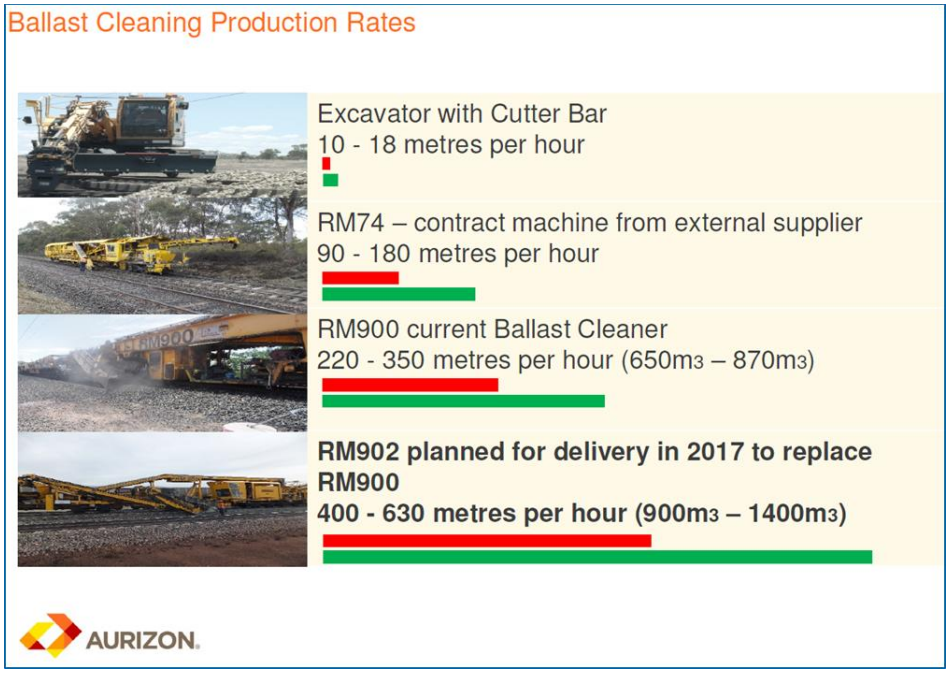

Figure 2 - Ballast-cleaning production rates from Aurizon Network's UT5 Maintenance Allowance presentation

Aurizon Network has used an overall production rate of 103 m per possession hour in the business case supporting the purchase of the RM902. However, from information provided in the Aurizon Network file

[41] Aurizon Network's UT5 submission: p169

[42] We note that Figure 2 says that Aurizon Network will take delivery of the RM902 in 2017. This is incorrect; it is supposed to be FY2019, as per page 169 of the UT5 submission to the QCA.

20170719 –Ballast Quantum and Closure Calculations, Aurizon Network has assumed a production rate of 77 m per possession hour in forecasting UT5 costs. Aurizon Network has not provided any evidence to support its use of a lower production rate in determining costs than it used in the business case justifying the purchase of the machine.

The production rate of 77 m per possession hour for the RM902 represents only a 34% increase in productivity over the quoted 49 m per possession hour for the RM900 quoted in the business case documents. We consider that Aurizon Networks assumed increase in productivity from use of the RM902 in determining UT5 costs to be low given the potential 80% difference in productivity rates per productive hour between the machines per the manufacturer's data.

6.1.1 Mainline productivity assessment

In this section we calculate the productivity rate in m per possession hour that we use to determine efficient UT5 costs for ballast cleaning. We use the following data to undertake this calculation:

- Ballast volume 2.45 m^3 per m of track
- 70% of ballast is screenable on average (see Aurizon Network's assumption for screenable ballast provided in Figure 3), of which on average 80% is returnable. Returnable screenable ballast is 56 % (i.e. 70% of 80%), resulting in a 44% (i.e. 100% minus 56%) disposal rate on average
- Spoil wagon train capacity is 1,200 m^3 based on 30 MFS wagons of 40 m^3 capacity
- RM900 production rate of 220 m per productive hour (historic rate from UT4)
- RM902 production rate is 500 m per productive hours (from the Aurizon presentation (Figure 2 above)
- 4 productive hours per possession, assuming Aurizon Network makes the changes as to how it manages possession times set out in Section 4.2.3 of Appendix C – Resurfacing Mini Report – 13 November 2017.

The *Excel* sheet excerpt Figure 3 is taken from the Aurizon Network file 20170719 –Ballast Quantum and Closure Calculations submitted to the QCA. This excerpt provides Aurizon Networks assumed screenable percentage of ballast excavated of 70% of the nominated scope of 140 km track length cleaned per annum.

RM900 (C01)	FY17 Total		
RM900 Production	107.726	Total Excavation	26%
04 Production (hrs)	508		
Production Rate(km/hr)	0.212		
Closure Hours (hrs)	2206	Adjustable Target (km)	120
Linear Km's / Closure Hour	0.049	FY17 Closure Hrs Required	2458
RM902 (C01)			
Initial 2012 Proposal		Target (km)	150
Linear Km's / Closure Hour	0.103	Closure Hrs Required	1459
Ballast Cleaning Modelling		Target (km)	140
Linear Km's / Closure Hour	0.077	Closure Hrs Required	1818
UT5 Corporate Plan		Target (km)	140
Linear Km's / Closure Hour	0.063	Closure Hrs Required	2208
RM902 (C01) Ballast Est.			
Target (adjustable)	140	Ballast required per km	2450

Screenable Return	80%
Total Excavation Return	0%

Assumed % of Undercutting		KM's	Est. Ballast in Track (m^3)	Est. Ballast Returned to Track (m^3)	Est. Ballast Required (m^3)
Screenable	70%	98	240100	192080	48020
Total Exc.	30%	42	102900	0	102900
		140		Total	150920

Figure 3 Aurizon Network ballast quantum calculation

Aurizon Network has allowed for the spoil material from ballast cleaning on the Blackwater and Goonyella systems to be removed from the work sites and transported by rail to dedicated ballast recycling sites[43]. Ballast spoil is dumped on the corridor on the Newlands and Moura systems during ballast undercutting for subsequent removal. In extreme cases spoil trains may be required to undertake a 200 km round trip during a possession. This can create significant impacts on average productivity due to the ballast cleaner having to cease operation when there is no remaining capacity in the wagons to hold spoil.

Plasser Australia has confirmed by email to GHD that the cubic metre excavation rate of the RM902 is 1,000 m^3 per hour. This equates to 500 m per hour production rate if the ballast cross-sectional area is 2 m^2 (as per Aurizon standard drawings). We note that Aurizon Network has allowed a ballast volume of 2.45 m^3 per track metre during ballast replacement. The difference in volumes removed (2 m^3 per track metre) and replaced (2.4 m^3 per track metre), due to the ballast compaction factor, per Aurizon Network advice provided in meetings with QCA staff[44]. That said, we note our derived linear rate of 500 m per hour production rate corresponds with

[43] Aurizon Network document entitled *Ballast Cleaning Plant Strategy Attachment 6*

[44] See Excel file 20170719 –Ballast Quantum and Closure Calculations

Aurizon Network's stated rate of 493 m per hour in the business-case documentation[45] for the purchase of the RM902.

Aurizon Network has indicated that for the 149 km target per annum for FY2020 and FY2021 when the RM902 is employed, 70% of the 149 km, or 104.3 km, will have screenable ballast and 44.7 km, or 30%, will require total ballast replacement[46]. The stated replacement ballast volume for screenable work is 20%, which equates to approximately 0.5 cubic metres per track metre. Thus for any given length of track, 44% of the ballast requires to be removed and replaced.

Information provided by Plasser Australia confirms the transfer rate between MFS wagons, or when offloading, is 1,400 m^3/h[47]. This is greater than the rate the excavation capacity of the RM902 (i.e. 1,000 m^3/h), and confirms movement of spoil along the MFS wagons in the spoil train is not a limiting factor.

The spoil wagon train has a capacity of 1,200 m^3 (using a fleet of 30 MFS 40 spoil wagons). Assuming that just one spoil wagon trip is made to the disposal site per shift (as per current practice), the RM902 is capable of producing 1,760 m^3 per possession, based on 1,000 m^3 per hour and 44% spoil removal. It will take 2.7 hours for the RM902 to produce 1,200 m^3 of spoil. This suggests that the RM902 can produce more spoil per shift than can be handled by the spoil train. Thus, it is the capacity of the spoil wagons that is the limiting factor setting productivity rate per possession when the RM902 is employed.

Using the limiting factor of 1,200 m^3 (enforced by the spoil wagon capacity) per possession and dividing this by the amount of spoil removed per m being 1.08 m^3 per m, results in 1,113 track m being cleaned in a possession. Dividing this by the 11 hour possession period results in a productivity rate per possession hour of 101.2 m per hour. Thus, we consider that the 103 m per hour productivity rate quoted by Aurizon Network in its business case for the RM902 is more appropriate to use in determining UT5 costs rather than the 77 m per possession hour assumed by Aurizon Network in its UT5 submission.

A similar calculation may be performed for the RM900 to determine production rates for the RM900 as follows:

A machine capable of advancing 300 m per h (a point estimate between 220 m/h to 350 m/h quoted by Aurizon Network) with a spoil removal volume of 1 cubic metre per track metre, being 0.5 cubic metres of spent ballast plus 0.5 cubic metres of coal and other contamination, will produce 300 cubic metres of spoil per hour. Using a fleet of 30 MFS 40 spoil wagons of 1,200 m^3 total capacity, the RM900 could clean 1,200 metres of track in 4 hours, and produce 1,200 m^3 of spoil.

Assuming an 11-hour closure, the RM900 would work for four hours and then clear site with the spoil train. The remaining time within the closure would allow for 600 cubic metres of ballast replacement and tamping, and the hand back to operations. The RM 900 average production rate would therefore be 109 m per hour in screenable ballast with machine working for 4 hours only in the closure. The shift production rate given by Aurizon is 49 m per hour.

Productivity per shift of four hours has been selected as the basis of our assessment as it reflects what should be readily achievable in terms of productivity per shift if Aurizon Network moved non-productive activities outside the possession time and if it managed interruptions in terms of train services in accordance with its obligations. We have observed that Aurizon Network does not exploit its possession times in a prudent and efficient manner in that it allows access holders' train services to interrupt planned maintenance tasks. Drivers of this efficiency gain will come from activities such as preparation time, equipment-inspection time and travel

[45] Aurizon Network document entitled *Ballast Cleaning Plant Strategy Attachment 6*

[46] See Excel file 20170719 –Ballast Quantum and Closure Calculations

[47] E-mail from Plasser Australia in March 2017

time being conducted before the possession time begins, in addition to not allowing interruptions to maintenance tasks.

With the commissioning of the RM902 with a linear production rate of 500 m per hour, a spoil rate of 1 m^3 per track metre and a spoil train capacity of 1,200 cubic metres, this machine would work for 2.5 hours to fill the spoil capacity, and cover 1,200 metres of track.

If only one filling of the spoil train were completed in an 11 hour closure then the production rate per shift hour would be 109 metres per hour as per the existing RM900. Thus, an 11 hour closure using the RM902 will not increase production compared to the RM900 with a single spoil train movement. More importantly, the production rate should be higher than the 77 m an hour allowed by Aurizon Network for UT5.

Information on the cycle time for a spoil train to leave site and return within the closure has not been provided by Aurizon Network, but Aurizon Network indicated in the QCA meeting that spoil return cycle would not be less than 3 hours. As such, the benefits of using the RM902 in short closures cannot be realised until the spoil train is able to make more than one disposal run and return to site.

We recommend that the productivity rate per closure hour of the RM900 and RM902 machines used to calculate costs for UT5 should be 109 m per possession hour and not the 77 m per possession hour used by Aurizon Network. This represents a 63.5% increase in productivity.

Finally, we consider that the introduction of a new ballast cleaner would not significantly alter the crew size needed for operation. Accordingly, most of the efficiency issues, in our view, relate to why Aurizon Network's share of productive time of shift hours is low and whether these impediments can be overcome by better spoil handing.

6.1.2 Track ballast undercutting – by excavator

No data on the scale of work or costs has been provided to us by Aurizon Network on this activity. As such we have not been able to undertake an assessment of prudency of scope or efficiency of cost of the expenditure categories ballast undercutting (other) and ballast undercutting – turnout – minor on a bottom up basis in the same way that we have for mechanised . However, we note that the scope of such works, based on previous years expenditure, are relatively small (total costs for spot track ballast undercutting by excavator are approximately 10% of the total costs for mechanised undercutting). We have therefore given consideration to the prudency and efficiency of proposed expenditure in UT5 by contrasting proposed expenditure with historic UT4 expenditure (see Section 8.2.2)

7. Assessment of Aurizon Network's unit rates for UT3, UT4 and UT5

In this section we have provided a high level assessment of Aurizon Network's actual unit rates for undertaking ballast undercutting for UT3 and UT4 and proposed unit rates for UT5. We have not undertaken a detailed analysis of the drivers that cause a change in unit rate between years as we have developed our UT5 recommendations on the basis of a bottom up approach. By contrast, Aurizon Network has developed its UT5 cost proposal using a top down unit rate of $400,000 per km ($FY2015) for mainlines and $125,200 per unit (FY2015) for turnouts. We consider that our bottom up approach yields a more appropriate estimate of costs for UT5 than Aurizon Network's top down approach. As such, there is little to be gained in undertaking a detailed analysis of the drivers underpinning year to year unit rate changes.

7.1 Mainline ballast undercutting

The table below presents the unit rates ($/km) for mainline ballast undercutting (RM900/RM902 and the excavator) at the CQCN level for UT3, UT4 and UT5 derived from the RFI response data providing overall cost and scope.

Table 40 – Aurizon Network's unit rates ($/km) of mainline ballast undercutting[48]

Financial Year	2010	2011	2012	2013	2014	2015
$FY2015	395,689	391,203	449,767	496,007	404,164	355,804
Nominal	356,932	362,873	428,317	479,952	398,045	355,804
Financial Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
$FY2015	467,568	418,404	400,007	399,774	399,137	398,740
Nominal	471,246	432,593	421,102	428,906	436,452	444,438

Unit rates rose from $395,689 (FY2010) to $496,007 (FY2013). Over UT3, this represents a compounding annualised growth rate (CAGR) of 5.8% and an average unit rate of $433,166. In the first year of UT4 (i.e. FY2014), the unit rate declined to $404,161, reflecting a sharp reduction of 18.5%. The unit rate dropped further to $355,804 in FY2015, before rising sharply to $467,568 in FY2016. The average rate for the UT4 period, which includes a forecast for FY2017, is $409,179. Therefore, Aurizon Network's cost performance, on a unit-rate basis, has improved from UT3 to UT4 ($433,166 down to $409,179).

Over UT5, unit rates plateau approximately between $398,740 and $400,007, which are broadly consistent with the QCA's UT4 final decision to provide for a cap of $400,000 for the UT5 period. Relative to UT4, average UT5 unit rates are lower ($399,414 compared with $409,179), suggesting that mainline ballast-undercutting costs have become more efficient. However, we note that Aurizon Network's unit rate forecast over the UT5 period has been fixed to reflect the QCA's UT4 final decision capped rate, which may not necessarily translate to what unit rates Aurizon Network expects will actually transpire.

[48] For the UT3 and UT4 period, we have divided the sum of C01 and C14 costs by the sum of scope achieved for the C01 (RM900) and C14 (excavator)

7.2 Turnout ballast undercutting

The table below presents the unit rates ($/turnout) for turnout ballast undercutting at the CQCN level for UT4 and UT5.

Table 41 – Aurizon Network's unit rates ($/turnout) of turnout ballast undercutting

Financial Year	2014	2015	2016	2017	2018	2019	2020	2021
$FY2015	78,342	86,989	102,108	138,783	125,215	125,142	124,942	124,818
Nominal	77,155	86,989	102,911	143,489	131,818	134,261	136,623	139,123

Aurizon Network did not provide the QCA with complete or comprehensible data for turnout-ballast-undercutting scopes for UT3 nor did it for costs (with the exception of FY2013). Accordingly, we have not presented unit rates for UT3.

Over UT4, unit rates increased sharply from $78,342 (FY2014) to $138,783 (FY2017), translating to a compound annual growth rate (CAGR) of 15%. Rates at the beginning of UT5 are expected to drop, with the forecast rate for FY2018 being $125,215. Over UT5, rates will decline at a marginal rate, from $125,215 (FY2018) to $124,818 (FY2021). In terms of efficiency, unit rates are expected to perform worse during UT5 (average rate of $125,029) relative to UT4 (average rate of $101,555).

7.3 Track-ballast-undercutting – by excavator[49]

Aurizon Network did not provide scopes for this maintenance sub-category for the UT3, UT4 and UT5 periods. As such we have been unable to develop unit rates for this sub-category.

[49] For clarity, these costs related to use of the excavator for the C02 and C03 maintenance cost sub-categories, not the C14 one, which relates to mainline ballast undercutting.

8. GHD assessment of proposed costs

8.1 Our approach

At a meeting with Aurizon Network staff and QCA staff on 12 July 2017, we received information and data entitled 'BCD Reports', which provided costs C01, C13 and C14 costs in FY2014, FY2015 and FY2016. The BCD reports contain Aurizon Network's actual incurred costs, divided into six cost areas. These cost areas do not readily align with the maintenance cost categories. We also consider that the BCD reports are useful as a comparison tool, rather than serving as a predictive cost model for the UT5 period. We have been provided data across all RFIs, some of which we have implemented our mechanised maintenance-cost model's input assumptions.

Given the limitations with these data sets, we have proposed a calculation method that does not rely exclusively on the data provided. The basis for this calculation method is converting Aurizon Network's proposed scopes (for mainlines and turnouts) into a number of productive and possession hours required, which can then be changed to other time-based parameters. These parameters include: labour shift hours required; number of labour shifts required; and number of days required.

We achieved the above by anchoring our analysis to machine productivity rates (in km/productive hour for mainlines, and number per shift for turnouts). For mainlines, the RM900 rate used is the lower end of specifications outlined in slide 20 of Aurizon Network's UT5 Maintenance Allowance Presentation, while the RM902 rate has been taken from the business case. The cost rates are then multiplied by the relevant time-based parameters (and any other associated factors) to generate line-item costs. As the original scopes are presented by system and year, we calculated costs for each system by year, assuming that all mainline work was conducted by the ballast cleaning machine only in the absence of information regarding the breakdown in mainline scope between the ballast cleaning machine and the excavator.

The above method is not appropriate for machinery-maintenance costs and depreciation, as neither of these line items are wholly related to scope. To account for this, we have used an asset-rollover model provided by QCA staff for yearly depreciation values. We understand that this model was developed from a Fixed Asset Register (FAR) provided by Aurizon to the QCA. The FAR includes assets which have been in use prior to June 30, 2016, while the New Assets list includes assets which began use after June 30, 2016. QCA staff arranged the FAR such that each asset was clearly assigned a depreciation cost for each year. QCA staff have discussed this model with Aurizon Network staff and that Aurizon Network is satisfied with the explanations from QCA staff. QCA staff requested that GHD use Depreciated Actual Cost (DAC), in nominal terms, noting that GHD cost estimates have been prepared in real terms ($FY2015). Each individual asset was not assigned depreciation by system in the model. To account for this, we have split the value of depreciation across the Blackwater, Goonyella, Moura and Newlands systems according to number of shifts in each system. We have made this decision because this method better represents the opportunity cost of the machine and the relative efficiency of each system.

Additionally, it is not immediately obvious if assets are used for mainlines only, turnouts only or some combination of these two. The exception to this is the ballast cleaning machine(s) and the excavator, as these are used for mainlines and turnouts respectively. Given that it is not important whether mainlines and turnouts have accurate depreciation values assigned to them, provided depreciation costs are accurately captured at an aggregate level, we have decided to assign the depreciation for the ballast cleaning machine(s) to mainlines, the depreciation of the excavator (and related items) to turnouts, and all remaining BCD assets to mainlines. The depreciation relating to the excavator (and its related equipment) was determined by searching for line items in the FAR containing the word "excavator" in the Asset Description (Asset Ds) column.

Actual values for maintenance in UT4 have been provided across each system in RFI 170713, 1_Tab 4. We have used the average yearly maintenance expenditure from UT4 for yearly maintenance expenditure in UT5, noting that this value may decrease given the retirement of the RM900 in favour of the RM902 for FY2020 onwards.

We encountered difficulty when attempting to calculate the fuel and consumable cost components of the MCI. This is because Aurizon Network did not break down its aggregate cost into these sub-cost categories. At present, fuel costs are calculated on the basis of the time-in-motion chart[50] that Aurizon Network supplied, together with the assumptions on the amount of work that is screenable (i.e. assessment of the quality of ballast to decide whether to replace the ballast or put the cleaned ballast back in the track) and the amount of scope that requires total excavation. Consumables were calculated on a per-quantity basis, with quantity used depending on the unit rate provided. Consumables accounted for include ballast (new ballast and disposal of spoil) and hire costs. Hire costs unit rates were given in $/machine/day, while ballast costs were given in $/t or $/m^3. To calculate ballast costs, the per-mass or per-volume rates were converted to per km using density and volume requirement per distance.

Due to the nature of information provided by Aurizon Network, it was difficult to determine which machines need to be hired, the quantity of machines to be hired and the hire duration compared to shift time, as well as the hire rate. In absence of Aurizon Network providing information to enable us to establish the basis of its equipment-hire practices, we have assumed that our calculated costs for equipment hire are prudent and efficient. Another source of difference in our cost estimates and Aurizon Network's estimates may be the portion of maintenance labour and parts allocated to each of labour and parts. Aurizon Network has not specified this split, so we have adopted a 50/50 share on the basis of no information provided by Aurizon Network. This would also indicate why our calculated labour costs are slightly higher than Aurizon Network's, despite a reduction in the number of shifts required.

We have used values from Aurizon Network wherever possible, which are supported by a combination of GHD assumptions and Evans and Peck unit rates taken from the independent cost estimates generated as accompanying information for Aurizon Network's UT4 cost model.[51] We have sense-checked these values, and replaced them and with more appropriate numbers where we had alternative information and supporting evidenced.

After we determined the real costs by system and year, we applied escalation factors to each cost to obtain nominal costs. There are two escalation factors used: CPI and MCI. CPI is used to escalate depreciation, while MCI is used to escalate all remaining categories. We have used CPI and MCI values from Aurizon Network.

For turnouts we have assumed that each turnout requires 25 m of track at most to be ballasted in our bottom up cost model. We have used Aurizon Network's excavator productivity rate to determine productive hours required per turnout. Costs have been developed on a bottom up basis in the same manner for mainline ballast undercutting as set out in this section.

8.2 GHD assessed efficient UT5 ballast undercutting expenditure

We set out below our assessment of efficient expenditure for ballast undercutting for UT5.

[50] RM900 Sequence Screenable and Total Excavation

[51] Taken from a **confidential report** that Aurizon Network included in its UT4 explanatory submissions to the QCA

8.2.1 Mechanised ballast undercutting

From application of the method set out in Section 8.1, our recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting expenditure for UT5 are as follows:

8.2.1.1 Mainlines

Our proposed adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting expenditure for each system are as follows:

Table 42 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs – Blackwater[52]

Ballast Undercutting (Mainlines) - Blackwater	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$24,555,675	$24,555,675	$19,076,002	$19,076,002	**$87,263,354**
GHD Costs ($FY2015)	$20,124,870	$20,522,669	$18,772,419	$18,764,633	**$78,184,592**
Adjustment ($FY2015)	-$4,430,805	-$4,033,006	-$303,583	-$311,369	**-$9,078,762**
Adjustment (%)	**-18%**	**-16%**	**-2%**	**-2%**	**-10%**

The majority of cost reductions for Blackwater that we have proposed for UT5 occur in FY2018 and FY2019. Aurizon Network has proposed $87.3 million of mainline ballast undercutting for UT5, while we have proposed $78.2 million. The reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the ballast undercutting plant hence lower number of shifts required, resulting in a 10% reduction in mainline ballast undercutting costs over the UT5 period.

Table 43 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs - Goonyella

Ballast Undercutting (Mainlines) - Goonyella	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$24,845,512	$24,845,512	$36,335,706	$36,335,706	**$122,362,436**
GHD Costs ($FY2015)	$20,960,260	$21,371,945	$27,283,839	$27,270,008	**$96,886,052**
Adjustment ($FY2015)	-$3,885,252	-$3,473,567	-$9,051,867	-$9,065,698	**-$25,476,384**
Adjustment (%)	**-16%**	**-14%**	**-25%**	**-25%**	**-21%**

The majority of cost reductions for Goonyella that we have proposed for UT5 occur in FY2020 and FY2021. Aurizon Network has proposed $122.4 million of Goonyella mainline ballast undercutting in UT5, while we have proposed $96.9 million. Again the reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the ballast undercutting plant hence lower number of shifts required, resulting in a 21% reduction in Goonyella mainline ballast undercutting costs over the UT5 period.

[52] Numbers may not add due to rounding

Table 44 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs – Moura

Ballast Undercutting (Mainlines) - Moura	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$1,161,785	$1,161,785	$1,382,655	$1,382,655	**$5,088,880**
GHD Costs ($FY2015)	$631,123	$695,835	$1,016,859	$1,016,279	**$3,360,096**
Adjustment ($FY2015)	-$530,662	-$465,950	-$365,796	-$366,376	**-$1,728,784**
Adjustment (%)	**-46%**	**-40%**	**-26%**	**-26%**	**-34%**

Aurizon Network has proposed $5.1 million of mainline ballast undercutting in UT5, while we have proposed $3.4 million, resulting in a recommended 34% reduction in Moura mainline ballast undercutting costs over the UT5 period. Again the reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the ballast undercutting plant hence lower number of shifts required.

Table 45 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs - Newlands

Ballast Undercutting (Mainlines) - Newlands	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$5,437,027	$5,437,027	$2,805,637	$2,805,637	**$16,485,328**
GHD Costs ($FY2015)	$3,742,350	$3,854,307	$2,502,351	$2,501,274	**$12,600,282**
Adjustment ($FY2015)	-$1,694,677	-$1,582,720	-$303,286	-$304,363	**-$3,885,046**
Adjustment (%)	**-31%**	**-29%**	**-11%**	**-11%**	**-24%**

Aurizon Network has proposed $16.5 million of mainline ballast undercutting in UT5, while we have proposed $12.6 million, resulting in a 24% reduction in Newlands mainline ballast undercutting costs over the UT5 period. Again the reduction in cost is due to assumed lower hire costs, on track labour costs and associated accommodation costs than forecast by Aurizon Network arising from the higher productivity assumed for the ballast undercutting plant and hence lower number of shifts required. We have accounted for GAP volumes on the Newlands network in reviewing the maintenance scopes and costs for the Newlands system.

Our recommended adjustments to Aurizon Network's proposed UT5 costs, at an aggregated level, from mainline mechanised ballast undercutting are presented in Table 46.

Table 46 – Recommended adjustments to Aurizon Network's proposed mainline mechanised ballast undercutting costs – CQCN

Ballast Undercutting (Mainlines) - CQCN	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$56,000,000	$56,000,000	$59,600,000	$59,600,000	**$231,200,000**
GHD Costs ($FY2015)	$45,458,603	$46,444,756	$49,575,468	$49,552,194	**$191,031,021**
Adjustment ($FY2015)	-$10,541,397	-$9,555,244	-$10,024,532	-$10,047,806	**-$40,168,979**
Adjustment (%)	**-19%**	**-17%**	**-17%**	**-17%**	**-17%**

Over the UT5 period, our recommended costs for mainline ballast undercutting are 17% lower than Aurizon Network's proposal.

The main driver for the mainline-related outcome is that we have calculated that Aurizon Network's RM900 and RM902 can both achieve 102.8 m of mainline scope per possession hour and that four hours productive time per possession is achievable; Aurizon Network has implicitly assumed that the RM900 can achieve 49.9 metres per possession hour and that, combined, the RM900 and RM902 can achieve 77.0 m per possession hour over the UT5 period[53] with assumed productive hours per possession being only 3 hours. Our recommended productivity rate has lowered the number of shifts that Aurizon Network requires, consequently reducing all on-track labour costs, some accommodation-related costs and some consumables-related costs in our bottom up modelling (see Section 8.2).

8.2.1.2 Turnouts

Our proposed adjustments to Aurizon Network's proposed turnout mechanised ballast undercutting expenditure for each system are as follows:

Table 47 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Blackwater

Ballast Undercutting (Turnouts) - Blackwater	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$2,128,616	$2,128,616	$2,379,041	$2,379,041	**$9,015,314**
GHD Costs ($FY2015)	$1,461,914	$1,437,148	$1,561,821	$1,529,951	**$5,990,834**
Adjustment ($FY2015)	-$666,702	-$691,468	-$817,220	-$849,090	**-$3,024,480**
Adjustment (%)	**-31%**	**-32%**	**-34%**	**-36%**	**-34%**

Aurizon Network has proposed $9.0 million of turnout ballast undercutting in UT5, while we have proposed $6.0 million, resulting in a 34% reduction in Blackwater turnout ballast undercutting costs over the UT5 period.

Table 48 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Goonyella[54]

Ballast Undercutting (Turnouts) - Goonyella	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$2,128,616	$2,128,616	$2,253,829	$2,253,829	**$8,764,890**
GHD Costs ($FY2015)	$1,533,063	$1,506,472	$1,590,592	$1,533,973	**$6,164,101**
Adjustment ($FY2015)	-$595,553	-$622,144	-$663,237	-$719,856	**-$2,600,789**
Adjustment (%)	**-28%**	**-29%**	**-29%**	**-32%**	**-30%**

Aurizon Network has proposed $8.8 million of turnout ballast undercutting in UT5, while we have proposed $6.2 million, resulting in a 30% reduction in Goonyella turnout ballast undercutting costs over the UT5 period.

Table 49 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Moura[55]

Ballast Undercutting (Turnouts) - Moura	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$125,213	$125,213	$250,425	$250,425	**$751,276**
GHD Costs ($FY2015)	$144,866	$144,726	$205,892	$203,519	**$699,002**

[53] Based on the mid-point of the RM900 and RM902 speeds, from the publicly available Aurizon Network UT5 Maintenance Allowance Presentation document

[54] Values may not add due to rounding

[55] Values may not add due to rounding

Adjustment ($FY2015)	$19,653	$19,513	-$44,533	-$46,906	**-$52,274**
Adjustment (%)	**16%**	**16%**	**-18%**	**-19%**	**-7%**

Costs proposed by Aurizon Network for turnout undercutting in Moura are small compared to other systems. GHD proposed costs approximately reflect those of Aurizon Network. Aurizon Network has proposed $0.75 million of turnout ballast undercutting in UT5, while we have proposed $0.70 million, resulting in a 7% reduction in Moura turnout ballast undercutting costs over the UT5 period.

Table 50 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – Newlands

Ballast Undercutting (Turnouts) - Newlands	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$876,489	$876,489	$375,638	$375,638	**$2,504,254**
GHD Costs ($FY2015)	$584,075	$578,458	$280,083	$275,676	**$1,718,292**
Adjustment ($FY2015)	-$292,414	-$298,031	-$95,555	-$99,962	**-$785,962**
Adjustment (%)	**-33%**	**-34%**	**-25%**	**-27%**	**-31%**

Our proposed cost reductions for turnout undercutting in Newlands come mostly in FY2018 and FY2019. Aurizon Network has proposed $2.5 million of turnout ballast undercutting in UT5, while we have proposed $1.7 million, resulting in a 31% reduction in Newlands turnout ballast undercutting costs.

Our recommended adjustments to Aurizon Network's proposed UT5 costs, at an aggregated level, from mainline mechanised ballast undercutting are presented in Table 51.

Table 51 – Recommended adjustments to Aurizon Network's proposed mechanised ballast undercutting costs – CQCN

Ballast Undercutting (Turnouts) - CQCN	FY2018	FY2019	FY2020	FY2021	Total
AN Costs ($FY2015)	$5,258,933	$5,258,933	$5,258,933	$5,258,933	**$21,035,732**
GHD Costs ($FY2015)	$3,723,919	$3,666,803	$3,638,388	$3,543,119	**$14,572,230**
Adjustment ($FY2015)	-$1,535,014	-$1,592,130	-$1,620,545	-$1,715,814	**-$6,463,502**
Adjustment (%)	**-29%**	**-30%**	**-31%**	**-33%**	**-31%**

The main driver for our recommended reduction in costs for turnouts (i.e. 31% over the UT5 period) is our assumption that each turnout requires 25 m of track at most to be ballasted in our bottom up cost model. The reduction in cost is mainly due to lower ballast costs, lower on track labour costs and lower hire costs for turnouts as compared to Aurizon Network costs (determined through application of a UT4 cost component split to UT5 costs).

8.2.2 Track ballast undercutting

In absence of information from Aurizon Network on scopes and unit rates for track ballast undercutting undertaken by excavator, we have assessed prudency and efficiency off Aurizon Network's proposed track ballast undercutting expenditure by comparing it with historic UT4 expenditure. Given that the increase in track length in the CQCN occurred during FY2017 of UT4, we do not consider that the 413 km increase in track length that occurred in FY2017 should result in a corresponding increase in track ballast undercutting for UT5 given the newness of these track sections. We also consider that, given the nature of the work, i.e. addressing small areas of track that are not suitable to be addressed through mechanised ballast undercutting, the work will vary year on year. As such, we consider that proposed UT5 expenditure should reflect average expenditure

during UT4 (which we have assumed to be efficient given the nature of the work and in absence of other information).

Table 52 and Table 53 below present Aurizon's ballast undercutting expenditure proposed for UT5 and historic UT4 expenditure respectively.

Table 52 - Aurizon Network's proposed ballast undercutting by excavator costs for UT5[56]

Ballast Undercutting	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)	Average UT5 ($FY2015)
C02-Ballast Undercutting (Other)	3,382,403	3,376,293	3,390,182	3,384,072	**13,532,950**	**3,383,238**
Proposed C02 uplift	1,520,000	1,720,000	1,900,000	2,100,000	**7,240,000**	**1,810,000**
C03 – Ballast Undercutting – Turnout - Minor	305,893	305,893	305,893	305,893	**1,223,573**	**305,893**
Total	**5,208,296**	**5,402,186**	**5,596,075**	**5,789,965**	**21,996,522**	**5,499,131**

Table 53 - Aurizon Networks historic ballast undercutting by excavator expenditure (UT4)[57]

Ballast Undercutting	FY 2014 ($FY2015)	FY 2015 ($FY2015)	FY 2016 ($FY2015)	FY 2017^ ($FY2015)	Total ($FY2015)	Average UT4 ($FY2015)
C02 – Ballast Undercutting (Other)	4,546,114	3,385,202	4,460,487	4,560,332	**16,952,134**	**4,238,034**
C03 – Ballast Undercutting – Turnout - Minor	112,555	44,646	84,057	294,032	**535,290**	**133,822**
Total	**4,658,669**	**3,429,847**	**4,544,543**	**4,854,364**	**17,487,424**	**4,371,856**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

Given that the 413 km increase in track length that occurred in UT4, e.g. for the Wiggins Island Rail Project, occurred in the last year of UT4, and is therefore relatively new, we do not consider that this increase in system track length should warrant an increase in the ballast undercutting by excavator cost allowance during UT5. Table 54 presents the comparison of expenditure for ballast undercutting by excavator between UT4 and the proposed UT5 expenditure. The suggested increase between periods of 26% would suggest the increase in track over the period would have similar magnitude, however this is not the case (the increase in track length during UT4 was approximately 14%). In absence of supporting information, and given the variable nature of the work, we consider it more appropriate to base proposed UT5 expenditure on the average of UT4 actual expenditure. Our proposed efficient costs for ballast undercutting by excavator are as provided in Table 55.

[56] Maintenance UT5 Cost Build: "Real Total NMP" (Rows 10 to 12)

[57] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells DX21:EA23

Table 54 - Comparison of Aurizon Networks UT4 and proposed UT5 expenditure for ballast undercutting by excavator

Ballast Undercutting	UT4 Average ($FY2015)[58]	UT5 Average ($FY2015)[59]	Increase (%)
C02-Ballast Undercutting (Other)	4,238,034	5,193,238[60]	23%
C03 – Ballast Undercutting – Turnout - Minor	133,822	305,893	129%
Total	**4,371,856**	**5,499,131**	**26%**

Table 55 - GHD's proposed efficient UT5 ballast undercutting by excavator expenditure

Ballast Undercutting	FY 2018 ($FY2015)	FY2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
C02 – Ballast Undercutting (Other)	4,238,034	4,238,034	4,238,034	4,238,034	**16,952,134**
C03 – Ballast Undercutting – Turnout - Minor	133,822	133,822	133,822	133,822	**535,290**
Total	**4,371,856**	**4,371,856**	**4,371,856**	**4,371,856**	**17,487,424**

[58] 170713 – RFI – UT5 Maintenance_AN: "1_Tab 1" (Cells DX21:EA23)

[59] Maintenance UT5 Cost Build: "Real Total NMP" (Cells D10:G12)

[60] Includes proposed C02 uplift

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GHD Advisory

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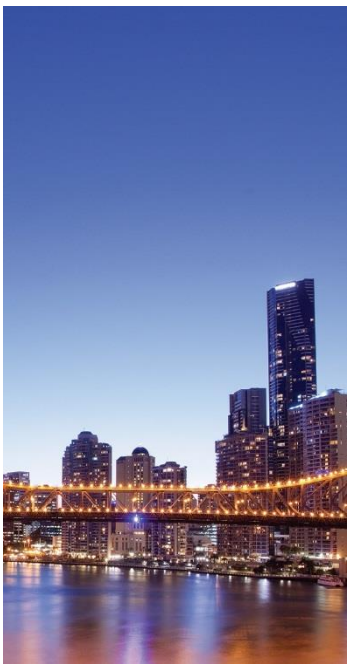

Appendix C - Resurfacing

Mini Report for the Queensland Competition Authority

15 November 2017

GHD

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1. Summary

1.1 Objective

The Queensland Competition Authority (QCA) engaged GHD (us) to review Aurizon Network's proposed maintenance costs for the regulatory period covering 2017-18 (FY2018) to FY2021 (known as the Undertaking 5 (UT5) period).

This mini-report assesses whether the resurfacing costs that Aurizon Network has proposed reflect prudent maintenance scopes and delivery practices and efficient costs. As requested in the QCA's Terms of Reference (ToR), our analysis considers the following key themes (see Table 1).

Table 1 – Analysis themes

Underlying themes	
Efficiency and prudency	The extent to which Aurizon Network's proposals are efficient and prudent.
Achievability	The extent to which the proposals are practically achievable.
Measurability	The extent to which the proposals provide a platform for measuring performance.
Transparency	The extent to which the proposals clearly articulate and commit to a set of outputs.
Accountability	The extent to which Aurizon Network is accountable for its performance.

In accordance with the ToR, we have undertaken the following in reviewing Aurizon Network's proposal:

- Considered ToR tasks on a system-by-system basis, as well as with respect to the aggregate of all systems. We have done this because Aurizon Network charges for access on a system-by-system basis. As applicable to the task, we have also considered the UT3 period (FY2010 to FY2013), UT4 period (FY2014 to FY2017) and UT5 period; we have done this on both a yearly and aggregate basis.
- Considered the ToR tasks in the context of the need to prioritise maintenance cost categories and their associated maintenance products. This prioritisation informs the depth of analysis we have undertaken for a particular maintenance cost category and its associated maintenance products.

1.2 Aurizon Network proposal

Aurizon Network's proposed resurfacing scopes over UT5 are driven by linking its tonnage forecasts to the amount of resurfacing that needs to occur. Accordingly, understanding Aurizon Network's volume forecasts is the first step for us to determine if resurfacing scopes are prudent.

The volume forecasts that Aurizon Network has proposed for UT5 are set out in Table 2.

Table 2 – Aurizon Network's proposed UT5 volume forecasts[1]

Resurfacing (million tonnes)	FY2018	FY2019	FY2020	FY2021
Blackwater	69.9	71.3	71.3	71.3
Goonyella	120.3	120.3	120.3	120.3
Moura	10.2	10.2	10.2	10.2
Newlands	9.2	9.2	9.2	9.2
GAP	16.2	17.5	17.5	17.5
Total	**225.8**	**228.5**	**228.5**	**228.5**

In Aurizon Network's forecast, Goonyella and Moura volumes, 120.3 million tonnes per annum (mtpa) mtpa and 10.2 mtpa respectively, will remain flat. Volumes for Blackwater and GAP will increase from FY2018 to FY2019 (6.9 mtpa to 71.3 mtpa for Blackwater, and 16.2 mtpa to 17.5 mtpa for GAP) and then remain flat over the rest of UT5. Overall, Aurizon Network has assumed that total tonnes across the CQCN will be 225.8 mtpa in FY2018, increase slightly to 228.5 mtpa, and then become flat over the UT5 period.

The volume forecasts that Aurizon Network has proposed align with Aurizon Network's proposed resurfacing scopes. Resurfacing includes both mechanised track resurfacing for main lines and turnouts, but does not include resurfacing that follows ballast-undercutting or structure-related activities. Table 3 presents Aurizon Network's proposed resurfacing scopes, on an aggregated and system-by-system basis, for the UT5 period.

Table 3 – Aurizon Network's proposed UT5 resurfacing scopes[2]

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Mainline scope (km)	2,084	2,108	2,108	2,108	8,408 [3]
Blackwater (km)	896	914	914	914	3,638
Goonyella (km)	966	966	966	966	3,866
GAP/Newlands (km)	156	162	162	162	642
Moura (km)	66	66	66	66	264
Turnout scope (no.)	379	382	382	382	1,525
Blackwater (no.)	173	175	175	175	698
Goonyella (no.)	181	181	181	181	724
GAP/Newlands (no.)	18	19	19	19	75

[1] Aurizon Network UT5 Submission

[2] Total volumes source: Excel model 170713 - RFI - UT5 Maintenance_AN.xlsx worksheet 1_Tab 6

[3] Number does not add up due to rounding.

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Moura (no.)	7	7	7	7	28

The overall scope for mainline resurfacing is 2,084 km in FY2018; it increases to 2,108 km from FY2019 onwards. We observe a similar trend for turnout resurfacing. The overall scope is 379 turnouts in FY2018, and increases to 382 turnouts in FY2019. The turnout scope remains at this level over the balance of the UT5 period.

Table 4 shows Aurizon Network forecasts aggregated resurfacing costs, covering mainline and turnout resurfacing activities which total $95.6 million (FY2015 base year). We understand that Aurizon Network prepared this forecast using a top-down approach based on its historic costs and volumes.

Table 4 – Aurizon Network's proposed UT5 resurfacing forecasts ($FY2015) [4]

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Mainlines	$19,341,917	$19,744,349	$20,111,134	$20,173,547	**$79,370,947**
Turnouts	$3,961,597	$4,044,023	$4,119,148	$4,131,931	**$16,256,699**
Total	**$23,303,515**	**$23,788,373**	**$24,230,281**	**$24,305,478**	**$95,627,646**[5]

1.3 QCA comparative volume forecasts

Table 5 shows the alternate UT5 volume forecasts independently prepared for the QCA. We note that the forecasts developed by the QCA are consistently higher than Aurizon Network's forecasts over the UT5 period, with increasing variance from year to year. In FY2018, the QCA's forecast is 5.5% higher than Aurizon Network's forecast. By FY2021, the difference between these comparative estimates and those of Aurizon Network is 16.3%.

Table 5 – QCA comparative UT5 volume forecasts[6]

Volumes (mtpa)	FY2018	FY2019	FY2020	FY2021
Blackwater	68.4	69.6	70.6	70.6
Goonyella	128.3	132.0	133.8	133.8
Moura	14.1	17.3	18.3	18.3
Newlands	11.7	14.2	14.2	14.2
GAP	15.9	18.9	23.9	28.9
Total	**238.3**	**251.9**	**260.7**	**265.7**
Total (Aurizon Network)	225.8	228.5	228.5	228.5

[4] Refer Excel model *Maintenance UT5 Cost Build - Demonstrating Aurizon Network Efficient Cost_v9.* Total and split costs retrieved from 'Total NMP' worksheet, cell D71:G74.

[5] Number does not add due to rounding

[6] As provided by QCA staff on 28 June 2017

Volumes (mtpa)	FY2018	FY2019	FY2020	FY2021
% variance based on Aurizon Network forecasts	5.5%	10.2%	14.1%	16.3%

As a comparison to the Aurizon Network proposal, the alternate volume forecasts developed by the QCA assumed an increase in volumes each year in UT5 for all CQCN systems except Blackwater. Assuming a nominal ±20% variance as a guide on assessing the reasonableness of a forecast, we consider the Aurizon Network proposed UT5 volume forecast tonnages (refer Table 2) as reasonable, given the variance between the Aurizon network proposal and the QCA forecasts are within this nominal range. We have therefore used the Aurizon Network tonnage volumes in our modelling to allow direct comparison between our forecast costs and Aurizon Network's forecast costs.

1.4 Summary of analysis of resurfacing scopes and costs

1.4.1 Scopes

Aurizon Network has presented a stable program of resurfacing indicating that the network has no resurfacing deficit. Hence, no concerted catch up is required and a standard analysis that links tonnage to scopes is sufficient to assess the prudency of the costs.

Aurizon Network's UT5 resurfacing program reflects a return period for resurfacing of 40 million gross tonnes (MGT), as per Aurizon Network's Asset Maintenance and Renewals Policy (AMRP). This is a reasonable return period for a railway of this type, carrying 26.5 Tonne per Axle Load (TAL) on a narrow-gauge network. We have based this finding from our experience with South African Railways (now Transnet).

In our view, Transnet's infrastructure is comparable with Aurizon Network's infrastructure because the former:

- is a heavy-haul narrow-gauge network carrying similar axle loads as Aurizon Network, and allows for both electric and diesel haulage
- operates under similar climatic conditions as Aurizon Network
- has similar native soil types
- has similar terrain

Accordingly, it is appropriate for us to refer to Transnet's operational decision-making practices as a comparable reference point to inform us if Aurizon Network's proposed resurfacing scopes reflect prudent below-rail practices.

Transnet adopts an intervention rate for resurfacing based on the following formulae: $\frac{48}{sqrt(MGT)}$. [7]

Using this formula for Aurizon Network's parameters for each CQCN below-rail system, the intervention rates[8], from Aurizon Network's AMRP, of 50 MGT for mainline resurfacing and 80 MGT for turnout resurfacing are, in our view, prudent on both a system-by-system basis and in aggregate. The overall scopes we derived using Transnet's empirical formula[9] are within our nominal ±20% range for assessing

[7] This formula is from South African Railways' (now Transnet) operational-related documentation, which are not publically available. We can provide a copy of this document to the QCA on a confidential basis.

[8] Aurizon Network's AMRP, page 7

[9] We note that the South African Railways (now Transnet) formula is appropriate for a wide tonnage range. However, Aurizon Network's blanket assumption of 50 MGT is, in our view, not appropriate for very low-tonnage networks.

reasonableness of Aurizon Network's proposed scopes. We therefore accept Aurizon Network's proposed resurfacing mainline and turnout scopes, as set out in Table 3 above, as being prudent.

1.4.2 Productivity

In response to our RFIs, Aurizon Network provided historical and forecast productivity data for the MMA503 to MMA507. The MMA503 to MMA507 are five high-production resurfacing machines that have been in use for mainline resurfacing from just before the commencement of FY2018. Although Aurizon Network's UT5 Maintenance Allowance presentation[10] states these machines can achieve 1,300 m/h, Aurizon Network staff advised on 28 July 2017, at a resurfacing-related meeting with GHD and QCA staff, that a more appropriate rate is 1,200 m/h.

Aurizon Network's UT5 Maintenance Allowance presentation also states that the MMA070 (also known as the CAT 71), one of the older-generation high-production machines, which is still being used for mainline resurfacing, can achieve productivity of 833 m/h.[11] In some instances, due to access issues, Aurizon Network uses the Unimat 500, 501 and 502 resurfacing machines for mainline-resurfacing works.

For turnout resurfacing, Aurizon Network uses the Unimat 500, 501 and 502 resurfacing machines only. No productivity data for the turnout-resurfacing practices were provided by Aurizon Network.

We have given consideration as to whether Aurizon Network's proposed mainline resurfacing scopes necessitated the purchase of five resurfacing machines. In our view, the UT5 mainline scopes for resurfacing using the Aurizon Network proposed volume forecasts can be met with four machines (when including some buffer capacity to address downtime to accommodate machine servicing). We present our calculations for this position below.

We determined the estimate of four machines by the following formula:

[UT5 mainline resurfacing scopes (km) / Business case projected maximum scopes (in 2028)] x Number of machines required (as per the business case) =

2,108 km[12] / 3,500 km x 5 machines = 3.01 machines

Using the maximum value of the alternate volume forecasts generated for QCA of 265.7 mtpa, we obtain a figure of 3.50 machines, which means four machines will be required to meet the UT5 scopes. This estimate of four machines recognises that 0.50 units of a machine serve as buffer capacity for the CQCN, to address downtime associated with some of the machines requiring servicing during UT5.

We note that Aurizon Network's bottom-up cost models and historical data imply the mainline-resurfacing productivity forecast for UT5 is 900 m/h, which includes the slower turnout tampers. In our view, the productivity rates associated with the turnout tampers should not be used to inform the main line production rates. From our analysis, we have determined that using four new high-production resurfacing machines would be more than sufficient for delivering the UT5 mainline scopes. We acknowledge that the Unimat 500 to 502 machines will be required for occasional spot resurfacing, but focussing on the resurfacing of turnouts. However, these form a minor component of the number of shifts required.

Accordingly, we have not accepted Aurizon Network's forecast average productivity rate of 900 m/h for UT5, assuming our approach of using the new high-production machines only. Rather, we consider it appropriate to use the rate of 1,200 m/h advised by Aurizon Network for the new high production machines. This is in line

[10] UT5 Maintenance Allowance presentation, page 22

[11] UT5 Maintenance Allowance presentation, page 22

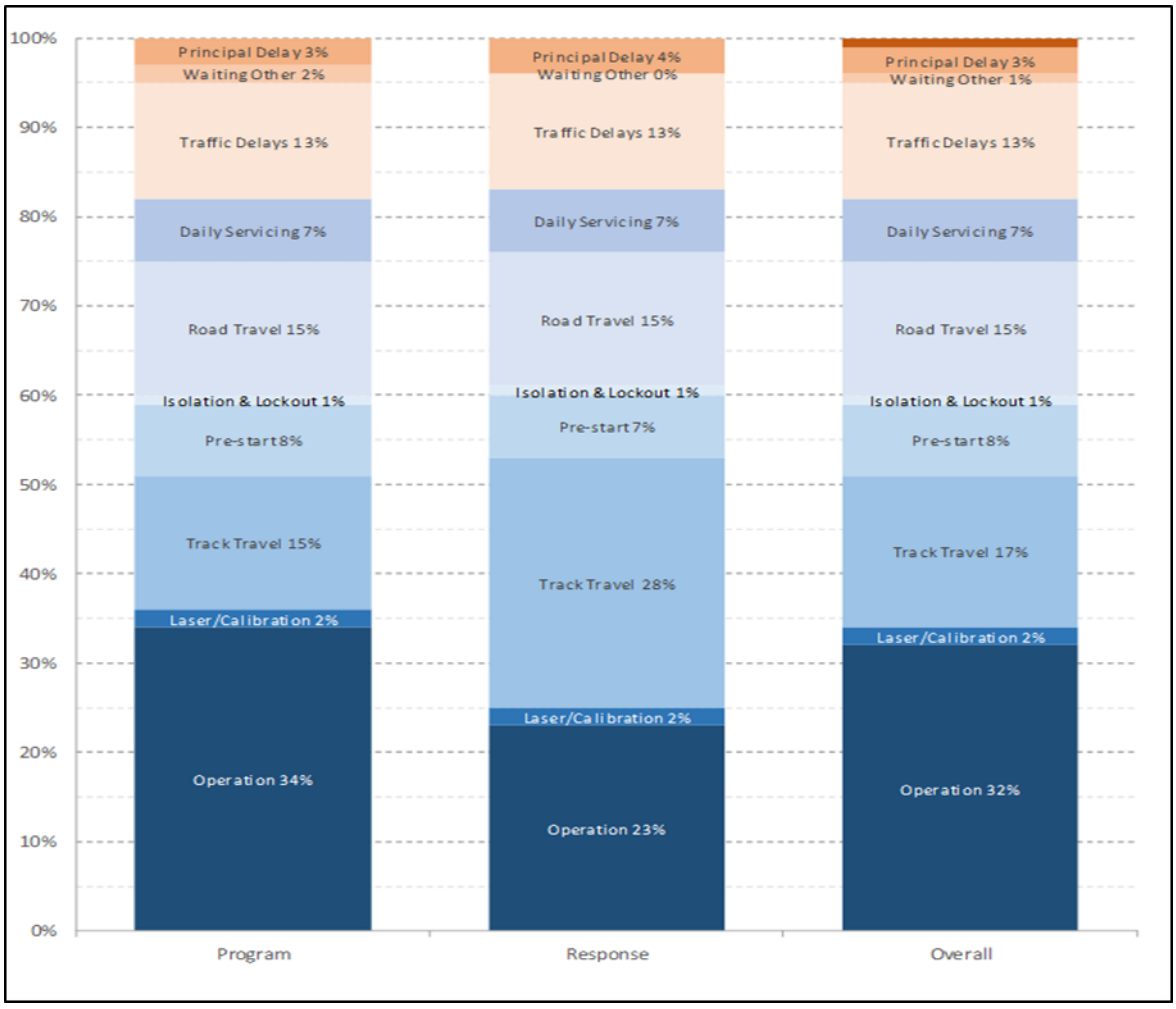
[12] Using Aurizon Network's volume forecasts and proposed maximum scope

with our understanding of the average reasonably achievable production rate of the machines used by Aurizon Network if the highest production rate machines are employed in preference to lower production rate machines. Further, our analysis of costs, including depreciation[13] is based on use of four high production resurfacing machines rather than five.

We also investigated Aurizon Network's use of shift time to make productive use of the new high-production resurfacing machines. In reviewing Aurizon Network's proposal, it was clear that a distinction had to be drawn between 'shift' and 'possession'. To clarify the difference, we have adopted the following definitions:

- **Shift** is the time that staff are available for work activities i.e. the nominated shift time and will be the possession time plus time for pre and post possession activities such as road travel for crew, on track travel from depot to site and back, machine service and crew briefing
- **Possession** is a track occupancy for engineering works, from the time the track is clear of the last train (as advised from Train Control) to the time the track occupancy is handed back to the control room at completion of work.

Aurizon Network's historical data indicates that 32.0% of shift time (see third bar of Figure 1) can be employed for productive use (i.e. Operation).



[13] Importantly, we note that our estimate of depreciation is based on the depreciated actual cost (DAC) estimates supplied to us by the QCA. These costs were provided to us on nominal terms; we have not converted the numbers into real $FY2015 terms, as the QCA instructed us to keep these numbers in the same manner as provided to us.

Figure 1 – Aurizon Network's activities during a resurfacing shift[14]

We have reviewed the productive hours rate proposed by Aurizon Network and consider, based on our rail experience and knowledge, that Aurizon Network has allocated too much unproductive time to Principal Delays (e.g. delays triggered because of response times from Train Control), Traffic Delays (e.g. late running of revenue trains causing possessions to start late), Daily Servicing (e.g. vehicle start-up and pre-work diagnostics) and Pre-Start (safety briefing to resurfacing crews) time.

Table 6 compares our positions in contrast with those of Aurizon Network; we have based our analysis on a nominal 9.5-hour shift as an example to draw distinctions between our positions on, in particular, Principal Delays, Traffic Delays, Daily Servicing and Pre-Start times against those of Aurizon Network. We have used red font where our recommendations are significantly different from Aurizon Network's historical data.

Table 6 – GHD's recommended productive resurfacing time in a nominal 9.5-hour shift

Factor	Aurizon Network's (minutes)	GHD recommendation (minutes)	Possession (GHD's view)	Non-possession (GHD's view)
Principal delay	15	10		10
Waiting other	6	6	6	
Traffic delay	74+	45	45	
Daily servicing	40	24		24
Road travel	91	91		91
Isolation/lockout	8	8	8	
Pre-start	46	20		20
Track travel	97	97	45	52*
Laser and calibration	11	15	15	
Operation	182	254	254	
Total	**570**	**570**	373	197
% of shift time that reflects productive use of machines	**32.0%**	**44.6%**	-	-

Notes:

* Allows for 26 minutes of travel to and from the nearest depot to the nearest passing loop to the worksite, at 60 km/h (80 km/h is the manufacture's quoted speed).

+ The delay is assumed to be during the possession; else, the delay would not be registered as a delay. Some allowance for Traffic Delays is reasonable, but we consider 74 minutes on average to be unreasonable.

[14] QCA staff's e-mail from George Passmore to GHD's Hiresh Devaser on 2 August 2017, *Resurfacing Time Code Allocation*, p. 2

Aurizon Network's productive use of a shift is 182 minutes / 570 minutes = 32.0 %. In comparison, our proposed figure is 254 minutes / 570 minutes = 44.6 %. We have adopted a productive time of 44.6% during a 9.5 hours shift for the purposes of generating our alternate forecasts.

1.4.3 Cumulative productivity impacts

When combining the impacts of:

1 Lifting the machine speed from an average of 900 m/h to 1,200 m/h

2 Reducing the number of high speed machines required from five to four

3 Lifting the productive-use-of-a-shift percentage from 32.0% to 44.6%,

the number of shifts required to deliver the resurfacing scopes can be substantially reduced. This is critical for understanding why our assessed efficient costs for resurfacing, as set out later in this report, differ from Aurizon Network's proposed UT5 costs.

1.4.4 Costs

We have reviewed costs for Aurizon Network's proposals for mainline resurfacing separately from turnout resurfacing. As part of the RFI process, Aurizon Network provided bottom-up cost models for its proposed resurfacing scopes over the four UT5 years. The bottom-up cost models include a labour rate and plant rate for each UT5 year. They also include information on how many labourers are required per shift and how many machines are needed to meet the mainline/turnout scope for the year in question. These labour and plant rates were also expressed on a per-shift basis in the bottom-up cost models. The per-shift labour and plant rates were multiplied by the total number of shifts for each coal system, to derive a total resurfacing cost, on a mainline and turnout basis, in each UT5 year on a system-by-system basis.

We have assessed the labour rates (starting at $167/h in FY2015, including superannuation, on-costs and other insurances), and found them to be efficient. We did this by comparing the $167/h rate with the enterprise bargaining agreement (including terms of escalation) that Aurizon (the Group) has for infrastructure-maintenance employees. We found the rates comparable with our estimate from industry (see 5.2.1). However, there was a slight error in Aurizon Network's model, in that it has used FY2016 rates, rather than FY2015 rates, for its labour costs. The correct rate to use is $164/h (FY2015); we have used this figure in our cost model. Finally, applying our knowledge and experience of efficient rail industry practices, we found the number of labourers per shift, for both mainline resurfacing and turnout resurfacing, to be reasonable.

Plant rates are divided into costs for consumables and for depreciation. We have not discovered evidence to indicate that that Aurizon Network's cost estimate of consumables (fuel and ballast for resurfacing practices) is efficient. With respect to depreciation, we have used the QCA's depreciation amounts from the roll-forward model the QCA created for all the maintenance equipment that Aurizon Network uses for resurfacing (and other maintenance activities). We understand that the QCA model reflects Aurizon Network's actual regulatory depreciation costs (or DAC) in relation to its resurfacing maintenance equipment. The QCA's estimates are lower than Aurizon Network's figures. Accordingly, our overall proposed plant rate is slightly lower than Aurizon Network's rate.

The steps that we have undertaken to determine efficient UT5 costs for mainline resurfacing are as follows:

1 Make UT5 forecast productivity rate 1,200 m/h, as compare to Aurizon Network's 900 m/h

2 Make UT5 forecast use of productive time within a shift 44.6%, as opposed to Aurizon Network's 32.0%

3 Using the information in steps 1 and 2, determine the number of shifts and machines required to meet the maintenance scopes for each system in each year

4 Apply the recommended labour rates and plant rates (revised to incorporate the QCA's determined regulatory depreciation) to the number of shifts for each system in each year

5 Determine a cost per system per year, and compare our figures with those of Aurizon Network.

The impact on Aurizon Network's maintenance budget for mainline resurfacing from Steps 1 to 5 is significant, representing a more than 30% reduction in proposed costs over UT5. We acknowledge the gravity of our recommendation on Aurizon Network's proposed costs.

For turnout resurfacing, we did not receive productivity data from Aurizon Network and have no way of verifying whether the associated practices are efficient. Although our conclusions on *mainline* resurfacing point to practices being inefficient, we have seen no evidence to suggest that Aurizon Network's turnout resurfacing practices are inefficient. As such we have only considered modest changes to Aurizon Network's cost proposal for turnout resurfacing to accommodate our use of Aurizon Network's proposed labour rate (with a minor escalation-related adjustment) and QCA depreciation rate. Taking these into account our estimate of efficient turnout costs is slightly higher than Aurizon Network's figures.

We have not presented our recommendation on turnout-resurfacing costs in a separate table, given the difference between our proposed cost reductions to Aurizon Network's estimates are marginal. Table 7 consolidates the impacts of our productivity and cost-related recommendations on Aurizon Network's mainline and turnout resurfacing costs.

Table 7 – Aurizon Network proposed and GHD assessed efficient UT5 resurfacing costs[15]

Resurfacing ($FY2015)	FY2018	FY2019	FY2020	FY2021	Total
Aurizon Network	$23,303,515	$23,788,373	$24,230,281	$24,305,478	$95,627,646
GHD	$15,036,449	$15,134,224	$15,144,248	$15,130,239	$60,445,160
Adjustment	**($8,267,066)**	**($8,654,149)**	**($9,086,033)**	**($9,175,239)**	**($35,182,486)**
Adjustment (%)	**(35%)**	**(36%)**	**(37%)**	**(38%)**	**(37%)**

Across the CQCN for the UT5 period, we assess that prudent and efficient resurfacing costs are $60.4 million ($FY2015). This represents a $35.2 million dollar reduction (or a 37% reduction) to Aurizon Network's proposed costs of $95.6 million. System-by-system reductions are presented in Chapter 5 of this mini-report.

The above assessment of resurfacing costs takes into account use of four MMAB507 resurfacing machines which we consider is adequate for the proposed scope. As such, we have included depreciation for four machines only in our assessment of costs. The incremental costs to recover the depreciation costs of the fifth set of resurfacing machines (e.g. MMA/B507) purchased by Aurizon Network are shown in Table 8.

Table 8 - Depreciation costs for fifth set of new resurfacing machines

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
GHD ($FY2015)	$1,170,990	$1,171,913	$1,161,889	$1,175,898	**$4,680,690**

[15] Numbers may not add due to rounding

2. Resurfacing description and activities

Rail resurfacing (or tamping) is the maintenance treatment to correct geometry issues associated with track alignment. It is the physical re-compacting of the upper layers of the ballast to provide a level surface and to increase the stability of the bearing surface for sleepers and rail, with realignment of the track vertically and horizontally.

Tamping is undertaken as the first step for dealing with track or ballast integrity deficiencies. Aurizon Network's proposed program assumes a smooth trajectory of track geometry deterioration, in which predictability is present.

Resurfacing work is integral to the safe and efficient operation of a ballasted track rail system, and is required on a cyclic-maintenance basis (in conjunction with inspections and recording data) and a post-track-construction basis. Track resurfacing requirements can be affected by rainfall, track structure/foundation condition, axle load, and line speed and traffic volumes. Any decision on whether tamping is required to be undertaken is based on inspection and a review of field performance data of the line section and/or consideration of the tonnage threshold.

Resurfacing is undertaken on Aurizon Network's main lines, including turnouts. The process involves the following resurfacing products:

- C19[16] Mechanised Resurfacing – Main Line
- C23 Mechanised Resurfacing - Turnouts
- C49 Stone blowing (not undertaken during UT5).

Maintenance tamping of turnouts is generally undertaken at a lower frequency than plain track particularly with concrete bearers supporting the turnout. Such a structure is more rigid than plain track, simply because the bearers are longer and heavier carrying four rails rather than two. These longer and heavier bearers reduce the pressure on the ballast compared to bearers used for plain track, which in turn reduces the deterioration of the ballast bed and alignment. The Aurizon Network intervention rate for turnouts nominated in the *Asset Maintenance and Renewals Policy* is 80 MGT rather than 50 MGT for plain track in recognition of the more rigid turnout.

2.1 Description of the resurfacing process

Over time, rail track will move from its design position due to a number of factors. Such factors include forces applied by rolling stock, the degradation of the ballast supporting the track, and movement in the underlying formation arising from train passage and ground settlement. This movement produces irregularities in the track alignment, which exaggerate the loading applied to the track and turnouts. This exaggerated track loading, if not removed, will cause further and potentially rapid deterioration of ballast. This, in the first instance, will cause rough running of the trains, which may then require the imposition of speed restrictions to limit further deterioration and prevent possible derailment.

[16] The 'C' refers to the activity codes that Aurizon Network has assigned to its various maintenance activities.

Resurfacing production works are undertaken either as part of cyclic tamping requirements associated with maintenance regimes, post construction/track relaying and/or re-alignment activities.

The process of mechanised resurfacing involves the use of 'on track' tamping/resurfacing machines. These machines lift and align the track then pack/tamp the ballast to the track's 'designed' position.

Machines used for this type of work can vary; however, regardless of equipment type or manufacturer, the process consists of the following generic steps:

- the lifting and lining unit moves rail and sleepers beneath the tamping unit into the correct vertical and horizontal position
- the tamping units drive vibrating tines into the ballast on both sides of a set of sleepers until squeezing depth is achieved
- the vibrating tines are pushed together to pack ballast under the lifted sleepers,
- the tamping unit retracts the tines, and the track is released by the lifting and lining unit
- the machine moves to the next sleeper set and the cycle repeats

The resurfacing process creates an obstruction to normal rail traffic. Therefore, resurfacing activities are typically planned well in advance of the actual site works taking place. Resurfacing requires a sectional block possession, which closes a line to normal traffic so resurfacing works can be undertaken. The resurfacing program requires active co-ordination between relevant network planning, operations, network engineering, and maintenance stakeholders within Aurizon Network. It also requires Aurizon Network to liaise closely with rail operators, coal customers and related supply chain operators to finalise the maintenance and possession planning which underpins its network maintenance operations.

The timing of the resurfacing works will differ from one railway to another depending on a variety of factors including traffic density, crossing loops spacing and daily temperature range. There may be requirement in summer months to conduct work at night as the rail temperature during the day will exceed the neutral temperature. Resurfacing the track above neutral temperature carries a significant risk of track buckling and is generally prohibited.

Fundamental tasks associated with resurfacing activities include:

- Review of track recording car data output
- Application for and arrangement of line blockage/track possession
- Coordination with other site activities, if work is to be undertaken within a shared possession or work site, site survey and set out, as required, prior to the resurfacing activity
- Travel by rail to the site of work, including coordination and reservation of time slot and programing
- Undertake the actual resurfacing works
- At completion of the works, the inspection of the work site, reconnection of signalling and electrification bonds, validation of overhead wiring position in relation to the centreline of the modified track
- Implementation of any agreed, (in consultation with operational stakeholders), temporary speed restrictions
- Hand back of the track into operation
- Follow up works and/or removal of speed restrictions

The above activities do not include the requisite rostering, annual planning, forecasting and spend activities undertaken and incurred by Aurizon Network.

Aurizon Network's work scope for UT5 is an estimate based on freight tonnage anticipated and an applied 50 MGT and 80 MGT mainline and turnout intervention respectively.

Aurizon Network only allows two track recording runs per annum, and although the output may be used to guide resurfacing works the planning will predominantly be based on forecasts with the recoding car used to confirm quality of work undertaken.

2.2 Resurfacing activities in the context of the network management principles

In the course of the engagement, we recognised that Aurizon Network's resurfacing practices are not, in our opinion, consistent with the network-management practices of a railway that is focussed on running a preventative-based regime for maintenance. We set out our reasons for arriving at this position in the following paragraphs together with a description of how we have assessed Aurizon Network's use of shift time to undertake productive work with its resurfacing equipment.

The *Network Management Principles* contained in Schedule G of the 2016 AU allow for planned possessions to be included in the Master Train Plan (MTP) at one to three months' notice. Clause 3.2 of Schedule G makes it clear that any MTP modification must not cause a planned possession to "not be met".

Clause 4 of Schedule G refers to Intermediate Train Plans (ITPs), which are a development of the MTP and are scheduled 48 hours prior to day of operations. Daily Train Plans (DTPs) are the final step in the planning process for operations; they are finalised in the day before the day of operations. Clause 5.5 (a) of Schedule G states that a DTP variation may not cause a planned possession not to be met.

Given the above, our interpretation of Schedule G of the 2016 AU is that any alteration to the MTP, ITP and DTP **must not cause a planned possession to not be met (i.e. a train service should never interfere with a planned possession)**. This requirement is consistent with the practices of a railway that is focussed on a preventative-maintenance regime. However, in our view, Aurizon Network does not always abide by this requirement; resulting in 13% of shift time being lost to revenue trains (and likely to be more than 13% impact on possession times); This was corroborated in our meetings with Aurizon Network staff, who indicated that revenue trains are sometimes prioritised over resurfacing activities (which would be planned possessions) on the day of operations.

In response to our queries about its practices of appearing to prioritise revenue trains over planned possessions, Aurizon Network said that 'healthy/unhealthy possessions are treated the same as train services'. Aurizon Network's response focused on the discretion that the Train Controller has in the day of operations. In particular, Aurizon Network identified the provision in Schedule G that allowed the Train Controller to give preference to late trains (caused by below-rail delays) over other train services if the Train Controller believes that giving such preference:

" *… would be consistent with 'critical objectives of the (late) Trains in question, and that it will result in less aggregated consequential delays to other Trains than otherwise would be the case.*"[17]

From our assessment of Aurizon Network's response, we consider that Aurizon Network's position is inconsistent with what Schedule G seeks to achieve for planned possessions. In our view, it is absolutely clear that Schedule G provides that planned possessions are protected; Schedule G requires that the MTP,

[17] E-mail response from Aurizon Network staff to QCA staff and GHD, 7 August 2017

ITP and DTP cannot be amended to accommodate changes in the times or quantity of train services if doing so means a planned possession is not met.

Given the above, it makes sense for the logic of planned possessions being ‘untouchable’ to apply to the day of operations. In this context, we do not accept Aurizon Network’s view that a planned possession should be treated in the same way as Train Services in the day of operations. In particular, we consider that Train Services should be scheduled around planned possessions.

Even if a planned possession has commenced late due to below-rail delays or due to other reasons, Aurizon Network has the discretion, in our view, to change the timing of Train Services to accommodate the requirement that a ‘planned possession must not be met’. The completion of planned possessions, according to plan, should usually be prioritised over the running of Train Services.

3. Aurizon Network UT4 resurfacing program

3.1 QCA approval of UT4

In approving the UT4 resurfacing program, the QCA considered the scope and direct maintenance expenditure proposed by Aurizon Network to be reasonable, as long as Aurizon Network delivered on the maintenance proposed scope for the UT4 period.

In approving the expenditure, the QCA took account of

"… the unit cost (i.e. the direct maintenance cost per gtk) in each year of the 2014 DAU period is lower than that of the UT3 period, and is forecast to decline over the 2014 DAU period … [and] … productivity improvements proposed by Aurizon Network for the 2014 DAU." [18]

However, the QCA noted that the maintenance efficiency was

"… strongly dependent on Aurizon Network's actual performance in the 2014 DAU period[19]."

The QCA noted that Aurizon Network under-delivered on the UT3 maintenance scope and considered this outcome inefficient given the actual maintenance expenditure in UT3 was close to the approved allowance.

3.2 UT4 forecast resurfacing scope and costs

Aurizon Network's resurfacing scope forecast for the regulatory period UT4 is shown in Table 9.

Table 9 –UT4 forecast resurfacing scope

Resurfacing	FY2014	FY2015	FY2016	FY2017	Total
Mainline scope (km)	1,731	1,946	2,231	2,376	8,284
Turnout scope (no.)	336	372	395	419	1,522

The Aurizon Network proposed budget for its UT4 resurfacing scope for main line and turnouts is shown in Table 10.

Table 10 –UT4 forecast resurfacing costs ($FY2012 million)

Resurfacing	FY2014	FY2015	FY2016	FY2017	Total
Aurizon Network proposal[20]	19.0	19.0	20.9	20.9	79.8
QCA final decision[21]	19.3	19.0	18.4	20.8	77.5

[18] QCA, Draft Decision: Aurizon Network 2014 Draft Access Undertaking - Maximum Allowable Revenue, September 2014, section 5.2.3, p. 110

[19] Ibid., p. 111

[20] QCA, Aurizon Network 2014 Access Undertaking - Volume IV - Maximum Allowable Revenue, April 2016, section 23.1.1, Table 57, p. 103

[21] Ibid., section 23.2.8, Table 67, p. 117 - values based on adjustments to Aurizon Network direct maintenance costs for revised volumes

3.3 UT4 performance

Table 11 shows the actual performance reported for period UT4 compared with the forecast scope for UT4 (Table 9). We note that stone blowing was discontinued from FY2016. Forecasts and actual costs for UT4 (FY2015) are shown in Table 12.

Table 11 –Variance of scope resurfacing

Resurfacing	FY2014	FY2015	FY2016	FY2017	Total
Forecast Main line scope (km) from Table 9	1,731	1,946	2,231	2,376	8,284
Forecast Main line stone blowing (km)	150	151	0	0	301
Forecast Main line resurfacing and stone blowing	1,881	2,097	2,231	2,376	8,586
Main line actual (km)	1,706	1,988	2,357	2,376	8,427
Main line actual stone blowing (km)	176	158	0	0	334
Main line actual resurfacing and stone blowing	1,882	2,146	2,357	2,376	8,761
Variance Actual to Scope km	1	49	126	0	176
Variance to forecast %	0.05	2.34	5.65	0	2.05
Turnout forecast scope (no.)	336	372	395	419	1,522
Turnout actual scope (no.)	398	392	428	419	1,637
Variance to forecast (No)	62	20	33	0	115
Variance to forecast %	18.45	5.37	8.35	0	7.56

During the first three years of UT4, Aurizon Network's actual production for both main line and turnouts exceeded the scope previously allowed but, significantly, the actual works for 2017 were as forecast. The reason for the exceedance of the forecast for the first three years of UT4 is a combination of the retention of existing resurfacing equipment and the phased introduction of the new high capacity units.

Given the higher output of the new resurfacing units, we consider that that Aurizon Network has improved the efficiency from UT3 to the end of UT4, which is to be expected after the expenditure of a significant sum on new equipment. It can be noted in Table 12 that the main line tamping actual in UT3 was 892 km below the forecast requirement and that the 477 km of resurfacing above forecast for UT4 did not compensate for the UT3 shortfall.

Table 12 –UT4 actual performance ($FY2015) [22]

Resurfacing	FY2014	FY2015	FY2016	FY2017	Total
Forecast Main line scope (km) from Table 9	1,731	1,946	2,231	2,376	**8,284**
Main line actual (km)	1,706	1,988	2,357	2,376	**8,427**
Main line actual stone blowing (km)	176	158	0	0	**334**
Main line actual costs ($FY2015) [23]	$17,571,129	$18,264,541	$18,314,776	$17,977,363	**$72,127,809**
Main line actual cost / km	$9,336	$8,511	$7,770	$7,566	**$8,233**
Turnout forecast scope (no.)	336	372	395	419	**1,522**
Turnout actual scope (no.)	398	392	428	419	**1,637**
Turnout actual costs ($FY2015)	$1,848,557	$2,888,908	$3,170,171	$3,757,228	**$11,664,865**
Turnout actual cost / turnout	$4,645	$7,370	$7,407	$8,967	**$7,126**

From Table 11, we note that the total amount of resurfacing undertaken during UT4 was in excess of the forecast scope. To understand the maintenance environment for UT4, we have reviewed the forecast and delivered scopes for main line and turnout resurfacing during periods UT3 and UT4, as shown in the following table. Based on Table 12, we note that unit rates for mainline resurfacing improved over most of the UT4 period, beginning at $9,336/km in FY2014 and decreasing to $7,770/km in FY2016.

We consider a prudent scope to be that which will match the forecast tonnage, but not exceed the requirement, while also remaining sufficient to ensure the network does not deteriorate. Exceeding the required scope has no advantage, as the work is not required. Conversely, if the scope is not achieved the danger arises of deterioration, as well as possible asset renewals being required, rather than maintenance.

The aim is therefore to confirm that only work to allow the network to be maintained in a steady state is undertaken against forecast tonnage.

As part of the ToR, GHD was asked to assess Aurizon Network's performance of actual scope achieved against planned scope for the UT3 and UT4 period.

[22] Sourced from Excel model 170713 - RFI- UT5 Maintenance_AN.xlsx worksheets 1_Tab 5 and 1_Tab 6

[23] Including stone blowing

Table 13 –UT3 and UT4 resurfacing (excluding stone blowing) [24]

Activity	UT3					UT4				
	09/10	**10/11**	**11/12**	**12/13**	**Total**	**13/14**	**14/15**	**15/16**	**16/17**	**Total**
Main line forecast (km)	1,462	1,528	1,557	1,646	6,193	1,731	1,946	2,231	2,376	8,285
Main line actual (km)	1,281	1,187	1,103	1,730	5,301	1,706	1,988	2,357	2,376	8,427
Turnouts forecast (no.)	290	295	299	310	1,194	336	372	395	419	1,522
Turnouts actual (no.)	411	315	259	469	1,454	398	392	428	419	1,637

We note that Aurizon Network was behind its forecast main line resurfacing volumes during the first three years of UT3, and through rescheduling and planning, moved to address the shortfall in FY2013 through increased resurfacing activity, which extended into the UT4 period.

For the entire UT3-4 period, main line resurfacing completed was 5.2% less than that forecast for the 8-year period, although the completed volume deficit was 21.5% compared to forecast after the first 3 years of UT3. The increased activity from FY2013 had made up most of the shortfall by 2016-17. From Table 11, we note that the increased activity in main line resurfacing resulted in a lower $/km average cost than those years with volumes in line with or less than forecast. The total resurfacing expenditure for UT4 (nominal) was $83,792,675 ($FY2015). The UT4 final decision (in $FY2015) included the following allocations for resurfacing:

Table 14 UT4 allocations for resurfacing ($FY2015)

Financial Year	Expenditure ($FY2015)
2013/14	$ 19.8 M
2014/15	$ 20.3 M
2015/16	$ 19.9 M
2016/17	$ 22.5 M
Total	**$ 82.5 M**

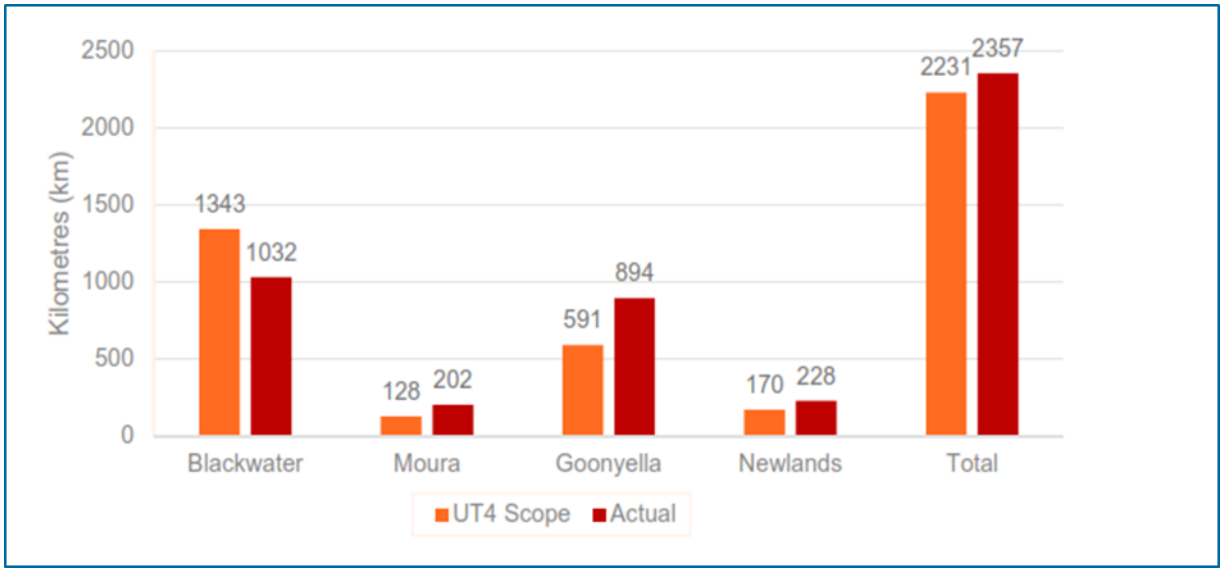
Therefore, Aurizon Network incurred expenditure approximately $1.3 million in excess of the allocation for resurfacing in the QCA UT4 final decision.

3.4 Aurizon Network resurfacing overview of FY2016

In FY2016, Aurizon Network undertook 2,357 km of main line resurfacing across the CQCN, which exceeded its scope target of 2,231 km, representing 5.6% over planned scope.

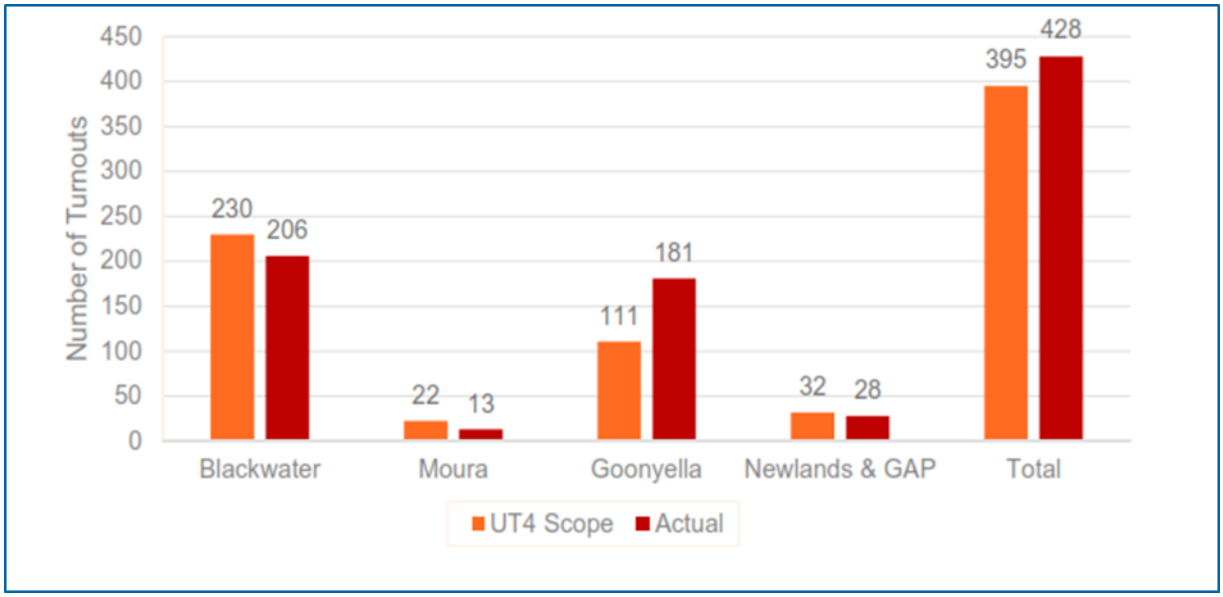
[24] Ibid., worksheet *1_Tab 6*

Figure 2 – FY2016 Mainline resurfacing by system[25]



In FY2016, Aurizon Network resurfaced 428 turnouts across the CQCN, which exceeded its scope target of 395 turnouts. Comparing UT3 and UT4 actual and compared scopes it is probable that the over production in the early years of UT4 was to offset the under production throughout UT3 with the final year of UT4 resurfacing of both main line and turnouts following the forecast

Figure 3 – FY2016 Turnout resurfacing by system[26]



Stone blowing was discontinued during FY2016 due to more effective results achieved with resurfacing. In summary, when comparing the forecast to completed resurfacing works, there is an improvement over the FY2016 period, culminating in an additional 126 km of main line resurfacing and turnout increase of 33 units.

[25] Aurizon Network 2015/16 Maintenance Cost Report, page 12

[26] Aurizon Network 2015/16 Maintenance Cost Report, page 13

In reviewing the FY2016 maintenance costs, Aurizon Network advised that it "…*delivered above the planned scope of works for resurfacing (turnouts) to meet assets' maintenance needs."* [27] We have previously noted that the main line resurfacing volumes during the first three years of UT3 were well behind forecast levels (refer Table 17), and anecdotal advice provided by Aurizon Network indicated that a revised program was planned to address the volume shortfall from FY2013 through to the end of UT4 (FY2017). Consequently, resurfacing volumes in the fourth year of UT3 and UT4 in aggregate were above the forecast volumes to address the backlog.

From our assessment of the planned workload we understand that Aurizon Network intends, through UT5, to undertake resurfacing works consistent with the anticipated throughput tonnages. This reflects that there is no requirement to recover from lost production.

In support of this, we note the statement in the 2016 Advisian report to Aurizon Network as below.

"… Advisian assesses that the Central Queensland Coal Network (CQCN) generally achieved the operational Key Performance Indicators (KPIs) of Below Rail Transit Time (BRTT) and Overall Track Condition Index (OTCI). The only exceptions were marginal exceedances in monthly BRTT on the Blackwater and Moura systems for one month each. There was no exceedance of annual BRTTs … Advisian assesses that there is no evidence to support that the CQCN has deteriorated in excess of what could be reasonably expected for an operational asset over time. Aurizon Network has adopted good operating practice and prudent and effective maintenance and asset replacement policies and practices".

This indicates that the network is to be maintained against forecast volumes, and the UT5 scope proposed by Aurizon Network allows only for maintenance required for forecast volumes and does not include allowance for clearing historic deficits.

[27] Ibid.

4. UT5 proposed resurfacing program

4.1 UT5 resurfacing scope, costs and forecast coal volumes

4.1.1 Volumes

Table 15 presents Aurizon Network's volume forecasts against the comparative volume forecasts developed by the QCA. We have not analysed whether the forecasts presented by both parties are reasonable, as that is not within the scope of our engagement. Rather, we have assessed both sets of volumes to inform our position on what prudent scopes for mainline and turnout resurfacing should be.

Table 15 –Forecast tonnage Aurizon Network/QCA

Forecast tonnage (million tonnes)	FY2018	FY2019	FY2020	FY2021
Blackwater	68.4	69.6	70.6	70.6
Goonyella	128.3	132.0	133.8	133.8
Moura	14.1	17.3	18.3	18.3
Newlands	11.7	14.2	14.2	14.2
GAP	15.9	18.9	23.9	28.9
Total (QCA)	238.3	251.9	260.7	265.7
Total (Aurizon Network)	225.8	228.5	228.5	228.5
% difference (QCA minus Aurizon Network)	5.5%	10.2%	14.1%	16.3%

We note that Aurizon Network projects a flat-line tonnage from FY2019 onwards, whereas the QCA's forecasts show continual tonnage growth over the four-year period.

4.1.2 Using Transnet as a comparator network for our analysis

We have assessed the resurfacing work previously undertaken and the work proposed to be undertaken and made a comparative assessment. We have applied South African Railways' (SAR - now Transnet) empirical formula to determine if the resurfacing (or tamping) frequency for a section is prudent.[28] Due to the high-level nature of the comparison we have undertaken this assessment on a whole-of-system basis and only accounts for the mainline resurfacing works.

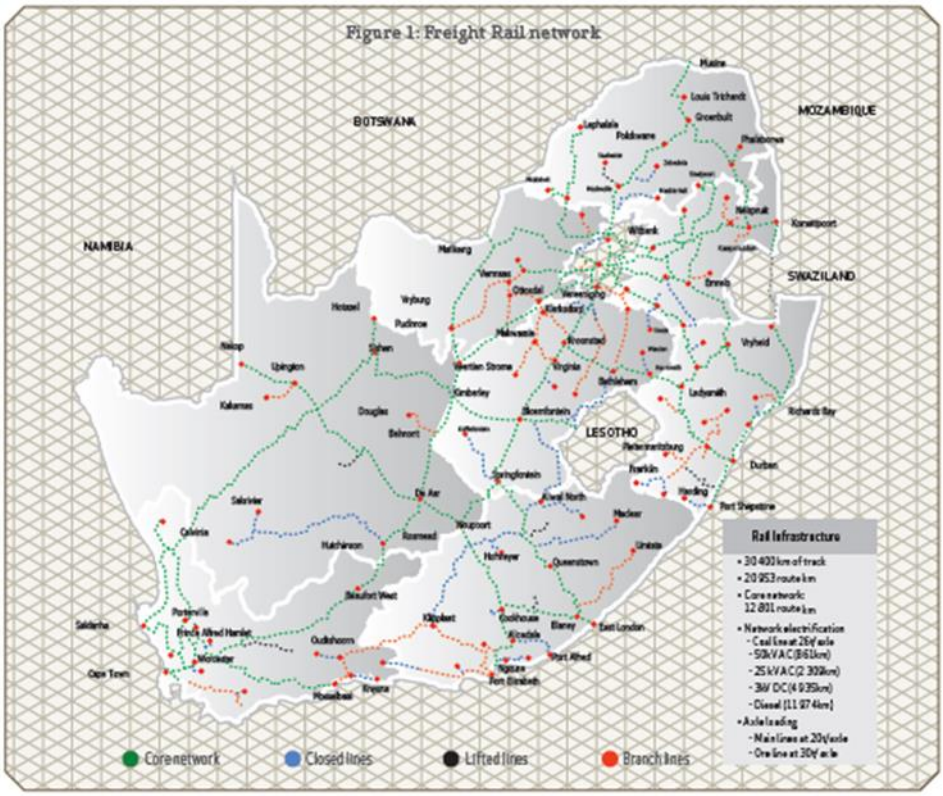
Details of the Transnet below-rail infrastructure are given in Table 19 and Figure 4.

[28] SAR, now under Transnet, operate a narrow gauge railway with similar characteristics to the CQCN, therefore, technical data relating to SAR's is regarded as appropriate for the purposes of comparison

Table 16 –Transnet infrastructure

Factor	Value
Track	
Total kilometres	30,400
Route kilometres	20,953
Core network kilometres	12,801
Traction power	
Coal line at 26 tonne axle loading	
50 kV AC	861 km
25 kV AC	2,309 km
3 kV Dc	4,935 km
Diesel	11,974 km
Axle load	
Mainline	20 tonne
Ore route	30 tonne

Figure 4 – Transnet network



Aurizon Network system volumes

Aurizon Network's total forecast volume throughput of the CQCN for FY2017 is 221.4 million net tonnes per annum (MNTA) rising to 225.7 MNTPA in FY2018[29]. This net tonne figure only relates to the weight of coal carried. The maintenance intervention rate is based on gross tonnes which includes for the mass of locomotives and wagons together with the coal i.e. the mass of a fully loaded train. The gross weight is calculated by applying a factor (averaged from MNTA to million gross tonnes per annum (MGTA) conversion factors) provided in Aurizon Networks system Network Strategic Asset Plan (NSAP) data input sheets).

The system tamping frequencies[30] are:

- track resurfacing – for each 50 MGT passing over a single track
- turnout resurfacing – for each 80 MGT passing over a turnout.

We note that the comparative forecasts developed by the QCA (Table 17) are consistently higher than Aurizon Network's forecasts over the UT5 period, with increasing variance from year to year. In FY2018, the QCA's forecast is 5.5% higher than Aurizon Network's forecast. By FY2021, the difference between the QCA's estimate and Aurizon Network's is 16.3%.

[29] Aurizon Network UT5 Submission Chapter 6 table 2.

[30] Aurizon Network, *Asset Maintenance and Renewal Policy*, doc no. AZN.NA.POL.03.6120.001, ver 2.0, section 1.1, p. 7

Table 17 –Comparative proposed UT5 tonnage volume forecasts developed by QCA

Volumes (Mtpa)	FY2018	FY2019	FY2020	FY2021
Blackwater	68.4	69.6	70.6	70.6
Goonyella	128.3	132.0	133.8	133.8
Moura	14.1	17.3	18.3	18.3
Newlands	11.7	14.2	14.2	14.2
GAPE	15.9	18.9	23.9	28.9
Total (QCA)	238.3	251.9	260.7	265.7
Total (Aurizon Network)	225.8	228.5	228.5	228.5
% difference (QCA minus Aurizon Network)	5.5%	10.2%	14.1%	16.3%

As a comparison to the Aurizon Network proposal, the alternate volume forecasts developed by QCA assumed an increase in volumes each year in UT5 for all CQCN systems except Blackwater. Assuming a nominal ±20% variance as a guide on assessing the reasonableness of a forecast, we consider the Aurizon Network proposed UT5 volume forecast tonnages (refer Table 2) as reasonable, given the variance between the Aurizon Network proposal and the QCA forecasts are within this nominal range.

We have therefore used the Aurizon Network tonnage volumes, and the related resurfacing scopes of resurfacing work to inform our analysis to allow direct comparison between our assessed efficient costs and Aurizon Network's proposed costs.

Network comparison

Transnet developed a proven empirical formula to determine the requirement for resurfacing work using the estimate of tonnage moving over a track. The Transnet network is comparable to the Aurizon Network infrastructure, with similar tonnage levels and the same track gauge.

In Transnet, the tamping cycle is defined by $48/\sqrt{T}$, where T is the gross traffic in million tonnes per annum (Mtpa).[31] Allowance has been made in the calculations in Table 18 of the tamping requirement for track duplication, mine locations across the networks and train operation density.

System Comparison

The following table presents the data and outputs based on the explanatory text above:

[31] Transnet, Concise Information on the Track Structure of the South African Railways, April 1983, section 3.2

Table 18 –Transnet tamping capacity comparison

System	Track length	Throughput 2018 Tnet	Net-gross conversion factor	Throughput gross	Aurizon Network tamping cycle	Comparative tamping cycle		Tamping capacity
	km	mtpa		mtpa	Per year	Months	Per year	Km/year
Blackwater	1,171	69.90	1.59	111.14	2.23	4.55	2.64	773
Goonyella	1,021	120.30	1.57	188.87	3.77	3.50	3.43	876
Moura	315	10.20	1.57	16.01	0.32	11.99	1.00	158
Newlands/ GAPE	311	25.40	1.48	37.59	0.75	7.83	1.53	476
Total	2,818	225.80		353.62	7.07		8.60	2,283

The tamping scope forecast by Aurizon Network in the UT5 submission is 2,084 km per year. Our calculated tamping scope, based on the tabulated data, is 2,283 km per year. We therefore consider, the system tamping cycles proposed by Aurizon Network for the mainline to be prudent.

With respect to turnouts, the CQCN has a turnout, on average, every 3.5 km of track (excluding yards). The turnouts on the main line carry the same tonnages as the main line[32]. Given this, using the mainline scopes (km) as provided Aurizon Network, we derived our estimate of turnout numbers by dividing Aurizon Network's mainline-km scopes by:

1 Dividing the relevant figures by 3.5, to reflect that there is a turnout every 3.5 km of mainline.

2 Dividing the number from Step 1 by the ratio of the intervention rates for turnouts and mainlines (i.e. 80 MGT/50 MGT).

Because of the construction of the turnouts on long bearers, which in turn has a reduced bearing pressure on the ballast, Aurizon Network can resurface turnouts less frequently than the mainline itself. From our rail experience and knowledge we consider that the nominated rate of 80 MGT for turnouts in Aurizon Network's AMRP is a reasonable value to use against the main line rate of 50 MGT.

Summary

The resurfacing scope for UT5 is given in Table 19. We have used an empirical formula developed by Transnet, South Africa, formerly South African Railways, to confirm the scope. The results from application of this formulae align closely with the 50 MGT allowance in the Aurizon Network AMRP document in the anticipated tonnage range.

Table 19 –Resurfacing scope

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Mainline scope (km)	2,084	2,108	2,108	2,108	8,408 [33]
Blackwater (km)	896	914	914	914	3,638

[32] The plain line is the part of the main line without turnouts.

[33] Number does not add up due to rounding.

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Goonyella (km)	966	966	966	966	3,866
Newlands/GAPE (km)	156	162	162	162	642
Moura (km)	66	66	66	66	264
Turnout scope (no.)	379	382	382	382	1,525
Blackwater (no.)	173	175	175	175	698
Goonyella (no.)	181	181	181	181	724
Newlands/GAPE (no.)	18	19	19	19	75
Moura (no.)	7	7	7	7	28

We consider the forecast resurfacing cycle frequencies associated with the UT5 period of 2,084 km in 1,018 hours, when compared with our analysis including factoring for double track areas, and mine location railing inefficiencies to be prudent.

4.2 Possession availability

Table 20 illustrates the possession types and the associated activities undertaken within each type. The possession types include maintenance access windows (MAWs) and System Shutdowns.

Table 20 –Possession types per product activity[34]

Maintenance Access Window only

System Shutdowns & Maintenance Access Window

System Shutdowns Only

Program/Work product	Goonyella	Newlands	Blackwater	Moura
Track-Track Resurfacing-High Production Resurfacing Machine				
Turnouts-Resurfacing-Turnout Tamper				
Points-5.00 Week Inspection-Signal Electricians				
Points-52 Week Inspection-Signal Electricians				
Track-General Track Maintenance Activities-Track Maintenance Gang				
Turnouts-Ballast Undercutting-Excavator				
Rail-Renewal-Track Construction Gang				
Rail-Restressing-Track Construction Gang				

[34] Aurizon Network's 2016 SOPs, page 29

Program/Work product	Goonyella	Newlands	Blackwater	Moura
Track-Ballast Undercutting-RM900				
Track-Ballast Undercutting-Excavator				
Track Upgrade				
Sleeper Replacement				
Turnouts-Renewal-Track Construction Gang				
Points-Renewal-Signals Construction Gang				
Culver barrels-Renewal-Concrete Construction Contractors				
Overhead Maintenance				
Bridge Renewals				
Level Crossings				

4.2.1 MAWs and System Shutdowns

MAWs are used to facilitate access to the network to perform resurfacing works with the intent to minimise the impact to revenue service capacity by reducing the reliance on full System Shutdowns (i.e. all lines blocked to 'non-engineering rail traffic). Whilst MAWs provide more opportunity to perform work with a minimised revenue capacity impact, System Shutdowns are still required to perform some tasks.

Table 21 indicates the number of available System Shutdowns and associated hours available.

Table 21 –System shutdown availability per year

Shutdown duration	Goonyella	Newlands	Blackwater	Moura	Total (shutdown)	Total (hours)
10 hours		4		4	8	80
12 hours	11	6	8	6	31	372
20 hours			2		2	40
24 hours	1				1	24
36 hours	4		2	1	7	252
40 hours			1		1	40
42 hours				1	1	42
60 hours			1		1	60
108 hours		1			1	108
Total					**53**	**1,018**

Table 22 shows that a total of 1,018 System Shutdown hours are not currently used by Aurizon Network to undertake resurfacing works, but are used for ballast undercutting. The table below indicates the number of possessions hours outside of System Shutdowns, MAWS in other words, available to Aurizon Network.

Table 22 –Summary of total MAWs possession time for each system in CQCN[35]

Possession activities	Goonyella (hours)	Newlands/ GAPE (hours)	Blackwater (hours)	Moura (hours)	Total (hours)
Ballast undercutter	929	224	558		1,711
Ballast undercutter (excavator)	536		243	9	788
Culvert renewals			4		4
General track maintenance	945	501	1,567	343	3,356
Points maintenance	339		486		825
Rail renewals	206		218		424
Rail restressing	187		168		355
Track laying	29		101		130
Track resurfacing	971	213	803	191	2,178
Turnout resurfacing	276	66	349	13	704
Total	**4,418**	**1,004**	**4,497**	**556**	**10,475**

Table 22 (above) shows that a total of 2,178 hours are required by Aurizon Network to undertake main line resurfacing activities using MAWs.

In the paragraphs below, we analyse the information that can be collectively drawn from Table 20 to Table 22.

Aurizon Network's System Shutdown data for FY2016 states that resurfacing works are only undertaken during MAWS and not during full System Shutdowns, thus not utilising, all or some of the, available full System Shutdowns. The business case that supported contract *NC.2713-2* for five high output resurfacing machines procurement was based on the machines working within MAWs possessions only.

We consider that this strategy represents an inefficient use of time, given that Aurizon Network not making use of the System Shutdown periods deprives Aurizon Network of the chance to undertake maintenance during these System Shutdowns and hence avoid network disruption. We note that failure to maintain tracks during System Shutdowns is only effective if it is safe to do so and we would not advocate the undertaking of maintenance if a shutdown occurs because of accidents or incidents on or near the line.

While Table 20 indicates that resurfacing activities take place during MAWs only, we discovered through meeting with Aurizon Network staff that Aurizon Network does not do that in practice. Indeed, during one of

[35] 2016 SOP Publication, p. 30

the meetings[36] with Aurizon Network and GHD, Aurizon Network stated that, in addition to the MAWS and System Shutdowns, they were able to undertake resurfacing activities during train operations where duplicated track permitted this. In effect, this increases the opportunity to utilise the machines more than is planned within the possessions.

Further to this, we note that Aurizon Network has said that

"… the opportunity to reduce costs is by increasing revenue train track access and delivering more scope in singular access windows"[37].

Increasing track access for operational revenue generating services could be achieved by increasing the productive time with the high capacity machines. In principle, we support the reasoning that Aurizon Network has articulated above. However, we consider that Aurizon Network's practices, for the reasons set out below, are not consistent its stated aims.

Aurizon Network has indicated that resurfacing operations are generally not undertaken during System Shutdowns. This is because the presence of other maintenance equipment is active on the network during System Shutdowns and some of this equipment moves at much lower rates than the resurfacing equipment; therefore, full utilisation of the resurfacing equipment cannot be attained. However, we consider that much of the network would still be accessible for the resurfacing machines, which could work away from any ballast cleaning activities.

It should be recognised that System Shutdowns will demand the operation of works trains and other on-track equipment, so the resurfacing must still be done around those planned movements. In this context, and given the high production capacity of the new resurfacing machines[38] , we consider that Aurizon Network is not maximising the utilisation of its resurfacing fleet through the possession hours that are being made available.

Based on the information and data provided to date, we do not consider there to be sufficient justification for resurfacing works not to be scheduled and undertaken during both MAWs and System Shutdowns. Incorporating shutdowns to the 2,178 hours, based on the above data, provides up to an additional 1,018 hours for the resurfacing fleet to undertake work. In conclusion, we recommend that Aurizon Network investigates more formally the use of both MAWs and System Shutdowns to undertake resurfacing activities; this can be done via an amendment process to the 2016 SOPs.

4.2.2 Number of machines needed

The next step we considered was whether Aurizon Network's proposed main line resurfacing scopes require five resurfacing machines. In our view, the UT5 mainline scopes for resurfacing using the QCA's volume forecasts, which have an upper bound of 265.7 mtpa, can be met with four machines (including some buffer capacity to address downtime to accommodate machine servicing). We present our calculations for this position below.

We determined the estimate of four machines by the following formula:

[UT5 mainline resurfacing scopes (km) / Business case projected maximum scopes (in 2028)] x Number of machines required (as per the business case) =

[36] On 28 July 2017.

[37] Aurizon Network UT5 Maintenance Allowance presentation, slide 21

[38] 5 off 09-2X CAT with dynamic stabilizer and 1 off 09-2X CAT tamping machines

2,108 km[39] / 3,500 km x 5 machines = 3.01 machines

Using QCA's volume forecasts of 265.7 mtpa, we obtain a figure of 3.50 machines, which means four machines will be required to meet the UT5 scopes. This estimate of four machines recognises that 0.50 units of a machine serve as buffer capacity for the CQCN, to address downtime associated with some of the machines requiring servicing during UT5.

Our cost estimates in chapter 5 have accounted for the depreciation[40] costs of only four machines in line with our assessment that four, rather than the purchased five, are required to meet the planned scopes.

4.2.3 Aurizon Network's use of shift time

Our analysis of Aurizon Network's use of shift time to undertake productive work is set out below. To support the time allocations for resurfacing work, Aurizon Network provided a detailed breakdown of a typical shift for program and response work, as shown in Figure 5. To clarify the difference between a possession and a shift, we have adopted the following definitions:

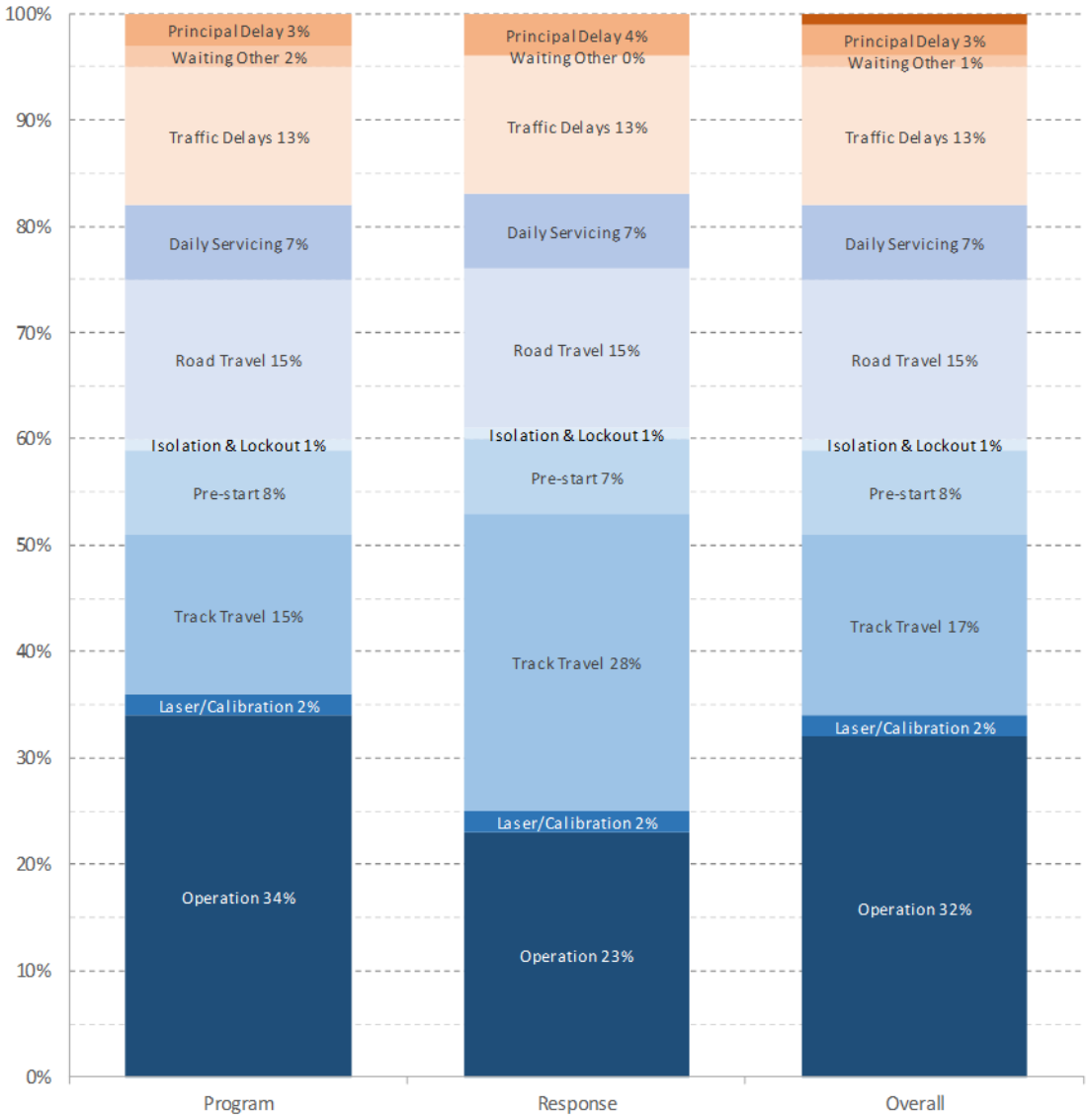
- **Possession** is a track occupancy for engineering works, from the time the track is clear of the last train (as advised from Train Control) to the time the track occupancy is handed back to the control room at completion of work
- **Shift** is the time that staff are available for work activities (i.e. the nominated shift time and will be the possession time plus time for pre and post possession activities such as road travel for crew, on track travel from depot to site and back, machine service and crew briefing).

Although the use of 24 hour shift working may have some advantage, it must be remembered that the MAWs are generally a maximum 12 hours in duration, and on single track sections using longer possessions would severely restrict revenue train movements. Aurizon Network has provided the below information with regard to the utilisation of shift and possession time.

[39] Using Aurizon Network's volume forecasts and proposed maximum scope

[40] Importantly, we note that our estimate of depreciation is based on the DAC estimates supplied to us by the QCA. These costs were provided to us on nominal terms; we have not converted the numbers into real $FY2015 terms, as the QCA instructed us to keep these numbers in the same manner as provided to us.

Figure 5 – Aurizon Network actual resurfacing time allocations



Aurizon Network considers all of the activities shown in blue shading as productive, and those in red shades as non-productive. The overall average time considered by Aurizon Network to be productive is approximately 83%.

Conversely, we consider that productive hours should be regarded as those hours during which resurfacing work is actually being undertaken. Using this definition, average productivity is approximately 32.0%.

Considering the geographical extent of the CQCN, possession establishment and breakdowns (which should be minimal for new equipment), we consider that there is merit in recommend that Aurizon Network reviewing the:

a. activities that are included as being 'within a shift' (i.e. road travel)

b. 'pre-possession' location of plant and staff so they are ready to commence work as soon as is practicable, once a possession and/or track access is established.

From our rail system experience and taking into account the discussion on ensuring that possession time is not interrupted by train services, we consider that Aurizon Network has allocated too much unproductive time to Principal Delays (e.g. delays triggered because of response times from Train Control), Traffic Delays (e.g. late running of revenue trains causing possessions to start late), Daily Servicing (e.g. vehicle start-up and pre-work diagnostics) and Pre-Start (safety briefing to resurfacing crews) time.

Table 23 compares our recommendation of resurfacing time in contrast with those of Aurizon Network. We have employed a nominal 9.5-hour shift (as Aurizon Network has based its resurfacing expenditure forecasts on 9.5 hour shifts) as an example to draw distinctions between our positions on, in particular, Principal Delays, Traffic Delays, Daily Servicing and Pre-Start times against those of Aurizon Network. We have used red font where our recommendations are significantly different from Aurizon Network's historical data.

Table 23 – GHD's recommended productive resurfacing time in a nominal 9.5-hour shift

Factor	Aurizon Network (minutes)	GHD recommendation (minutes)	Possession (GHD's view)	Non-possession (GHD's view)
Principal Delay	15	10		10
Waiting other	6	6	6	
Traffic Delay	74+	45	45	
Daily Servicing	40	24		24
Road Travel	91	91		91
Isolation/lockout	8	8	8	
Pre-start	46	20		20
Track Travel	97	97	45	52*
Laser and calibration	11	15	15	
Operation	182	254	254	
Total	570	570	373	197
% of shift time that reflects productive use of machines	32.0%	44.6%	-	-

Notes:

* Allows for 26 minutes of travel to and from the nearest depot to the nearest passing loop to the worksite, at 60km/h (80km/h is the manufacture's quoted speed).

+ The delay is assumed to be during the possession; else, the delay would not be registered as a delay. Some allowance for Traffic Delays is reasonable, but 74 minutes on average is considered unreasonable.

Aurizon Network's productive use of a shift is 182 minutes / 570 minutes = 32.0 %. In comparison, our proposed figure is 254 minutes / 570 minutes = 44.6%.

Given that the Aurizon Network's expenditure forecasts have been based on a 9.5 hour shift, we have adopted a productive time of 44.6% in our analysis to determine efficient costs.

4.3 Our commentary on Aurizon Network's business case for purchasing the five resurfacing machines

Aurizon Network procured and commissioned five high-output resurfacing machines between mid-2015 and mid-2016 to replace existing resurfacing fleet assets that were nearing in-service life expiry.[41]

The business case[42] was based on expenditure of $74.1 million for the new machines, with the objective of providing

"… a very high resurfacing capability that would enable Aurizon Network to meet the projected increase in resurfacing tasks over the 15 years of the asset lives with reduced impact on network availability"[43].

We note that the current resurfacing fleet

"... is near life expired with a mixture of makes and models … [and] … has significant reliability issues which have affected scope delivery within current closures. The forecast tonnage profile and pathing complexity means that this fleet will not be able to deliver the required scope of work at the end of UT4 and beyond."[44]

These new very high output machines, comprising a tamper and regulator, respectively, are known as:

- MMA503 and MMB503
- MMA504 and MMB504
- MMA505 and MMB505
- MMA506 and MMB506
- MMA507 and MMB507

The following were the primary considerations in the justification for the very high production option:

- increasing the scope of maintenance activities during the period FY2018 to FY2031.
- halving the track possession time required for performing resurfacing activities.
- delivering greater flexibility and resilience as tonnages increase towards and beyond 300 Mtpa.
- purchase of the proposed resurfacing equipment will release train paths on the CQCN.

Figure 6 shows a comparison of existing and new machine production rates. The new machines are the MMA503 to MMA507, each capable of nominally achieving 1,300 m/h.

[41] In a UT5 Maintenance Allowance presentation dated December 2016, Aurizon Network originally proposed to commission eight new tamping machines during the UT5 period

[42] Aurizon Network, Capital Expenditure Feasibility Investment Approval Request: Resurfacing Plant Investment Project, November 2013

[43] Ibid., p. 3

[44] Ibid.

Figure 6 – Aurizon Network plant resurfacing rates[45]

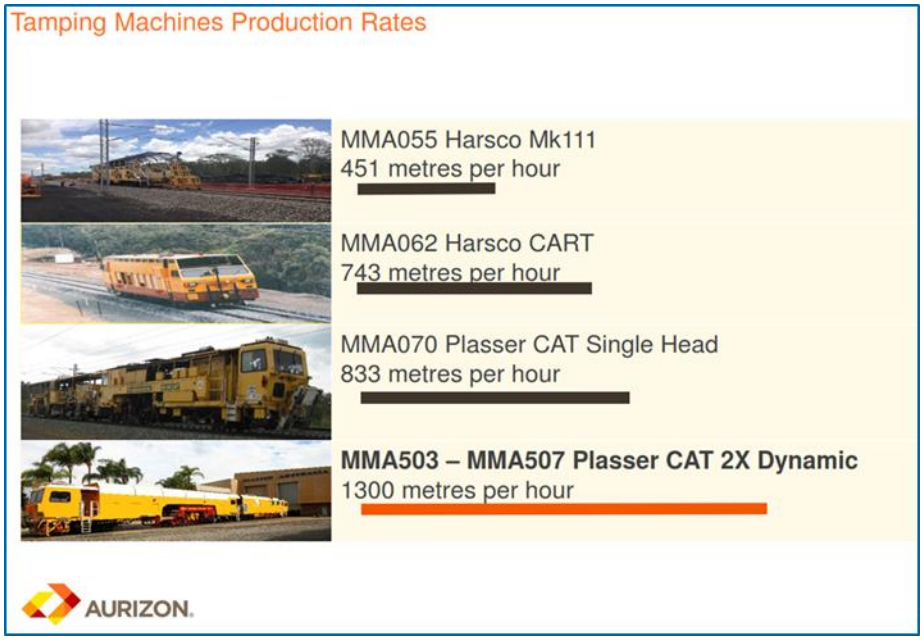


Table 24 shows the resurfacing fleet inventory, including plant recently decommissioned.

Table 24 – UT5 plant status overview[46]

Asset number	Manufacturer	Model	Machine description	Age (years)	Status
MMA054	-	-	-	-	Decommissioned
MMA055	Harsco	MK3-HTR140	Tamper - Truss Beam	27	Decommissioned
MMA056	Harsco	MK3-HTR140TCS	Tamper - Truss Beam	26	Disposed
MMA059	Plasser	UNIMAT 08-475 4S	Tamper - Switch - High Production	22	Decommissioned
MMA062	Harsco	CART 180	Tamper - Continuous Action	22	Scrapped
MMA070	Plasser	CAT 09-16	Tamper - Continuous Action	18	Decommissioned
MMA071	Plasser	09-2X CAT	Tamper - Continuous Action - Two Sleeper	16	In Service
MMA072	Plasser	09-3X CAT	Tamper - Continuous Action - Three Sleeper	16	Decommissioned
MMA076	Plasser	08-275	Tamper - Switch - Medium Production	26	Scrapped
MMA078	Plasser	09-16CSM	Tamper - Continuous Action - High Production	18	Decommissioned

[45] Aurizon Network's Maintenance Allowance presentation, slide 22

[46] GHD analysis based on *1_2_6 (4) Resurfacing Plant Mtce – detail* MS Excel workbook

Asset number	Manufacturer	Model	Machine description	Age (years)	Status
MMA500	Plasser	UNIMAT 08-475 4S	Tamper - Switch - High Production	4	In Service
MMA501	Plasser	UNIMAT 08-475 4S	Tamper - Switch - High Production	4	In Service
MMA502	Plasser	08-275	Tamper - Switch - Medium Production	16	In Service
MMA503	Plasser	09-2X CAT Dynamic	Tamper - Continuous Action - Two Sleeper	2	In Service
MMA504	Plasser	09-2X CAT Dynamic	Tamper - Continuous Action - Two Sleeper	2	In Service
MMA505	Plasser	09-2X CAT Dynamic	Tamper - Continuous Action - Two Sleeper	2	In Service
MMA506	Plasser	09-2X CAT Dynamic	Tamper - Continuous Action - Two Sleeper	1	In Service
MMA507	Plasser	09-2X CAT Dynamic	Tamper - Continuous Action - Two Sleeper	1	In Service
MMB039	Harsco	BE-QR80	Ballast Regulator	28	Decommissioned
MMB044	Harsco	BE-QR91	Ballast Regulator	25	Decommissioned
MMB048	Plasser	SSP302	Ballast Regulator - High Production	21	Decommissioned
MMB049	Plasser	SSP302	Ballast Regulator - High Production	21	Decommissioned
MMB050	Plasser	SSP302	Ballast Regulator - High Production	21	Decommissioned
MMB052	Plasser	SSP302	Ballast Regulator - High Production	21	In Service
MMB057	Plasser	SSP300Z	Ballast Regulator - High Production	16	In Service
MMB058	Plasser	SSP300Z	Ballast Regulator - High Production	16	Decommissioned
MMB059	Plasser	BT101	Broom Trailer attached to MMA 59	22	Decommissioned
MMB500	Plasser	SSP302	Ballast Regulator - High Production	4	In Service
MMB501	Plasser	SSP302	Ballast Regulator - High Production	4	In Service
MMB503	Plasser	SSP302	Ballast Regulator - High Production	2	In Service
MMB504	Plasser	SSP302	Ballast Regulator - High Production	2	In Service
MMB505	Plasser	SSP300Z	Ballast Regulator - High Production	1	In Service

Asset number	Manufacturer	Model	Machine description	Age (years)	Status
MMB506	Plasser	SSP302	Ballast Regulator - High Production	1	In Service
MMB507	Plasser	SSP302	Ballast Regulator - High Production	1	In Service
MMC008	Plasser	DTS 62N	Dynamic Track Stabiliser	18	Decommissioned
MMC009	Plasser	DTS 62N	Dynamic Track Stabiliser	16	In Service
MMC010	Plasser	DTS 62N	Dynamic Track Stabiliser	17	In Service

From the table above, the resurfacing plant inventory provides a main line overall resurfacing output capability of 7,333 m/h, based on tamping machines in service, including the newly acquired machines.

The tonnage forecast contained in the resurfacing procurement business cases assumed an annual growth rate of 4.2% from the contracted capacity, in line with Aurizon Network forecasts. The business case goes on to say:

"*Based on the assumptions and parameters detailed the results of analysis (Benefits of High Production Maintenance Equipment Report — Addendum 6) clearly indicated that the introduction of higher production rate resurfacing equipment has the potential to yield additional capacity for revenue train services"*

The analysis of the tabled capacities indicates capacity uplift over current production capability of, among other things:

- 4.5% for the high production option
- 13% for the very high production option.

Aurizon Network approved the purchase of the very high production machinery on the basis it would add significant benefits through efficiencies to their operations and therefore increase the value provided to their customers.

In our view, the procurement of all five high-production machines to be utilised within MAWs possessions is neither prudent nor efficient, whilst recognising that the older fleet was becoming life-expired and costly to operate. From our analysis (see Section 4.2.2) we consider that the required number of new machines is four not five. As such we have based on assessment of efficient costs on four new machines being utilised.

4.4 Information we relied on

The information drawn ono in the preparation of this report, included, but is not limited to, the following resurfacing documents and key data sets:

- Aurizon Network UT4 Submission
- Aurizon Network UT5 Submission
- Resurfacing machine actual data (UT5 Maintenance_v8_QCA)
- Network Capacity and Maintenance-Renewals (MAWs and Shutdowns)
- Previous Maintenance Cost Report
- UT5 Maintenance Allowance
- Capital Expenditure – Feasibility Investment Approval Request, Resurfacing Plant Investment

- Project Capacity Analysis – benefit of High Production Maintenance Equipment
- Aurizon's NSAP Model data
- Resurfacing plant investment – signed business case
- Practical completion – Resurfacing fleet.

5. Aurizon Network UT5 cost model

5.1 Aurizon Network proposal

5.1.1 Base year

Aurizon Network has nominated FY2015 as the base year for its UT5 expenditure forecasts. The total actual costs for FY2015, including for stone blowing, were $21,153,449 (see Table 25).[47]

Table 25 – Actual base year costs in FY2015

System	Actual costs
Blackwater	$9,994,272
Goonyella	$6,912,745
Moura	$1,737,667
Newlands	$2,508,765
Total	**$21,153,449**

Using FY2015 as the base year, the Aurizon Network proposed top-down forecast (including adjustments for accommodating the stoneblower discontinuation) for UT5 is shown in Table 26. The adjustments Aurizon Network has made in its UT5 proposal are intended to *"… remove non-recurrent / one-off costs that are not expected to be incurred during UT5*."

Table 26 –Aurizon Network UT5 adjustment to base year[48]

Adjustment costs	FY2018	FY2019	FY2020	FY2021	Total
Base year FY2015	$21,153,449	$21,153,449	$21,153,449	$21,153,449	$84,613,796
Stone blower mothballed	**($800,000)**	**($800,000)**	**($800,000)**	**($800,000)**	**($3,200,000)**
Renewed fleet depreciation[49]	$4,095,155	$4,095,155	$4,095,155	$4,095,155	$16,380,622
Renewed fleet maintenance	$4,443,582	$4,578,751	$5,429,182	$5,010,847	$19,462,362
Surplus plant write-off/sale	**($888,485)**	**($888,485)**	**($888,485)**	**($888,485)**	**($3,553,938)**
New fleet efficiency	**($4,057,500)**	**($4,057,500)**	**($4,057,500)**	**($4,057,500)**	**($16,230,000)**
Consumables	**($88,988)**	**$58,501**	**($350,021)**	**$143,511**	**($236,996)**
Volume change vs base year	**($553,700)**	**($351,500)**	**($351,500)**	**($351,500)**	**($1,608,200)**

[47] Aurizon Network *MS Excel* model Maintenance UT5 Cost Build - Demonstrating Aurizon Network Efficient Costs v9_QCA v2.xlsx worksheet Resurfacing, cell C10

[48] Aurizon Network *MS Excel* model Maintenance UT5 Cost Build - Demonstrating Aurizon Network Efficient Costs v9_QCA v2.xlsx worksheet Resurfacing

[49] As calculated by Aurizon Network

Adjustment costs	FY2018	FY2019	FY2020	FY2021	Total
Total	$23,303,515	$23,788,373	$24,230,281	$24,305,478	$95,627,646

5.1.2 Main cost drivers

The Aurizon Network UT5 maintenance-cost model identifies the top cost drivers in its resurfacing production program as being labour (40% of total costs), consumables (25% of total costs) and depreciation of machinery (24% of total costs). Table 27 shows the Aurizon Network costs (in FY2015 terms) by category, based on a top-down analysis using FY2015 as the base year, and Table 28 shows the UT5 forecast costs by product.

Table 27 –Aurizon Network proposed UT5 costs by MCI accounting cost component ($FY2015) [50]

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total	% of total
Labour	$9,327,771	$9,521,846	$9,545,226	$9,559,679	$37,954,523	39.7%
Consumables	$5,545,588	$5,660,970	$6,127,973	$6,243,666	$3,578,197	24.7%
Fuel	$845,486	$863,078	$865,197	$866,507	$3,440,268	3.6%
Travel and accommodation	$1,952,232	$1,992,851	$1,997,744	$2,000,769	$7,943,595	8.3%
Depreciation	$5,632,438	$5,749,627	$5,694,141	$5,634,857	$22,711,063	23.7%
Total	**$23,303,515**	**$23,788,373**	**$24,230,281**	**$24,305,478**	**$95,627,646**	**100.0%**

Table 28 –Aurizon Network proposed UT5 costs by product (real $FY2015) [51]

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total	% of total
C19 Mainline	$19,341,917	$19,744,349	$20,111,134	$20,173,547	$79,370,946	83.0%
C23 Turnouts	$3,961,597	$4,044,023	$4,119,148	$4,131,931	$16,256,700	17.0%
Total	**$23,303,515**	**$23,788,373**	**$24,230,281**	**$24,305,478**	**$95,627,646**	**100.0%**

5.2 GHD assessment of proposed costs

Using the scopes that we considered prudent for mainlines and turnouts, we have assessed the proposed resurfacing expenditure forecasts using the following input parameters:

- Labour unit rate
- Plant unit rate
- Machine production rate
- Productive hours as a percentage of shift.

[50] Excel model Maintenance UT5 Cost Build - Demonstrating Aurizon Network Efficient Costs v9_QCA_v2.xlsx worksheet Resurfacing

[51] Ibid., worksheet *Total NMP*

5.2.1 Labour unit rate

Aurizon Network generated a labour rate based on general ledger data, with costs recorded separately for resurfacing in north and south regions. These costs were recorded against account codes, with the following contributing approximately 80% to the annual total:

- salaries and wages - 34.34%
- accommodation - 9.78%
- trade services (include cleaning services, security but excluding contractors and professional services) - 9.24%
- overtime - 8.15%
- allowances - 6.59%
- superannuation - 4.49%
- annual leave - 3.61%
- payroll tax - 2.68%.

The remaining approximately 20% of the labour costs is distributed across another 61 account codes, and each of these codes has a relatively minor contribution to the overall total.

Table 29 shows the total actual general ledger costs reported by Aurizon Network for resurfacing in the north and south regions of CQCN for FY2016.

Table 29 – Aurizon Network total actual FY2016 costs

System	Actual costs
CQCN North	$6,044,917
CQCN South	$8,962,142
Overheads	$1,111,206
Total	**$16,118,265**

Table 30 –Aurizon Network total hours booked

Region	Team	Shifts	Total staff	Total hours
CQCN North	Team CAT 71	167	8	12,692
	Team 2X 503	166	8	12,616
	Team 2X 507	164	8	12,464
	Team Unimat 500	171	7	11,371.5
North subtotal				49,143.5
CQCN South	Team 2 X 504	164	8	12,464
	Team 2 X 506	166	8	12,616
	Team Unimat 502	168	7	11,172
	Team Unimat 501	171	7	11,371.5

Region	Team	Shifts	Total staff	Total hours
South subtotal				47,623.5
Total				**96,767.0**

The average hourly labour rate was calculated by Aurizon Network as $16,118,265 divided by 96,767 hours or $166.57, based on FY2016 actual costs. As a comparison, we have used the hourly rates for different rail workers as defined[52] within the current Enterprise Agreement. We selected the mid-range pay rate for each of the skill levels, and applied average industry on-costs and overheads to generate an hourly rate for rail workers as shown in Table 31.

Table 31 – GHD indicative labour hourly rates for rail workers

Aurizon agreement level	Aurizon agreement classification	Role	Base hourly rate	Labour rate with on-costs and overheads
RIW2	CI1.4	Labour/TPOs	$ 27.51	$ 80.00
RIW3	CI2.2	Skilled labourer	$ 30.55	$ 89.00
RIW4	CI3.3	Train operator	$ 37.66	$ 107.00
RIW5	CI4.2	Site manager	$ 43.37	$ 121.00

A typical work crew for a ballast tamper and regulator comprises 4 labour/train protection officers (TPOs), 2 skilled labourers, 1 train operator and 1 site manager. To calculate a comparative cost for labour, we included consideration of nominal shift allowances and accommodation (totalling $190 per person per shift). The comparative cost for a shift was $12,087.

In Aurizon Network's bottom-up cost models, Aurizon Network relied upon a crew size of 7 for the older machines (i.e. Unimat 500, 501 and 502) and 8 for the other newer machines (e.g. MMA series). Across all of the machines listed by Aurizon Network, the average number of FTEs is 7.625.

Using 7.625 FTEs, the average hourly rate based on our estimate is $166.86.

We have adjusted the labour rate proposed by Aurizon Network to account for Aurizon Network using FY2016 costs as the basis for the calculation, in lieu of FY2015, which is the accepted base year for the top-down forecasts. The MCI index for the 3-year period between FY2015 (agreed base year) and FY2018 (the first year of UT5) is 5.27%. Assuming a uniform escalation over this period, the annual MCI escalation is 1.76%.

We have adjusted the labour hourly rate proposed by Aurizon Network of $167 by a decrease of 1.76% to $164.

5.2.2 Plant unit rate

In generating a plant unit rate per shift, Aurizon Network used general ledger numbers to average annual actual costs. The five account codes that represented approximately 88% of the total costs were:

- on-track vehicles - 29.77%

[52] *Aurizon Construction and Maintenance Enterprise Agreement 2015*, Rail Infrastructure Workers table of fortnightly pay, p. 70. Available here: https://www.fwc.gov.au/documents/documents/agreements/fwa/ae415356.pdf

- lease depreciation of plant and equipment - 18.70%
- depreciation of plant and equipment - 18.05%
- salaries and wages - 12.80%
- amortisation leased plant & equipment - 8.40%.

These costs were broken into different cost centres

- materials
- labour
- fuel, hire charges and technical advice
- machine depreciation
- depreciation of small plant.

Table 32 shows the summary of the Aurizon Network FY2016 cost allocations for the tampers and regulators used for resurfacing work during UT5.

Table 32 – Aurizon Network UT5 plant rate

Asset	Material	Labour	Fuel, hire, technical advice	Machine depreciation	Small vehicle depreciation	Total	Shifts
Tamper	$2,219,758	$3,254,668	$199,016	$3,816,089	$800,920	$10,290,451	1,270
Regulator	$1,492,914	$2,620,321	$22,113	$2,141,247	$88,991	$6,365,586	1,270

Aurizon Network's combined plant rate for the tamper and regulator is $13,113 per shift.

In developing a plant rate, we have separated the materials and labour associated with maintaining the machines, which contributes to the plant rate, and the depreciation of the resurfacing machinery. We have accepted the *actual* costs for plant (adjusted to FY2015), which resulted in the variable plant rate as shown in Table 33. However, we have used alternative depreciation estimates to reflect the QCA's preferred approach for depreciation, based on a roll-forward model that it developed from the capital costs of all maintenance equipment. We refer to the QCA's estimate as the 'depreciation schedule'.

Table 33 – GHD assessment of plant rate

Asset	Material	Labour	Fuel, hire, technical advice	Shifts	Plant rate per shift
Tamper	$2,180,690	$3,197,386	$195,513	1,270	$4,388.13
Regulator	$1,466,639	$2,574,204	$21,724	1,270	$3,198.49
Total					**$7,586.63**

In assessing the depreciation to be applied to each system, we have used the Aurizon Network planned number of shifts and allocated machines for each system for each year of UT5 to distribute the annual depreciation costs to mainlines only. We have elected to do this because customers are not charged on a mainline-turnout split in the CQCN; rather, they are charged on a system basis. Thus, as long as the cost split on a system basis is accurate, the share of depreciation between mainlines and turnouts is trivial. The plant cost rate used in our expenditure estimates is a combination of a depreciation component (the

depreciation charges for the machines planned to be used for resurfacing in the different systems) and a component based the maintenance and fuel costs for the machines per shift.

5.2.3 Productive hours

In section 4.2, our bottom-up cost model provides for a 44.6% use of shift time for productive work of the resurfacing machines. This has reduced the number of shifts required for Aurizon Network to meet its resurfacing scopes for mainlines and turnouts.

5.2.4 GHD assessment of UT5 forecast costs

Table 34 shows our assessment of prudent and efficient costs for UT5, based on the following criteria:

1 Make UT5 forecast productivity rate 1,200 m/h, not 900 m/h

2 Make UT5 forecast use of productive time within a shift 44.6%, not 32.0%

3 Using the information in steps 1 and 2, determine the number of shifts required to meet the maintenance scopes for each system in each year

4 Apply the recommended labour rates and plant rates (revised to incorporate the QCA's determined regulatory depreciation) to the number of shifts for each system in each year

5 Determine a cost per system per year, and compare our cost figures with those of Aurizon Network.

Table 34 – GHD assessment of UT5 resurfacing costs

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total	% of total
C19 Mainline	$13,039,205	$13,118,487	$13,128,511	$13,114,502	$52,400,705	86.69%
C23 Turnouts	$1,997,244	$2,015,737	$2,015,737	$2,015,737	$8,044,455	13.31%
Total	**$15,036,449**	**$15,134,224**	**$15,144,248**	**$15,130,239**	**$60,445,160**	**100.00%**

This represents a 37% reduction on the total Aurizon Network proposed resurfacing costs for UT5. Our assessed UT5 resurfacing costs have been divided across the standard MCI accounting cost components using the accepted labour rate and our estimated rates for consumables, fuel and accommodation as shown in Table 35.

Table 35 – GHD assessed forecast by MCI accounting cost components[53]

Activity	FY2018	FY2019	FY2020	FY2021	Total	% of Total
Labour	$5,694,340	$5,749,148	$5,749,148	$5,749,148	$22,941,784	37.95%
Consumables	$3,357,283	$3,389,565	$3,389,565	$3,389,565	$13,525,977	22.38%
Fuel	$587,957	$593,610	$593,610	$593,610	$2,368,788	3.92%
Travel and accommodation	$618,676	$624,630	$624,630	$624,630	$2,492,566	4.12%
Depreciation	$4,778,193	$4,777,271	$4,787,295	$4,773,286	$19,116,045	31.63%
Total	$15,036,449	$15,134,224	$15,144,248	$15,130,239	$60,445,160	100.00%

[53] Numbers may not add due to rounding

Activity	FY2018	FY2019	FY2020	FY2021	Total	% of Total
Aurizon Network forecast ($FY2015)	$23,303,515	$23,788,373	$24,230,281	$24,305,478	$95,627,646	
Variation to Aurizon Network forecast ($)	**($8,267,066)**	**($8,654,148)**	**($9,086,033)**	**($9,175,239)**	**($35,182,486)**	
Variation to Aurizon Network forecast (%)	**(35%)**	**(36%)**	**(37%)**	**(38%)**	**(37%)**	

Our assessment of the addition cost arising from including the depreciation of the fifth machine purchased by Aurizon Network (e.g. MMA/B507) is provided in Table 36.

Table 36 - Impact on GHD's cost recommendation for including the depreciation costs for four five new resurfacing machines

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
GHD ($FY2015)	$1,170,990	$1,171,913	$1,161,889	$1,175,898	$4,680,690

5.2.5 GHD assessment of UT5 forecast costs by system

The following tables summarise our assessment by system and product.

Table 37 – GHD assessment by system - mainline

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Goonyella					
Aurizon Network forecast ($FY2015)	$8,967,997	$9,050,706	$9,218,838	$9,247,448	$36,484,989
GHD forecast ($FY2015)	$6,021,243	$5,988,360	$5,992,889	$5,986,559	$23,989,051
Variance ($FY2015)	**($2,946,754)**	**($3,062,346)**	**($3,225,949)**	**($3,260,889)**	**($12,495,938)**
Variance (%)	**(33%)**	**(34%)**	**(35%)**	**(35%)**	**(34%)**
Blackwater					
Aurizon Network forecast ($FY2015)	$8,314,262	$8,558,848	$8,717,843	$8,744,898	$34,335,851
GHD forecast ($FY2015)	$5,596,824	$5,661,637	$5,665,944	$5,659,925	$22,584,330
Variance ($FY2015)	**($2,717,438)**	**($2,897,211)**	**($3,051,899)**	**($3,084,973)**	**($11,751,521)**
Variance (%)	**(33%)**	**(34%)**	**(35%)**	**(35%)**	**(34%)**
Newlands					

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Aurizon Network forecast ($FY2015)	$1,447,589	$1,517,128	$1,545,311	$1,550,107	$6,060,135
GHD forecast ($FY2015)	$980,844	$1,030,891	$1,031,708	$1,030,566	$4,074,009
Variance ($FY2015)	**($466,745)**	**($486,237)**	**($513,603)**	**($519,541)**	**($1,986,126)**
Variance (%)	**(32%)**	**(32%)**	**(33%)**	**(34%)**	**(33%)**
Moura					
Aurizon Network forecast ($FY2015)	$612,070	$617,668	$629,142	$631,094	$2,489,974
GHD forecast ($FY2015)	$440,294	$437,599	$437,970	$437,451	$1,753,315
Variance ($FY2015)	**($171,776)**	**($180,069)**	**($191,172)**	**($193,643)**	**($736,659)**
Variance (%)	**(28%)**	**(29%)**	**(30%)**	**(31%)**	**(30%)**

Table 38 – GHD assessment by system - turnouts

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Goonyella					
Aurizon Network forecast ($FY2015)	$1,894,450	$1,916,147	$1,951,743	$1,957,800	$7,720,140
GHD forecast ($FY2015)	$924,650	$924,650	$924,650	$924,650	$3,698,600
Variance ($FY2015)	**($969,800)**	**($991,497)**	**($1,027,093)**	**($1,033,150)**	**($4,021,540)**
Variance (%)	**(51%)**	**(52%)**	**(53%)**	**(53%)**	**(52%)**
Blackwater					
Aurizon Network forecast ($FY2015)	$1,805,484	$1,852,628	$1,887,044	$1,892,900	$7,438,056
GHD forecast ($FY2015)	$924,650	$943,143	$943,143	$943,143	$3,754,079
Variance ($FY2015)	**($880,834)**	**($909,485)**	**($943,901)**	**($949,757)**	**($3,683,977)**
Variance (%)	**(49%)**	**(49%)**	**(50%)**	**(50%)**	**(50%)**
Newlands					
Aurizon Network forecast ($FY2015)	$188,398	$201,143	$204,879	$205,515	$799,935
GHD forecast ($FY2015)	$110,958	$110,958	$110,958	$110,958	$443,832
Variance ($FY2015)	**($77,400)**	**($90,185)**	**($93,921)**	**($94,557)**	**($356,103)**

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Variance (%)	**(41%)**	**(45%)**	**(46%)**	**(46%)**	**(45%)**
Moura					
Aurizon Network forecast ($FY2015)	$73,266	$74,105	$75,482	$75,716	$298,569
GHD forecast ($FY2015)	$36,986	$36,986	$36,986	$36,986	$147,944
Variance ($FY2015)	**($36,280)**	**($37,119)**	**($38,496)**	**($38,730)**	**($150,625)**
Variance (%)	**(50%)**	**(50%)**	**(51%)**	**(51%)**	**(50%)**

5.3 Conclusions

Aurizon Network submitted the UT5 resurfacing forecast for UT5, based on an average of 33% operational hours per shift and an average production rate of 900 m/hour based on a mixture of new and old machines.

We consider that the UT5 forecast for resurfacing costs should be based on a productive-hour rate of 44.6% and a production rate of 1,200 m/h. In forming this position, we have assumed only four new machines are fully utilised in doing the resurfacing work, and that the other, older machines are used for spot resurfacing and to support with follow-up tamping work after the ballast-undercutting work on mainlines.

Table 39 shows the GHD assessed UT5 forecast by product.

Table 39 – GHD assessment by resurfacing product

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
C19 Mainline					
Aurizon Network forecast ($FY2015)	$19,341,917	$19,744,349	$20,111,134	$20,173,547	$79,370,946
GHD forecast ($FY2015)	$13,039,205	$13,118,487	$13,128,511	$13,114,502	$52,400,705
Variance ($FY2015)	**($6,302,712)**	**($6,625,863)**	**($6,982,623)**	**($7,059,044)**	**($26,970,242)**
Variance (%)	**(33%)**	**(34%)**	**(35%)**	**(35%)**	**(34%)**
C23 Turnouts					
Aurizon Network forecast ($FY2015)	$3,961,597	$4,044,023	$4,119,148	$4,131,931	$ 16,256,700
GHD forecast ($FY2015)	$1,997,244	$2,015,737	$2,015,737	$2,015,737	$8,044,455
Variance ($FY2015)	**($1,964,353)**	**($2,028,286)**	**($2,103,411)**	**($2,116,194)**	**($8,212,245)**
Variance (%)	**(50%)**	**(50%)**	**(51%)**	**(51%)**	**(51%)**
Total					
Aurizon Network forecast ($FY2015)	$23,303,515	$ 23,788,373	$24,230,281	$24,305,478	$95,627,646
GHD forecast ($FY2015)	$15,036,449	$15,134,224	$15,144,248	$15,130,239	$60,445,160

Resurfacing	FY2018	FY2019	FY2020	FY2021	Total
Variance ($FY2015)	**($8,267,066)**	**($8,654,149)**	**($9,086,033)**	**($9,175,239)**	**($35,182,486)**
Variance (%)	**(35%)**	**(36%)**	**(37%)**	**(38%)**	**(37%)**

Our recommended position results in an overall reduction in Aurizon Network's resurfacing cost forecast of 37% to $60.45 million.

Level 9 145 Ann Street Brisbane QLD 4000 Australia
GPO Box 668 Brisbane QLD 4001 Australia

61 7 3316 3000
advisory@ghd.com

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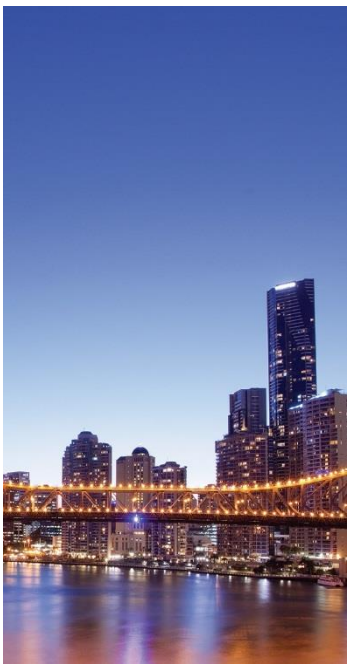

Appendix D - Rail Grinding

Mini Report for the Queensland Competition Authority

15 November 2017

GHD

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1. Summary

The Queensland Competition Authority (QCA) has engaged GHD to review Aurizon Network's proposed maintenance costs for UT5. This mini-report assesses whether Aurizon Network's proposed rail grinding costs reflect prudent and efficient maintenance scopes and delivery practices. As requested in the QCA's TOR, our analysis considers the following themes, as described in Table 1 below.

Table 1 – Analysis themes

Underlying themes	Title
Efficiency and prudency	The extent to which Aurizon Network's proposals are efficient and prudent.
Achievability	The extent to which the proposals are practically achievable.
Measurability	The extent to which the proposals provide a platform for measuring performance.
Transparency	The extent to which the proposals clearly articulate and commit to a set of outputs.
Accountability	The extent to which Aurizon Network is accountable for its performance.

1.1 Aurizon Network's proposal

Table 2 presents Aurizon Network's proposed rail grinding scopes for the UT5 period, while Table 3 presents Aurizon Network's proposed rail grinding costs ($70.9 million ($FY2015) over UT5). Scopes are presented on a finished-km basis.

Table 2 – Aurizon Network's proposed UT5 rail grinding scopes[1]

Rail grinding	FY2018	FY2019	FY2020	FY2021
Mainline (km)	4,139	4,139	4,139	4,140
Turnout scope (no.)	748	757	781	782

Table 3 – Aurizon Network's proposed UT5 rail grinding costs [2]

Rail grinding ($FY2015)	FY2018	FY2019	FY2020	FY2021
Mainline	14,020,456	13,971,791	13,885,396	13,798,354
Turnouts	3,833,781	3,815,547	3,791,229	3,767,463
Total	**17,854,237**	**17,787,338**	**17,676,625**	**17,565,817**

[1] Mainline and turnout scopes sourced from Aurizon Network UT5 Submission: page 171

[2] Real Costs sourced from Aurizon Network UT5 Submission: page 171; Maintenance UT5 Cost Build Model: Product Summary – Real$; Total NMP and QCA staff's Adapted Model UT5 – AN's cost build QCA structure: AN costs (R). Split between Mainline and Turnouts based on information provided in *170713 –RFI –UT5 Maintenance_AN*, worksheet '2_Tab 1', and has been scaled to the total costs found in the *UT5 Cost Build* to account for the less than 0.00001% difference between the totals.

1.2 Summary of analysis of rail-grinding scopes, practices and costs

1.2.1 Scopes

We consider the scope proposed by Aurizon Network against the projected tonnages over the CQCN to be reflective of a prudent program of preventative grinding. The proposed scopes also correspond to the intervention rates allowed in Aurizon Network's Asset Maintenance and Renewals Policy (AMRP). The Aurizon Network proposed intervention rate allowances for tonnages and curvature are comparable with those of the Australian Rail Track Corporation (ARTC), as defined in *ETN–01-02 Rail Grinding Manual for Plain Track* [3].

Aurizon Network uses the following intervention frequencies: [4]

- Straight track 40 MGT
- Curves 1001 to 2500 metres radius 20 MGT
- Curves less than 1000 metre radius 10 MGT
- Turnouts 40 MGT.

For comparison, ARTC uses the following for its coal tracks[5]:

- Straight track and greater than 900 metres 40 MGT
- Curves 450 to 900 metres radius 20 MGT
- Curves less than 450 metre radius 10 MGT
- Turnouts – the ARTC document refers to plain track only but, since turnouts are generally located on straight track, the intervention frequency would be similar to straight track as used by Aurizon Network.

ARTC's smaller-radius criteria reflects the use of standard gauge rather than narrow gauge, which will allow easier bogie curving for the same radius. This is because the vertical loading to the rail on curves will be higher for narrow gauge than standard gauge due the narrower distance between the wheels on an axle. In our view, accounting for the difference in gauge, Aurizon Network's proposed intervention rates are comparable with ARTC's. Given the tonnage task on Aurizon Network's infrastructure and the comparability of its intervention rates with ARTC, we do not recommend any adjustment to Aurizon Network's proposed rail-grinding scopes.

The intervention target at 40MGT for both Aurizon Network and ARTC takes into account varying axle loads, in that 40 MGT at 30 tonnes axle loading is reached after the passage of 1.333 million axles and 1.51 million axles at 26.5 tonne axle load.

Neither the Aurizon Network Asset Maintenance and Renewals Policy nor the ARTC ETN–01-02 Rail Grinding Manual for Plain Track document used in analysing the scope make a distinction for standard or head hardened rail. Experience elsewhere suggests that, in terms of fatigue, head-hardened rail may not provide a greater rail life than standard rail:

"*These observations would explain why some head-hardened rails have had to be removed from track after only 200 million gross tons of traffic as a result of severe spalling to a depth of 3 mm."*[6]

[3] See ARTC document ETN-01-02. The ETN–01-02 Rail Grinding Manual for Plain Track is available here: https://extranet.artc.com.au/docs/eng/track-civil/workinstruct/rail/ETN-01-02.pdf

[4] Refer to Aurizon Network's AMRP

[5] ETN–01-02 Rail Grinding Manual for Plain Track

[6] *Investigation of rolling contact fatigue in a head-hardened rail*, V.Dikshit, P.Clayton, D.Christensen

(available at https://doi.org/10.1016/0043-1648(91)90008-I)

It would therefore be unwise to reduce the grinding program for head-hardened rail. Also, given the limited lengths of head-hardened rail in track, it is unlikely that any real benefit (i.e. no actual savings in costs because it does not alter the overall amount of grinding required) would be achieved.

In the article from which the above quote is taken, we note that the only benefit to rail grinding from rail material choice is obtained by adopting a premium "super clean" rail steel in lieu of head-hardened rail. We understand that Aurizon Network have recently chosen to adopt such a steel for future rail renewal that will be sourced from a European supplier. Aurizon Network has done this to increase rail life and reduce wear and tear of the rail. It is unlikely that any substantial quantity will be installed in track for a number of years and thus will have no effect on the rail-grinding scopes and costs for UT5. In this context, our recommendation is to not propose a reduction to Aurizon Network's grinding scopes for the CQCN as a whole, but we have recommended adjustments *across* each CQCN system. The paragraph below addresses these recommendations.

In Table 4, we set out Aurizon Network's scopes and compare that with our proposed efficient scopes for the CQCN and its component systems. Scopes are presented on a finished-km basis.

Our principles for determining proposed scopes is based on the following approach:

- Convert forecast net tonnes, using Aurizon Network's forecast in FY2019 (same as FY2020 and FY2021), which is Aurizon Network's highest annual forecast for UT5, to gross net tonnes. This conversion process uses Aurizon Network's NSAP data
- Isolate percentage of track that is 'straight' (40 MGT intervention rate) or 'curved' (20 MGT intervention rate) for each CQCN system (see first for rows). Given the level of information we had on curved track, we have assumed that all curved track falls within the 20 MGT intervention-rate category (i.e. none of the curved track has radius <1,000 m intervention-rate category)
- Determine length of grinding required, using the: Aurizon Network AMRP intervention rates for straight and curved track; forecast gross tonnes for the CQCN, as a whole, and each CQCN system.

Table 4 – Grinding scope analysis (system and CQCN levels)

Parameter	CQCN	Blackwater	Goonyella	Newlands (and GAP)	Moura
Total length (km)	2,674	1,107	979	328	260
Straight (km)	1,506	681	468	228	129
Curve (km)	1,168	426	511	100	131
Curve percentage	43.7%	38.50%	52.20%	30.50%	50.40%
Million Net Tonnes Forecasts (AN's FY2019 forecast)	228	71	120	27	10
Million Gross Tonnes Forecasts (AN's FY2019 forecast)[7]	357	113	188	40	16
Total mainline scopes (km)	**CQCN**	**Blackwater**	**Goonyella**	**Newlands (and GAP)**	**Moura**
AN	4,140	1,822	1,822	331	166
GHD	3,715	1,282	2,156	213	64

[7] Based on MNT to MGT conversion factors set out in Aurizon Network's NSAP models, ranging from 1.478 to 1.59

Parameter	CQCN	Blackwater	Goonyella	Newlands (and GAP)	Moura
AN/GHD	111.4%	142.1%	84.5%	155.0%	259.1%

Our estimate of the prudent scope for the CQCN (i.e. 3,715 km) is within 12% of Aurizon Network's estimate (4,140 km). This could be accounted for with the curve radius intervention-rate category utilised. Given our 20% materiality threshold, consistent with the engineering judgement that we exercised consistently in this report, we consider Aurizon Network's proposed *overall* scopes to be prudent. However, the conclusion is not the same on a *system-by-system* level. In particular, in the context of the Aurizon Network's volume forecast of approximately 228 mtpa in FY2019 to FY2021, we note that Aurizon Network's scopes for:

- Blackwater – are 42% higher than our estimate of the prudent scope
- Goonyella – are 16% lower than our estimate of the prudent scope
- Newlands (and GAP) – are 55% higher than our estimate of the prudent scope
- Moura – are 159% higher than our estimate of the prudent scope.

The Moura, Newlands (and potentially Blackwater) systems, based on their age of construction (and the construction technologies available at the time) could well have a disproportionate quantity of curves at <1,000 m, so it could be argued that Aurizon Network's rail grinding scopes are prudent, but without the accurate curve data, these assumptions are not able to be substantiated.

On the above basis, we consider the appropriate scopes for each system to be as shown in Table 5. We have used our partitioning of scopes from the second last row of Table 4, covering 3,715 km of scope, to inform, using a proportioning principles, our partitioning of scopes in Table 5, covering 4,140 km of scope. We have used FY2021 as the anchor for our assessment, as it is the highest scope over the UT5 period but only one km higher than the scopes (i.e. 4,139 km) in each of the other UT5 years.

Table 5 – GHD's proposed recommendations on rail-grinding mainline scopes

Entity	CQCN	Blackwater	Goonyella	Newlands (and GAP)	Moura
Aurizon Network (km)	4,140	1,822	1,822	331	166
GHD (km)	4,140	1,429	2,403	237	71
Difference (GHD – AN) (km)	0	(393)	581	(94)	(95)

As per the information captured in Table 5, we have reduced the scopes for Blackwater (by 393 km), Newlands and GAP (by 94 km) and Moura (by 95 km) systems. For the Goonyella system, we have increased the scope by 581 km. Ultimately, this means an increase in rail-grinding costs allocated to the Goonyella system, and a decrease for rail-grinding costs in the other CQCN systems (discussed in subsection 1.2.3).

Applying the above proportions to the number of Aurizon Network's proposed turnouts over the UT5 period, we have derived our estimate of what we consider a prudent number of turnout rail grinding is (see Table 6 below).

Table 6 – GHD's proposed recommendations on rail-grinding turnout scopes

Entity	System	FY2018	FY2019	FY2020	FY2021
Aurizon Network (no.)	Blackwater	329	333	344	345
	Goonyella	329	333	344	345
	GAP/Newlands	60	60	61	62
	Moura	30	30	31	31
	CQCN	**748**	**756**	**779**	**785**
GHD (no.)	Blackwater	258	261	269	271
	Goonyella	434	439	452	455
	GAP/Newlands	43	43	45	45
	Moura	13	13	13	13
	CQCN	**748**	**756**	**779**	**785**

Consistent with our position on CQCN scopes for rail grinding, we have:

- not proposed amending the total number of turnouts that Aurizon Network has proposed to grind over the UT5 period
- amended the proportion of turnouts to be ground, among the four CQCN systems. In particular, we have proposed increasing the Goonyella turnout scopes and reducing the other systems' turnout scopes. The proportions reflect our position on mainline rail grinding.

1.2.2 Practices

The nature of the grinding operations requires that the works be undertaken throughout the year and predominantly at night (e.g. to reduce risk of fires from the grinding process). In summer, high temperatures during the day increase the risk of uncontrolled fire during the day. Dry and loose kindling can be sparked when brought into contact with the sparks emitted by grinding equipment. Winter also sees cooler temperatures at night and lowers the chance of ignition of bush or kindling, given the majority of the CQCN lies in arid climes. Consequently, grinding operations exhibit distinct patterns of seasonality, with troughs observed in the summer and peaks in the winter.

Operations can also be better monitored at night because of the contrast of light on the maintenance workers. Reduction of visual glare and the avoidance of hazards associated with protracted work in high temperatures, most notably heat-stroke.

Aurizon Network contracts its CQCN grinding operations to Aurizon Operations. Capabilities of the equipment, plus the effective hours available on track made available by Aurizon Network, determine whether Aurizon Operations can meet agreed scopes (e.g. distances).

The Aurizon Network FY2016 Maintenance Cost Report indicates that the grinding completed in FY2016 was 3,932 kilometres for mainline and 783 for turnouts. Therefore, the equipment and personnel should be capable of providing the capacity to undertake the scope identified for UT5 (i.e. 4,140 km for mainline and up to 782 turnouts). However, we need to also account for possession hours made available for grinding.

The FY2016 grinding scopes were determined from Aurizon Network productivity data, as set out in 170512 RFI UT5 Maintenance v8. In that model[8], the aggregated FY2016 performance across the four CQCN systems is shown in the following table.

Table 7 – FY2016 rail grinding performance summary[9]

Product	Total shift hours	Total productive hours	Total amount ground	Average amount ground per shift	Average amount ground per shift hour	Average amount ground per productive hour
Mainline (km)	2,009	392	4,012.7	20.4	2.0	10.2
Turnouts (no.)	1,198	293	800	7.5	0.7	2.7

The shift hours given for grinding are qualified by Aurizon Network[10] as hours from motel/depot to return to motel/depot. In the absence of other information, we have assumed that 3 to 4 hours in a 10-hour shift are used for travel to site and other pre- and post-operation activities. This is based on Aurizon Network shift activities by percentage for resurfacing activities, which identifies 15% of a shift allocated to road travel and 17% to track travel. For a 10 hour shift, this yields hours on site of 6 or 7 hours.

Within this time, there will be non-productive activities, including crew briefing, awaiting passage of trains and other non-productive activities. For our analysis, we consider a productive hour to be an hour during which the grinding equipment and crew are actually grinding rails in track. This is consistent with the definitions set out in our resurfacing report:

… we are of the opinion that productive hours should be regarded as those hours during which resurfacing work is actually being undertaken.[11]

If the productive hours on track average 2 hours, then the effective time represents only 33% of time on track or 20% of shift time. This is only a little better than the resurfacing or ballast cleaning effective hours, despite the use of a subcontractor, Aurizon Operations. A major element with respect to achievability is the time allocated on track, which is largely within the control of Aurizon Network.

Information provided after the rail-grinding meeting[12] with Aurizon Network indicates that Aurizon Operations regularly requests 8 hours on track at three months' notice. In comparison, Aurizon Network generally reduces the planned possession to 4 hours, in the ITP and DTP periods before the day of operations. However, the *actual* time allocated per possession over a 2-week period suggests that, on average, 6 hours on track is achieved.[13]

For clarity to the reader, Aurizon Operations operates the rail-grinding trains and supporting machinery for the grinding process; Aurizon Operations does not provide any Train Control services for the rail-grinding (or any other maintenance task, for that matter) task. Train Control is provided by Aurizon Network, which means that Aurizon Operations' ability to use the rail-grinding machine during a Possession is at the behest of Aurizon Network's direction via Train Control.

[8] See worksheet 2_Tab3 in the *170713 – RFI - UT5 Maintenance_AN*

[9] Aurizon Network allows for one shift per day with Aurizon Operations.

[10] Explained to GHD at a meeting with Aurizon Network staff on 8 August 2017 at Aurizon Network's office.

[11] See page 29 of our Mini Report for Resurfacing

[12] Meeting held on 8 August 2017

[13] RFI2 response from Aurizon Network, and discussed at the meeting on 8 August 2017

Importantly, it should also be considered that, in the context of maintenance (using resurfacing as an example), Aurizon Network should not be looked as a single unit. As an example, we note that Aurizon Network's Train Control team have different motivations from that of the resurfacing team. Similarly, the Aurizon Network team responsible for planning the rail-grinding operation task with Aurizon Operations is different from the Aurizon Network Train Control team. It would be expected that the Aurizon Network maintenance-related teams would seek to align incentives with the Aurizon Network Train Control team. However, this may not always happen in practice, and is something we consider that Aurizon Network should actively seek to improve at in order to discharge a preventative-maintenance regime in an efficient manner.

For Aurizon Operations to succeed with meeting its rail-grinding scopes, Aurizon Network's maintenance-related teams and Train Control teams must be highly coordinated (which does not seem to be occurring in practice) for Aurizon Operations *to be able to actually use* the possession time it has been allocated (and not just get some of the allocated time, which is what has transpired in practice).

Aurizon Operations indicates that the shift length allowed is 12 hours, which includes time travel time from and to crew members' accommodation. Total travel time is therefore generally 4 hours in total, leaving 8 hours on site as Aurizon Operations requested from Aurizon Network. The productivity per shift in terms of maximum time available for productive work is therefore a maximum of 8 hours from 12 hours, being 67%.

Given that the grinding frequency for straights and curves are widely different, with 40 MGT on straights and 10 MGT on curves below 1000 m radius, there will be occasions that will require considerable travel between grinding locations within the shift.

For example, if a track section involves three different grinding intervention rates of 40 MGT (start of section, covering 45% of distance), 10 MGT (middle of section, covering 10 % of distance) and 20 MGT (end of section, covering 45% of distance), we note that over a 10 MGT increment that happens four times:

- The 40 MGT section needs to be ground only once
- The 10 MGT section needs to be ground four times
- The 20 MGT section needs to be ground twice.

What this means is that there will be occasions where Aurizon Network, via Aurizon Operations, will have to travel past at least 45% of a track section to service only the short 10 MGT section. This poses efficiency issues for Aurizon Network and Aurizon Network to be cognisant of. Considering this, it is possible that average productive time per 12 hour shift will be 30% only. We reiterate here that this assessment is borne out by the data supplied by Aurizon Network. Given the above, we consider Aurizon Operations' use of possession time to be prudent and, accordingly, Aurizon Network's operational practices related to rail-grinding decisions are deemed to be efficient.

1.2.3 Costs

1.2.3.1 Aurizon Operations' internal contract with Aurizon Network vs. a market-based contract

The costs allowed by Aurizon Network for the proposed grinding program through UT5 are based on an internal contract between Aurizon Network and Aurizon Operations (as owner of the Aurizon Group's mechanised grinding fleet).

[redacted]

[redacted]

While Aurizon Network's current rail-grinding contract with Aurizon Operations was not available for inspection, there is no reason to suggest that Aurizon Network's rail grinding costs are not efficient. Aurizon Operations is also contracted to ARTC in the Hunter Valley and the wider ARTC network, and to Brookfield (Now Arc) and BHP Billiton in Western Australia, all of whom we understand conduct competitive tendering processes for rail grinding services.

If there are any substantial differences in rate between Aurizon Network, ARTC, Arc and BHP Billiton, it is possible that the differences will be due to the individual circumstances of the railway, particularly when the same contractor is being used. For example, rail grinding operations may be conducted less often and involve more grinding pass kilometres for every completed kilometre. Similarly, the track configuration of curves and tangents also affects the number of grinding pass kilometres as curves require more metal removal than tangents. Also, rail grinding costs are related to support services such as removal and replacement of level crossings and rail lubricators. Possessions themselves vary in extent and structure from railway to railway. These factors affect the total all-up cost of the rail grinding task.

Of note, however, is the absence of any reference to initiatives in the UT5 rail-grinding program. We note that inefficiency may arise from the lag between one contract period and the next, where new initiatives could be applied but have not been applied because of ambiguous KPI specification and the lack of contract accountability. We also note that items of change that have occurred in the last five years with rail grinding include Aurizon's new Enterprise Agreements, which have the potential to provide for more flexible and productive use of possession time within shifts.

It is unclear if the above changes have been reflected in the contract cost negotiated by Aurizon Network with Aurizon Operations. As such, future business opportunities should be monitored and contract pricing structures should be reviewed as network operations, workforce management and new knowledge evolve. Despite the absence of any initiatives in this area, we are satisfied that Aurizon Network is receiving value for money in the delivery of rail grinding services from Aurizon Operations over the UT5 period. However, we recommend that Aurizon Network provides more evidence of seeking to achieve unit cost reductions in grinding costs over and beyond the UT5 period.

1.2.3.2 Split of costs across CQCN systems

We propose pro-rating Aurizon Network's forecast rail-grinding costs across the CQCN systems in line with our recommended scopes for each CQCN system. Aurizon Network's proposed costs on a system-by-system level for rail grinding on the mainline are set out in Table 8.

Table 8 - Aurizon Network's rail-grinding cost proposal - mainlines[14]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 9 sets out our proposed prudent and efficient costs for rail grinding on the mainline over the UT5 period.

Table 9 – GHD's recommended rail-grinding costs – mainlines

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Consistent with our position on scopes, our recommended costs for mainline rail grinding in the Goonyella coal system are higher than Aurizon Network's forecasts, while our recommended costs for mainline rail grinding in other CQCN systems is lower than Aurizon Network's forecasts. Overall, however, we have not amended Aurizon Network's total-cost proposal for mainline rail grinding.

Our position on turnout rail grinding is captured by Table 10.

Table 10 - GHD's recommended rail-grinding costs - turnouts[15]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[14] Split between Mainline and Turnouts based on *170713-RFI-UT5 Maintenance_AN,* worksheet '2_Tab 1',cell EB15:EE17 and scaled to the total cost found in *Maintenance UT5 Cost Build*, worksheet 'Total NMP', cell D75:G75, accounting for 0.00001% difference between the totals.

[15] Ibid

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Consistent with our position on turnout scopes, our recommended costs for turnout rail grinding in the Goonyella coal system are higher than Aurizon Network's forecasts, while our recommended costs for turnout rail grinding in other CQCN systems is lower than Aurizon Network's forecasts. Overall, however, we have not amended Aurizon Network's total-cost proposal for turnout rail grinding.

1.2.3.3 MCI accounting cost components

Aurizon Network's UT5 maintenance-cost proposal did not include a breakdown of rail-grinding costs on an MCI cost-component basis. We have assumed Aurizon Network has not provided this breakdown of costs because rail-grinding is 100% externally procured and has been done so on the basis of a fixed and variable charge. Accordingly, we did not seek an MCI breakdown of costs from Aurizon Network.

1.2.4 GHD's recommendations on accountability and incentives

Since Aurizon Operations, rather than Aurizon Network, undertakes grinding operations, the company with the greater incentive to be accountable will be Aurizon Operations. It will be necessary to see the actual contract to understand the incentives in place to deliver the scope of work. Aurizon Network has not been willing to provide us a copy of its contract with Aurizon Operations, due to Aurizon Operations' preference to not disclose it to us. However, Aurizon Network made the following statement in response to RFI 2[16] for our consideration:

"At this stage, given the competitiveness of the Aurizon Operations offer (in terms of both price and quality of service), there is no intention to conduct a separate tender process for the UT5 regulatory period. Aurizon Operations has been maintained as the efficient service provider."[17]

In our experience, we would expect the contract to provide for both time and productivity payments, in a manner that would ensure Aurizon Operations would receive compensation if its rail grinding equipment was on site and ready to operate but for reasons within Aurizon Network's control, such as track possessions, the equipment could not actually be used for productive activity. Conversely, if Aurizon Network provides track possession hours, the contract should indicate the minimum level of productivity and provide for additional payments related to kilometres of grinding completed. In this context, Aurizon Network will need to plan, in detail, how to optimise the use of reduced possessions to deliver an increasing scope.

[16] RFI Master tab in RFI 2 workbook

[17] RFI2 response

2. Rail grinding

2.1 Maintenance product description

Rail grinding is the process of removing metal from the head of the rail to either reshape the rail head, remove defects or prevent defects occurring. The first process is referred to as corrective grinding, whilst the latter is referred to as preventative grinding. The intention of grinding is to maximise the life of the rail and improve train running. The Aurizon Network grinding program will predominantly be preventative, to elongate rail lifespan to the maximum extent practicable and to eliminate the probability of defects inhibiting rail operations.

Given the high tonnages and high axle loading associated with rail operations, prevention of rolling contact fatigue (RCF) to the rail head is crucial, as it can lead to premature failure of the running rails. In dealing with RCF, the primary concern is the development of cracks in the rail surface, which are initially horizontal. At a depth of 0.2 mm, the cracks become vertical. Left unchecked, this will lead to uncontrolled crack propagation and rail failure. For this reason, it is generally considered desirable to remove a minimum of 0.2 mm of metal from the rail head during a grinding operation, to ensure the horizontal cracks are removed and cannot develop further as vertical cracks.

In general, the grinding cycle will be controlled by the tonnage passing over the track. It will also be heavily influenced by the degree of track curvature. As the curve radius becomes smaller, the outer rail will be subject to increasing horizontal loading from the wheel flange. As it steers the train into the curve, side-wear ensues to the head. At the same time, the inner rail head will tend to flatten due to the imbalance in wheel loads when curving. In the case of curves, the rail heads may be ground to differing profiles, commonly referred to as asymmetric grinding, to improve wheel running in curves and minimise side loading to the outer rail.

Table 11 includes CQCN details that are relevant for assessing the prudency of the scopes for Aurizon Network's proposed rail-grinding program for the UT5 period.

Table 11 – CQCN Characteristics

Network Characteristics	Blackwater	Goonyella	Newlands	Moura	GAPE
Total track					Not included in rail grinding program
Including yards, sidings and passing loops	1,171.361 km	1,021.319 km	315.094 km	311.416 km	
Duplicated track	296.950 km	182.773 km	0 km	14.107 km	
Passing loops	27.298 km (16 passing loops)	35.506 km (15 passing loops)	25.111 km (14 passing loops)	23.025 km (12 passing loops)	
Sidings	14.371 km (35 sidings)	10.535 km (34 sidings)	2.048 km (11 sidings)	4.449 km (11 sidings)	
Electrified track	1,122.527 km	1,014.842 km	13.700 km	0 km	
Access roads	979.895 km	669.079 km	216.797 km	260.873	
Level crossings	228 crossings	275 crossings	149 crossings	82 crossings	
Lubricators	40 sites	33 sites	22 sites	13 sites	

Network Characteristics	Blackwater	Goonyella	Newlands	Moura	GAPE
Crew change facilities	87 sites	130 sites	44 sites	46 sites	

Aurizon Network's rail-grinding cost proposal contains the following categories:

- Mechanised rail grinding for mainlines
- Mechanised rail grinding for turnouts.

2.2 Description of the production process

This subsection describes how Aurizon Network undertakes its rail-grinding operations via Aurizon Operations; we do not comment in this subsection on the efficiency of the rail-grinding machines or on the efficiency of how Aurizon Network uses its possession time to enable Aurizon Operates to complete the agreed rail-grinding scopes.

Following meetings with both Aurizon Network and Aurizon Operations[18], we understand that the vast majority of rail grinding operations are undertaken outside system shutdowns. The principal factors driving this method of working are the lengths of work covered by grinding being much larger than those for other mechanised operations (e.g. ballast undercutting). Accordingly, the method selected limits the scope of grinding work. The major factor involved is the need for repeated treatments of the rail in locations determined by both tonnage and curvature. For example, if the Goonyella system is carrying 100 MNT annually, then, assuming the conversion factor is about 1.59[19] for net to gross tonnes, then the MGT is 159. At this level of tonnage, the straights are ground at 40 MGT, or approximately 4 times per year, but curves are to be ground at 10 MGT, approximately just over every three weeks.

Given the size of the system and frequency of operation to maintain an effective program, the majority of the work is undertaken at night throughout the year. Temperatures are cooler at night and there is less chance of ignition of bush. Operations can also be better monitored at night because of the contrast of light. Grinding in summer also brings a higher risk of fire and heat-shock to be suffered by workers operating in high temperatures during the day. The task is highly seasonal.

Advice provided by Aurizon Operations[20] indicates that a rail measuring program with hi-rail equipment is running some weeks in advance of a grinding program to determine a precise scope of works and the proposed works then programmed with Aurizon Network at two months prior. With respect to equipment, Aurizon Operations uses an 80-stone grinder and a 24-stone grinder. The first machine is used exclusively for plain track, while the second machine is used for both plain track and turnouts.

[18] 3 August 2017 and 8 August 2017

[19] Using Aurizon Network's NSAP models

[20] Meetings with Aurizon Operations and Aurizon Network on 8 August 2017

3. QCA's UT4 final decision

3.1 Summary of key aspects of decision

In this subsection, we summarise the QCA's UT4 final decision on Aurizon Network's proposed scopes and costs for rail grinding. We note that the QCA's decision did not assess rail grinding on the basis of mainlines and turnouts. Rather, it took a top-down approach for the assessment of scopes and costs. We do not comment on whether the advice that the QCA received from Jacobs (the nominated consultant) was appropriate; the subsection merely summarises the decisions on scope and costs for rail-grinding services.

3.1.1 Scopes

For rail grinding, Jacobs found that under Aurizon Network's proposal, the scope (in km) per million tonnes is relatively constant over the UT4 period, which suggested that the scope is directly proportional to volumes under Aurizon Network's cost build-up. Jacobs used this implied relationship to estimate the revised rail grinding scope.

The cost adjustments were then calculated on the basis of this revised scope and unit costs implied in Aurizon Network's numbers. The QCA considered Jacobs' methodology to be consistent with short run variable cost (SRVC) and with the variability in Aurizon Network's maintenance costs. Jacobs' parameters for estimating the adjustments were based on Aurizon Network's submitted costs; hence, the variability was already embedded in Aurizon Network's original proposal.[21]

3.1.2 Costs

The table below summarises the QCA's required adjustments to Aurizon Network's proposed rail-grinding costs for UT4.[22]

Table 12 – QCA's required adjustments to Aurizon Network's UT4 proposed rail grinding costs

Rail grinding	FY2014	FY2015	FY2016	FY2017
AN costs ($FY2012), $M	12.5	13.5	14.0	14.4
QCA adjustment ($FY2012), ± $M	+0.9	+0.2	-1.0	-1.5
QCA approved ($FY2012), $M	13.4	13.7	13.0	12.9

Overall, the QCA's recommended changes to Aurizon Network's rail-grinding costs were minimal.

[21] QCA final decision on Aurizon Network's UT4 proposal, volume IV, p. 115

[22] QCA final decision on Aurizon Network's UT4 proposal, volume IV, pp. 107 and 115

4. Aurizon Network's UT5 proposed scopes

In undertaking the analysis for this section, we have considered the projected tonnage task for UT5 and CQCN system lengths. Given that all systems consist of welded rail on concrete sleepers with ballast, we do not consider that the condition of the rail itself will determine the grinding program or scope. Even new rail will, after a certain amount of tonnage has traversed on it, require preventative grinding treatment to ensure the maximum possible life eventuates. Deformation of the rail head will occur any time the tonnage overhead exceeds the local yield stress of the rail. Because of this, rail grinding is considered the most effective rail maintenance operation. The practice reduces the need to replace the rail and maintains the head in optimum condition, allowing for the efficient movement of rolling stock.

Our analysis of the proposed scope against projected tonnage and comparison with the standards used by similar rail organisations, suggests the scope proposed is prudent in maintaining the various systems forming the network. Nevertheless, after a grinding operation, numerous factors will cause the rail surface to deteriorate, including, tonnage, wheel wear, and steel quality.

Simply replacing rails to remove the defects in the running rails is not a cost-effective option. Tying a re-railing program to rail grinding works has no genuine benefits. We also note that the current practice on many rail networks is to undertake a grinding program on new rails *before* traffic loading, as a preventive measure and to reshape the rail head to match the wheel profile.

We have used the above context to analyse the grinding scopes proposed by Aurizon Network for the UT5 period. We have considered the projected tonnages, systems lengths, amount of curved track and duplications. In general, the condition of the infrastructure will have little impact on grinding operations, particularly as all tracks forming the CQCN mainlines are continuous rail on concrete sleepers on ballast and are capable of supporting 22 or 26.5 TAL.

The location of works should have little influence on the costs incurred, unless there are significant relocation distances between various work sites. Similarly, with suitable planning, the amount of active time would be comparable between one system and another for a given track length. Finally, we do not consider Aurizon Network's legislative and regulatory obligations have any direct drivers on rail-grinding work scopes. What drives a grinding program is the need to maximise rail life by removing defects and holding the head of the rail to a profile suitable for the wheel profiles in use to prevent rail defects.

5. GHD's analysis on scopes, practices and costs

5.1 Scopes

We consider the scope proposed by Aurizon Network against the projected tonnages over the CQCN to be reflective of a prudent program of preventative grinding. The proposed scopes also correspond to the intervention rates allowed in Aurizon Network's Asset Maintenance and Renewals Policy (AMRP). The Aurizon Network proposed intervention rate allowances for tonnages and curvature are comparable with those of the Australian Rail Track Corporation (ARTC), as defined in *ETN–01-02 Rail Grinding Manual for Plain Track* [23].

Aurizon Network uses the following intervention frequencies: [24]

- Straight track 40 MGT
- Curves 1001 to 2500 metres radius 20 MGT
- Curves less than 1000 metre radius 10 MGT
- Turnouts 40 MGT.

For comparison, ARTC uses the following for its coal tracks[25]:

- Straight track and greater than 900 metres 40 MGT
- Curves 450 to 900 metres radius 20 MGT
- Curves less than 450 metre radius 10 MGT
- Turnouts – the ARTC document refers to plain track only but, since turnouts are generally located on straight track, the intervention frequency would be similar to straight track as used by Aurizon Network.

ARTC's smaller-radius criteria reflects the use of standard gauge rather than narrow gauge, which will allow easier bogie curving for the same radius. This is because the vertical loading to the rail on curves will be higher for narrow gauge than standard gauge due the narrower distance between the wheels on an axle. In our view, accounting for the difference in gauge, Aurizon Network's proposed intervention rates are comparable with ARTC's. Given the tonnage task on Aurizon Network's infrastructure and the comparability of its intervention rates with ARTC, we do not recommend any adjustment to Aurizon Network's proposed rail-grinding scopes.

The intervention target at 40MGT for both Aurizon Network and ARTC takes into account varying axle loads, in that 40 MGT at 30 tonnes axle loading is reached after the passage of 1.333 million axles and 1.51 million axles at 26.5 tonne axle load.

Neither the Aurizon Network Asset Maintenance and Renewals Policy nor the ARTC ETN–01-02 Rail Grinding Manual for Plain Track document used in analysing the scope make a distinction for standard or head hardened rail. Experience elsewhere suggests that, in terms of fatigue, head-hardened rail may not provide a greater rail life than standard rail:

[23] See ARTC document ETN-01-02. The ETN–01-02 Rail Grinding Manual for Plain Track is available here: https://extranet.artc.com.au/docs/eng/track-civil/workinstruct/rail/ETN-01-02.pdf

[24] Refer to Aurizon Network's AMRP

[25] ETN–01-02 Rail Grinding Manual for Plain Track

"*These observations would explain why some head-hardened rails have had to be removed from track after only 200 million gross tons of traffic as a result of severe spalling to a depth of 3 mm."*[26]

It would therefore be unwise to reduce the grinding program for head-hardened rail. Also, given the limited lengths of head-hardened rail in track, it is unlikely that any real benefit (i.e. no actual savings in costs because it does not alter the overall amount of grinding required) would be achieved.

In the article from which the above quote is taken, we note that the only benefit to rail grinding from rail material choice is obtained by adopting a premium "super clean" rail steel in lieu of head-hardened rail. We understand that Aurizon Network have recently chosen to adopt such a steel for future rail renewal that will be sourced from a European supplier. Aurizon Network has done this to increase rail life and reduce wear and tear of the rail. It is unlikely that any substantial quantity will be installed in track for a number of years and thus will have no effect on the rail-grinding scopes and costs for UT5. In this context, our recommendation is to not propose a reduction to Aurizon Network's grinding scopes for the CQCN as a whole, but we have recommended adjustments *across* each CQCN system. The paragraph below addresses these recommendations.

In Table 13, we set out Aurizon Network's scopes and compare that with our proposed efficient scopes for the CQCN and its component systems. Scopes are presented on a finished-km basis.

Our principles for determining proposed scopes is based on the following approach:

- Convert forecast net tonnes, using Aurizon Network's forecast in FY2019 (same as FY2020 and FY2021), which is Aurizon Network's highest annual forecast for UT5, to gross net tonnes. This conversion process uses Aurizon Network's NSAP data
- Isolate percentage of track that is 'straight' (40 MGT intervention rate) or 'curved' (20 MGT intervention rate) for each CQCN system (see first for rows). Given the level of information we had on curved track, we have assumed that all curved track falls within the 20 MGT intervention-rate category (i.e. none of the curved track has radius <1,000 m intervention-rate category)
- Determine length of grinding required, using the: Aurizon Network AMRP intervention rates for straight and curved track; forecast gross tonnes for the CQCN, as a whole, and each CQCN system.

Table 13 – Grinding scope analysis (system and CQCN levels)

Parameter	CQCN	Blackwater	Goonyella	Newlands (and GAP)	Moura
Total length (km)	2,674	1,107	979	328	260
Straight (km)	1,506	681	468	228	129
Curve (km)	1,168	426	511	100	131
Curve percentage	43.7%	38.50%	52.20%	30.50%	50.40%
Million Net Tonnes Forecasts (AN's FY2019 forecast)	228	71	120	27	10
Million Gross Tonnes Forecasts (AN's FY2019 forecast)[27]	357	113	188	40	16

[26] *Investigation of rolling contact fatigue in a head-hardened rail*, V.Dikshit, P.Clayton, D.Christensen (available at https://doi.org/10.1016/0043-1648(91)90008-I)

[27] Based on MNT to MGT conversion factors set out in Aurizon Network's NSAP models, ranging from 1.478 to 1.59

Parameter	CQCN	Blackwater	Goonyella	Newlands (and GAP)	Moura
Total mainline scopes (km)	**CQCN**	**Blackwater**	**Goonyella**	**Newlands (and GAP)**	**Moura**
AN	4,140	1,822	1,822	331	166
GHD	3,715	1,282	2,156	213	64
AN/GHD	111.4%	142.1%	84.5%	155.0%	259.1%

Our estimate of the prudent scope for the CQCN (i.e. 3,715 km) is within 12% of Aurizon Network's estimate (4,140 km). This could be accounted for with the curve radius intervention-rate category utilised. Given our 20% materiality threshold, consistent with the engineering judgement that we exercised consistently in this report, we consider Aurizon Network's proposed *overall* scopes to be prudent. However, the conclusion is not the same on a *system-by-system* level. In particular, in the context of the Aurizon Network's volume forecast of approximately 228 mtpa in FY2019 to FY2021, we note that Aurizon Network's scopes for:

- Blackwater – are 42% higher than our estimate of the prudent scope
- Goonyella – are 16% lower than our estimate of the prudent scope
- Newlands (and GAP) – are 55% higher than our estimate of the prudent scope
- Moura – are 159% higher than our estimate of the prudent scope.

The Moura, Newlands (and potentially Blackwater) systems, based on their age of construction (and the construction technologies available at the time) could well have a disproportionate quantity of curves at <1,000 m, so it could be argued that Aurizon Network's rail grinding scopes are prudent, but without the accurate curve data, these assumptions are not able to be substantiated.

On the above basis, we consider the appropriate scopes for each system to be as shown in Table 14. We have used our partitioning of scopes from the second last row of Table 13, covering 3,715 km of scope, to inform, using a proportioning principles, our partitioning of scopes in Table 14, covering 4,140 km of scope. We have used FY2021 as the anchor for our assessment, as it is the highest scope over the UT5 period but only one km higher than the scopes (i.e. 4,139 km) in each of the other UT5 years.

Table 14 – GHD's proposed recommendations on rail-grinding mainline scopes

Entity	CQCN	Blackwater	Goonyella	Newlands (and GAP)	Moura
Aurizon Network (km)	4,140	1,822	1,822	331	166
GHD (km)	4,140	1,429	2,403	237	71
Difference (GHD – AN) (km)	0	(393)	581	(94)	(95)

As per the information captured in Table 14, we have reduced the scopes for Blackwater (by 393 km), Newlands and GAP (by 94 km) and Moura (by 95 km) systems. For the Goonyella system, we have increased the scope by 581 km. Ultimately, this means an increase in rail-grinding costs allocated to the Goonyella system, and a decrease for rail-grinding costs in the other CQCN systems (see later subsection). Applying the above proportions to the number of Aurizon Network's proposed turnouts over the UT5 period, we have derived our estimate of what we consider a prudent number of turnout rail grinding is (see Table 15 below).

Table 15 – GHD's proposed recommendations on rail-grinding turnout scopes

Entity	System	FY2018	FY2019	FY2020	FY2021
Aurizon Network (no.)	Blackwater	329	333	344	345
	Goonyella	329	333	344	345
	GAP/Newlands	60	60	61	62
	Moura	30	30	31	31
	CQCN	**748**	**756**	**779**	**785**
GHD (no.)	Blackwater	258	261	269	271
	Goonyella	434	439	452	455
	GAP/Newlands	43	43	45	45
	Moura	13	13	13	13
	CQCN	**748**	**756**	**779**	**785**

Consistent with our position on CQCN scopes for rail grinding, we have:

- not proposed amending the total number of turnouts that Aurizon Network has proposed to grind over the UT5 period
- amended the proportion of turnouts to be ground, among the four CQCN systems. In particular, we have proposed increasing the Goonyella turnout scopes and reducing the other systems' turnout scopes. The proportions reflect our position on mainline rail grinding.

5.1.1 Practices

The nature of the grinding operations requires that the works be undertaken throughout the year and predominantly at night (e.g. to reduce risk of fires from the grinding process). In summer, high temperatures during the day increase the risk of uncontrolled fire during the day. Dry and loose kindling can be sparked when brought into contact with the sparks emitted by grinding equipment. Winter also sees cooler temperatures at night and lowers the chance of ignition of bush or kindling, given the majority of the CQCN lies in arid climes. Consequently, grinding operations exhibit distinct patterns of seasonality, with troughs observed in the summer and peaks in the winter.

Operations can also be better monitored at night because of the contrast of light on the maintenance workers. Reduction of visual glare and the avoidance of hazards associated with protracted work in high temperatures, most notably heat-stroke.

Aurizon Network contracts its CQCN grinding operations to Aurizon Operations. Capabilities of the equipment, plus the effective hours available on track made available by Aurizon Network, determine whether Aurizon Operations can meet agreed scopes (e.g. distances).

The Aurizon Network FY2016 Maintenance Cost Report indicates that the grinding completed in FY2016 was 3,932 kilometres for mainline and 783 for turnouts. Therefore, the equipment and personnel should be capable of providing the capacity to undertake the scope identified for UT5 (i.e. 4,140 km for mainline and up to 782 turnouts). However, we need to also account for possession hours made available for grinding.

The FY2016 grinding scopes were determined from Aurizon Network productivity data, as set out in 170512 RFI UT5 Maintenance v8. In that model[28], the aggregated FY2016 performance across the four CQCN systems is shown in Table 16.

Table 16 – FY2016 rail grinding performance summary[29]

Product	Total shift hours	Total productive hours	Total amount ground	Average amount ground per shift	Average amount ground per shift hour	Average amount ground per productive hour
Mainline (km)	2,009	392	4,012.7	20.4	2.0	10.2
Turnouts (no.)	1,198	293	800	7.5	0.7	2.7

The shift hours given for grinding are qualified by Aurizon Network[30] as hours from motel/depot to return to motel/depot. In the absence of other information, we have assumed that 3 to 4 hours in a 10-hour shift are used for travel to site and other pre- and post-operation activities. This is based on Aurizon Network shift activities by percentage for resurfacing activities, which identifies 15% of a shift allocated to road travel and 17% to track travel. For a 10 hour shift, this yields hours on site of 6 or 7 hours.

Within this time, there will be non-productive activities, including crew briefing, awaiting passage of trains and other non-productive activities. For our analysis, we consider a productive hour to be an hour during which the grinding equipment and crew are actually grinding rails in track. This is consistent with the definitions set out in our resurfacing report:

… we consider that productive hours should be regarded as those hours during which resurfacing work is actually being undertaken.[31]

If the productive hours on track average 2 hours, then the effective time represents only 33% of time on track or 20% of shift time. This is only a little better than the resurfacing or ballast cleaning effective hours, despite the use of a subcontractor, Aurizon Operations. A major element with respect to achievability is the time allocated on track, which is largely within the control of Aurizon Network.

Information provided after the rail-grinding meeting[32] with Aurizon Network indicates that Aurizon Operations regularly requests 8 hours on track at three months' notice. In comparison, Aurizon Network generally reduces the planned possession to 4 hours, in the ITP and DTP periods before the day of operations. However, the *actual* time allocated per possession over a 2-week period suggests that, on average, 6 hours on track is achieved.[33]

For clarity to the reader, Aurizon Operations operates the rail-grinding trains and supporting machinery for the grinding process; Aurizon Operations does not provide any Train Control services for the rail-grinding (or any other maintenance task, for that matter) task. Train Control is provided by Aurizon Network, which means that Aurizon Operations' ability to use the rail-grinding machine during a Possession is at the behest of Aurizon Network's direction via Train Control.

Importantly, it should also be considered that, in the context of maintenance (using resurfacing as an example), Aurizon Network should not be looked as a single unit. As an example, we note that Aurizon

[28] See worksheet 2_Tab3 in the *170713 RFI UT5 Maintenance v8*

[29] Aurizon Network allows for one shift per day with Aurizon Operations.

[30] Explained to GHD at a meeting with Aurizon Network staff on 8 August 2017 at Aurizon Network's office.

[31] See page 29 of our Mini Report for Resurfacing

[32] Meeting held on 8 August 2017

[33] RFI2 response from Aurizon Network, and discussed at the meeting on 8 August 2017

Network's Train Control team have different motivations from that of the resurfacing team. Similarly, the Aurizon Network team responsible for planning the rail-grinding operation task with Aurizon Operations is different from the Aurizon Network Train Control team. It would be expected that the Aurizon Network maintenance-related teams would seek to align incentives with the Aurizon Network Train Control team. However, this may not always happen in practice, and is something we consider that Aurizon Network should actively seek to improve at in order to discharge a preventative-maintenance regime in an efficient manner.

For Aurizon Operations to succeed with meeting its rail-grinding scopes, Aurizon Network's maintenance-related teams and Train Control teams must be highly coordinated (which does not seem to be occurring in practice) for Aurizon Operations *to be able to actually use* the possession time it has been allocated (and not just get some of the allocated time, which is what has transpired in practice).

Aurizon Operations indicates that the shift length allowed is 12 hours, which includes time travel time from and to crew members' accommodation. Total travel time is therefore generally 4 hours in total, leaving 8 hours on site as Aurizon Operations requested from Aurizon Network. The productivity per shift in terms of maximum time available for productive work is therefore a maximum of 8 hours from 12 hours, being 67%.

Given that the grinding frequency for straights and curves are widely different, with 40 MGT on straights and 10 MGT on curves below 1000 m radius, there will be occasions that will require considerable travel between grinding locations within the shift.

For example, if a track section involves three different grinding intervention rates of 40 MGT (start of section, covering 45% of distance), 10 MGT (middle of section, covering 10 % of distance) and 20 MGT (end of section, covering 45% of distance), we note that over a 10 MGT increment that happens four times:

- The 40 MGT section needs to be ground only once
- The 10 MGT section needs to be ground four times
- The 20 MGT section needs to be ground twice.

What this means is that there will be occasions where Aurizon Network, via Aurizon Operations, will have to travel past at least 45% of a track section to service only the short 10 MGT section. This poses efficiency issues for Aurizon Network and Aurizon Network to be cognisant of. Considering this, it is possible that average productive time per 12 hour shift will be 30% only. We reiterate here that this assessment is borne out by the data supplied by Aurizon Network. Given the above, we consider Aurizon Operations' use of possession time to be prudent and, accordingly, Aurizon Network's operational practices related to rail-grinding decisions are deemed to be efficient.

5.2 Costs

5.2.1 Aurizon Operations' internal contract with Aurizon Network vs. a market-based contract

The costs allowed by Aurizon Network for the proposed grinding program through UT5 are based on an internal contract between Aurizon Network and Aurizon Operations (as owner of the Aurizon Group's mechanised grinding fleet).

[redacted]

[redacted]

While Aurizon Network's current rail-grinding contract with Aurizon Operations was not available for inspection, there is no reason to suggest that Aurizon Network's rail grinding costs are not efficient. Aurizon Operations is also contracted to ARTC in the Hunter Valley and the wider ARTC network, and to Brookfield (Now Arc) and BHP Billiton in Western Australia, all of whom we understand conduct competitive tendering processes for rail grinding services.

If there are any substantial differences in rate between Aurizon Network, ARTC, Arc and BHP Billiton, it is possible that the differences will be due to the individual circumstances of the railway, particularly when the same contractor is being used. For example, rail grinding operations may be conducted less often and involve more grinding pass kilometres for every completed kilometre. Similarly, the track configuration of curves and tangents also affects the number of grinding pass kilometres as curves require more metal removal than tangents. Also, rail grinding costs are related to support services such as removal and replacement of level crossings and rail lubricators. Possessions themselves vary in extent and structure from railway to railway. These factors affect the total all-up cost of the rail grinding task.

Of note, however, is the absence of any reference to initiatives in the UT5 rail-grinding program. We note that inefficiency may arise from the lag between one contract period and the next, where new initiatives could be applied but have not been applied because of ambiguous KPI specification and the lack of contract accountability. We also note that items of change that have occurred in the last five years with rail grinding include Aurizon's new Enterprise Agreements, which have the potential to provide for more flexible and productive use of possession time within shifts.

It is unclear if the above changes have been reflected in the contract cost negotiated by Aurizon Network with Aurizon Operations. As such, future business opportunities should be monitored and contract pricing structures should be reviewed as network operations, workforce management and new knowledge evolve. Despite the absence of any initiatives in this area, we are satisfied that Aurizon Network is receiving value for money in the delivery of rail grinding services from Aurizon Operations over the UT5 period. However, we recommend that Aurizon Network provides more evidence of seeking to achieve unit cost reductions in grinding costs over and beyond the UT5 period.

5.2.2 Split of costs across CQCN systems

We propose pro-rating Aurizon Network's forecast rail-grinding costs across the CQCN systems in line with our recommended scopes for each CQCN system. Aurizon Network's proposed costs on a system-by-system level for rail grinding on the mainline are set out in Table 17.

Table 17 - Aurizon Network's rail-grinding cost proposal - mainlines[34]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 18 sets out our proposed prudent and efficient costs for rail grinding on the mainline over the UT5 period.

Table 18 – GHD's recommended rail-grinding costs – mainlines

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Consistent with our position on scopes, our recommended costs for mainline rail grinding in the Goonyella coal system are higher than Aurizon Network's forecasts, while our recommended costs for mainline rail grinding in other CQCN systems is lower than Aurizon Network's forecasts. Overall, however, we have not amended Aurizon Network's total-cost proposal for mainline rail grinding.

Our position on turnout rail grinding is captured by Table 19.

Table 19 - GHD's recommended rail-grinding costs – turnouts[33]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[34] Split between Mainline and Turnouts based on *170713-RFI-UT5 Maintenance_v8_QCA*, worksheet '2_Tab 1',cell EB15:EE17 and scaled to the total cost found in *Maintenance UT5 Cost Build*, worksheet 'Total NMP', cell D75:G75, accounting for 0.00001% difference between the totals.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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Consistent with our position on turnout scopes, our recommended costs for turnout rail grinding in the Goonyella coal system are higher than Aurizon Network's forecasts, while our recommended costs for turnout rail grinding in other CQCN systems is lower than Aurizon Network's forecasts. Overall, however, we have not amended Aurizon Network's total-cost proposal for turnout rail grinding.

5.2.3 MCI accounting cost components

Aurizon Network's UT5 maintenance-cost proposal did not include a breakdown of rail-grinding costs on an MCI cost-component basis. We have assumed Aurizon Network has not provided this breakdown of costs because rail-grinding is 100% externally procured and has been done so on the basis of a fixed and variable charge. Accordingly, we did not seek an MCI breakdown of costs from Aurizon Network.

6. GHD's analysis of incentives

6.1 Incentives for meeting maintenance scopes

This subsection assesses what incentives there are for managers and on-ground staff to meet the maintenance scopes provided for in UT5. In our experience, incentive arrangements do exist in the rail industry, and is usually based on the basis of hours available for maintenance work and production achieved. Accordingly, it is appropriate for such an incentive arrangement to exist for the below-rail service provider in the CQCN and its maintenance contractors.

We have not sighted the new rail-grinding contract and we understand that it had not been executed at the time of our analysis. We understand from Aurizon Network's comments during the rail-grinding meetings[35] that the new contract largely reflects the extant contract. However, without the actual details of the new contract evidenced to us, it cannot be determined with certainty whether the contract provides for incentives for Aurizon Operations to maximise productivity, possible productive hours and track access. The production data provided after the meeting with Aurizon Network and Aurizon Operations[36] confirm the grinding operations are throughout the year and are not confined to major system shutdowns and possessions.

There appears at present to be no dedicated production incentive in the current contract between Aurizon Network and Aurizon Operations, although KPI values do exist. Additional information is required to discern whether these KPIs constitute suitable productivity incentives. However, we have decided to take Aurizon Network's provided data at face value and our below analysis is based on that premise.

6.2 Existing compensation mechanisms if scope is not met

There is an incentive arrangement between Aurizon Operations and Aurizon Network for the rail-grinding contract. In particular, a maximum of [redacted] of aggregate fees may be paid contingent on the performance of Aurizon Operations relative to the following listed key performance indicators (KPIs):

- Percentage of work completed to specifications
- On-time track handover, handback achieved
- Work free of lost time injuries
- Work free of events giving rise to safe-working breaches
- Work free of temporary speed restrictions.

These KPIs are assigned weightings as agreed upon by both Aurizon Network and Aurizon Operations for each year, which are used to determine the incentive paid. The effectiveness of this incentive structure cannot be determined until an appropriate analysis of the existing penalty scheme is also undertaken. Of particular importance is ensuring that perverse incentives, in this case improved cost-effectiveness, cannot arise by paying the penalty instead of aiming to exceed targets. We do not comment on whether [redacted] is a reasonable number as there is no publicly available information on what percentages are nominated in external grinding contracts; we have instead focussed on the KPI underpinning Aurizon Network's agreement with Aurizon Operations.

The KPIs used for incentive payment determinations reflect an earnest desire to achieve efficient outcomes. However they are also "lagged indicators", in that they do not address events preceding incidents. Rather, they refer to the incidents themselves. Good performance and practice are not

[35] Meeting held in Aurizon Network's offices on 3 and 8 August 2017.

[36] On 8 August 2017.

necessarily targeted by these KPIs. A more appropriate style of KPI is a “leading indicator”, which observes the initial point at which an incident may be triggered. An example would be the number of safety audits not conducted on time. It is suggested that Aurizon Network modify these KPIs to better reflect actual performance, rather than outcomes.

There was no concrete evidence of penalty schemes in place in the current contract between Aurizon Network and Aurizon Operations. In this context, the main area we have focussed on is the percentage of work completed to specifications. This KPI is vague because it does not outline what the specifications are. It is unclear if the KPI covers distances, grind profile / quality and time allocated to Aurizon Operations for undertaking rail grinding. Since CQCN access holders fund Aurizon Network on the basis of grinding distances / turnouts ground, the grinding contract should, subject to the QCA’s views, possess KPIs that clearly align to these considerations.

6.3 Recommendations

Since Aurizon Operations, rather than Aurizon Network, undertakes grinding operations, the company with the greater incentive to be accountable will be Aurizon Operations. It will be necessary to see the actual contract to understand the incentives in place to deliver the scope of work. Aurizon Network has not been willing to provide us a copy of its contract with Aurizon Operations, due to Aurizon Operations’ preference to not disclose it to us. However, Aurizon Network made the following statement in response to RFI 2[37] for our consideration:

“At this stage, given the competitiveness of the Aurizon Operations offer (in terms of both price and quality of service), there is no intention to conduct a separate tender process for the UT5 regulatory period. Aurizon Operations has been maintained as the efficient service provider.”[38]

In our experience, we would expect the contract to provide for both time and productivity payments, in a manner that would ensure Aurizon Operations would receive compensation if its rail grinding equipment was on site and ready to operate but for reasons within Aurizon Network’s control, such as track possessions, the equipment could not actually be used for productive activity. Conversely, if Aurizon Network provides track possession hours, the contract should indicate the minimum level of productivity and provide for additional payments related to kilometres of grinding completed. In this context, Aurizon Network will need to plan, in detail, how to optimise the use of reduced possessions to deliver an increasing scope.

[37] RFI Master tab in RFI 2 workbook

[38] RFI2 response

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Level 9 145 Ann Street Brisbane QLD 4000 Australia
GPO Box 668 Brisbane QLD 4001 Australia

61 7 3316 3000
advisory@ghd.com

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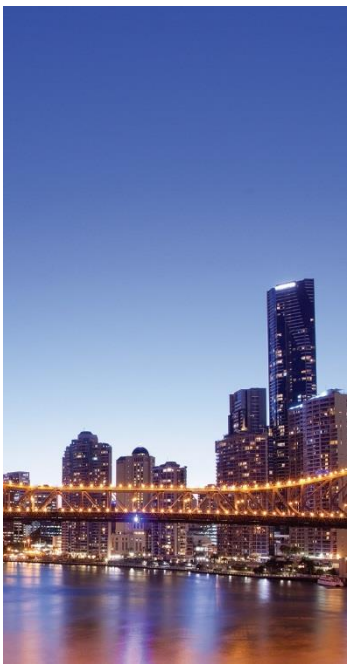

Appendix E – General Maintenance

Mini Report for the Queensland Competition Authority

15 November 2017

GHD

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Disclaimer

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The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1. Executive summary

1.1 Objective and overview of General Maintenance expenditure

The Queensland Competition Authority (QCA) has engaged GHD (us) to review Aurizon Network's (AN) proposed maintenance costs for UT5.

In this mini report, we assess whether an agreed sample of Aurizon Network's proposed general-maintenance costs reflect prudent and efficient maintenance scopes, costs and delivery practices. As requested in the QCA's Terms of Reference (ToR), our analysis considers the following key themes (see Table 1).

Table 1 – Analysis themes

Underlying themes	Title
Efficiency and prudency	The extent to which Aurizon Network's proposals are efficient and prudent.
Achievability	The extent to which the proposals are practically achievable.
Measurability	The extent to which the proposals provide a platform for measuring performance.
Transparency	The extent to which the proposals clearly articulate and commit to a set of outputs.
Accountability	The extent to which Aurizon Network is accountable for its performance.

The following general-maintenance sub-categories were agreed with the QCA to be reviewed:

- Rail repair (C54)
- Fire and vegetation management (C44)
- Track inspections (C50)
- Maintenance ballast (C42)
- Rail stress adjustment (C47)

The above approach covers at least 50% of general-maintenance costs, which is the approach that we have agreed with the QCA. Table 2 presents Aurizon Network's proposed general-maintenance scopes for the selected sub-categories over the UT5 period. In accordance with our Sampling and Prioritising Method Paper agreed with the QCA, we have not extrapolated our findings from this sample to the other categories within general maintenance.

As such, we do not comment on the prudency and efficiency of the total general maintenance category budget. However, as we included general maintenance cost sub-categories C02 – Ballast Undercutting (Other) and C03 - Ballast Undercutting – Turnout – Minor in our assessment of ballast undercutting costs, Aurizon Network's proposed expenditure for these items should be removed from the UT5 expenditure for general maintenance.

Table 2 – Aurizon Network's proposed UT5 general maintenance scope[1]

General maintenance	FY 2018	FY 2019	FY 2020	FY 2021
Rail repair (no.) [2]	Not stated	Not stated	Not stated	Not stated
Fire and vegetation management (km) [3]	5,700	5,700	5,700	5,700
Track inspections (km)	96 hour cycle	96 hour cycle	96 hour cycle	96 hour cycle
Maintenance ballast (km) [4]	No defined scope	No defined scope	No defined scope	No defined scope
Rail stress adjustment (km) [5]	No defined scope	No defined scope	No defined scope	No defined scope

Aurizon Network has not identified a scope of works for any of selected sub-categories with the exception of fire and vegetation management in the corridor. Nor did Aurizon Network provide detail of the scopes in response to the QCA's request for information (RFI). Instead, Aurizon Network advised that its respective engineers developed a cost for each cost sub-category for the UT5 period based on historic expenditure and that these were then refined in consultation with internal stakeholders. From our experience, we consider that a suitable method for arriving at a cost for general maintenance activities is one that is based on experience and history with due allowance for labour, plant, materials, changes in practices/technologies, material changes in rail network infrastructure and, where appropriate, contractors. However, we also consider it appropriate for Aurizon Network to capture historic information on scopes undertaken under the general maintenance category to facilitate future assessment of general maintenance costs.

In developing this report, in absence of projected scopes and details of historic scopes from Aurizon Network, we have relied largely on the experience of our engineering staff and drawn on in-house cost data to assess the prudency of scope and efficiency of costs for the sub-category sample. We recognise that, given that some of the workload varies year by year on reactive basis, it is not possible to develop absolute scopes of work for these activities (although as mentioned, information on historic scopes should be available to support projected expenditure). As such, the expenditure for UT5 may be considered an allowance for work that is likely to occur based on historic scopes and expenditure.

Table 3 presents Aurizon Network's proposed general-maintenance costs for the sub-categories reviewed (approximately $100 million ($FY2015) over UT5) for the selected sub-categories in this mini-report.

Table 4 presents GHD's proposed general-maintenance costs for the sub-categories reviewed in this mini-report and Table 5 compares the totals of the general maintenance sub-category costs proposed by Aurizon Network and GHD for UT5 ($FY2015).

[1] Aurizon Network's response to RFI 4 from the QCA

2 170620 – Aurizon Network's responses to UT5 Maintenance RFI 4, Tab 'GM-Total(2)' Row 27

3 Assumes semi-annual sweeps of entire network

4 170620 – Aurizon Network's responses to UT5 Maintenance RFI 4, Tab 'GM-Total(2)' Row 30

5 170620 – Aurizon Network's responses to UT5 Maintenance RFI 4, Tab 'GM-Total(2)' Row 31

Table 3 – Aurizon Network's proposed UT5 general maintenance costs (real FY2015) [6] for five sub-categories

General maintenance ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Rail repair	6,831,229	6,831,229	6,831,229	6,831,229
Fire and vegetation management	5,834,910	5,834,910	5,834,910	5,834,910
Track inspections	5,697,185	5,697,185	5,697,185	5,697,185
Maintenance ballast	3,464,591	3,464,591	3,464,591	3,464,591
Rail stress adjustment	3,136,956	3,136,956	3,136,956	3,136,956
Total	**24,964,871**	**24,964,871**	**24,964,871**	**24,964,871**

Table 4 - GHD's proposed UT5 general maintenance costs (real FY2015) for five sub-categories

General maintenance ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Rail repair	6,071,658	6,071,658	6,071,658	6,071,658
Fire and vegetation management	5,632,050	5,632,050	5,632,050	5,632,050
Track inspections	4,000,000	4,000,000	4,000,000	4,000,000
Maintenance ballast	3,128,175	3,128,175	3,128,175	3,128,175
Rail stress adjustment	3,136,957	3,136,957	3,136,957	3,136,957
Total	**21,968,840**	**21,968,840**	**21,968,840**	**21,968,840**

Table 5 - Summary of UT5 general maintenance costs (real FY2015) proposed by AN and GHD for the five sub-categories

General maintenance ($FY2015)	Total AN Proposed ($FY2015)	Total GHD Proposed ($FY2015)	Difference ($FY2015)	Difference %
Rail repair	27,324,916	24,286,632	-3,038,284	-11%
Fire and vegetation management	23,339,640	22,528,200	-811,440	-3%
Track inspections	22,788,740	16,000,000	-6,788,740	-30%
Maintenance ballast	13,858,364	12,512,700	-1,345,664	-10%
Rail stress adjustment	12,547,824	12,547,828	4	0%
Total	**99,859,484**	**87,875,360**	**-11,984,124**	**-12%**

Table 6 presents Aurizon Network's proposed general maintenance costs for all general maintenance categories, not including track-ballast undercutting. Table 7 presents our proposed general maintenance costs for all general maintenance categories, noting that we only assessed 5 of these categories through our

[6] Real Costs sourced from Maintenance UT5 Cost Build Model: Product Summary – Real$; Total NMP

sample and prioritisation process. Table 8 presents a comparison between Aurizon Network's proposed general maintenance costs for all general maintenance categories (not including track-ballast undercutting) and GHD's proposed general maintenance costs for all general maintenance categories (not including track-ballast undercutting).

Table 6 – Aurizon Network's proposed UT5 general maintenance costs (real FY2015) [7] for five sub-categories

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)
Earthworks - Non Formation	C06	2,896,355	2,896,355	2,896,355	2,896,355	11,585,420
Fencing	C07	308,294	308,294	308,294	308,294	1,233,176
Rail Joint Management	C08	780,691	780,691	780,691	780,691	3,122,764
Turnout Maintenance	C10	2,987,665	2,987,665	2,987,665	2,987,665	11,950,660
Minor Yard Maintenance	C28	579,483	579,483	579,483	579,483	2,317,932
Track Geometry Recording	C29	1,988,226	1,988,226	1,988,226	1,988,226	7,952,904
Rail Flaw Detection - On Track Vehicle	C30	1,536,116	1,536,116	1,536,116	1,536,116	6,144,464
Monument/Signage Maintenance	C37	521,130	521,130	521,130	521,130	2,084,520
Maintenance Ballast	C42	3,464,591	3,464,591	3,464,591	3,464,591	13,858,364
Sleeper Management	C43	2,583,151	2,583,151	2,583,151	2,583,151	10,332,604
Fire & Vegetation Management	C44	5,834,910	5,834,910	5,834,910	5,834,910	23,339,640
Rail Stress Adjustment	C47	3,136,956	3,136,956	3,136,956	3,136,956	12,547,824
Rail Flaw Detection - Manual	C48	477,871	477,871	477,871	477,871	1,911,484
Track Inspections	C50	5,697,185	5,697,185	5,697,185	5,697,185	22,788,740
Track Clean-up	C51	1,474,629	1,474,629	1,474,629	1,474,629	5,898,516
Rail Lubrication	C52	1,836,077	1,836,077	1,836,077	1,836,077	7,344,308
Top & Line Spot Resurfacing	C53	2,012,495	2,027,262	2,027,262	2,027,262	8,094,281
Rail Repair	C54	6,831,229	6,831,229	6,831,229	6,831,229	27,324,916
Level Crossing Maintenance	C57	1,686,455	1,686,455	1,686,455	1,686,455	6,745,820
Inventory Management		-278,280	-247,896	-217,944	-188,419	-932,539

[7] Real Costs sourced from Maintenance UT5 Cost Build Model: Product Summary – Real$; Total NMP

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)
Total		**46,635,229**	**46,400,380**	**46,430,332**	**46,459,857**	**185,645,798**

Table 7 - GHD's proposed UT5 general maintenance costs (real FY2015) for five sub-categories

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)
Earthworks - Non Formation	C06	2,896,355	2,896,355	2,896,355	2,896,355	11,585,420
Fencing	C07	308,294	308,294	308,294	308,294	1,233,176
Rail Joint Management	C08	780,691	780,691	780,691	780,691	3,122,764
Turnout Maintenance	C10	2,987,665	2,987,665	2,987,665	2,987,665	11,950,660
Minor Yard Maintenance	C28	579,483	579,483	579,483	579,483	2,317,932
Track Geometry Recording	C29	1,988,226	1,988,226	1,988,226	1,988,226	7,952,904
Rail Flaw Detection - On Track Vehicle	C30	1,536,116	1,536,116	1,536,116	1,536,116	6,144,464
Monument/Signage Maintenance	C37	521,130	521,130	521,130	521,130	2,084,520
Maintenance Ballast	C42	3,128,175	3,128,175	3,128,175	3,128,175	12,512,700
Sleeper Management	C43	2,583,151	2,583,151	2,583,151	2,583,151	10,332,604
Fire & Vegetation Management	C44	5,632,050	5,632,050	5,632,050	5,632,050	22,528,200
Rail Stress Adjustment	C47	3,136,957	3,136,957	3,136,957	3,136,957	12,547,828
Rail Flaw Detection - Manual	C48	477,871	477,871	477,871	477,871	1,911,484
Track Inspections	C50	4,000,000	4,000,000	4,000,000	4,000,000	16,000,000
Track Clean-up	C51	1,474,629	1,474,629	1,474,629	1,474,629	5,898,516
Rail Lubrication	C52	1,836,077	1,836,077	1,836,077	1,836,077	7,344,308
Top & Line Spot Resurfacing	C53	2,012,495	2,027,262	2,027,262	2,027,262	8,094,281
Rail Repair	C54	6,071,658	6,071,658	6,071,658	6,071,658	24,286,632
Level Crossing Maintenance	C57	1,686,455	1,686,455	1,686,455	1,686,455	6,745,820
Inventory Management		-278,280	-247,896	-217,944	-188,419	-932,539
Total		**43,359,198**	**43,404,349**	**43,434,301**	**43,463,826**	**173,661,674**

Table 8 - Summary of UT5 general maintenance costs (real FY2015) proposed by AN and GHD for the five sub-categories

General maintenance ($FY2015)	ID	Total AN Proposed ($FY2015)	Total GHD Proposed ($FY2015)	Difference ($FY2015)	Difference %
Earthworks - Non Formation	C06	11,585,420	11,585,420	0	0
Fencing	C07	1,233,176	1,233,176	0	0
Rail Joint Management	C08	3,122,764	3,122,764	0	0
Turnout Maintenance	C10	11,950,660	11,950,660	0	0
Minor Yard Maintenance	C28	2,317,932	2,317,932	0	0
Track Geometry Recording	C29	7,952,904	7,952,904	0	0
Rail Flaw Detection - On Track Vehicle	C30	6,144,464	6,144,464	0	0
Monument/Signage Maintenance	C37	2,084,520	2,084,520	0	0
Maintenance Ballast	C42	13,858,364	12,512,700	-1,345,664	-10
Sleeper Management	C43	10,332,604	10,332,604	0	0
Fire & Vegetation Management	C44	23,339,640	22,528,200	-811,440	-3
Rail Stress Adjustment	C47	12,547,824	12,547,828	4	0
Rail Flaw Detection - Manual	C48	1,911,484	1,911,484	0	0
Track Inspections	C50	22,788,740	16,000,000	-6,788,740	-30
Track Clean-up	C51	5,898,516	5,898,516	0	0
Rail Lubrication	C52	7,344,308	7,344,308	0	0
Top & Line Spot Resurfacing	C53	8,094,281	8,094,281	0	0
Rail Repair	C54	27,324,916	24,286,632	-3,038,284	-11
Level Crossing Maintenance	C57	6,745,820	6,745,820	0	0
Inventory Management		-932,539	-932,539	0	0
Total		**185,645,798**	**173,661,674**	**-11,984,124**	**-6**

1.2 Summary of review of sub-categories

We have summarised our analysis and findings on prudency and efficiency of Aurizon Network's proposed scopes and costs for the five general-maintenance sub-categories in the following sub-sections. We provide detailed analysis underpinning our findings of prudency of scope and efficiency of costs in Section 0.

1.2.1 Rail repair

Description

Aurizon Network defines 'rail repair' as the repair of defects and failures in railway rails. This includes internal rail defects, defective welds or broken rails. For rail repairs to be classed as maintenance, as opposed to a renewal, the work in any one occurrence must be within a length of 12 m of rail.

Given the relatively small scale of each operation, we understand that this work is undertaken by Aurizon Network staff directly and is not subcontracted. Additionally, this work is reactive in nature and is based on detected defects.

Prudency of scope

We recognise that it is not possible for Aurizon Network to plan for, or be aware of all faults in rails or of faults that are yet to occur in a given period and, as such, Aurizon Network will be unable to define precisely future scope. However, we would expect Aurizon Network to be able to draw on historic data of works carried out together with information available on the condition of the rail at any particular location to develop the scope for UT5 and ultimately forecast expenditure.

Given that periodic rail repair activities are required on a rail system we consider this expenditure sub-category to be prudent. However, in absence of information on historic activities in terms of lengths or numbers of rails repaired to support forecast expenditure, we are unable to determine that the scope supporting the forecast expenditure is prudent or not.

Efficiency of costs

Aurizon Network has allowed $6,831,229 per annum for the duration of UT5. As discussed above, Aurizon Network has not provided details on the potential scope underlying the proposed annual cost for rail repair but has stated that it has based its UT5 proposed costs on historic costs. Historical UT4 actual expenditure and proposed UT5 expenditure is shown in Table 9.

Table 9 – Aurizon Network's historic and proposed rail repair maintenance expenditure by system[8]

Rail repair ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	386,295	717,968	587,557	657,019	678,368
Goonyella	2,196,356	2,899,486	2,639,656	2,440,358	2,519,653
Blackwater	2,430,421	2,892,034	2,197,654	3,351,302	3,460,198
Moura	254,209	172,195	296,555	167,565	173,010
CQCN	**5,267,280**	**6,681,684**	**5,721,422**	**6,616,244**	**6,831,229**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

[8] 170713 – RFI, 3_Tab4' Row 96. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

The historic costs during UT4 average approximately $6 million per annum which, from our engineering judgement and for a system of 2,564 km (average km of track during UT4)[9] we consider to be reasonable and hence efficient.

We note that Aurizon Network has escalated FY2017 costs by 3.25% to derive its proposed UT5 expenditure. Given that proposed costs are real in FY2015 dollars, we see no justification for applying such an escalator, particularly since the increase in track length in UT4 of 413 km[10] occurred in the latter part of UT4 and hence should not contribute to rail repair costs during UT5. Since the costs will vary year on year, we consider it more appropriate for the proposed UT5 costs to be based on the average of the UT4 costs in $FY2015, to smooth out these variances in expenditure.

Our recommended efficient costs on a system level are provided in Table 10.

Table 10 – GHD's proposed efficient UT5 rail repair efficient expenditure

Rail repair ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021	Total
Newlands	587,210	587,210	587,210	587,210	2,348,840
Goonyella	2,543,964	2,543,964	2,543,964	2,543,964	10,175,856
Blackwater	2,717,853	2,717,853	2,717,853	2,717,853	10,871,412
Moura	222,631	222,631	222,631	222,631	890,524
CQCN	**6,071,658**	**6,071,658**	**6,071,658**	**6,071,658**	**24,286,632**

Our proposed efficient expenditure represents an 11% or $3,038,284 overall reduction, on Aurizon Network's proposed UT5 expenditure for rail repair.

1.2.2 Fire and vegetation management

Description

Aurizon Network is responsible for the proper maintenance of the corridor; including control of weeds and maintenance of firebreaks. In addition, it also has an obligation to ensure the safe operation of the rail network and this will include for example ensuring control of vegetation at level crossings to ensure maintenance of sight distances, and to ensure maintenance operations are carried out safely and efficiently. We understand that the principal process for vegetation control is by mechanical means.

Prudency of scope

Aurizon Network is responsible for maintaining the below-rail corridor safely and efficiently which requires fire and vegetation management. Aurizon Network has advised a high level scope of managing 5,700 km per annum, which equates to undertaking fire and vegetation management twice per year. We consider this scope to be prudent for 'average' rainfall conditions.

Efficiency of costs

Average expenditure during UT4 was approximately $5.6 million per annum. For an average corridor width of 40 m and total length managed of 5,770 km (assuming undertaking vegetation management twice per year per section of track), the cost of vegetation management is less than $0.03 per m^2 which we consider to be reasonable.

Table 11 shows historic UT4 expenditure and proposed UT5 expenditure.

[9] Aurizon Network response to QCA RFI 3 170512-RFI-UT5 Maintenance_v8_QCA v1 SMc.xlsx row 5 of 3_Tab 6

[10] Aurizon Network response to QCA RFI 3 170512-RFI-UT5 Maintenance_v8_QCA v1 SMc.xlsx row 5 of 3_Tab 6

Table 11 – Historic and proposed fire and vegetation management expenditure by system[11]

FVM ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	902,447	790,663	955,248	632,185	830,655
Goonyella	2,970,239	2,551,751	2,421,060	2,578,240	2,662,016
Blackwater	1,946,138	1,556,703	1,839,176	1,849,687	1,909,126
Moura	345,727	278,709	490,742	419,483	433,113
CQCN	**6,164,551**	**5,177,827**	**5,706,226**	**5,479,594**	**5,834,910**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

We note that Aurizon Network's proposed UT5 expenditure for each system, with the exception of Newlands, represents an approximately 3% increase in FY2017 expenditure. For Newlands the FY2018 proposed expenditure is approximately the average of FY2014 to FY2017 expenditure plus an additional allowance of approximately $10,000. Aurizon has not provided information supporting increasing historic FY2017 costs to derive those submitted for UT5.

Given the year on year variable nature of the costs, we consider it appropriate to base UT5 costs on the average of the UT4 costs to smooth out this variance. We have developed our recommended efficient costs based on an average of UT4 costs on a system level as provided in Table 12.

Table 12 – GHD's proposed efficient UT5 fire and vegetation management expenditure

Rail repair ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021	Total
Newlands	820,136	820,136	820,136	820,136	3,280,544
Goonyella	2,630,323	2,630,323	2,630,323	2,630,323	10,521,292
Blackwater	1,797,926	1,797,926	1,797,926	1,797,926	7,191,704
Moura	383,665	383,665	383,665	383,665	1,534,660
CQCN	**5,632,050**	**5,632,050**	**5,632,050**	**5,632,050**	**22,528,200**

Our proposed efficient expenditure represents a 3.5%, or $811,440 reduction, on Aurizon Network's proposed UT5 expenditure for fire and vegetation management.

1.2.3 Track inspections

Description

Track inspections are undertaken to identify defects and damage on the track or in the corridor that could cause delays or disruptions to service operations to inform the scope for maintenance and renewals works. The activity is undertaken through on-track visual inspection patrol in a hi-rail vehicle (track inspection), supplemented by an on-track machine-based inspection by a specialist recording vehicle (track recorder) contracted, with crew, from Queensland Rail. The data from the inspections is processed and used to inform reports setting out the requirements for maintenance and renewals.

Prudency of scope

Aurizon Network is required under its safety management system to undertake periodic rail track and corridor condition inspections. This activity informs required maintenance and renewal works. As such we consider the activity to be prudent.

During UT4, the track inspection was undertaken on a four day (96 hour) cycle supplemented by a track recording vehicle owned and operated by Queensland rail running twice yearly. However post 2015, Aurizon

[11] 170713 – RFI, 3_Tab 4' Row 68. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

Network is permitted by the Office of National Rail Safety Regulator (ONRSR) to undertake track and corridor visual inspections on a 192 hour cycle[12]. Aurizon Network has based its UT5 expenditure track inspection on historic costs (96 hour cycle) and has therefore not factored-in the reduction in scope allowed through this relaxation of the visual inspection cycle.

As such, from our analysis, we consider the scope that Aurizon Network has priced for UT5 not to be prudent; as the proposed expenditure does not take into account this relaxation in the required visual inspection cycle.

Efficiency of costs

Aurizon Network has not provided details of the make of the costs for track inspections. We have therefore endeavoured to reverse engineer the costs based on experience and the limited data provided by Aurizon network as detailed in Section 2.6.

We estimate the total costs for visual track inspection on a 96 hour inspection cycle plus track recording vehicle at approximately $5.25 million which is comparable to the UT4 actual costs (Table 13), when taking the requirement for emergency inspections into account.

Table 13 – Aurizon Network's historic and proposed track inspection costs by system [13]

Track inspections ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	650,162	743,040	706,963	715,123	630,910
Goonyella	1,598,426	1,729,256	1,558,676	1,519,637	1,566,416
Blackwater	3,194,448	3,222,830	2,679,861	2,279,797	2,933,558
Moura	623,743	611,662	421,072	574,509	566,300
CQCN	**6,066,778**	**6,306,789**	**5,366,572**	**5,089,066**	**5,697,185**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

By adopting a 192 hour cycle for visual track inspections from a 96 hour cycle we consider that Aurizon Network could reduce its costs for track inspection with a hi rail vehicle to approximately $2 million (rounding to the nearest $ million). This reduces track inspection costs by approximately $1.7 million per annum. We set out our proposed efficient expenditure, on the basis of adopting a 192 hour inspection cycle in Table 14 below.

Table 14 – GHD's proposed efficient UT5 track inspection expenditure by system

Track Inspections	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
Newlands	582,477	582,477	582,477	582,477	2,329,908
Goonyella	1,868,111	1,868,111	1,868,111	1,868,111	7,472,444
Blackwater	1,276,925	1,276,925	1,276,925	1,276,925	5,107,700
Moura	272,487	272,487	272,487	272,487	1,089,948
CQCN	**4,000,000**	**4,000,000**	**4,000,000**	**4,000,000**	**16,000,000**

Our proposed efficient expenditure represents a 30%, or $6,788,740 reduction, on Aurizon Network's proposed UT5 expenditure for track inspections.

[12] Appendix C Aurizon Network's UT5 Submission

[13] 170713 – RFI, 3_Tab4' Row 80. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

1.2.4 Maintenance ballast

Description

Aurizon Network defines 'Maintenance Ballast' as the purchase, transport and placement of ballast to restore the ballast profile in areas where there has been loss of ballast in relatively small areas. This excludes activities connected with mainline and turnout ballast undercutting[14].

Prudency of Scope

Maintenance of ballast is crucial to ensuring that interlocking rocks (ballast) beneath the bed of the rail retain their structural integrity. Failure to do so leads to sagging of rails, loss of horizontal integrity and ultimately train delays or derailment. As such, we consider the activity of ballast maintenance to be prudent.

Aurizon Network has not provided information that will allow us to assess the prudency of the scope of work involved with ballast maintenance. However, we have been able to make an estimate of the volume of ballast used each year across the whole of the network for the UT4 period as a proxy for assessing the prudency of scope for the UT4 period (see Section 2.7). The volume used represents a replacement of 0.55% of ballast a year under this maintenance ballast category.

We note that actual year on year usage will vary with weather conditions and local track construction factors and usage as indicated by the variance in UT4 expenditure. However, from our rail engineering knowledge and experience, we consider replacing 0.55% of ballast a year, as an allowance, under this maintenance ballast category for a network of this type and size to be reasonable. As such we consider a prudent annual scope of work for UT5 to be equal to the average annual scope of work undertaken during UT4.

Efficiency of costs

From our analysis of UT4 and UT5 costs (Table 15), Aurizon Network looks to have derived an annual UT5 cost for the Goonyella and Moura systems by escalating its 2017 costs for this expenditure sub-category by 3.25% and for the Blackwater system by escalating 2017 costs by 3.21%. Conversely, the proposed UT5 annual cost for Newlands represents a 51% reduction on FY2017 costs and a 20% reduction on the UT4 average. Aurizon Network has provided limited information supporting the escalation of UT4 costs to derive the UT5 costs for the Goonyella, Blackwater and Moura systems. Aurizon Network has not provided any information underpinning the reduction in UT4 expenditure to derive UT5 costs for Newlands. In response to QCA RFI 4[15], Aurizon Network stated that the required uplift is due to increased track length on the Blackwater System and the additional track installed as part of the Wiggin Island Rail Project. We note from Aurizon Network's response to RFI 3 that the overall track length increased by 413 km between FY16 and FY17[16].

However, given that this increase in track occurred in the later years of UT4, and is therefore relatively new, we do not consider that this increase in system track length should warrant an increase in the maintenance ballast cost allowance during UT5.

Table 15 – Aurizon Network's historic and proposed maintenance ballast costs[17]

Maintenance ballast ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	39,451	173,430	269,113	329,208	161,978

[14] Aurizon Network Asset Maintenance and Renewals Policy page 22

[15] Aurizon Network response to QCA RFI 4 – 170620 – Aurizon Networks Response to UT5 Maintenance RFI4.xlsx

[16] Aurizon Network response to QCA RFI 3 170512-RFI-UT5 Maintenance_v8_QCA v1 SMc.xlsx row 5 of 3_Tab 6

[17] 170713 – RFI, 3_Tab 4' Row 60. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

Maintenance ballast ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Goonyella	502,113	480,144	645,794	625,733	646,065
Blackwater	1,826,608	2,050,934	1,836,624	2,409,763	2,487,069
Moura	262,721	216,278	680,639	164,145	169,479
CQCN	**2,630,894**	**2,920,787**	**3,432,170**	**3,528,850**	**3,464,591**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

In absence of supporting information, and given the variable nature of the work, we consider it more appropriate to base proposed UT5 expenditure on the average of UT4 actual expenditure. Our proposed efficient costs for ballast maintenance are as provided in Table 16.

Table 16 – GHD's proposed efficient UT5 maintenance ballast expenditure by system

Maintenance Ballast ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021	Total
Newlands	202,801	202,801	202,801	202,801	811,204
Goonyella	563,446	563,446	563,446	563,446	2,253,784
Blackwater	2,030,982	2,030,982	2,030,982	2,030,982	8,123,928
Moura	330,946	330,946	330,946	330,946	1,323,784
CQCN	**3,128,175**	**3,128,175**	**3,128,175**	**3,128,175**	**12,512,700**

Our proposed efficient expenditure represents a 9.7%, or $1,345,664 reduction, on Aurizon Network's proposed UT5 expenditure for maintenance ballast.

1.2.5 Rail stress adjustment

Description

The CQCN main lines are constructed of continuously welded rail (CWR) which are installed under tension to avoid buckling due to heating. Over time, as trains repeatedly climb or brake, rails may lose stress-free qualities at designed effective neutral temperature of 38°C. Rail (and then tracks) may then be subject to excessive internal thermal forces and be more prone to buckling.

The only effective way of returning the rail to the effective neutral temperature is to restress the rail by adding or removing rail material. Rail restressing begins with identification of track subject to excessive thermal forces by visual observation. This is confirmed with an appropriate method, such as non-destructive testing or loading.

Prudency of scope

Rail stress adjustment is a necessary activity for a CWR network and therefore the activity is prudent. Aurizon Network has not provided us with information on how it determines rail stress adjustment scope, nor how it has developed the proposed UT5 costs.

In absence of information on scope we have endeavoured to derive a scope from analysis of UT4 expenditure. Assuming a 6-man team for rail stress adjustment and an hourly man-hour costs of $150[18] the

[18] We have used $150/hr as an industry benchmark for track/signalling workers that includes direct costs, overheads and expenses for our top down benchmarking. This contrasts with our bottom up assessment for other cost categories where we have adopted the EBA rate.

average UT4 annual hours spent on rail stress adjustment is 2,335 hours. From our engineering knowledge and rail experience, we consider this to be reasonable for the CQCN and therefore prudent.

Efficiency of cost

As with the other sub-categories reviewed for general maintenance, we consider that UT5 scopes should be based on work undertaken during UT4 and that these scopes be used to derive proposed UT5 expenditure. From our analysis of historic UT4 expenditure and proposed UT5 expenditure (provided in Table 17), we note that Aurizon Network has escalated FY2017 expenditure by roughly 3.2% for all rail systems to develop its UT5 proposed expenditure. Aurizon Network has not provided any information supporting escalation of FY2017 expenditure to derive proposed UT5 expenditure.

However, we note that, with the exception of FY2017 costs for Moura, costs have been increasing year on year in real terms which may reflect the change in work practice of stress testing after all track alterations. Also, the costs for FY2014 are significantly below the costs for the remainder of UT4. We therefore do not consider it appropriate to base UT5 costs on an average of each of the years in UT4 as we have for the other sub-categories assessed. Taking an average of FY2015-FY2017 costs yields an expenditure amount of approximately $3 million. The proposed UT5 expenditure is within 6.5% of the average FY2015-FY2017 actual expenditure of $3 million. On this basis, and given Aurizon Network's stated change in work practices around always stress testing rail after track alterations, we consider Aurizon Network's proposed UT5 costs for rail stress adjustment to be efficient.

Table 17 – Aurizon Network's historic and proposed rail stress adjustment expenditure[19]

Rail stress adjustment ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	87,489	146,327	231,463	393,318	406,098
Goonyella	93,812	370,287	657,678	828,649	855,575
Blackwater	551,475	1,441,762	1,496,118	1,502,152	1,549,857
Moura	56,106	566,739	888,248	315,185	325,427
CQCN	**788,883**	**2,525,114**	**3,273,507**	**3,039,304**	**3,136,957**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

Our proposed efficient expenditure for UT5 for rail stress adjustment is as shown in Table 18.

Table 18 – GHD's proposed efficient UT5 costs for rail stress adjustment

Rail Stress Adjustment	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
Newlands	406,098	406,098	406,098	406,098	1,624,392
Goonyella	855,575	855,575	855,575	855,575	3,422,300
Blackwater	1,549,857	1,549,857	1,549,857	1,549,857	6,199,428
Moura	325,427	325,427	325,427	325,427	1,301,708
CQCN	**3,136,957**	**3,136,957**	**3,136,957**	**3,136,957**	**12,547,828**

1.2.6 Track ballast undercutting

Aurizon Network captures costs for cost sub-categories C02 – Ballast Undercutting (Other) and C03 - Ballast Undercutting – Turnout – Minor within its general maintenance cost category. However, as we included these cost sub-categories in our assessment of Aurizon Network's overall ballast undercutting costs, Aurizon

[19] 170713 – RFI, 3_Tab 4' Row 72. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

Network's proposed expenditure for these items should be removed from the UT5 efficient general-maintenance expenditure. Table 19 shows Aurizon Network's proposed UT5 expenditure on ballast undercutting that should be removed from the general maintenance cost category.

Table 19 Aurizon Network proposed general maintenance track ballast undercutting costs[20]

Ballast Undercutting	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
C02-Ballast Undercutting (Other)	4,902,403	5,096,293	5,290,182	5,484,071	**20,772,949**
Proposed C02 uplift[21]	1,520,000	1,720,000	1,900,000	2,100,000	**7,240,000**
C03 – Ballast Undercutting – Turnout - Minor	305,893	305,893	305,893	305,893	**1,223,572**
Total	**6,728,296**	**7,122,186**	**7,496,075**	**7,889,964**	**29,236,522**

[20] Maintenance UT5 Cost Build, Real Total NMP Cells D10:G11

[21] Maintenance UT5 Cost Build, Infrastructure Maintenance (IM), Row 39

2. GHD's review of General Maintenance scopes and expenditure

2.1 General maintenance sample selection

The General Maintenance category as defined by AN in its Asset Management Policy covers 12 activity groupings ranging from track inspections, track recording, general track maintenance, rail flaw detection, track repair through to corridor maintenance including vegetation management. Such activities will form part of the duties identified by Aurizon Network as works required under its Safety Management System and will be subject to audit and compliance by the ONRSR. For many of the items within this category the works required are labour intensive and are not suitable for mechanised activities.

The following general-maintenance sub-categories were agreed with the QCA to be reviewed:

- Rail repair (C54)
- Fire and vegetation management (C44)
- Track inspections (C50)
- Maintenance ballast (C42)
- Rail stress adjustment (C47)

The above approach covers at least 50% of general-maintenance costs, which is the approach that we have agreed with the QCA.

Table 20 presents Aurizon Network's proposed general-maintenance costs for the sub-categories reviewed (approximately $100 million ($FY2015) over UT5) for the selected sub-categories in this mini-report. We also propose removing cost sub-categories C02 – Ballast Undercutting (Other) and C03 - Ballast Undercutting – Turnout – Minor from the general maintenance cost category as we captured Aurizon Network's proposed expenditure on these items in the ballast undercutting cost category determined efficient expenditure.

Table 20 – Aurizon Network's proposed UT5 general maintenance costs (real $FY2015) [22] for five sub-categories

General maintenance ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Rail repair	6,831,229	6,831,229	6,831,229	6,831,229
Fire and vegetation management	5,834,910	5,834,910	5,834,910	5,834,910
Track inspections	5,697,185	5,697,185	5,697,185	5,697,185
Maintenance ballast	3,464,591	3,464,591	3,464,591	3,464,591
Rail stress adjustment	3,136,956	3,136,956	3,136,956	3,136,956
Total	**24,964,871**	**24,964,871**	**24,964,871**	**24,964,871**

Table 21 presents Aurizon Network's proposed UT5 general maintenance costs for all general maintenance cost categories with their respective contributions to the total general maintenance cost, demonstrating the five sub-categories cover at least 50% of the general-maintenance costs.

[22] Real Costs sourced from Maintenance UT5 Cost Build Model: Product Summary – Real$; Total NMP

Table 21 - Aurizon Network's proposed UT5 general maintenance costs (real $FY2015) for general maintenance categories[23]

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)	% Total
Ballast Undercutting (Other)	C02	4,902,403	5,096,293	5,290,182	5,484,071	20,772,949	10.0%
Ballast Undercutting - Turnout - Minor	C03	305,893	305,893	305,893	305,893	1,223,572	0.6%
Earthworks - Non Formation	C06	2,896,355	2,896,355	2,896,355	2,896,355	11,585,420	5.6%
Fencing	C07	308,294	308,294	308,294	308,294	1,233,176	0.6%
Rail Joint Management	C08	780,691	780,691	780,691	780,691	3,122,764	1.5%
Turnout Maintenance	C10	2,987,665	2,987,665	2,987,665	2,987,665	11,950,660	5.8%
Minor Yard Maintenance	C28	579,483	579,483	579,483	579,483	2,317,932	1.1%
Track Geometry Recording	C29	1,988,226	1,988,226	1,988,226	1,988,226	7,952,904	3.8%
Rail Flaw Detection - On Track Vehicle	C30	1,536,116	1,536,116	1,536,116	1,536,116	6,144,464	3.0%
Monument/Signage Maintenance	C37	521,130	521,130	521,130	521,130	2,084,520	1.0%
Maintenance Ballast	C42	3,464,591	3,464,591	3,464,591	3,464,591	13,858,364	6.7%
Sleeper Management	C43	2,583,151	2,583,151	2,583,151	2,583,151	10,332,604	5.0%
Fire & Vegetation Management	C44	5,834,910	5,834,910	5,834,910	5,834,910	23,339,640	11.2%
Rail Stress Adjustment	C47	3,136,956	3,136,956	3,136,956	3,136,956	12,547,824	6.0%
Rail Flaw Detection - Manual	C48	477,871	477,871	477,871	477,871	1,911,484	0.9%
Track Inspections	C50	5,697,185	5,697,185	5,697,185	5,697,185	22,788,740	11.0%
Track Clean-up	C51	1,474,629	1,474,629	1,474,629	1,474,629	5,898,516	2.8%
Rail Lubrication	C52	1,836,077	1,836,077	1,836,077	1,836,077	7,344,308	3.5%
Top & Line Spot Resurfacing	C53	2,012,495	2,027,262	2,027,262	2,027,262	8,094,281	3.9%
Rail Repair	C54	6,831,229	6,831,229	6,831,229	6,831,229	27,324,916	13.2%
Level Crossing Maintenance	C57	1,686,455	1,686,455	1,686,455	1,686,455	6,745,820	3.2%
Inventory Management	-	-278,280	-247,896	-217,944	-188,419	-932,539	-0.4%

[23] Real Costs sourced from Maintenance UT5 Cost Build Model: IM – General Maintenance

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)	% Total
Total		**51,563,525**	**51,802,566**	**52,026,408**	**52,249,821**	**207,642,319**	**100%**

2.2 Overview of information provision

Aurizon Network has not identified a scope of works for any of selected sub-categories with the exception of fire and vegetation management in the corridor. Nor did Aurizon Network provide detail of the scopes in response to the QCA's RFIs. Instead, Aurizon Network advised that its respective engineers developed a cost for each cost sub-category for the UT5 period based on historic expenditure and these were then refined in consultation with internal stakeholders.

From our experience, we consider that a suitable method for arriving at a cost for general maintenance activities is one that is based on experience and history with due allowance for labour, plant and materials, and, where appropriate, contractors. However, we also consider that an efficient operator should be able to provide historic information on scopes undertaken under the general maintenance category.

At a high level we note that:

- Aurizon Network has not made it possible to assess directly the suitability and competitiveness of the contracting framework used to outsource the vegetation management contracts which make-up some 90% of the costs for the Fire and Vegetation Management sub-category
- Track inspections are based on historic costs and have not been adjusted to reflect a lower inspection cycle regime that has been allowed by the ONRSR
- No evidence was provided of the terms of the contract with Queensland Rail for the hire of the track recording car and crew for track inspections
- Aurizon Network has not provide details of how it monitors the use of ballasts or its costs.

Table 22 presents Aurizon Network's proposed general-maintenance scopes for the selected sub-categories reviewed (approximately $100 million ($FY2015)) over the UT5 period.

Table 22 – Aurizon Network's proposed UT5 general maintenance scopes[24]

General maintenance	FY 2018	FY 2019	FY 2020	FY 2021
Rail repair (no.)	Not stated	Not stated	Not stated	Not stated
Fire and vegetation management (km)	5,700	5,700	5,700	5,700
Track inspections (km)	96 hour cycle	96 hour cycle	96 hour cycle	96 hour cycle
Maintenance ballast (km)	No defined scope	No defined scope	No defined scope	No defined scope
Rail stress adjustment (km)	No defined scope	No defined scope	No defined scope	No defined scope

In developing this report, in absence of projected scopes and details of historic scopes from Aurizon Network, we have relied largely on the experience of our engineering staff to assess the prudency of scope and efficiency of costs for the sub-category sample. We recognise that, given that the workload varies year by year on reactive basis, it is not possible to develop absolute scopes of work for these activities (although

[24] Aurizon Network's response to RFI 4 from the QCA

as mentioned, information on historic scopes should be available to support projected expenditure). As such, the expenditure for UT5 may be considered an allowance for work that is likely to occur based on historic scopes, and, particularly expenditure.

2.3 Description of Aurizon Network's expenditure budgeting process

In answer to our RFI 4 requesting information on Aurizon Network's budgeting process for the General Maintenance cost category, Aurizon Network responded as follows:

"In setting the UT5 cost proposal for this activity, Aurizon Network assessed expenditure trends (actual spend over the last 3 years and current year spend), which were then reviewed/amended by Asset Managers and Maintainers, taking the latest Asset Renewals Plan into consideration. Using their expert and detailed knowledge of network conditions and forthcoming activities, Asset Managers proposed amendments to the expenditure trends for the FY2018 to FY2021 years. The result of which formed the basis of the UT5 maintenance cost proposal for this product."

We understand from this statement that Aurizon has based proposed UT5 expenditure for General Maintenance on historic cost data and experience. We consider this approach to be reasonable given that the work is largely reactive and hence it is difficult to develop a defined program of works for a particular activity. However, whilst it is difficult for Aurizon Network to develop costs based on a particular scope of work, given the year on year variability of the work, we recognise that Aurizon Network needs to propose an "allowance" for undertaking these activities during UT5. For example, as rail repairs or rail stressing activities are reactive, the actual volume of work will vary year on year. Similarly, vegetation management activities will vary depending on weather conditions. For example vegetation management activities will be lower during dry years than during wet years where two treatments may be required.

However, from our analysis of UT4 expenditure and proposed UT5 expenditure we note that Aurizon Network has typically escalated FY2017 expenditure by between 3.2 and 3.3% to derive a proposed UT5 annual expenditure. This is at odds with how Aurizon Network advised it has developed UT5 costs.

We provide our analysis of prudency of scope and efficiency of cost of the sample of General Maintenance items in the following sub-sections

2.4 Rail repair

2.4.1 Description

This work is defined by Aurizon Network as the repair of defects and failures in railway rails that may cause train delays or cancellations. Such defects include internal rail defects, defective welds or broken rails. For rail repairs to be classed as maintenance, as opposed to a renewal, the work in any one occurrence must be within a length of 12 m of rail. Works may also include:

- supporting works such as the replacement of glued insulated rail joints,
- the installation of rail-mounted equipment
- repairs to areas of track near signals on severe gradients that are prone to wheel burn (wheel-spinning) from starting locomotives
- replacement of short lengths of rail found to have internal defects (utilising ultrasound testing)
- repairs to turnouts if mechanical wear is found in the crossing units

Given the relatively small scale of each operation, this work is generally undertaken by Aurizon Network staff directly and not subcontracted. Additionally, this work is reactive in nature and is based on detected defects.

2.4.2 Prudency of scope

Defining a scope for such works will entail making allowances for repairs that are unknown at the time such as potential weld failures or internal defects in the rail. This cost sub-category excludes rail repairs arising from track buckling which are addressed in the rail stress adjustment cost category. We would therefore expect the scope to be based on historical data that Aurizon Network has available together with knowledge of the condition of the rail at any particular location. We also expect that the scope for this activity will also take account of any improvement programs such as replacing existing rail as part of a renewal program.

We consider that Aurizon Network will possesses historical data of the types and numbers of repairs, which it should have been able to provide to allow an assessment of the accuracy and suitability of the proposed expenditure for rail repair. However, Aurizon Network did not provide any data on allowed quantities and scope underpinning the proposed expenditure in response to our RFIs.

Given that periodic rail repair activities are required on a rail system we consider this expenditure sub-category to be prudent. However, in absence of information on historic activities in terms of lengths or numbers of rail repaired to support forecast expenditure, we are unable to determine that the scope supporting the forecast expenditure is prudent or not. We have therefore

2.4.3 Efficiency of cost

Aurizon Network has allowed $6,831,229 per annum for the duration of UT5. As discussed above, Aurizon Network has not provided details on the potential scope underlying the proposed annual cost for rail repair but has stated that it has based its UT5 proposed costs on historic costs. Historical, UT4 actual expenditure and proposed UT5 expenditure is shown in Table 23.

Table 23 – Aurizon Network's historic and proposed rail repair maintenance expenditure by system[25]

Rail repair ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	386,295	717,968	587,557	657,019	678,368
Goonyella	2,196,356	2,899,486	2,639,656	2,440,358	2,519,653
Blackwater	2,430,421	2,892,034	2,197,654	3,351,302	3,460,198
Moura	254,209	172,195	296,555	167,565	173,010
CQCN	**5,267,280**	**6,681,684**	**5,721,422**	**6,616,244**	**6,831,229**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

In absence of information on actual scope from Aurizon Network, we have assessed whether historic costs are efficient from an expected manning level as follows:

The historic costs during UT4 average approximately $6 million per annum. This is predominantly a labour intensive operation with labour costs representing, from our engineering experience, greater than 90% of total costs. A labour charge rate of $150 per hour[26] gives annual labour hours of approximately 40,000 per annum. Assuming a 40 hour working week and 46 working weeks in a year indicates a team for rail repair of 22 full time equivalents (FTE). From our engineering and rail experience we consider this to be a reasonable manning level for a specialist rail repair team and number of labour hours for a system of 2,655 km. As such we consider UT4 costs to be reasonable and hence efficient.

[25] 170713 – RFI, 3_Tab4' Row 96. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

[26] We have used $150/hr as an industry benchmark for track/signalling workers that includes direct costs, overheads and expenses for our top down benchmarking. This contrasts with our bottom up assessment for other cost categories where we have adopted the EBA rate.

We note that Aurizon Network has escalated FY2017 costs by 3.25% to derive its proposed UT5 expenditure. Given that proposed costs are real in FY2015 dollars, we see no justification for applying such an escalator particularly since the increase in track length in UT4 of 413 km[27] occurred in the latter part of UT4 and hence should not contribute to rail repair costs during UT5. Further, since the costs will vary year on year, we consider it more appropriate for the proposed UT5 costs to be based on the average of the UT4 costs, to smooth out these variances in expenditure.

Our recommended efficient costs on a system level are provided in Table 24.

Table 24 – GHD's proposed efficient UT5 rail repair expenditure

Rail repair	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
Newlands	587,210	587,210	587,210	587,210	2,348,840
Goonyella	2,543,964	2,543,964	2,543,964	2,543,964	10,175,856
Blackwater	2,717,853	2,717,853	2,717,853	2,717,853	10,871,412
Moura	222,631	222,631	222,631	222,631	890,524
CQCN	**6,071,658**	**6,071,658**	**6,071,658**	**6,071,658**	**24,286,632**

Our proposed efficient expenditure represents an 11% or $3,038,284 overall reduction, on Aurizon Network's proposed UT5 expenditure for rail repair.

2.5 Fire and vegetation management

2.5.1 Description

Aurizon Network is responsible for the proper maintenance of the corridor including control of weeds and maintenance of firebreaks. In addition, it also has an obligation to ensure the safe operation of the rail network and this will include, for example ensuring, control of vegetation at level crossings to ensure maintenance of sight distances, and to ensure maintenance operations are carried out safely and efficiently.

Details of Aurizon Network's approach to fire and vegetation management is given in the Aurizon *Central Queensland Coal Network Vegetation Management Guideline*.

Aurizon Network will also be required to control weed species within the corridor and prevent their migration to adjacent properties or to other areas in the corridor. In addition, one of the major issues for Aurizon Network as manager of the corridor is the prevention of bushfires. In this regard, Aurizon Network may be liable for a substantial negligence claim in the event a bushfire within the corridor caused extensive damage or losses to an adjacent property.

Aurizon Network prohibits and restricts the use of controlled burning as a means of vegetation control or the widespread use of chemicals. The restrictions have come about due to concerns of loss of control of back-burns in the case of fires and ecological effects of chemicals. The principal vegetation control is by mechanical means. Burning is only employed as a last resort.

2.5.2 Prudency of scope

Data provided by Aurizon Network in response to RFI 4 indicates that the quantity of vegetation management allowed is 5,700 km per annum at a cost of approximately $1,000 per km. Given the length of the CQCN, this equates to a scope of cutting or managing the corridor vegetation twice per year, which we

[27] Aurizon Network response to QCA RFI 3 170512-RFI-UT5 Maintenance_v8_QCA v1 SMc.xlsx row 5 of 3_Tab 6

consider reasonable based on cutting once before the wet season and again after the wet season, and localised treatment at level crossings, yards and at signals.

We consider this scope prudent as the activity is required and the scope allowance of 5,700 km per annum allowing cutting of vegetation twice per year is in keeping with practices of a prudent rail operator.

2.5.3 Efficiency of costs

Aurizon Network has provided no detailed information as to whether this work is undertaken by direct labour or by subcontractors, but experience suggests specialist subcontractors would be employed to undertake this work using appropriate vegetation removal, equipment. From our evaluation of the cost build given by Aurizon Network in response to RFI 4 we note that 90% of the costs allowed are for "hire", which could be taken as contractor costs. From our review of Aurizon Network's procurement strategy we understand that contracts of this value are competitively tendered and hence market tested.

Aurizon Network states that the weather conditions during UT4 resulted in increased costs during UT4 over the previous undertaking and that a similar allowance has been made for UT5. Aurizon Network has not provided a breakdown detailing the underpinning scope and costs by activity for the UT5 allowances. In reality the actual amount of fire and vegetation management undertaken will vary year on year, such variance predominantly driven by weather conditions. More work will be required in a wet year than a dry year. However, given that weather conditions for UT4 represented a return to 'normal' conditions from drought conditions, we consider it appropriate for Aurizon Network to base proposed UT5 expenditure on historical UT4 expenditure

We have therefore endeavoured to assess the efficiency of the UT4 expenditure as follows:

Assuming the corridor width on average in the CQCN is approximately 40 metres in width, then the area to be treated, based on an annual scope of 5,770 km (assuming vegetation management is carried out twice per year) is 22,800 hectares. The average UT4 annual expenditure on fire and vegetation management is approximately $5,600,000 per annum. For 22,800 hectares managed, this equates to less than $0.03 per square metre which, from our rail engineering knowledge and experience, we consider to be efficient.

Table 25 shows historic UT4 expenditure and proposed UT5 expenditure.

Table 25 – Historic and proposed fire and vegetation management expenditure by system[28]

FVM ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	902,447	790,663	955,248	632,185	830,655
Goonyella	2,970,239	2,551,751	2,421,060	2,578,240	2,662,016
Blackwater	1,946,138	1,556,703	1,839,176	1,849,687	1,909,126
Moura	345,727	278,709	490,742	419,483	433,113
CQCN	**6,164,551**	**5,177,827**	**5,706,226**	**5,479,594**	**5,834,910**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

We note that Aurizon Network's proposed UT5 expenditure for each system, with the exception of Newlands, represents an approximately 3% increase in FY2017 expenditure. For Newlands the FY2018 proposed expenditure is approximately the average of FY2014 to FY2017 expenditure plus an additional allowance of approximately $10,000. Aurizon has not provided information supporting increasing historic FY2017 costs to derive those submitted for UT5.

[28] 170713 – RFI, 3_Tab 4' Row 68. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

Given the year on year variable nature of the costs, we consider it appropriate to base UT5 costs on the average of the UT4 costs to smooth out this variance. We have developed our recommended efficient costs based on an average of UT4 costs on a system level as provided in Table 26.

Table 26 – GHD's proposed efficient UT5 fire and vegetation management expenditure

Rail repair	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
Newlands	820,136	820,136	820,136	820,136	3,280,543
Goonyella	2,630,323	2,630,323	2,630,323	2,630,323	10,521,290
Blackwater	1,797,926	1,797,926	1,797,926	1,797,926	7,191,704
Moura	383,665	383,665	383,665	383,665	1,534,661
CQCN	**5,632,050**	**5,632,050**	**5,632,050**	**5,632,050**	**22,528,198**

Our proposed efficient expenditure represents a 3.5%, or $811,440 reduction, on Aurizon Network's proposed UT5 expenditure fire and vegetation management.

2.6 Track inspections

2.6.1 Description

Aurizon Network allows for the routine visual inspection of track and corridor by on track hi-rail vehicles on a 96-hour cycle. These operations are to identify defects and damage on the track or in the corridor that could cause delays or disruptions to service operations.

These on-track routine visual inspections are supplemented by an on-track machine-based inspection carried out using a specialist recording vehicle (track recorder) contracted, with crew, from Queensland Rail to define the geometry of the track and overhead wiring. Track recording operations allow for accurate assessments of track condition, and the locations of significant deteriorations.

The input from both forms of inspection, if accurately recorded and processed, form the basis on which work programs and maintenance operations are identified.

Aurizon Network has further suggested the use of drones for inspection in its presentation to the QCA. It is believed this will have little value for routine track inspections, but will be used for inspections of OHW and structures. AN has confirmed this to be the case in its response to RFI 4 as *"UAVs have been used to improve Aurizon Network's' understanding of potential zones of failure on electrical assets as well as to closely inspect components of our bridge structures, which are otherwise very difficult to access via conventional means"*.

2.6.2 Prudency of scope

Aurizon Network is required under its safety management system to undertake periodic rail track and corridor condition inspections. As such we consider the activity to be prudent.

Aurizon Network has provided limited information on the scope of activity to enable us to assess prudency of scope. We have therefore endeavoured to evaluate prudency of scope based on our in house knowledge and experience.

During UT4, the track inspection was undertaken on a four day (96 hour) cycle supplemented by a track recording vehicle owned and operated by Queensland rail. However as we discuss in detail in our evaluation of efficiency of costs below, post 2015, Aurizon Network is permitted to undertake track and corridor inspections on a 192 hour cycle. Aurizon Network has based its UT5 expenditure track inspection on historic costs. From this, we understand that Aurizon Network is not currently working to a 192 hour track inspection

cycle and has therefore not factored in the reduction in scope allowed through this relaxation of the inspection cycle. As such, from our analysis we consider the scope that Aurizon Network has priced not to be prudent as the proposed expenditure does not take into account this relaxation in the inspection cycle.

2.6.3 Efficiency of costs

Aurizon Network has not provided details of the make of the costs for track inspections. We have therefore endeavoured to reverse engineer the costs based on experience and the limited data provided by Aurizon network as follows. Historically, Aurizon Network has undertaken on track inspection with a hi-rail vehicle on a 96 hour cycle (i.e. 4 day cycle) that is each section of track is inspected 365/4=91 times per year, which we have approximated to 90 to account for extended shutdown periods. Assuming an average speed of 20 kph, i.e. half the maximum 40 kph is achieved on average, and a track length of 2,700 km for the CQCN, the hours required on track per inspection cycle is 135 hours (2,700/20).

We understand that Aurizon Network uses a two-man team for inspections (for, among other things, safety reasons given the remote working), and therefore the minimum man-hours on track will be 270 per track inspection, or 24,300 per annum (90 x 270). At an assumed man hour cost of $150/h to cover overtime and expenses, the annual cost is approximately $3.65 million (24,300 x 150). In addition to this, we estimate the cost for Queensland Rail's track recorder to be $1.6 million. This estimate is based on a four man crew at combined cost of $1000/h, 600 hours of recording, 200 hours of travel time and an hourly hire cost for the track recording machine of $1,000. We estimate the total costs for this activity on a 96 hour inspection cycle at approximately $5.25 million which is comparable to the UT4 actual costs as shown in Table 27.

Table 27 – Aurizon Network's historic and proposed track inspection costs by system[29]

Track inspections ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	650,162	743,040	706,963	715,123	630,910
Goonyella	1,598,426	1,729,256	1,558,676	1,519,637	1,566,416
Blackwater	3,194,448	3,222,830	2,679,861	2,279,797	2,933,558
Moura	623,743	611,662	421,072	574,509	566,300
CQCN	**6,066,778**	**6,306,789**	**5,366,572**	**5,089,066**	**5,697,185**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

On-track inspections potentially reduce available train paths and hence network capacity. After completing a risk assessment process, Aurizon Network gained ONRSR approval in 2015 for inspections on a 192-hour cycle[30] for concrete sleeper tracks with welded rails. We consider that this relaxation from a 96 hour inspection cycle to a 192 hour visual inspection cycle should apply to all systems within the CQCN and is expected to provide for major savings in direct costs. It will also allow the release of train paths that would otherwise be used for the on track inspections.

By adopting a 192 hour cycle, we consider that Aurizon Network could reduce its costs for track inspection with a hi-rail vehicle to approximately $2 million (rounding to the nearest $ million). The total annual cost for track inspections therefore becomes $2 million for track inspections by a hi-rail vehicle plus $1.6 million for the inspections carried out by the Queensland Rail track recorder, resulting in a total efficient annual cost, including an allowance for emergency inspections, of $4 million per annum.

[29] 170713 – RFI, 3_Tab4' Row 80. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

[30] Appendix C Aurizon Network UT5 Submission

We therefore consider Aurizon Network's proposed costs for UT5 not to be efficient and we set out our proposed efficient expenditure, on the basis of adopting a 192 hour inspection cycle as approved by the ONRSR in Table 28 below.

Table 28 – GHD's proposed efficient UT5 track inspection expenditure by system

Track Inspections	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
Newlands	582,477	582,477	582,477	582,477	2,329,908
Goonyella	1,868,111	1,868,111	1,868,111	1,868,111	7,472,444
Blackwater	1,276,925	1,276,925	1,276,925	1,276,925	5,107,700
Moura	272,487	272,487	272,487	272,487	1,089,948
CQCN	**4,000,000**	**4,000,000**	**4,000,000**	**4,000,000**	**16,000,000**

Our proposed efficient expenditure represents a 30%, or $6,788,740 reduction, on Aurizon Network's proposed UT5 expenditure for rail repair.

2.7 Maintenance ballast

2.7.1 Description

Aurizon Network defines 'Maintenance Ballast' as the purchase and transportation and placement of ballast to restore the ballast profile, not connected with other operations[31]. As such maintenance ballast is not a part of and is additional to any ballast replacement arising from resurfacing, ballast cleaning, turnout replacement or re-railing works. It is simply placing relatively small volumes of ballast at locations where the existing ballast does not adequately surround or support the sleepers. Transportation of such small quantities of ballast is undertaken by truck or by train depending on circumstances and location.

2.7.2 Prudency of scope

Maintenance of ballast is crucial to ensuring that interlocking rocks (ballast) beneath the bed of the rail retain their structural integrity. Failure to do so leads to sagging of rails, loss of horizontal integrity and, ultimately, train delays or derailment. As such, we consider the activity of ballast maintenance to be prudent. As such we consider that the activity is prudent.

Maintenance-ballast work occurs when storms or other phenomena cause the ballast to be washed away on a small isolated area, or where resurfacing has resulted in a shortage of ballast in isolated spots. As such, the scope of work cannot be accurately quantified for the entire UT5 period. We therefore consider it appropriate to base the scope for the UT5 period on historical scopes.

Aurizon Network has not provided information that will allow us to assess the prudency of the scope of work involved with ballast maintenance. However, we have been able to make an estimate of the volume of ballast used each year across the whole of the network for the UT4 period as a proxy for assessing the prudency of scope for the UT4 period. The breakdown provided by Aurizon Network as a response to RFI 4 for the UT4 period suggests that labour, accommodation, and plant maintenance costs total $834,389 against an average UT4 annual expenditure of $3,128,175. Assuming the balance of approximately $2.3 million is predominantly for ballast, and using a ballast cost at $40 per tonne, or $65 per cubic metre delivered[32], the volume used per annum is of the order of 35,000 cubic metres. This volume represents more than 15 km of full ballast replacement or 0.55% of the CQCN ballast volume.

[31] Aurizon Network Asset Maintenance and Renewals Policy page 22.

[32] GHD internal cost data

We note that actual year on year usage will vary with weather conditions and local track construction factors and usage as indicated by the variance in UT4 expenditure. Given this annual variation in the amount of ballast replaced and that this is a relatively low expenditure item, we did not request details on actual quantities used by Aurizon Network. However, from our rail engineering knowledge and experience, we consider replacing 0.55% of ballast a year under this maintenance ballast category for a network of this type and size to be reasonable. As such we consider a prudent annual scope of work for UT5 to be equal to the average annual scope of work undertaken during UT4.

2.7.3 Efficiency of costs

Aurizon Network has not presented the basis on which the proposed UT5 costs have been determined other than to state that its respective engineers developed a cost for each cost sub-category for the UT5 period based on historic expenditure and these were then refined in consultation with internal stakeholders and knowledge of condition of track. As indicated above we consider that UT5 costs could be calculated based the cubic metres of ballast used historically during UT4 at a unit rate that includes materials, transport, plant and labour costs.

However, from our analysis of UT4 and UT5 costs (Table 29), Aurizon Network looks to have derived an annual UT5 cost for the Goonyella and Moura systems by escalating its 2017 costs for this expenditure sub-category by 3.25% and for the Blackwater system by escalating 2017 costs by 3.21%. Conversely, the proposed UT5 annual cost for Newlands represents a 51% reduction on FY2017 costs and a 20% reduction on the UT4 average. Aurizon Network has provided limited information supporting the escalation of UT4 costs to derive the UT5 costs for the Goonyella, Blackwater and Moura systems. Aurizon Network has not provided any information underpinning the reduction in UT4 expenditure to derive UT5 costs for Newlands.

In response to QCA RFI 4[33], Aurizon Network stated that:

"*The spend on C42 proposed for UT5 is more equivalent to the planned expenditure on this product for FY2017 (e.g. $3.6m; proposed FY2018 allowance is $3.6m). The comparison to FY2015 in this instance understates the level of expenditure incurred and required for UT5.*

The required uplift is due to increased length of track (i.e. WIRP) and comments specifically discussed include:

- *Increased kms in Blackwater System, an additional 14 kms.*
- *Current renewals and fix on failure maintenance practice to continue - however due to age of ballast in network will realise an initial increase in FY17 with CPI increases only for the remaining years until FY 21*."

Given that the increase in track, 413 km occurred in the later years of UT4 (FY17)[34], and is therefore relatively new, we do not consider that this increase in system track length should warrant an increase in the maintenance ballast cost allowance during UT5.

Table 29 – Aurizon Network's historic and proposed maintenance ballast costs[35]

Maintenance ballast ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	39,451	173,430	269,113	329,208	161,978

[33] 170620 – Aurizon Network's responses to UT5 Maintenance RFI 4 Tab RFI 4 cell K20

[34] Aurizon Network response to QCA RFI 3 170512-RFI-UT5 Maintenance_v8_QCA v1 SMc.xlsx row 5 of 3_Tab 6

[35] 170713 – RFI, 3_Tab 4' Row 60. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

Maintenance ballast ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Goonyella	502,113	480,144	645,794	625,733	646,065
Blackwater	1,826,608	2,050,934	1,836,624	2,409,763	2,487,069
Moura	262,721	216,278	680,639	164,145	169,479
CQCN	**2,630,894**	**2,920,787**	**3,432,170**	**3,528,850**	**3,464,591**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

In absence of supporting information, and given the variable nature of the work, we consider it more appropriate to base proposed UT5 expenditure on the average of UT4 actual expenditure. Our proposed efficient costs for ballast maintenance are as provided in Table 30.

Table 30 – GHD's proposed efficient UT5 maintenance ballast expenditure by system

Maintenance Ballast ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021	Total
Newlands	202,801	202,801	202,801	202,801	811,204
Goonyella	563,446	563,446	563,446	563,446	2,253,784
Blackwater	2,030,982	2,030,982	2,030,982	2,030,982	8,123,928
Moura	330,946	330,946	330,946	330,946	1,323,784
CQCN	**3,128,175**	**3,128,175**	**3,128,175**	**3,128,175**	**12,512,700**

Our proposed efficient expenditure represents a 9.7%, or $1,345,664 reduction, on Aurizon Network's proposed UT5 expenditure for maintenance ballast.

2.8 Rail stress adjustment

2.8.1 Description

The main lines of the CQCN are continuously welded rail (CWR) on concrete sleepers on a ballast base of 250 or 300 mm thickness. The advantage of CWR is the removal of rail joints, which removes a major ongoing maintenance cost, but for CWR to be stable it must be installed at a temperature that ensures, as far as possible, that the track will not suffer excessive thermal buckling or expansions under temperature shocks. The desirable temperature for installation of the rail is the referred to as the Neutral Temperature, or Stress Free Temperature.

Aurizon Network track standards require that CWR have a neutral temperature of 38°C and this is determined from the anticipated temperature range the track will experience. Over time, as trains repeatedly climb or brake, rail and then tracks may lose stress-free qualities at a design neutral temperature. They then may then be subject to excessive internal thermal forces and be more prone to buckling.

The only effective way of returning the rail to the effective neutral temperature is to restress the rail by adding or removing rail material. Rail restressing begins with identification of track subject to excessive thermal forces by visual observation of, for example, rail buckling. This is confirmed with an appropriate method, such as non-destructive testing or loading.

The process of rail stress adjustment should confirm that the track is in its correct position relative to design specifications and would entail cutting the rail in a temperature range close to the neutral temperature. "Growth" of the rail indicates excessive compression forces on the rail. Conversely, shrinking indicates excessive tension within the rail. Rail pieces can be removed or added to ensure that rails at the *design*

neutral temperature are in neither excessive compression nor tension. The restressing operation itself entails releasing the rail from the sleepers, adjusting the length with respect to the neutral temperature and re-welding the rails within a tolerance of ±3°C of the design neutral temperature.

Due to the nature of the work, it is a particularly labour intensive operation typically involving a team of six men working in a possession. Rail adjustment will take place over lengths of up to one kilometre on straights but for much shorter lengths on curves. It is suited to cooler times of the year, where the neutral temperature is more easily achieved and given the dangers encountered by maintenance crews working for extended periods in high temperatures.

2.8.2 Prudency of scope

Rail stress adjustments are a crucial aspect of the maintenance program and prevents internal force accumulation that can lead to crack propagation and track buckling

As such, we consider the activity of rail stress adjustment to be prudent.

Aurizon Network has not provided us with information on how it determines rail stress adjustment scope, nor how it has developed the proposed UT5 costs. We consider that it should be possible for Aurizon Network to develop a scope of work required based on historic scopes and use this to develop proposed costs for UT5. Such scope would include an allowance for a number of immediate action operations where the track buckles or shows signs of buckling without warning. We note that on page 177 of Aurizon Network's Draft Access Undertaking, Aurizon Network states that it has implemented a revised work practice in which rail stress testing is conducted after all rail related activities. We consider that this represents good practice that will lead to improved rail services and fewer derailments. We also consider that this change in work practices will largely be neutral on rail stress adjustment costs in the long term as the increase in rail stressing costs to accommodate the additional track stress testing will be offset by a reduction in subsequent rail stress adjustment works required to address track buckles. We further note that in page 156 of its Draft Access Undertaking, Aurizon Network states that a more planned approach to rail stressing after track disturbance works has resulted in a 33% improvement (reduction) in track buckles.

In absence of any other information, we consider a prudent scope of work for this activity for UT5 to be equal to the average scope of work undertaken during UT4. We have therefore endeavoured to derive a scope from analysis of UT4 expenditure. Again, Aurizon has provided no quantities but assuming a labour rate of $150 including overtime and accommodation then the work-hours for the average UT4 expenditure of approximately $3 million is of the order of 20,000 hours. Given that this work would require a team of six this represents 3,335 hours of rail stress adjustment per annum. From our experience, we consider this to be reasonable for a network the size of CQCN.

Given that the UT5 costs appear relatively consistent with those presented in UT4. Scopes have not been provided but on the basis of scope of work for UT5 to be the same as for UT4 (on average per annum), we would consider the scope prudent.

2.8.3 Efficiency of costs

As with the other sub-categories reviewed for General Maintenance, we consider that UT5 scopes should be based on work undertaken during UT4 and that these scopes be used to derive proposed UT5 expenditure. From our analysis of historic UT4 expenditure and proposed UT5 expenditure (provided in Table 31), Aurizon Network has escalated FY2017 expenditure by roughly 3.2% for all rail systems to develop its UT5 proposed expenditure. Aurizon Network has not provided any information supporting escalation of FY2017 expenditure to derive proposed UT5 expenditure.

However, we note that, with the exception of FY2017 costs for Moura, costs have been increasing year on year in real terms which may reflect the initial increase in costs arising from introducing a work practice of stress testing after all rail related activities resulting in an increase of rail stressing activities. Also, the costs for FY2014 are significantly below the costs for the remainder of UT4. We therefore do not consider it appropriate to base UT5 costs on an average of each of the years in UT4 as we have for the other sub-categories assessed. Taking an average of FY2015-FY2017 costs yields an expenditure amount of approximately $3 million. The proposed UT5 expenditure is within 6.5% of the average FY2015-FY2017 actual expenditure of $3 million. On this basis, and given the change in working practices around always undertaking rail stress testing following track alterations, we consider Aurizon Network's proposed UT5 costs for rail stress adjustment to be efficient.

Table 31 – Rail stress adjustment[36]

Rail stress adjustment ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017^	FY2018 (UT5)
Newlands	87,489	146,327	231,463	393,318	406,098
Goonyella	93,812	370,287	657,678	828,649	855,575
Blackwater	551,475	1,441,762	1,496,118	1,502,152	1,549,857
Moura	56,106	566,739	888,248	315,185	325,427
CQCN	**788,883**	**2,525,114**	**3,273,507**	**3,039,304**	**3,136,957**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

Our proposed efficient expenditure for UT5 for rail stress adjustment is as shown in Table 32.

Table 32 – GHD's proposed efficient UT5 costs for rail stress adjustment

Rail Stress Adjustment	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
Newlands	406,098	406,098	406,098	406,098	1,624,392
Goonyella	855,575	855,575	855,575	855,575	3,422,300
Blackwater	1,549,857	1,549,857	1,549,857	1,549,857	6,199,428
Moura	325,427	325,427	325,427	325,427	1,301,708
CQCN	**3,136,957**	**3,136,957**	**3,136,957**	**3,136,957**	**12,547,828**

2.9 Track ballast undercutting

Aurizon Network captures costs for cost sub-categories C02 – Ballast Undercutting (Other) and C03 - Ballast Undercutting – Turnout – Minor within its general maintenance cost category. However, as we included these cost sub-categories in our assessment of Aurizon Network's overall ballast undercutting costs, Aurizon Network's proposed expenditure for these items should be removed from the UT5 efficient general-maintenance expenditure. Table 33 shows Aurizon Network's proposed UT5 expenditure on ballast undercutting that should be removed from the general maintenance cost category.

[36] 170713 – RFI, 3_Tab 4' Row 72. NB: The FY2018 numbers are taken from Aurizon Network's UT5 Submission, NOT the 170713 RFI

Table 33 Aurizon Network proposed general maintenance track ballast undercutting costs[37]

Ballast Undercutting	FY 2018 ($FY2015)	FY 2019 ($FY2015)	FY 2020 ($FY2015)	FY 2021 ($FY2015)	Total ($FY2015)
C02-Ballast Undercutting (Other)	4,902,403	5,096,293	5,290,182	5,484,071	**20,772,949**
Proposed C02 uplift[38]	1,520,000	1,720,000	1,900,000	2,100,000	**7,240,000**
C03 – Ballast Undercutting – Turnout - Minor	305,893	305,893	305,893	305,893	**1,223,572**
Total	**6,728,296**	**7,122,186**	**7,496,075**	**7,889,965**	**29,236,522**

2.10 Assessment of achievability, measurability, transparency and accountability

Given the common themes of our assessment of these other areas of assessment, we have grouped our findings for the sub-categories assessed in this sub-section.

2.10.1 Achievability

In assessing achievability, we have considered the scope of works for each of the sub-categories and the available resources to determine if the scopes proposed are realistic within the allocated timescales.

Tasks suitable for subcontractors can be accelerated by engaging a suitable quantity of subcontract workers. Given there are five systems in the network, multiple contractors could be engaged at various times through the year, sequentially or on a rotating roster.

Tasks that Aurizon Network chooses to undertake in-house, would require consideration of resources available and the overall scale of the task. However, there are specialist subcontractors available that could handle rail restressing and rail repair that could supplement Aurizon Network's work force. Track recording car operations are undertaken by Queensland Rail under contract with a vehicle capable of recording at train speed and covering the entire CQCN network of 2,655 km twice per annum is a realistic target.

Given the availability of contract labour to undertake many of the maintenance tasks, we consider that the scope of works proposed by Aurizon Network in the sub-categories reviewed to be achievable.

2.10.2 Measurability

As discussed earlier Aurizon Network has provided very little information in the way of measurable scope of work for the General Maintenance cost sub-categories reviewed. For example, the Aurizon Network Maintenance Cost Report 2016 does not provide detail of works and costs for these specific activities. Rail repair, maintenance ballast and attendant costs allowed by Aurizon Network in RFI 4 are based on historic costs. By default therefore, work scopes for UT5 are based on work undertaken historically in UT4.

The only measurable scope provided by Aurizon Network for these General Maintenance cost sub-categories was for Fire and Vegetation Management. Aurizon Network has proposed a scope of 5,770 km

[37] Maintenance UT5 Cost Build, Real Total NMP, Cells D10:G11

[38] Maintenance UT5 Cost Build, Infrastructure Maintenance (IM), Row 39

for vegetation management for each of the UT5 years at a unit cost of $1,011 per km as the Aurizon Network RFI 4 response. Given that, contractors would undertake this work the data in terms of km managed should be readily available.

Similarly, if Aurizon Network were now working with a 192-hour visual inspection cycle on all systems within the CQCN then the annual distance covered by a rail inspection team for a system of 2,655 km would be 92 by 2,655 km, equal to 120,000 km. The hi-rail inspection records would be an item that the ONRSR would audit as part of the rail safety legislation and should be readily available. The same should apply to a bi-annual track recording undertaken.

We consider that Aurizon Network should be able to capture data on the amount of work undertaken for all of these costs to enable it to quantity and measure the performance through UT5 and to enable the QCA to assess actual performance and cost against proposed performance and costs.

In short, all of the General Maintenance cost sub-category activities reviewed are capable of measurement and hence assessment of performance against target. However, Aurizon Network has not been able to provide such information to us in response to our RFIs.

2.10.3 Transparency

As discussed above we consider that Aurizon Network should be capable of developing future costs for many General Maintenance work tasks on the basis of an assessment of quantities of work i.e. scope of work to be undertaken. That is on a 'bottom up' basis. However, during our assessment it is clear that Aurizon Network has largely developed UT5 annual expenditure by escalating UT4 FY2017 expenditure. As such the make-up of the scope of work and development of proposed costs is not transparent.

2.10.4 Accountability

The UT5 submission document does not detail the incentives that may be used to ensure staff have a clear and achievable goal and motive for ensuring the defined and agreed work scope is completed within each period.

We understand that Aurizon Network operates a new enterprise agreement titled as *Aurizon Construction and Maintenance Enterprise Agreement 2015*. From our review of the Aurizon Enterprise agreement we understand that no formalised bonus or productivity scheme is included and hence no incentive is provided to its staff to undertake work efficiently.

3. Conclusions

Table 34 presents Aurizon Network's proposed general-maintenance costs for the sub-categories reviewed (approximately $100 million ($FY2015) over UT5) for the selected sub-categories in this mini-report.

Table 35 presents GHD's proposed general-maintenance costs for the sub-categories reviewed in this mini-report and Table 36 compares the totals of the general maintenance sub-category costs proposed by Aurizon Network and GHD for UT5 ($FY2015).

Table 34 – Aurizon Network's proposed UT5 general maintenance costs (real FY2015) [39] for five sub-categories

General maintenance ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Rail repair	6,831,229	6,831,229	6,831,229	6,831,229
Fire and vegetation management	5,834,910	5,834,910	5,834,910	5,834,910
Track inspections	5,697,185	5,697,185	5,697,185	5,697,185
Maintenance ballast	3,464,591	3,464,591	3,464,591	3,464,591
Rail stress adjustment	3,136,956	3,136,956	3,136,956	3,136,956
Total	**24,964,871**	**24,964,871**	**24,964,871**	**24,964,871**

Table 35 - GHD's proposed UT5 general maintenance costs (real FY2015) for five sub-categories

General maintenance ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Rail repair	6,071,658	6,071,658	6,071,658	6,071,658
Fire and vegetation management	5,632,050	5,632,050	5,632,050	5,632,050
Track inspections	4,000,000	4,000,000	4,000,000	4,000,000
Maintenance ballast	3,128,175	3,128,175	3,128,175	3,128,175
Rail stress adjustment	3,136,957	3,136,957	3,136,957	3,136,957
Total	**21,968,840**	**21,968,840**	**21,968,840**	**21,968,840**

Table 36 - Summary of UT5 general maintenance costs (real FY2015) proposed by AN and GHD for the five sub-categories

General maintenance ($FY2015)	Total AN Proposed ($FY2015)	Total GHD Proposed ($FY2015)	Difference ($FY2015)	Difference %
Rail repair	27,324,916	24,286,632	-3,038,284	-11%

[39] Real Costs sourced from Maintenance UT5 Cost Build Model: Product Summary – Real$; Total NMP

Fire and vegetation management	23,339,640	22,528,200	-811,440	-3%
Track inspections	22,788,740	16,000,000	-6,788,740	-30%
Maintenance ballast	13,858,364	12,512,700	-1,345,664	-10%
Rail stress adjustment	12,547,824	12,547,828	4	0%
Total	**99,859,484**	**87,875,360**	**-11,984,124**	**-12%**

Table 37 presents Aurizon Network's proposed general maintenance costs for all general maintenance categories, not including track-ballast undercutting. Table 38 presents our proposed general maintenance costs for all general maintenance categories, noting that we only assessed 5 of these categories through our sample and prioritisation process. Table 39 presents a comparison between Aurizon Network's proposed general maintenance costs for all general maintenance categories (not including track-ballast undercutting) and GHD's proposed general maintenance costs for all general maintenance categories (not including track-ballast undercutting).

Table 37 – Aurizon Network's proposed UT5 general maintenance costs (real FY2015) [40] for five sub-categories

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)
Earthworks - Non Formation	C06	2,896,355	2,896,355	2,896,355	2,896,355	11,585,420
Fencing	C07	308,294	308,294	308,294	308,294	1,233,176
Rail Joint Management	C08	780,691	780,691	780,691	780,691	3,122,764
Turnout Maintenance	C10	2,987,665	2,987,665	2,987,665	2,987,665	11,950,660
Minor Yard Maintenance	C28	579,483	579,483	579,483	579,483	2,317,932
Track Geometry Recording	C29	1,988,226	1,988,226	1,988,226	1,988,226	7,952,904
Rail Flaw Detection - On Track Vehicle	C30	1,536,116	1,536,116	1,536,116	1,536,116	6,144,464
Monument/Signage Maintenance	C37	521,130	521,130	521,130	521,130	2,084,520
Maintenance Ballast	C42	3,464,591	3,464,591	3,464,591	3,464,591	13,858,364
Sleeper Management	C43	2,583,151	2,583,151	2,583,151	2,583,151	10,332,604
Fire & Vegetation Management	C44	5,834,910	5,834,910	5,834,910	5,834,910	23,339,640
Rail Stress Adjustment	C47	3,136,956	3,136,956	3,136,956	3,136,956	12,547,824
Rail Flaw Detection - Manual	C48	477,871	477,871	477,871	477,871	1,911,484
Track Inspections	C50	5,697,185	5,697,185	5,697,185	5,697,185	22,788,740
Track Clean-up	C51	1,474,629	1,474,629	1,474,629	1,474,629	5,898,516

[40] Real Costs sourced from Maintenance UT5 Cost Build Model: Product Summary – Real$; Total NMP

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)
Rail Lubrication	C52	1,836,077	1,836,077	1,836,077	1,836,077	7,344,308
Top & Line Spot Resurfacing	C53	2,012,495	2,027,262	2,027,262	2,027,262	8,094,281
Rail Repair	C54	6,831,229	6,831,229	6,831,229	6,831,229	27,324,916
Level Crossing Maintenance	C57	1,686,455	1,686,455	1,686,455	1,686,455	6,745,820
Inventory Management		-278,280	-247,896	-217,944	-188,419	-932,539
Total		**46,633,509**	**46,648,276**	**46,648,276**	**46,648,276**	**186,578,337**

Table 38 - GHD's proposed UT5 general maintenance costs (real FY2015) for five sub-categories

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)
Earthworks - Non Formation	C06	2,896,355	2,896,355	2,896,355	2,896,355	11,585,420
Fencing	C07	308,294	308,294	308,294	308,294	1,233,176
Rail Joint Management	C08	780,691	780,691	780,691	780,691	3,122,764
Turnout Maintenance	C10	2,987,665	2,987,665	2,987,665	2,987,665	11,950,660
Minor Yard Maintenance	C28	579,483	579,483	579,483	579,483	2,317,932
Track Geometry Recording	C29	1,988,226	1,988,226	1,988,226	1,988,226	7,952,904
Rail Flaw Detection - On Track Vehicle	C30	1,536,116	1,536,116	1,536,116	1,536,116	6,144,464
Monument/Signage Maintenance	C37	521,130	521,130	521,130	521,130	2,084,520
Maintenance Ballast	C42	3,128,175	3,128,175	3,128,175	3,128,175	12,512,700
Sleeper Management	C43	2,583,151	2,583,151	2,583,151	2,583,151	10,332,604
Fire & Vegetation Management	C44	5,632,050	5,632,050	5,632,050	5,632,050	22,528,200
Rail Stress Adjustment	C47	3,136,957	3,136,957	3,136,957	3,136,957	12,547,828
Rail Flaw Detection - Manual	C48	477,871	477,871	477,871	477,871	1,911,484
Track Inspections	C50	4,000,000	4,000,000	4,000,000	4,000,000	16,000,000
Track Clean-up	C51	1,474,629	1,474,629	1,474,629	1,474,629	5,898,516
Rail Lubrication	C52	1,836,077	1,836,077	1,836,077	1,836,077	7,344,308
Top & Line Spot Resurfacing	C53	2,012,495	2,027,262	2,027,262	2,027,262	8,094,281

General maintenance ($FY2015)	ID	FY 2018	FY 2019	FY 2020	FY 2021	Total ($FY2015)
Rail Repair	C54	6,071,658	6,071,658	6,071,658	6,071,658	24,286,632
Level Crossing Maintenance	C57	1,686,455	1,686,455	1,686,455	1,686,455	6,745,820
Inventory Management		-278,280	-247,896	-217,944	-188,419	-932,539
Total		**43,637,478**	**43,652,245**	**43,652,245**	**43,652,245**	**174,594,213**

Table 39 - Summary of UT5 general maintenance costs (real FY2015) proposed by AN and GHD for the five sub-categories

General maintenance ($FY2015)	ID	Total AN Proposed ($FY2015)	Total GHD Proposed ($FY2015)	Difference ($FY2015)	Difference %
Earthworks - Non Formation	C06	11,585,420	11,585,420	0	0
Fencing	C07	1,233,176	1,233,176	0	0
Rail Joint Management	C08	3,122,764	3,122,764	0	0
Turnout Maintenance	C10	11,950,660	11,950,660	0	0
Minor Yard Maintenance	C28	2,317,932	2,317,932	0	0
Track Geometry Recording	C29	7,952,904	7,952,904	0	0
Rail Flaw Detection - On Track Vehicle	C30	6,144,464	6,144,464	0	0
Monument/Signage Maintenance	C37	2,084,520	2,084,520	0	0
Maintenance Ballast	C42	13,858,364	12,512,700	-1,345,664	-10
Sleeper Management	C43	10,332,604	10,332,604	0	0
Fire & Vegetation Management	C44	23,339,640	22,528,200	-811,440	-3
Rail Stress Adjustment	C47	12,547,824	12,547,828	4	0
Rail Flaw Detection - Manual	C48	1,911,484	1,911,484	0	0
Track Inspections	C50	22,788,740	16,000,000	-6,788,740	-30
Track Clean-up	C51	5,898,516	5,898,516	0	0
Rail Lubrication	C52	7,344,308	7,344,308	0	0
Top & Line Spot Resurfacing	C53	8,094,281	8,094,281	0	0

General maintenance ($FY2015)	ID	Total AN Proposed ($FY2015)	Total GHD Proposed ($FY2015)	Difference ($FY2015)	Difference %
Rail Repair	C54	27,324,916	24,286,632	-3,038,284	-11
Level Crossing Maintenance	C57	6,745,820	6,745,820	0	0
Inventory Management		-932,539	-932,539	0	0
Total		**185,645,798**	**173,661,674**	**-11,984,124**	**-6**

Our recommended position results in an overall reduction in Aurizon Network's general maintenance cost forecast of 6% to $173.66 million.

Level 9 145 Ann Street Brisbane QLD 4000 Australia
GPO Box 668 Brisbane QLD 4001 Australia

61 7 3316 3000
advisory@ghd.com

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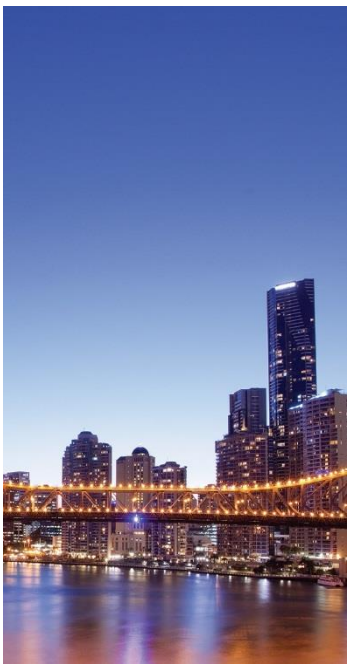

Appendix F – Signalling

Mini Report for the Queensland Competition Authority

15 November 2017

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1. Executive summary

The Queensland Competition Authority (QCA) engaged GHD (us) to review Aurizon Network's proposed maintenance costs for the regulatory period covering 2017-18 (FY2018) to FY2021 (known as the UT5 period). This mini-report assesses whether the costs that Aurizon Network has proposed for Corrective Maintenance (T28) and Preventative Maintenance (T29) reflect prudent and efficient maintenance scopes and delivery practices.

As requested in the QCA's Terms of Reference (ToR), our analysis, where relevant and possible, considers the following themes set out in Table 1**.**

Table 1 Analysis themes

Underlying themes	Title
Efficiency and prudency	The extent to which Aurizon Network's proposals are efficient and prudent.
Achievability	The extent to which the proposals are practically achievable.
Measurability	The extent to which the proposals provide a platform for measuring performance.
Transparency	The extent to which the proposals clearly articulate and commit to a set of outputs.
Accountability	The extent to which Aurizon Network is accountable for its performance.

In accordance with the ToR, we have undertaken the following in carrying out our review:

- We have considered all tasks on a rail system-by-rail system basis, as well as with respect to the aggregate of all systems.
- In addition, as applicable to the task, we have considered the UT3 period (FY2010 to FY2013), UT4 period (FY2014 to FY2017) and UT5 period (FY2018 to FY2021) on both a yearly and aggregate basis.
- We have considered the tasks in the context of the need to prioritise maintenance cost categories and their associated maintenance products. This prioritisation informs the depth of analysis we have undertaken for a particular maintenance cost category and its associated maintenance products.

1.1 Efficiency and prudency

The principal cost for signalling maintenance work is, in our opinion, the cost of labour and labour-related expenses. Any major additions or renewals of the signalling system do not belong in the maintenance budgets. Rather, they must be disclosed as capital or renewal expenditures.

The average actual direct labour for the preventative and corrective maintenance subcategories in FY2015 terms, over the UT4 period but excluding FY2017[1], is $11,195,194 and $7,182,080, respectively. This equates to $18.3 million ($FY2015). For the overall signalling cost category, the labour component is $21.8 million (average for FY2014-FY2016 actual expenditure). No data were provided by Aurizon Network allowing analysis of the cost build-ups and, hence, we were unable to construct a bottom-up cost model for the Signalling category. We have based our analysis of efficiency of costs by benchmarking, UT4 using labour levels as a proxy for work scope.

[1] FY2017 is excluded because FY2017 was not complete when Aurizon Network provided its RFI response to the QCA.

Using an allowance of $150 per labour hour[2] for signalling staff, a figure for which is based on our industry experience, for direct costs, overheads plus expenses and allowing 2,000 labour hours per annum per signalling staff member, then $21.8 million equates to a field work force of approximately 73 persons. This allocates about a single person for each 40 km of signalled track.

In our experience and applying our engineering judgement, the allocation of one person per 40 km is comparable with similar rail networks in remote areas with little or no suburban passenger traffic. For example, Transnet, a coal transport rail system in South Africa. We therefore consider that a total labour component cost of $21.8 million for UT4 is efficient. We note that this is within 3% of Aurizon Network's proposed annual labour costs for UT5, based on our reallocation of labour and consumable costs from that proposed by Aurizon Network (see Section 3.3). We also note that the proposed UT5 annual signalling maintenance expenditure represents a real 2% increase on average UT4 annual expenditure. Given the additional track installed (413 km[3]) during the latter part of UT4 such as on the Blackwater System and during Stage 1 part of the Wiggin Island Rail Project[4] coupled with Aurizon Network's proposed split between preventative and corrective maintenance we consider this 2% real increase to be reasonable.

In summary we consider the scale of works, albeit defined in staff numbers required, rather than quantities of scope, as being appropriate and prudent as they align with the staffing levels of what we consider the benchmark below-rail operator would have. Based on the approach that we have adopted, we also consider the total proposed associated signalling costs to be reasonable in light of:

- Change in track length of the overall network during the latter part of UT4 (413 km[5])
- No declared change in technology that will substantially increase signalling inspection efficiency
- Comparison relative only to historical UT4 costs previously determined to be prudent and efficient.

However, we note that several material inconsistencies appear in the Aurizon Network cost build-up, which we have discussed below.

1.2 Signalling maintenance category breakdown by accounting cost component

Over the UT4 period, Aurizon Network's actual (FY2014-FY2016)[6] average annual labour costs for signalling is $21.8 million (FY2015 terms), while that for consumables is about $1.0 million (FY2015). In comparison, the figures, respectively, for the Aurizon Network UT5 forecast is $11.5 million and $11.6 million.

Aurizon Network has not indicated that the CQCN will significantly increase in size, or the signalling system will be maintained in a different manner from UT4 to UT5. As such, there is no reason for the proposed change in the apportionment of costs to the different cost components, with some $10 million of labour costs during UT4 being transferred to proposed consumable costs during UT5 is unclear. Accordingly, we propose a cost breakdown with respect to labour and consumables for UT5 that reflects the actual cost category

[2] Unlike the resurfacing and ballast undercutting reports, we have adopted a top down approach for assessing the prudency of scope for signalling (by checking the size of the labour force for the CQCN). In particular, we have used an industry benchmark total labour rate of $150/h in assessing the prudency of scope. Therefore, the use of the EBA figures is not needed to inform the top down approach which relies on benchmark rates.

[3] Aurizon Network response to QCA RFI 3 170713-RFI-UT5 Maintenance_AN.xlsx row 5 of 3_Tab 6

[4] Aurizon Network response to QCA RFI 4 – 170620 – Aurizon Networks Response to UT5 Maintenance RFI4.xlsx

[5] Aurizon Network response to QCA RFI 3 170713-RFI-UT5 Maintenance_AN.xlsx row 5 of 3_Tab 6

[6] FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

expenditure breakdown for UT4 (FY2014-FY2016). ***Table 2*** reflects our recommendations; we also recommend that the same proportions for be applied for the system-by-system analysis.

Table 2: GHD recommended cost component breakdown for UT5 signalling costs[7]

Cost component	% weight	GHD recommendation (annual), $FY2015
Labour	92.1	22,530,453
Consumables	4.3	1,046,430
Fuel	0.0	3,256
Travel and accommodation	0.4	87,661
Depreciation	3.3	804,124
Total	**100.0**	**24,471,925**

1.3 Summary of analysis of signalling scopes and costs

From our analysis, we consider Aurizon Network's proposed UT5 scope and expenditure for signalling maintenance are prudent and efficient for the following reasons: The determined allocation of one person per 40 km is comparable with our benchmark below-rail operator (Transnet). The UT5 proposed costs are only 2% real higher than actual UT4 costs (see Table 4) which we consider appropriate given the additional track installed during the latter part of UT4 and the proposed ratio of preventative to corrective maintenance scope.

Our proposed efficient signalling maintenance expenditure for UT5 is provided below in ***Table 3***

Table 3 GHD determined efficient UT5 signalling maintenance expenditure

Signalling ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021	UT5 total
Total	**24,471,925**	**24,471,925**	**24,471,925**	**24,471,925**	**24,471,925**

Our main amendment to Aurizon Network's cost proposal relates to its breakdown on cost component basis to reflect the same breakdown between labour and consumables as per UT4 as set out in ***Table 2***.

[7] We have included the forecast cost data for FY17 in determining the average spend over the UT4 period. However, we did not include the FY17 data in calculating the percentage weightings, as we considered the use of actual historical data, without any influence of forecast data, to be more appropriate.

Table 4 Aurizon Network's UT5 cost projections for signalling activities[8]

UT Scheme	UT4				UT5			
Financial Year (Prices in $FY2015)	***FY14***	***FY15***	***FY16***	***FY17***	***FY18***	***FY19***	***FY20***	***FY21***
T28 - Prevent Signalling Field Maintenance	11,280,294	12,581,707	11,888,570	10,090,989	8,376,036	8,376,036	8,376,036	8,376,036
T29 - Correct Signalling Field Maintenance	7,647,258	9,402,503	8,942,919	7,930,307	10,351,697	10,351,697	10,351,697	10,351,697
T40 - Signalling Level Xing Protect - Preventative	500,476	429,062	550,258	406,941	705,524	705,524	705,524	705,524
T41 - Signalling Level Xing Protect - Corrective	350,980	420,174	553,932	357,416	467,924	467,924	467,924	467,924
T42 - Signalling Train Protect System (ATP Mtce) - Preventative	34,349	14,192	27,727	31,827	--	--	--	--
T43 - Signalling Train Protect System (ATP Mtce) - Corrective	37,665	30,376	28,295	31,827	41,668	41,668	41,668	41,668
T44 - Wayside Monitoring System Mtce - Preventative	483,536	425,413	343,128	395,480	681,886	681,886	681,886	681,886
T45 - Wayside Monitoring System Mtce - Corrective	708,557	882,296	675,625	698,440	914,388	914,388	914,388	914,388
T46 - Weighbridge Maintenance - Preventative	270,961	378,958	393,315	310,649	514,655	514,655	514,655	514,655
T47 - Weighbridge Maintenance - Corrective	483,696	562,225	411,436	602,733	786,566	786,566	786,566	786,566
T48 - Weighbridge Maintenance - Recertification	3,944	8,362	21,120	42,406	32,957	32,957	32,957	32,957
T54 - Signalling Control Systems	139,408	92,881	62,852	213,130	140,776	140,776	140,776	140,776
T58 - Cable Route Maintenance	599,802	1,054,556	1,010,792	1,113,553	1,457,849	1,457,849	1,457,849	1,457,849
Total	**22,540,926**	**26,282,704**	**24,909,969**	**22,225,699**	**24,471,925**	**24,471,925**	**24,471,925**	**24,471,925**

[8] UT4 numbers from 170713 – RFI – UT5 Maintenance_AN; 'Signalling(1) Rows 8 to 23', UT5 numbers from Maintenance UT5 Cost Build: "IM – Signalling" Rows 10 to 23

2. Description of signalling activities

Aurizon Network undertakes a comprehensive signalling maintenance program across the CQCN. The activities undertaken in this program are described below. Aurizon Network has also indicated the likely maintenance costs associated with each activity across the network. Preventative programs are gradual in nature and often preferred to corrective maintenance. Once faults are realised, corrective measures often require rapid responses at short notice to ensure collisions are avoided in areas such as way-side junctions or level crossings.

Table 5 Descriptions

Activities	Description
T28 - Prevent Signalling Field Mtce	A preventative program to ensure potential signalling faults are addressed before they are realised
T29 - Correct Signalling Field Mtce	A program to repair existing system faults
T40 - Signalling Level Xing Protect - Preventative	Preventative maintenance to ensure signalling and the mechanical booms at level crossings are maintained in proper order.
T41 - Signalling Level Xing Protect - Corrective	Repair works to repair faults in level crossings.
T42 - Signalling Train Protect System (ATP Mtce[9]) - Preventative	Preventative inspection and repair of Automated Train Protection systems. These include advance warning alerts and braking directives, amongst others.
T43 - Signalling Train Protect System (ATP Mtce) - Corrective	Corrective works to repair Automated Train Protection mechanisms.
T44 - Wayside Monitoring System Mtce - Preventative	Preventative monitoring and repair of wayside-alert systems. These systems prevent collisions of merging trains from multiple lines.
T45 - Wayside Monitoring System Mtce - Corrective	Corrective maintenance to address existing faults
T46 - Weighbridge Maintenance - Preventative	Inspection and pre-emptive repair of weighbridges.
T47 - Weighbridge Maintenance - Corrective	Repairs for weighbridge faults.
T48 - Weighbridge Maintenance - Recertification	Costs associated with the periodic testing and certification of weighbridges. These are leveraged panels that measure loads of heavy vehicles.
T54 - Signalling Control Systems	General maintenance of the signalling control and network
T58 - Cable Route Maintenance	Maintenance, inspection and repair of signalling cables or the trenches and pipes that house them.

[9] Mtce is a contraction of 'Maintenance'

3. Analysis of scope and costs

Aurizon Network has, despite the requests under the QCA RFIs, not presented a detailed scope of work for signalling maintenance. The extent of information provided is limited to the number of inspections planned under preventative maintenance and the number of potential incidents under corrective maintenance. In absence of provided detailed scopes, our analysis of these activities is limited only to a comparison between proposed costs for UT5 and actual costs for UT4. And a comparison of our determined staff numbers, based on an average staff cost per hour, with a comparable, benchmark below rail operator (Transnet).

3.1 Analysis of signalling maintenance scope

Using an allowance of $150 per labour hour[10] for signalling staff covering direct costs, overheads plus expenses, a figure for which is based on our industry experience, and allowing 2,000 labour hours per annum per signalling staff member, then the $21.8 million UT4 actual average spend (average for FY2014-FY2016) [11] equates to a field work force of approximately 73 persons. This allocates about a single person for each 40 km of signalled track. In our experience, the allocation of one person per 40 km is comparable to similar rail networks in remote areas with little or no suburban passenger traffic. We have used Transnet, a similar coal transport rail system in South Africa as a basis for benchmarking.

Given the points above, we consider the scale of works, albeit defined in staff numbers required, rather than quantities of scope as being appropriate and prudent as they are in line with the staffing levels of our benchmark below rail operator.

3.2 Analysis of signalling maintenance costs

In this section we review UT4 and UT5 overall signalling maintenance expenditure and by activity within the signalling maintenance cost category. Analysis of signalling maintenance practices demonstrates several unique trends (see Table 6 to Table 8). Unit rates in respect of cost per km of track or costs per inspection for preventative and corrective field maintenance are projected to remain relatively constant within the UT5 period and are comparable to unit rates in the UT4 period. Aurizon Network has not indicated that any significant upgrades to the network are scheduled to take place during the UT5 periods and hence the scope of overall signalling maintenance should not be materially different for UT5 compared to UT4.

We have observed the following from our analysis of UT5 proposed and UT4 actual costs:

- In the UT4 period, $11.46 million per annum and $8.48 million per annum, on average, were spent on preventative and corrective maintenance, respectively. In the UT5 period, $8.38 million per annum and $10.35 million are projected respectively for preventative and corrective maintenance. This represents a minor decrease (~3%) in expenditure and also a higher allocation of funds to corrective maintenance in UT5 than in UT4. We consider this expenditure profile to be reasonable but are unclear as to why Aurizon Network has forecast more corrective maintenance costs than preventative maintenance costs for UT5.
- Level crossing expenditure is projected to rise. Average preventative maintenance for level crossings in UT5 is set to rise 50% and corrective maintenance is set to rise 11%. Preventative maintenance will

[10] Unlike the resurfacing and ballast undercutting reports, we have adopted a top down approach for assessing the prudency of scope for signalling (by checking the size of the labour force for the CQCN). In particular, we have used an industry benchmark total labour rate of $150/h in assessing the prudency of scope. Therefore, the use of the EBA figures is not needed to inform the top down approach which relies on benchmark rates.

[11] FY2017 costs are Aurizon Network's projected costs due to the timing of the data provision.

take a greater role in UT5, representing 151% of UT5 level crossing expenditure as opposed to 112% in UT4. We consider that allocation of greater budget to preventative rather than corrective maintenance is in keeping with good asset management practice and should yield a future overall reduction in maintenance costs and improved network performance. However, Aurizon Network provided no information on the reasons behind the overall increase in costs for level crossing maintenance expenditure and hence we are unable to comment whether the increase is reasonable or not.

- Preventative maintenance of train monitoring systems (ATP) is projected to decline to zero in UT5. Aurizon Network has not provided an explanation for this reduction in preventative maintenance of ATP which we consider is not in keeping with good practice.
- Recertification costs are projected to rise 74% on UT4 levels. Weighbridge maintenance is set to rise by approximately 53% in the preventative and corrective schemes. Again, Aurizon Network has provided no justification for this change.

Aurizon Network's preventative maintenance incurs a charge of between $477 and $800 per hour[12] for a signalling maintenance crew (the rate varying depending on the size of the crew), FY2015 terms, over FY2014 to FY2016. During UT3 and UT4, the average time taken to undertake a preventative maintenance activity was approximately one hour.

In comparison, over the same period, Aurizon Network's corrective maintenance incurred an average charge of $367 to $730 per hour, in FY2015 terms for a signalling maintenance crew (the rate varying depending on the size of the crew). It should be noted this range of $367 to $730 per hour does not account for the losses that might be incurred in relation to train path losses during the repair operation. These categories are separate from crossing or wayside faults, but Aurizon Network's data indicate that average closure times for corrective maintenance (between detection and correction) was 58 hours in UT3 and 34 hours in UT4[13].

We have observed a general move to emphasise corrective signalling maintenance in UT5. GHD suggests that Aurizon Network could consider accounting for the likely costs of closure (or of signalling-related incidents) on supply chain stakeholders, in informing its budgets to prevent over-emphasis of corrections and greater emphasis on prevention.

In summary, Aurizon Network proposed UT5 total signalling maintenance costs are $24.47 million per annum (FY2015) which represents a 2% real increase over average UT4 costs (FY2014-FY2017). We note that proposed UT5 signalling preventative maintenance expenditure is approximately 27% below UT4 levels. Conversely, proposed UT5 corrective maintenance costs are 22% higher than those incurred in UT4. Aurizon Network has not provided indications as to the reasoning behind these changes. We do not understand why Aurizon Network has proposed this shift in maintenance costs from preventative to reactive when good practice asset management would dictate that appropriate preventive maintenance will drive down reactive maintenance costs resulting in lower overall maintenance costs.

Given that we consider manning levels, based on our calculations, to be prudent as they compare favourably with our benchmark rail operator, and that labour makes up the majority of the costs for this activity, based on our re-allocation of costs in UT5 from consumables to labour to be in keeping with UT4 actuals (see Section 3.3), we consider the proposed UT4 costs to be efficient.

We also note that the proposed UT5 annual signalling maintenance expenditure represents a real 2% increase on average UT4 annual expenditure. Given the additional track installed (413 km[14]) during the latter part of UT4 such as on the Blackwater System and during Stage 1 part of the Wiggin Island Rail Project[15]

[12] Calculated from Signalling(3) worksheet in Aurizon Network's response to RFI4

[13] Taken from Signalling(3) worksheet in Aurizon Network's response to RFI4

[14] Aurizon Network response to QCA RFI 3 170713-RFI-UT5 Maintenance_AN.xlsx row 5 of 3_Tab 6

[15] Aurizon Network response to QCA RFI 4 – 170620 – Aurizon Networks Response to UT5 Maintenance RFI4.xlsx

coupled with Aurizon Network's proposed split between preventative and corrective maintenance we consider this 2% real increase to be reasonable.

In summary we consider the scale of works, albeit defined in staff numbers required, rather than quantities of scope, as being appropriate and prudent as they align with the staffing levels of what we consider the benchmark below-rail operator would have. Based on the approach that we have adopted, we also consider the total proposed associated signalling costs to be reasonable in light of:

- Change in track length of the overall network during the latter part of UT4 (413 km[16])
- No declared change in technology that will substantially increase signalling inspection efficiency
- Comparison relative only to historical UT4 costs previously determined to be prudent and efficient.

However, we note that several material inconsistencies appear in the Aurizon Network cost build-up, which we have discussed below in Section 3.3.

[16] Aurizon Network response to QCA RFI 3 170713-RFI-UT5 Maintenance_AN.xlsx row 5 of 3_Tab 6

Table 6 Aurizon Network's financial projections for signalling activities[17]

UT Scheme	UT4				UT5			
Financial Year (Prices in $FY2015)	***FY14***	***FY15***	***FY16***	***FY17***	***FY18***	***FY19***	***FY20***	***FY21***
T28 - Prevent Signalling Field Maintenance	11,280,294	12,581,707	11,888,570	10,090,989	8,376,036	8,376,036	8,376,036	8,376,036
T29 - Correct Signalling Field Maintenance	7,647,258	9,402,503	8,942,919	7,930,307	10,351,697	10,351,697	10,351,697	10,351,697
T40 - Signalling Level Xing Protect - Preventative	500,476	429,062	550,258	406,941	705,524	705,524	705,524	705,524
T41 - Signalling Level Xing Protect - Corrective	350,980	420,174	553,932	357,416	467,924	467,924	467,924	467,924
T42 - Signalling Train Protect System (ATP Mtce) - Preventative	34,349	14,192	27,727	31,827	--	--	--	--
T43 - Signalling Train Protect System (ATP Mtce) - Corrective	37,665	30,376	28,295	31,827	41,668	41,668	41,668	41,668
T44 - Wayside Monitoring System Mtce - Preventative	483,536	425,413	343,128	395,480	681,886	681,886	681,886	681,886
T45 - Wayside Monitoring System Mtce - Corrective	708,557	882,296	675,625	698,440	914,388	914,388	914,388	914,388
T46 - Weighbridge Maintenance - Preventative	270,961	378,958	393,315	310,649	514,655	514,655	514,655	514,655
T47 - Weighbridge Maintenance - Corrective	483,696	562,225	411,436	602,733	786,566	786,566	786,566	786,566
T48 - Weighbridge Maintenance - Recertification	3,944	8,362	21,120	42,406	32,957	32,957	32,957	32,957
T54 - Signalling Control Systems	139,408	92,881	62,852	213,130	140,776	140,776	140,776	140,776
T58 - Cable Route Maintenance	599,802	1,054,556	1,010,792	1,113,553	1,457,849	1,457,849	1,457,849	1,457,849

[17] UT4 numbers from 170713 – RFI – UT5 Maintenance_AN; 'Signalling(1) Rows 8 to 23', UT5 numbers from Maintenance UT5 Cost Build: "IM – Signalling" Rows 10 to 23

UT Scheme	UT4				UT5			
Total	**22,540,926**	**26,282,704**	**24,909,969**	**22,225,699**	**24,471,925**	**24,471,925**	**24,471,925**	**24,471,925**

Table 7 Comparison of activity expenditures across undertaking periods[18]

Variable	UT5/UT4	UT4 P/C	UT5 P/C	UT4 total	UT5 total
T28 & T29 discussed in Section 3.3.	*Expenditure*	*Ratio of prevention to correction*		As above	As above
T40 - Signalling Level Xing Protect - Preventative	150%	112%	151%	1,886,737	2,822,096
T41 - Signalling Level Xing Protect - Corrective	111%			1,682,502	1,871,696
T42 - Signalling Train Protect System (ATP Mtce) - Preventative	0%	84%	0%	108,095	Nil
T43 - Signalling Train Protect System (ATP Mtce) - Corrective	130%			128,163	166,672
T44 - Wayside Monitoring System Mtce - Preventative	166%	56%	75%	1,647,556	2,727,544
T45 - Wayside Monitoring System Mtce - Corrective	123%			2,964,918	3,657,552
T46 - Weighbridge Maintenance - Preventative	152%	66%	65%	1,353,882	2,058,620
T47 - Weighbridge Maintenance - Corrective	153%			2,060,090	3,146,264
T48 - Weighbridge Maintenance - Recertification	174%	n.a.	n.a.	75,832	131,828

[18] UT4 numbers from 170713 – RFI – UT5 Maintenance_AN; 'Signalling(1) Rows 8 to 23', UT5 numbers from Maintenance UT5 Cost Build: "IM – Signalling" Rows 10 to 23

Variable	UT5/UT4	UT4 P/C	UT5 P/C	UT4 total	UT5 total
T54 - Signalling Control Systems	111%	n.a.	n.a.	508,271	563,104
T58 - Cable Route Maintenance	154%	n.a.	n.a.	3,778,703	5,831,396

Table 8 Unit costs for prevention and maintenance in field

T28	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	UT3 average	UT4 average	UT5 average
Cost	7,596,494	8,445,132	9,167,417	11,280,294	12,581,707	11,888,570	10,090,989	8,403,015	11,460,390	8,376,042
Failures fixed	13,031	15,040	16,563	15,979	15,434	20,206	18,849	14,878	17,617	-
Hours to fix	1.00	0.89	0.86	0.95	1.01	0.89	0.84	0.92	0.92	-
$/hr	584	631	641	743	803	661	639	619	712	-
$ / inspection	583	562	553	706	815	588	535	566	661	-
T29	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**UT3 average**	**UT4 average**	**UT5 average**
Cost	6,765,217	7,733,485	7,233,803	7,647,258	9,402,504	8,942,919	7,930,307	7,244,169	8,480,747	10,351,701
Failures fixed	5,797	5,832	5,760	5,495	5,398	5,137	4,534	5,796	5,141	-
Hours to fix	44.32	58.19	72.09	39.69	32.27	29.56	33.29	58	34	-
$/hr	26	23	17	35	54	59	53	22	50	-
$ / fault	1,167	1,326	1,256	1,392	1,742	1,741	1,749	1,250	1,656	-

T28 is the “Preventative Maintenance” program and T29 is the “Corrective Maintenance” program.

3.3 Signalling maintenance category breakdown by accounting cost component

In this section we review the breakdown of the signalling maintenance cost category into accounting cost components that align with Aurizon Network's cost component breakdown for Maintenance Cost Index purposes.

The data provided by Aurizon also indicates that while an average of $21.8 million was spent, per annum on Labour (FY2014-FY2016), this has dropped to $11.48 million each year in UT5. Simultaneously, consumables in UT5 are set to increase approximately eleven-fold from the UT4 average of $1.0 million (FY2014-2016).

Aurizon Network has not declared any changes to the way that labour services are to be grouped to GHD. Whilst we consider that the overall totals for UT5 are reasonable and in line with UT4 expenditures, we consider that the proposed UT5 breakdown of costs is incorrect. Given that we were not provided with activity specific breakdowns of expenditure types by accounting cost component, we adopted the following equation, for example, when calculating expenditure for T28 (Preventative Signalling Field Maintenance) and T29 (Corrective Signalling Field Maintenance) in the context of accounting cost components:

$$Labour\ (T28) = Labour\ (All\ signalling)\ X\ \frac{(Expenditure\ [T28])}{(All\ expenditure)}$$

That is, we assumed labour in a certain activity could be expressed as a percentage of total signalling expenditure. Table 9 shows the make-up of actual costs for signalling maintenance for UT4 and Table 10 shows the proposed expenditure for UT5. In UT5. Aurizon Network's proposal indicates, on an accounting cost component basis, a reduction of approximately 40% in labour costs and ten-fold increase in consumables. Aurizon Network has not provided any data supporting this movement in expenditure from labour to consumables. As signalling maintenance is a labour intensive activity, we consider that the Aurizon Network provided cost breakdown provided for the UT5 period is incorrect and should be similar to UT4 actuals. For example, we expect the consumables expenditure to predominantly cover spare parts. We do not think it likely that the expenditure on spare parts should increase from circa $1 million for UT4 to $11.6 million for UT5.

We also question the observed change in the allowance for travel and accommodation. It increases five-fold from UT4 to UT5 whilst labour has decreased. The following tables were extracted from Aurizon Network's document 170620 Aurizon Networks Responses to UT5 RFI4 Tabs Signalling 1 and Signalling 2. Table 9 represents actual costs for UT4 and Table 10 represents the UT5 forecast costs.

Table 9 UT4 actual costs by cost component breakdown

UT4 Actual Costs (accounting cost component breakdown)				
Component	**FY14**	**FY15**	**FY16**	**FY17^**
Labour	19,580,975	23,685,009	22,226,697	19,919,557
Consumables	995,825	741,364	1,304,628	1,083,080
Fuel	6,286	1,787	1,392	1,212

UT4 Actual Costs (accounting cost component breakdown)				
Travel and accommodation	88,438	52,866	113,514	155,837
Depreciation	632,902	924,799	779,768	905,667
CPI	1,236,500	876,876	483,970	160,344
Total	**22,540,926**	**26,282,702**	**24,909,969**	**22,225,699**

^FY2017 costs are Aurizon Network's planned expenditure costs rather than actual due to timing of data provision

Table 10 UT5 proposed cost by cost component breakdown

UT5 Forecast Costs (accounting cost component breakdown)				
Component	**FY 18**	**FY 19**	**FY 20**	**FY 21**
Labour	11,482,299	11,482,299	11,482,299	11,482,299
Consumables	11,632,118	11,632,118	11,632,118	11,632,118
Fuel	287,474	287,474	287,474	287,474
Travel and accommodation	403,025	403,025	403,025	403,025
Depreciation	667,009	667,009	667,009	667,009
CPI	0	0	0	0
Total	**24,471,925**	**24,471,925**	**24,471,925**	**24,471,925**

However, and irrespective to our questioning on the changes in cost allocation between UT4 and UT5, as indicated in Table 9 and Table 10 in terms of total costs, Aurizon Network has proposed that UT5 total expenditure on signalling maintenance increase by approximately 2% over average UT4 actual costs.

4. Conclusions

4.1 Efficiency and prudency

Aurizon Network has provided very limited information with regards to the scope of the signalling maintenance cost category. We have therefore assessed prudency of scope and efficiency of costs based on our rail and engineering knowledge of the activity and by comparison with a benchmark below rail operator (Transnet) that operates a similar coal network.

The principal cost for signalling maintenance work is, in our opinion, the cost of labour and labour-related expenses. Any major additions or renewals of the signalling system do not belong in the maintenance budgets. They must be disclosed as capital or renewal expenditures.

From our comparison of UT4 expenditure and UT5 we note that Aurizon Network has moved approximately $10 million of the labour cost (UT4 expenditure) into consumables in its UT5 expenditure proposal. We do not understand why Aurizon Network has moved this labour cost element into consumables as, from our knowledge, consumables typically consist of spares. The UT4 actual expenditure for consumables is circa $1 million. In our analysis we have assumed that the ratio of cost components remains the same between UT4 and UT5.

Given that Aurizon Network has provided limited scope information, we have back calculated the allowance made by Aurizon Network in terms of work force numbers for hands-on signalling staff against the funds allowed. It is worth noting that the total funds allowed by Aurizon Network for UT5 are similar to those for UT4 based on the FY 2015 prices.

Using an allowance of $150 per labour hour for signalling staff, a figure for which is based on our industry experience, for direct costs, overheads plus expenses and allowing 2,000 labour hours per annum per signalling staff member, then $21.8 million equates to a field work force of approximately 73 persons. This allocates about one person for each 40 kilometres of signalled track. In our experience, this allocation is comparable to similar rail networks in remote areas with little or no suburban passenger traffic such as our benchmark below rail operator Transnet.

From this back calculation, we therefore consider the scope to be prudent as the calculated number of employees involved in maintenance is comparable to our benchmark.

As the majority of costs relate to labour, we also consider that the UT4 expenditure is efficient, given that an appropriate number of full time equivalents are employed in signalling operations. We note that UT5 annual proposed expenditure is approximately 2% higher in real terms over UT4 average costs. Given the 413 km increase in track length during the latter part of UT4 and the ratio of preventative to corrective maintenance scope we consider this real increase to be reasonable. As such we consider that the proposed UT5 costs are efficient. Our proposed efficient signalling maintenance expenditure for UT5 is provided below in Table 11.

Table 11 GHD determined efficient UT5 signalling maintenance expenditure

Signalling ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021	UT5 total
Total	**24,471,925**	**24,471,925**	**24,471,925**	**24,471,925**	**24,471,925**

Our main amendment to Aurizon Network's cost proposal relates to its breakdown on an accounting cost component breakdown basis (see section 4.2).

4.2 Accounting cost component breakdown of signalling costs

Aurizon Network has, despite the requests under the QCA RFI scheme, not presented a detailed scope of work for signalling maintenance. The extent of information provided is limited to the number of inspections planned under preventative maintenance and the number of potential incidents under corrective maintenance. As with general maintenance, it is our opinion that the bulk of the sums allowed are based on historical values of maintaining the signalling systems rather than a directly specified or calculated scope. Given that this budget is for maintenance works only, then it should only allow for spares as replacement parts and not upgrading of the signalling systems.

Although the overall costs for signalling maintenance between UT4 and UT5 are similar (Aurizon Network has proposed an overall 2% real increase) Aurizon Network has materially changed the allocation of costs between the sub-cost categories. In particular, some $10 million of labour costs incurred in UT4 have been moved to consumables such that the proposed expenditure on consumables has increased from the $1 million incurred in UT4 annually to some $11.6 million in UT5. We understand that consumables largely relates to spares. Any requirement to add or renew signalling infrastructure should not fall under the maintenance budget and must be declared as capital or renewal expenditure, and be recovered by the ex post capital expenditure assessments under UT5 (assuming UT5 maintains the UT4 requirements for capital expenditure reviews).

Given that Aurizon Network has not indicated that the CQCN will significantly increase in size, or the signalling system will be maintained in a different manner from UT4 to UT5, the reason for such change in cost allocation between the different cost sub-components is unclear. In addition, there is a contradiction between the elements, in that the labour cost falls significantly during UT5, but at the same time, the labour-related elements for accommodation and travel increase substantially. If these indirect costs have been reallocated or renamed as 'consumables', no guidance has been provided by Aurizon Network on this matter.

It is our opinion that the cost breakdown proposed by Aurizon Network for UT5 is incorrect for the reasons set out above and does not reflect the actual costs that may be incurred against each component. We therefore consider that the breakdown of proposed UT5 costs requires correction.

We consider the accounting cost component breakdown for UT5 should more closely reflect the actual breakdown of UT4 costs (FY2014-FY2016). The table below reflects our recommendation of how costs should be split

Table 12: GHD recommended accounting cost component breakdown for UT5 signalling costs

Accounting cost component	% weight	GHD recommendation (annual), $FY2015
Labour	92.1	22,530,453
Consumables	4.3	1,046,430
Fuel	0.0	3,256
Travel and accommodation	0.4	87,661
Depreciation	3.3	804,124
Total	**100.0**	**24,471,925**

Level 9 145 Ann Street Brisbane QLD 4000 Australia
GPO Box 668 Brisbane QLD 4001 Australia

61 7 3316 3000
advisory@ghd.com

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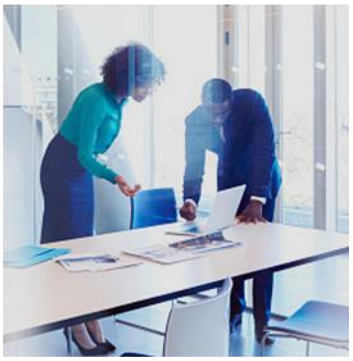

Appendix G – Maintenance Planning and Support

Mini Report for the Queensland Competition Authority

15 November 2017

GHD

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1. Summary

1.1 Objective

The Queensland Competition Authority (QCA) has engaged GHD (us) to review Aurizon Network's proposed maintenance costs for UT5.

This mini-report will assess whether Aurizon Network's proposed maintenance planning & support (MPS) costs reflect prudent and efficient maintenance scopes and delivery practices.

MPS covers costs related to administrative and planning activities necessary for planning and scheduling the required maintenance activities. We note, as part of UT4, these MPS costs were allocated among broader maintenance product categories; and were not defined separately.

Table 1 presents Aurizon Network's proposed MPS costs ($17.6 million ($FY2015) over UT5).

Table 1 – Aurizon Network's proposed UT5 MPS costs[1]

Maintenance Planning & Support	FY 2018	FY 2019	FY 2020	FY 2021
($FY2015)	4,393,330	4,393,330	4,393,330	4,393,330

1.2 Summary of analysis of MPS scopes and costs

The MPS category, because of its nature, does not have any scopes. It is an allocation of funds that Aurizon Network has to provide administrative activities necessary for planning and scheduling the required maintenance activities[2] carried out under the maintenance categories of ballast undercutting, resurfacing, grinding, general maintenance, signalling, traction, telecommunications and structures. It also covers other administrative functions such as time-sheeting and placing orders for inventory and materials. Because no scopes exist, we are only in a position to interrogate the MPS costs in the context of historical data over UT4 (as UT3 data were not provided) and by considering what labour rates for MPS are appropriate.

1.2.1 Labour costs

We note that the costing method used by Aurizon Network in developing UT5 costs for MPS was *"based on historical timesheets during UT4"*[3]. In our view, MPS costs should be completely labour-based. We consider this position appropriate because equipment for inspections would be captured by the Track Inspections sub-category within the General Maintenance category. This means the MPS category should comprise labour costs and travel-and-accommodation costs only, noting that costs for items like density measurers, track geometry recorders and rail profile measurers would be captured within the General Maintenance category. It is unclear to us why fuel (covering movement of machinery, not that of motor vehicles) costs, consumables costs and depreciation costs would be captured in the MPS category, given those three cost groupings should be covered by the other maintenance-cost categories. In this context, our assessment considers only the MCI accounting-cost components of: labour; and travel and accommodation. We do not consider as

[1] Maintenance UT5 Cost Build, "Infrastructure Maintenance (IM)", Row 14

[2] Aurizon Network UT5 Submission page 186

[3] Aurizon Network UT5 Submission: Table 24, page 159

prudent and efficient any of the MPS costs that relate to fuel, consumables and depreciation. As part of its response to RFI4, Aurizon Network provided the following information on labour rates (in $FY2015) for the A07 and A15 sub-categories comprising MPS (see Figure 1).

Figure 1: Aurizon Network's actual labour rates for MPS costs ($FY2015)[4]

A07	2013/14	2014/15	2015/16
Total Labour Hours	7,281	5,246	6,385
Avg hourly rate	115	163	113
Total Direct labour Cost	835,053	853,394	723,281
A15	2013/14	2014/15	2015/16
Total Labour Hours	35,985	27,602	25,691
Avg hourly rate	135	126	114
Total Direct labour Cost	4,846,912	3,473,790	2,923,765

The average labour rate for the A07 and A15 sub-categories is $128/ hr. In our resurfacing mini report, we provided indicative labour hourly rates for rail workers (summarised in Table 2), based on the current Aurizon Enterprise Agreement that is current till 2018.

Table 2 - GHD indicative labour hourly rates for all workers[5]

Aurizon agreement level (FY2016)	Aurizon agreement classification	Role	Base hourly rate	Labour rate with on-costs and overheads
RIW2	CI1.4	Labour/TPOs	$27.51	$80.00
RIW3	CI2.2	Skilled labourer	$30.55	$89.00
RIW4	CI3.3	Train operator	$37.66	$107.00
RIW5	CI4.2	Site manager	$43.37	$121.00

The Enterprise Agreement for Construction and Maintenance was ratified on 21 August 2015. At this time when Aurizon Network had been privatised for nearly five years, indicating that the Executive Leadership team of Aurizon would have had opportunity to renegotiate the salaries of its rail infrastructure workers, to the best of the business' commercial ability, to reflect market conditions and expectations for wages in the rail-maintenance sector. Against this background, we have assumed that the wages in the current Aurizon Enterprise Agreement for Construction and Maintenance reflect a negotiated outcome subject to competitive pressures.

[4] E-mail correspondence from Michael Bray at Aurizon Network to Hiresh Devaser of GHD on 10 August 2017, *RE: Clarification on MPS costs*

[5] See Table 35, including supporting text, is in the GHD Resurfacing Mini Report. Main source is *Aurizon Construction and Maintenance Enterprise Agreement 2015*, Rail Infrastructure Workers table of fortnightly pay. Link: https://www.fwc.gov.au/documents/documents/agreements/fwa/ae415356.pdf

In our view, an MPS staff member would likely be paid, on average, a wage between a skilled labourer and train operator. Our understanding is that train operators are paid a premium for working in remote regions like the CQCN, while an MPS worker, which may have to be degree qualified and appropriately skilled, would likely command a premium relative to a skilled labourer working on site.

Based on the logic above, the total hourly labour rate for an MPS worker could be the mid-point of $89.00 and $107.00; this figure is $98.00 ($FY2016). Representing this total hourly labour rate in $FY2015, which we get by reducing the rate by 1.76%[6], consistent with the MCI increase from FY2015 to FY2016, the labour rate is $96.30 in $FY2015.

Relative to Aurizon Network's implied hourly labour rate of $128/hr, our rate of $96.30 is 24.8% lower than Aurizon Network's rate. Aurizon Network's average annual labour cost over UT4 (excluding FY2017) is $4,644,300 ($FY2015). Applying a 24.8% reduction to this average annual labour cost yields a figure of $3,494,293 ($FY2015).

Assuming that MPS workers are salaried (not contractors), the annual salary, including on-costs, per MPS worker would be $96.30 x 52 x 40 = $200,304. Dividing the annual labour cost amount that we have estimated of $3,494,293 by $200,304 yields a figure of less than 18 FTEs. For a below-rail system that rails in excess of 225 million tonnes of coal per year, we consider having 18 FTEs, or about 9 FTEs each for the Northern Bowen Basin and Southern Bowen Basin, to not be an inefficient practice. The implied number of FTEs does not appear excessive to us.

1.2.2 Travel and accommodation costs

Annual travel-and-accommodation costs over UT4 (excluding FY2017) are $21,254 ($FY2015). We propose using this figure for our UT5 estimate, as it is a relatively small quantum of money and is based on actual costs borne by Aurizon Network from FY2014 to FY2016.

1.2.3 Limitations of our approach

In our view, Aurizon Network has not provided sufficient evidence to demonstrate that:

- MPS costs are not already masked by the maintenance-cost categories that we have not reviewed (e.g. telecommunications, traction and structures)
- MPS costs have been removed from the cost categories that previously captured these costs during UT4
- MPS costs are not being claimed via forecast operating costs over the UT5 period.

We have not assessed the above issues in providing our recommendation. We recommend that the QCA consult with its consultant for the UT5 opex review prior to making a decision on whether to accept GHD's recommendation on MPS costs.

1.2.4 Conclusion

In the context of the analysis in Sections 1.2.1 to 1.2.3, we consider a prudent and efficient annual MPS allowance over UT5 to be $3,515,547 ($FY2015). This represents a 20.0% reduction in Aurizon Network's proposal of $4,393,330 ($FY2015). In summary, our recommended prudent and efficient MPS costs is as per Table 3.

[6] Based on a GHD-derived MCI, as explained page 38 of the resurfacing mini report

Table 3 – GHD recommended UT5 MPS costs (MCI accounting-cost component basis)

MPS ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Labour	3,494,293	3,494,293	3,494,293	3,494,293
Consumables	0	0	0	0
Fuel	0	0	0	0
Travel and accommodation	21,254	21,254	21,254	21,254
Depreciation	0	0	0	0
Total (GHD)	**3,515,547**	**3,515,547**	**3,515,547**	**3,515,547**
Total (AN)	**4,393,330**	**4,393,330**	**4,393,330**	**4,393,330**
Difference (GHD – AN)	**($877,783)**	**($877,783)**	**($877,783)**	**($877,783)**

2. GHD's analysis of MPS costs

MPS is a new maintenance sub-category that Aurizon Network has introduced for UT5. Aurizon Network explained MPS costs as follows:

> *[MPS] costs relate to administrative activities necessary for planning and scheduling the required maintenance activities and other administrative functions such as time-sheeting and placing orders for inventory and materials. Each depot has an inventory logistics officer who is responsible for ensuring goods are ordered and made available from the central Inventory Material Logistics warehouses to either the depot or to the requisite job site.*
>
> *For clarity, [MPS] costs are booked (via timesheets) to specific work orders within Aurizon Network's [Network Maintenance Plan]. In doing so, Aurizon Network ensures that the costs associated with this activity are kept separate and distinct from the other maintenance cost categories. The UT5 proposal for these activities has been adjusted to account for expected labour cost savings as a result of recent restructures.*[7]

Aurizon Network said that MPS costs were previously allocated amongst direct cost categories and, accordingly, there is no UT4 allowance to compare the UT5 proposal against.[8]

2.1 Description

The MPS category comprises:

- Inventory management (A07)
- Asset management (A15).

The MPS category, because of its nature, does not have any scopes. It represents a budget that Aurizon Network has to provide planning and support services to the maintenance categories of ballast undercutting, resurfacing, grinding, general maintenance, signalling, traction, telecommunications and structures. Because no scopes exist, we are only in a position to interrogate the MPS costs in the context of historical data over UT4 (as UT3 data were not provided) and by considering what labour rates for MPS are appropriate.

2.2 Our analysis

2.2.1 Aurizon Network's proposal

Because the MPS category does not have scopes, we assessed the efficiency of proposed MPS costs over the UT5 period. As part of our RFI process with Aurizon Network, we sought clarification on the breakdown of MPS costs and details of what activities are included. On this, Aurizon Network said that:

- A07 includes the management of all inventory and inventory stores, clean up, stock takes, retrieval of material, audits, inventory administrative duties, minor asset stock takes and audits
- A15 includes activities that support the management of the asset, planning, management meetings, data input/analysis (e.g. systems including RIMS, IMAC, TEAR, and TSMS).

[7] Aurizon Network UT5 submission: 186

8 Aurizon Network UT5 submission: 182

In providing the above information, Aurizon Network supplied data on the split between A07 and A015 costs (see Table 4).

Table 4 - Aurizon Networks proposed UT5 MPS costs (A07 and A015)[9]

MPS ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Inventory management	868,981	868,981	868,981	868,981
Asset management	3,524,349	3,524,349	3,524,349	3,524,349
Total	**4,393,330**	**4,393,330**	**4,393,330**	**4,393,330**

Aurizon Network also provided a breakdown on the MCI accounting-cost component basis (see Table 5). Aurizon Network has proposed an annual MPS cost ($FY2015) of $4.39 M.

Table 5 - Aurizon Network's proposed UT5 MPS costs (MCI accounting-cost component basis)[10]

MPS ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Labour	2,061,363	2,061,363	2,061,363	2,061,363
Consumables	2,088,260	2,088,260	2,088,260	2,088,260
Fuel	51,609	51,609	51,609	51,609
Travel and accommodation	72,353	72,353	72,353	72,353
Depreciation	119,745	119,745	119,745	119,745
Total	**4,393,330**	**4,393,330**	**4,393,330**	**4,393,330**

Aurizon Network also provided historical costs for MPS, namely for the UT4 period (see Table 6). Across UT4 (except for FY2017), the average annual MPS cost ($FY2015) is $4.91 M. Aurizon Network's UT5 MPS proposal reflects a 10.4% reduction in costs relative to the UT4 average cost of $4.39 M.

Table 6 - Aurizon Network's actual UT4 MPS costs (MCI accounting cost-component basis)[11]

MPS ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017*
Labour	5,924,909	4,375,229	3,632,762	4,565,439
Consumables	144,918	17,350	74,461	39,973
Fuel	1,201	87	32	--
Travel and accommodation	19,347	21,555	22,859	18,531
Depreciation	178,074	176,167	127,546	210,217
CPI	73,689	416,248	216,852	164,880

[9] Maintenance UT5 Cost Build, "Real Total NMP", Cells D57:G59

[10] 170713 – RFI – UT5 Maintenance_AN, MPS(1), Cells G30:J36

[11] 170713 – RFI – UT5 Maintenance_AN, 1_Tab 2, Cells C30:F36

MPS ($FY2015)	FY 2014	FY 2015	FY 2016	FY 2017*
Total	**6,342,137**	**5,006,637**	**4,074,513**	**4,999,039**

**FY2017 does not cover that financial year's full costs, as Aurizon Network submitted these data before FY2017 finished*

Based on our review of Table 6, what is unclear to us is why the UT5 labour-cost component decreases sharply in parallel with a steep increase in the consumables-cost component, relative to UT4. In particular, average labour costs over UT5 ($4,644,300) are less than half those of UT4 ($2,061,363), while average consumables costs over UT5 ($2,088,260) are more than 20 times greater than those of UT4 ($78,910). We were not able to reconcile why these discrepancies exist. However, the discrepancies do not affect our approach for determining prudent and efficient costs for the MPS category (see Subsection 2.2.2 below).

2.2.2 Our position

2.2.2.1 CQCN level

The MPS category, because of its nature, does not have any scopes. It is a bucket of funds that Aurizon Network has to provide planning and support services to the maintenance categories of ballast undercutting, resurfacing, grinding, general maintenance, signalling, traction, telecommunications and structures. Because no scopes exist, we are only in a position to interrogate the MPS costs in the context of historical data over UT4 as provided by Aurizon Network in response to QCA's RFI 4 (as UT3 data were not provided) and by considering what labour rates for MPS are appropriate. We note that Aurizon has stated that the costs associated with the new MPS category were previously captured in the maintenance categories for which the planning work was undertaken. As such the UT5 proposal for these maintenance cost categories have been adjusted to account for the labour costs for maintenance planning and support being separately identified in UT5.

2.2.3 Labour costs

In our view, MPS costs should be completely labour-based. We consider this position appropriate because equipment for inspections would be captured by the Track Inspections sub-category within the General Maintenance category. This means the MPS category should comprise labour costs and travel-and-accommodation costs only, noting that costs for items like density measurers, track geometry recorders and rail profile measurers would be captured within the General Maintenance category.

It is unclear to us why fuel (covering movement of machinery, not that of motor vehicles) costs, consumables costs and depreciation costs would be captured in the MPS category, given those three cost groupings should be covered by the other maintenance-cost categories and given that Aurizon Network has stated that the MPS category covers administrative activities only. In this context, our assessment considers only the MCI accounting-cost components of: labour; and travel and accommodation. We do not consider as prudent and efficient any of the MPS costs that relate to fuel, consumables and depreciation. As part of its response to RFI4, Aurizon Network provided the following information on labour rates (in $FY2015) for the A07 and A15 sub-categories comprising MPS (see Figure 2).

Figure 2: Aurizon Network's actual labour rates for MPS costs ($FY2015)[12]

A07	2013/14	2014/15	2015/16
Total Labour Hours	7,281	5,246	6,385
Avg hourly rate	115	163	113
Total Direct labour Cost	835,053	853,394	723,281
A15	2013/14	2014/15	2015/16
Total Labour Hours	35,985	27,602	25,691
Avg hourly rate	135	126	114
Total Direct labour Cost	4,846,912	3,473,790	2,923,765

The average labour rate for the A07 and A015 sub-categories is $128/ hr. In our resurfacing mini report, we provided indicative labour hourly rates for rail workers (summarised in Table 2), based on the current Aurizon Enterprise Agreement that is current until 2018.

Table 7 - GHD indicative labour hourly rates for all workers[13]

Aurizon agreement level (FY2016)	Aurizon agreement classification	Role	Base hourly rate	Labour rate with on-costs and overheads
RIW2	CI1.4	Labour/TPOs	$27.51	$80.00
RIW3	CI2.2	Skilled labourer	$30.55	$89.00
RIW4	CI3.3	Train operator	$37.66	$107.00
RIW5	CI4.2	Site manager	$43.37	$121.00

The Enterprise Agreement for Construction and Maintenance was ratified on 21 August 2015. This was done at a point in time when Aurizon Network had been privatised for nearly five years, indicating that the Executive Leadership team of Aurizon would have had ample opportunity to renegotiate the salaries of its rail infrastructure workers, to the best of the business' commercial ability, to reflect market conditions and expectations for wages in the rail-maintenance sector. Against this background, we have assumed that the wages in the current Aurizon Enterprise Agreement for Construction and Maintenance reflect a negotiated outcome subject to competitive pressures.

In our view, an MPS staff member would likely be paid, on average, a wage between a skilled labourer and train operator. Our understanding is that train operators are paid a premium for working in remote regions like the CQCN, while an MPS worker, which may have to be degree qualified and appropriately skilled, would likely command a premium relative to a skilled labourer working on site.

[12] E-mail correspondence from Michael Bray at Aurizon Network to Hiresh Devaser of GHD on 10 August 2017, *RE: Clarification on MPS costs*

[13] See Table 35, including supporting text, is in the GHD Resurfacing Mini Report. Main source is *Aurizon Construction and Maintenance Enterprise Agreement 2015*, Rail Infrastructure Workers table of fortnightly pay. Link: https://www.fwc.gov.au/documents/documents/agreements/fwa/ae415356.pdf

Based on the logic above, the total hourly labour rate for an MPS worker could be the mid-point of $89.00 and $107.00; this figure is $98.00 ($FY2016). Representing this total hourly labour rate in $FY2015, which we get by reducing the rate by 1.76%[14], consistent with the MCI increase from FY2015 to FY2016, the labour rate is $96.30 in $FY2015.

Relative to Aurizon Network's implied hourly labour rate of $128/hr, our rate of $96.30 is 24.8% lower than Aurizon Network's rate. Aurizon Network's average annual labour cost over UT4 (excluding FY2017) is $4,644,300 ($FY2015). Applying a 24.8% reduction to this average annual labour cost yields a figure of $3,494,293 ($FY2015).

Assuming that MPS workers are salaried (not contractors), the annual salary, including on-costs, per MPS worker would be $96.30 x 52 x 40 = $200,304. Dividing the annual labour cost amount that we have estimated of $3,494,293 by $200,304 yields a figure of less than 18 FTEs. For a below-rail system that rails in excess of 225 million tonnes of coal per year, we consider having 18 FTEs, or about 9 FTEs each for the Northern Bowen Basin and Southern Bowen Basin, to not be an inefficient practice. The implied number of FTEs does not appear excessive to us.

2.2.4 Travel and accommodation costs

Annual travel-and-accommodation costs over UT4 (excluding FY2017) are $21,254 ($FY2015). We propose using this figure for our UT5 estimate, as it is a relatively small quantum of money and is based on actual costs borne by Aurizon Network from FY2014 to FY2016.

2.2.5 Limitations of our approach

In our view, Aurizon Network has not provided sufficient evidence to demonstrate that:

- MPS costs are not already masked by the maintenance-cost categories that we have not reviewed (e.g. telecommunications, traction and structures)
- MPS costs are not being claimed via forecast operating costs over the UT5 period.

We have not assessed the above issues in providing our recommendation. We recommend that the QCA consult with its consultant for the UT5 opex review prior to making a decision on whether to accept GHD's recommendation on MPS costs (see below).

Overall, we consider a prudent and efficient annual MPS allowance over UT5 to be $3,515,547 ($FY2015). This represents a 20.0% reduction in Aurizon Network's proposal of $4,393,330 ($FY2015). Our recommended prudent and efficient MPS costs are in Table 8.

Table 8 – GHD recommended UT5 MPS costs (MCI accounting-cost component basis)

MPS ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Labour	3,494,293	3,494,293	3,494,293	3,494,293
Consumables	0	0	0	0
Fuel	0	0	0	0
Travel and accommodation	21,254	21,254	21,254	21,254
Depreciation	0	0	0	0

[14] Based on a GHD-derived MCI, as explained page 38 of the resurfacing mini report

MPS ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Total (GHD)	**3,515,547**	**3,515,547**	**3,515,547**	**3,515,547**
Total (AN)	**4,393,330**	**4,393,330**	**4,393,330**	**4,393,330**
Difference (GHD – AN)	**($877,783)**	**($877,783)**	**($877,783)**	**($877,783)**

In our view, MPS costs should be split on a gtk basis. This is because gtks are a primary indicator, among others, of the amount and extent of maintenance that need to happen for each CQCN system. We have assessed the forecast gtk splits across systems over the UT5 period, using the QCA's forecasts (see Table 9).

Table 9 – Percentage split of GTKs across systems (QCA's forecast)

GTK%	FY 2018	FY 2019	FY 2020	FY 2021
Blackwater	40%	39%	39%	38%
Goonyella	44%	43%	42%	41%
Newlands/GAP	12%	13%	15%	16%
Moura	4%	4%	4%	4%
Total	**100%**	**100%**	**100%**	**100%**

Applying the percentages in Table 9 to our recommended CQCN-level MPS costs, we obtain the figures as set out in Table 10

Table 10 – GHD's recommended costs by coal system

MPS costs ($FY2015)	FY 2018	FY 2019	FY 2020	FY 2021
Blackwater	1,412,241	1,377,041	1,369,062	1,350,248
Goonyella	1,530,967	1,508,765	1,472,779	1,449,271
Newlands/GAP	439,145	474,594	515,909	560,622
Moura	133,193	155,147	157,798	155,406
Total	**3,515,547**	**3,515,547**	**3,515,547**	**3,515,547**

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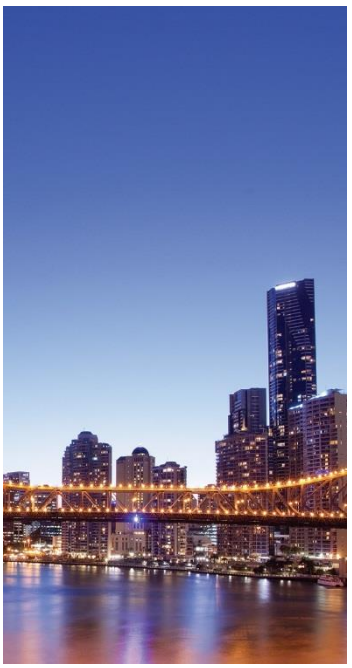

Appendix H – Documents Reviewed Reference List

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Disclaimer

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1. Documents Reviewed

1.1 Reference List

Aurizon Network, 2013*, Capital Funding Request.pdf*

Aurizon Network, 2013, *Capital Funding Request.pdf*

Aurizon Network, 2013, *Aurizon and SAP.pdf*

Aurizon Network, 2013, *Attachment 1 Financial Summary.pdf*

Aurizon Network, 2014, *Aurizon Network System Rules Capricornia Coal Chain.pdf*

Aurizon Network, 2014, *Decision Minute BCM Tranche 2 - CFO Signed 07Jan2014.pdf*

Aurizon Network, 2014, *Decision Minutes BCM Tranche 1 signed CEO 01Jul2013.pdf*

Aurizon Network, 2014, *1.1.8 (3) Decision Minute BCM Tranche 2 CFO signed.pdf*

Aurizon Network, 2014, *National Performance Forum Investment Framework Feasibility Capital Expenditure Decision Minute.pdf*

Aurizon Network, 2015, *Payment Schedule BCM Contract Cost Extract – Confidential.pdf*

Aurizon Network, 2015*, Aurizon Construction and Maintenance Enterprise Agreement 2015.pdf*

Aurizon Network, 2015, *VHPBCM -proof of purchase 1.pdf,* Aurizon Network

Aurizon Network, 2015, *VHPBCM -proof of purchase 2.pdf,* Aurizon Network

Aurizon Network, 2015, *VHPBCM -proof of purchase 3.pdf,* Aurizon Network

Aurizon Network, 2015, *Mechanised Production Excavator Undercutter Process.pdf*

Aurizon Network, 2015, *Programming Track Recording Run Defects Work Instruction.pdf*

Aurizon Network, 2015, *Change Management Plan Maximum Intervals between Scheduled Patrol Inspections in the CQCN.pdf*

Aurizon Network, 2015, *SHE Risk Assessment.pdf*

Pope, K 2016, *Category Management Plan Construction and Maintenance Service.docx, Aurizon Network*

Aurizon Network, 2016, *CMP Network Support Services.docx*

Aurizon Network, 2016, *CMP Track Formation Materials.docx*

Innes, S 2016, *CMP Track Machines.pdf,* Aurizon Network

Aurizon Network, 2016, *Criticality Ratings Assessment Policy – Renewals Prioritisation.pdf*

Aurizon Network, 2016, Asset Renewals Scope Prioritisation.pdf

Aurizon Network, 2016, *UT5 Maintenace and CapexForecast.ppt*

Pope, K 2016, *Steel Rail and Associated Equipment Category Plan.pdf,* Aurizon Network

Aurizon Network, 2017, *170512 RFI UT5 Maintenance V8 QCA.xlsx*

Aurizon Network, 2017, *170403 Mech Production Processes V2.xlsx*

Aurizon Network, 2017, *Meeting Agenda UT5 Maintenance Proposal - Ballast Cleaning.pdf*

Aurizon Network, 2017, *Maintenance and Renewal Product Codes Definition List.pdf*

Aurizon Network, 2017, *Network Strategic Asset Plan Maintenance Model.pdf*

Aurizon Network*,* 2017 *RFI 1.1.8 (1) Tranche 2 Ballast Cleaning Machine Schedule Update.pdf*

Aurizon Network, 2017, *RFI1 UT5 Maintenance Assessment – Information Request 1.docx*

Aurizon Network, 2017, *Procurement Corporate Principle.pdf*

Aurizon Network, 2017, *The Way We Buy Buyers Ed.pdf*

Aurizon Network, 2017, *The Way We Buy EP Edition.pdf*

Aurizon Network, 2017, *The Way We Manage.pdf*

Aurizon Network, 2017, *The Way We Source DIY.pdf*

Aurizon Network, 2017, *The Way We Source EP.pdf*

Aurizon Network, 2017, *The Way We Work.pdf*

Aurizon Network, 2017, *EP PRI 001 Procurement Corporate Principle.pdf*

Aurizon Network, 2017, *Master Data Standard Vendor Master.pdf*

Aurizon Network, 2017, *Positioning asset renewal CAPEX in the sustainable below rail business.ppt*

Aurizon Network, 2017, *UT5 Maintenance Allowance.ppt*

Aurizon Network, *CMP Summary Signalling Telecoms and Operational Systems.ppt*

Backhouse, M 2016, *System Operating Parameters.pdf,* Brisbane, Aurizon Network

Backhouse, M 2017, *Covering email 18 July 2018.docx,* Brisbane, Aurizon Network

Backhouse, M 2017, *Covering email 19 July 2018.docx,* Brisbane, Aurizon Network

Bell, R 2015, *Ballast Scope Development RB May 2015.ppt,* Aurizon Network

Brown, J 2014, *Resurfacing Planning and Resource Allocation Process.pdf*, Aurizon Network

Buckett, G 2014, *Stage Gate Process: Capital Expenditure Feasibility Investment Approval Request Network Assets Management System.pdf,* Aurizon Network

Buckett, G 2014, *Stage Gate Process: Capital Expenditure Prefeasibility Investment Approval Request Network Assets Management System (NAMS) Program.pdf,* Aurizon Network

Buckett, G 2016, *Network Asset Management Systems (NAMS).pdf,* Aurizon Network

Burger, A 2012, *Stage Gate Process: Capital Expenditure Prefeasibility Investment Approval Request.pdf,* Aurizon Network

Burger, A 2012, *Stage Gate Process: Capital Expenditure Concept Investment Approval Request Coal Fouling Removal Project – Ballast Cleaning Fleet.pdf*, QR National

Burger, A 2015, *Certificate of Practical Completion.pdf,* Aurizon Network

Burger, A 2015, *Certificate of Practical Completion.pdf,* Aurizon Network

Burger, A 2016, *Certificate of Practical Completion M566/MMB505.pdf,* Aurizon Networks

Burger, A 2016, *Certificate of Practical Completion Separable Portion 3B (M565/MMA505).pdf* ,Aurizon Network

Burger, A 2016, *Certificate of Practical Completion* Separable Portion 4B (*M567/MMA506).pdf, Aurizon Network*

Burger, A 2016, *Certificate of Practical Completion Separable Portion 4A (M568/MMB506).pdf,* Aurizon Network

Burger, A 2016, *Certificate of Practical Completion Separable Poriton 5B (M569/MMA507).pdf,* Aurizon Network

Burger, A 2016, *Certificate of Practical Completion Separable Portion 5A (M570*/*MMB507).pdf* Aurizon Network

Charanpreet, S Batts, A 2016, *Central Queensland Coal Network Vegetation Management Guidelines.pdf*, Aurizon Network

Chetcuti, M 2012, *Ltr to QRNNS - BCM Business Case Support.pdf, Integrated Logistics Company*

Ellem, P 2014, *Scheduled Assured Maintenance Overview Confidential.pdf,* Aurizon Network

Engineers Australia, 2010, *Our Code of Ethics.pdf*

Harris, M 2017, *Central Queensland Coal Network Vegetation Management Guideline.pdf*

Kearney, S 2017, *RFI3.1.2.1 (1) Master Data Standard Vendor Master.pdf,* Aurizon Network

Kummant, A 2017, *170531 - Cover Letter to QCA re s185 response.pdf,* Aurizon Network

Leschkau, C 2014, *Southern Bowen Basin System Operating Parameters.pdf,* Aurizon Network

Livingston, J 2014, *Asset Maintenance and Renewal Policy Confidential.pdf,* Aurizon Network

Melton, T 2013 *NAMS Concept IAR Attachment 3a.pdf*, Aurizon Network

Newport, D, 2014, *Completion Certificate MMAB500.pdf,* Aurizon Network

Newport, D, 2014, *Letter of Practical Completion All Signed.pdf,* Aurizon Network

O'Connor, A 2013, *Stage Gate Process : Capital Expenditure Concept Investment Approval Request.pdf*, Aurizon Network

O'Connor, A 2013, *Stage Gate Process: Capital Expenditure Prefeasibility Investment Approval Request Resurfacing Plant Investment Requrest.pdf*, Aurizon Network

Poulton, A, 2015, Certificate of *Practical Completion.pdf,* Aurizon Network

Poulton, A 2015, *Certificate of Practical Completion.pdf,* Aurizon Network

QR National, 2012, *Ballast Cleaning – Demand Definition Version 2.pdf*

QR National, 2012, *Capital funding request.pdf*

Queensland Competition Authority, 2016, *Final Decision Aurizon Network 2014 Access Undertaking Volume IV Maximum Allowable Revenue.pdf*

Queensland Government, 2013, *Code of Practice for Registered Professional Engineers.pdf,* Board of Professional Engineers of Queensland

Shelley, S 2013, *Network Asset Management System Program Version 1.3 Stage Gate Process: Capital Expenditure Concept Investment Approval Request.pdf, Aurizon Network*

Smith, A 2013, *Capacity Analysis Benefit of High Production Maintenance Equipmen.pdft,* Aurizon Network

Warwick, R 2013, *IAR Ballast Cleaning Tranche1 Signed Business Case.pdf,* Aurizon Network

Warwick, R 2013, *Ballast Cleaning Feasibility IAR Tranche v NPF V9Dec2013.pdf*, Aurizon Network

Warwick, R 2013, *Stage Gate Process: Capital Expenditure Feasibility Investment Approval Request.pdf,* Aurizon Network

Warwick, R 2013, *Stage Gate Process: Capital Expenditure Feasibility Investment Approval Request, Resurfacing Plant Investment Project.pdf*, Aurizon Network

Welchman, S 2007, *Coal Dust Loss Management Project Environmental Evaluation.pdf*, Katestone Environmental

White, J 2016,*Mechanised Production Quality Manual.pdf,* Aurizon Network

Windle, J 2017, *Final and Submitted Confidentiality Claim Maintenance RFI Response Signed.pdf,* Aurizon Network

Windle, J 2017, *170531 - Confidentiality Claim - Maintenance RFI response.pdf,* Aurizon Network

1.2 No Author Noted:

2011 Equipment Effectiveness Report 12 months to Dec 2011 BCD.pdf

2016 1.8.1 (1) UT5 Maintenance Depreciation, ROA AM & Mech Prod - QCA.xlsx

2017 1.2.1 (1) Enterprise Procurement (EP) KPI's.xlsx

1.2.6 (4) Resurfacing Plant Mtce – detail.xlsx

1.2.8 (1) Resurfacing Contract Cost Extract – Confidential.pdf

170403 - Mech Production Processes v2.xlsx

170404 - Mtce requirements of Resurfacing Fleet Listing-March17.xlsx

170421 - RFI 1_1_1 and 1_2_1 Mech Production Processes.xlsx

Aurizon's Approach to Plain Line Rail Grinding.docx

170510 Ringfenced UT5 NSAPScope CQCN GATPE WIRP Itemised.xlsx

170511 - Supporting Doc for 1_Tab 3 and 1_Tab 7.xls

170512 - NMP_BCD by product FY10-16 actual_FY17-21 forecast_QCA.xlsx

170512- RFI - UT5 Maintenance_v8_QCA v1 SMc JB addn RFI2-3.xlsx

170512- RFI - UT5 Maintenance_v8_QCA v1 SMc.xlsx

170519 - Workings for RFI4 1_8_1(3).xlsx

170531 - RFI - UT5 Maintenance_v9_QCA.xlsx

170531 - Scope performance commentary.docx

170620 - Aurizon Networks Responses to UT5 Maintenance RFI 4.xlsx

170623 - Data for depreciation on New Resurfacing Fleet.xlsx

170623 - FAR Extract - FY16 Resurfacing Depreciation excluding new consists – DRAFT.xlsx

170713 - RFI - UT5 Maintenance_AN.xlsx

20170719 - Ballast Quantum and Closure Rate Calculations.xlsx

All Systems GPR Data and Undercutting History Kian Nam Loke.xlsx

Aurizon's Approach to Plain Line Rail Grinding.docx

BCD_17236_08_24_14_39.xlsx

BCM_Update FY18_Scope_Depots - Mainline Single Track Criticality.xlsx

Blackwater NSAP Maintenance Model UT5 Tonnes Aug16 QCA.xlsx

Delegations Matrix Core Financial Delegations.pdf

FY14 BCD report – MB.xlsx

FY14 NMP report – MB.xlsx

FY15 BCD report – MB.xlsx

FY15 NMP report – MB.xlsx

FY16 BCD report – MB.xlsx

FY16 NMP report – MB.xlsx

Goonyella NSAP Maintenance Model UT5 Tonnes Aug16 QCA.xlsx

IM_17236_08_24_15_25.xlsx

Mech Prod Minor_17236_08_24_16_09.xlsx

Moura NSAP Maintenance Model UT5 Tonnes Aug16 QCA.xlsx

NSAP Model Motes WIRP and GAPE.docx

Network Capacity and Maintenance-Renewals_v3.docx

Newlands NSAP Maintenance Model UT5 Tonnes Aug16 QCA.xlsx

Fact Sheet About Engineering Registration Requirements in Queensland.pdf- Engineering Registration in Queensland

Resurfacing_17236_08_24_15_06.xlsx

Resurfacing Demand Approval 20131104 v4 (Addendum 1).docx

Resurfacing Model 2017-2018 QCA Submission.xlsx

Resurfacing Model 2018-2019 QCA Submission.xlsx

Resurfacing Model 2019-2020 QCA Submission.xlsx

Resurfacing Model 2020-2021 QCA Submissionxlsx

RFI1 – UT5 Maintenance.xlsx

RFI_1 1.1.5 (2) Flowchart of Mechanised Production Project Costs.pdf

RFI 1.2.6 (2) and (5) Resurfacing.docx

RFI2 – UT5 Maintenance.docx

RFI3 – UT5 Maintenance.docx

RFI3 – UT5 Maintenance v2.xlsx

RFI3 – UT5 Maintenance.xlsx

RFI 3.1.7 (3) Network Capacity and Maintenance-Renewals.docx

RFI_3 1_7 (3) Network Capacity and Maintenance-Renewals (Updated).docx

RFI4 – Maintenance costs.xlsx

RFI4 – UT5 Mainteance.docx

RM900 Sequence Screenable and Total Excavation.pdf

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Level 9 145 Ann Street Brisbane QLD 4000 Australia
GPO Box 668 Brisbane QLD 4001 Australia

61 7 3316 3000
advisory@ghd.com

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Level 9 145 Ann Street Brisbane QLD 4000 Australia
GPO Box 668 Brisbane QLD 4001 Australia

61 7 3316 3000
advisory@ghd.com

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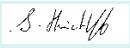
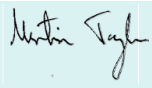
Final	Hiresh Devaser Paul Harding Alistair Fryer John Portwood	Stephen Hinchliffe		Martin Taylor		15/11/2017

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