MAY 2019

SYSTRA SCOTTLISTER

QUEENSLAND COMPETITION AUTHORITY:

QUEENSLAND RAIL WEST MORETON SYSTEM

REVIEW OF PROPOSED MAINTENANCE, CAPITAL & OPERATIONS EXPENDITURE

DRAFT ACCESS UNDERTAKING 2 (DAU2)

Disclaimer

The report dated 18 February 2019 (the "Report") was prepared by SYSTRA Scott Lister as Queensland Competition Authority (QCA)'s technical advisor for the Project pursuant to an Agreement by and between SYSTRA Scott Lister and the Client, dated 11 December 2018. QCA represents and warrants that it has not issued and amendments, modifications or supplements not listed above. The Report speaks only as of its date, and SYSTRA Scott Lister has no obligation to update the report to address changes in facts or circumstances that occur after such date that might materially impact the contents of the Report or any of the conclusions set forth therein.

The Report was prepared for QCA in respect of Queensland Rail's West Moreton System.
SYSTRA Scott Lister accepts no liability for reliance on the Report by Third Parties.

The Report, information contained therein and any statements contained within are all based upon information provided to SYSTRA Scott Lister by the QCA and from publicly available information or sources, in the course of evaluations of the Project. SYSTRA Scott Lister provides no assurance as to the accuracy of any such third-party information and bears no responsibility for the results of any actions taken on the basis of the third-party information included in the report.

REVISION	DESCRIPTION	DATE
A	Draft	1st March 2019
B	Draft	27th March 2019
0	Final	3rd May 2019

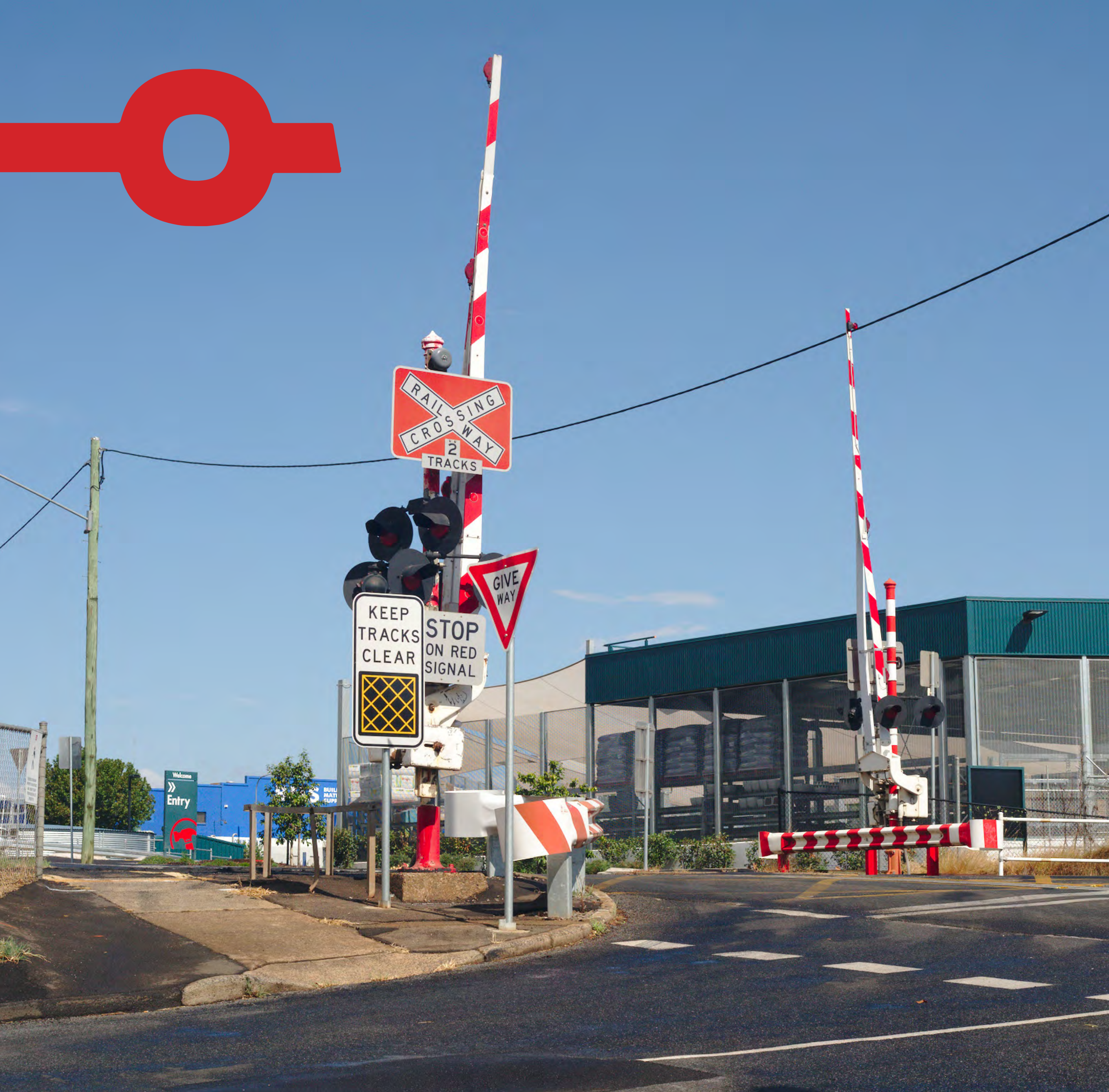
Graphics by Brokat Studio

www.brokat.studio

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS



SYSTRA SCOTTLISTER

Queensland Competition Authority | West Moreton System

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

INTRODUCTION

The West Moreton System is part of the Queensland Rail network. It has a length of 321km and extends between the townships of Rosewood to the East and Columboola in the West. At Rosewood the system joins the South East Queensland (SEQ) urban rail network and at Columboola the system joins Queensland Rail's Western System.

The West Moreton System is shown in Figure 1 below.

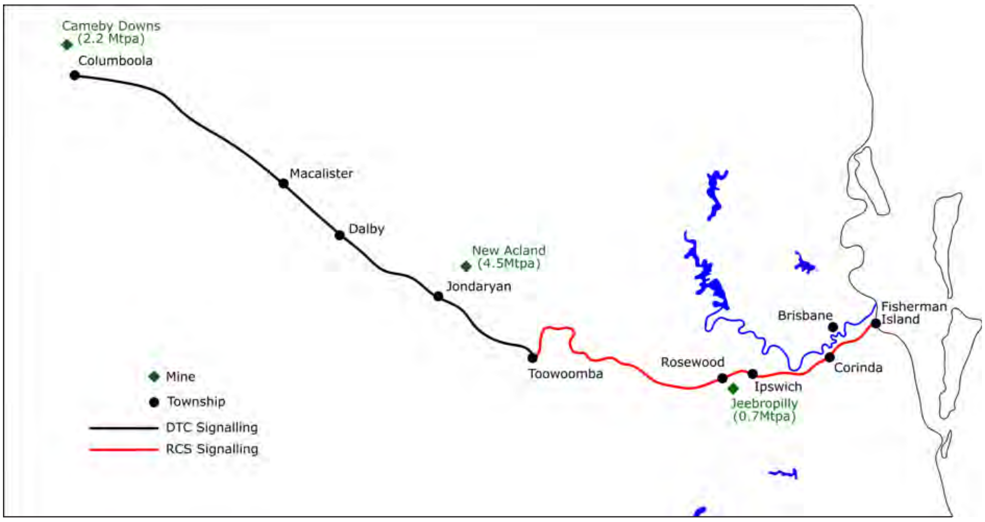


Figure 1. West Moreton System

The system comprises two corridors; Rosewood to Jondaryan (R2J) and Jondaryan to Columboola (J2C). The system is dual track for parts of R2J, and is single track with passing loops across the Toowoomba and Little Liverpool Ranges and the Toowoomba to Jondaryan component of R2J. The system is single track with passing loops for all of the J2C corridor. Signalling for R2J is Remote Controlled Signalling (RCS) from Rosewood to Toowoomba, then Direct Train Control (DTC) from Toowoomba to Jondaryan and all of J2C.

The most significant traffic on the line is coal. The Cameby Downs Mine utilises the entire length of the West Moreton System to transport approximately 2.2 million tonnes[A] of thermal coal from a loading loop near Columboola to the Port of Brisbane. Currently approximately 4.5 million tonnes[B] of thermal coal joins at Jondaryan from the New Acland Mine. There is a possibility that the New Acland Mine may increase production to approximately 7 million tonnes subject to environmental approval of a proposed expansion; this would bring the total coal traffic between Jondaryan and Rosewood to 9.1 million tonnes per annum (mtpa). This increase in tonnage is not confirmed. The Jeebropilly Mine near Rosewood will close in 2019 and does not impact this review. Other traffic is minimal. This traffic includes some agricultural products and two return passenger trains per week. The passenger train is the "Westlander", which runs from Roma St to Charleville.

SYSTRA Scott Lister have based this assessment on traffic of 9.1 million net tonnes per annum of thermal coal; with 2.1 million tonnes originating from the Cameby Downs Mine and 7 million tonnes from the New Acland Mine.

[A] Cameby Downs Mine Continued Operations Project, Section 226 Consideration Report, 2016
[B] New Acland, Key Information, 2018, www.newhopegroup.com.au/content/projects/operations/new-acland-1

The West Moreton System is an old system; it was the first railway constructed in Queensland with elements commissioned as early as 1865. From an engineering perspective, it traverses difficult terrain. The alignment includes the challenging vertical and horizontal alignments on the Toowoomba Range, difficult "black soil" ground conditions and rivers prone to major floods. Effective and efficient maintenance of such a system in the context of relatively small traffic tonnages, and the corresponding pressure on maintenance budgets, requires careful judgement.

ARTC's proposed Inland Rail project will duplicate the alignment through the Toowoomba Range from Rosewood to Gowrie. This is planned to be operational in 2024/2025. The Inland Rail Business Case[1] appears to be based on the current coal traffic on the West Moreton System transferring to the Inland Rail track. ARTC's Inland Rail, once commissioned, will potentially make the portion of the West Moreton System between Rosewood and Gowrie redundant.

Queensland Rail state the timing and impact of Inland Rail on the West Moreton System is still unconfirmed and they maintain a position that the West Moreton System must be maintained to meet commitments independent of Inland Rail.

The West Moreton system is a low tonnage system. Target transit times exist and records indicate reasonable asset performance. As the supply chain is an "even railing" system with adequate stockpile capacity at the Port of Brisbane, some slow transit speeds and inconsistency in transit times can be managed by the coal producers[2]. Slow speeds and inconsistent transit times could potentially be tolerated by the coal producers where some expenditure on maintenance or capital costs could be avoided or deferred.

"The West Moreton System is an old system with elements commissioned as early as 1865."

[1] Attachment A: ARTC 2015 Inland Rail Programme Business Case

[2] A low tonnage coal supply chain that is transporting a relatively uniform product under an "even railing" model, as opposed to "cargo assembly", has some ability to absorb inconsistent train arrival times provided there is sufficient stockpile capacity at the port. Port of Brisbane has stockpile capacity of 909,000 tonnes which represents approximately 19 days of full operation of the ship loaders at the port.

OBJECTIVE

The West Moreton System is a regulated asset and Access Undertaking 1 (AU1) currently applies. A new access undertaking will commence in 2020 for a five year term. This undertaking will be prepared in draft form as Draft Access Undertaking 2 (DAU2). This review of capital, maintenance and operations cost is an element of the consultation process to assist progressing DAU2 into the final Access Undertaking 2 (AU2).

The objective of this study is to provide an assessment of the reasonableness and efficiency of the maintenance, capital, and operations cost estimate submission by Queensland Rail for the West Moreton System access agreement commencing in 2020, Access Undertaking 2 (or AU2).

The Queensland Rail submission is based on the 9.1 mtpa scenario without Inland rail operational.

METHODOLOGY

SYSTRA Scott Lister analysed Queensland's proposed maintenance and capital program against the current asset condition in the context of Queensland Rail's Civil Engineering Track Standards (CETS), Civil Engineering Structural Standards (CESS), approaches by other rail agencies, and good asset management and engineering practice.

OVERVIEW

SYSTRA Scott Lister assessed the Queensland Rail submission for maintenance and capital funding for the West Moreton System under three scenarios:

1. ***A low tonnage scenario of 2.1 mtpa***
2. ***A high tonnage scenario of 9.1 mtpa with Inland Rail commissioned in 2024/2025***
3. ***A base case high tonnage scenario of 9.1 mtpa with delayed Inland Rail commissioning.***

SYSTRA Scott Lister has suggested some amendments to maintenance approach, scope and cost. SYSTRA Scott Lister also suggests that a whole of life assessment of some proposed capital works, considering the wider context of the West Moreton System, could lead to savings through deferral of works or scope reduction. This particularly applies to bridge renewals in the Rosewood to Jondaryan Corridor.

In the assessment, SYSTRA Scott Lister recommends Queensland Rail adopt a formation rebuild campaign or alternative strategy to address specific areas where multiple resurfacing deployments are required every year.

In terms of current asset condition the Queensland Rail engineering team are doing a good job of maintaining this challenging rail within the prescribed CETS track geometry limits.

The low tonnage 2.1 mtpa scenario places demands on Queensland Rail to maintain the track 'fit for purpose'. SYSTRA's assessment of the low 2.1 mtpa tonnage scenario illustrates a requirement to adjust Queensland Rail's asset management strategy. This adjustment may require:

- ***Engagement with ARTC to clearly define Inland Rail/West Moreton System interfaces and timings***
- ***Consideration of maintenance and capital deferral options such as strategically applied speed restrictions and possible temporarily mothballing of some dual track sections***
- ***Review of the viability of being able to operate a separate train control centre for the Southern Freight Supply Chain.***

Queensland Rail must ensure that the West Moreton System satisfies, as a minimum, the prescriptive requirements of the CETS and the CESS. There is a mechanism to review and update the CETS and CESS in regards to specific circumstances and to reflect current engineering and asset management developments.

SYSTRA Scott Lister assesses that it is reasonable and prudent, given the low tonnages and traffic intensity, that the current primary driver for rail maintenance for the West Moreton System is ensuring safe operations at minimal cost. As the system approaches 9.1 mtpa the descent of loaded trains down the Toowoomba Range will potentially constrain capacity; and at this point transit time reliability and on time performance will become increasingly important.

TOTAL MAINTENANCE, CAPITAL & OPERATIONS

The total value of the Queensland Rail submission for the five year period of the DAU2 for the 9.1 mtpa scenario without Inland Rail is ***$349.022 m***.

This comprises capital works, maintenance, and operations as shown in Figure 2 below. Queensland Rail provided, but did not formally submit, a 2.1 mtpa scenario. Queensland Rail's view of the 2.1 mtpa scenario is that it would only be a temporary situation and that either an existing coal producer or a new producer would require tonnages to increase back towards 9.1 mtpa. SYSTRA, on the other hand, analysed the 2.1 mtpa scenario as a medium to long term situation.

Queensland Rail in the response to the QCA Request For Information states *"Notwithstanding the short-term potential of lower volumes on the West Moreton System, the medium term outlook is 9.1 mtpa".*

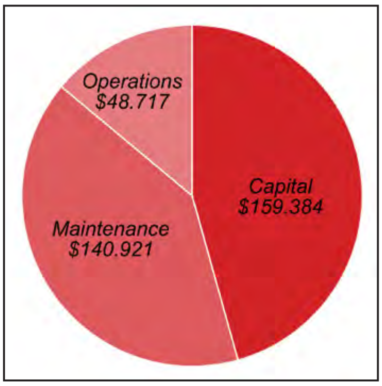


Figure 2. Breakdown of Queensland Rail submission for maintenance, capital and operations for DAU 2020 (millions)

A summary of the SYSTRA Scott Lister assessment at a high level is in Table 1.

Table 1. Summary of SYSTRA Scott Lister assessment ($ million 2020/2021)

Item	Queensland Rail		SYSTRA Assessment			
	2.1 mtpa	9.1 mtpa (no Inland Rail)	2.1 mtpa	9.1 mtpa (with Inland Rail)	9.1 mtpa (without Inland Rail)	Note
Maintenance	101.825	140.921	*87.430*	*117.996*	*117.996*	*1*
Capital	144.495	159.384	*91.275*	*115.345*	*155.465*	*2*
Operations	48.717	48.717	*35.497*	*42.346*	*46.057*	*3*
TOTAL	**295.037**	**349.022**	***214.202***	***275.687***	***319.517***	

SYSTRA Scott Lister note that Queensland Rail has not included the strategic use of speed restrictions as a means of reducing or deferring maintenance and capital costs. SYSTRA Scott Lister understand this approach is generally not good practice as it creates operational constraints. However in some scenarios, such as the low tonnage 2.1 mtpa scenario, these options may need to be considered and documented in the Asset Management Plan to create an economically sustainable operation.

MAINTENANCE

1. Maintenance: SYSTRA Scott Lister assesses Queensland Rail's method for projecting costs to higher and lower tonnages from a base case of a 6.25 mtpa scenario could be enhanced. SYSTRA Scott Lister recommend a reduction in resurfacing and track lowering works, with part of this budget reallocated to rebuilding formations.

2. Capital: SYSTRA Scott Lister assesses a number of capital works may be deferred until certainty of Inland Rail and New Acland coal production is established. SYSTRA Scott Lister assess complete renewal of a number of timber bridges is unnecessary under certain scenarios.
SYSTRA Scott Lister recommends Queensland Rail develop a medium term formation rebuild strategy. The SYSTRA Scott Lister analysis has not included quantification of the impact on reducing the cost of capital type works in terms of cost per unit of production due to longer and less restrictive track access. Longer and less restrictive access reduces the impact of mobilisation, demobilisation and expensive equipment fixed costs; consequently lowering unit production costs.

3. Operations: SYSTRA Scott Lister determined the budget allocation for operation costs, less train control costs, as a percentage of direct costs is approximately 10%. SYSTRA Scott Lister assesses this as reasonable and has applied this percentage across all scenarios.

The Queensland Rail maintenance forecast is in line with the approved AU1 forecast and subsequent actual costs incurred under a 6.25 mtpa scenario projected for a 9.1 mtpa scenario using a linear projection based on net tonnes. The Queensland Rail maintenance submission is shown in Figure 2 below.

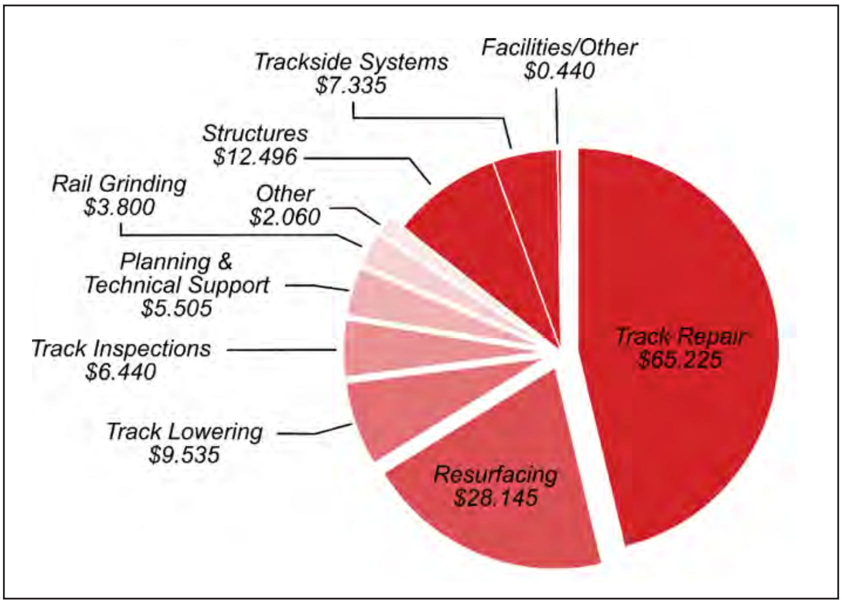


Figure 2. Breakdown of Queensland Rail maintenance submission for DAU2

SYSTRA Scott Lister determined Queensland Rail's linear interpolation method for projecting maintenance costs for the 9.1 mtpa scenario oversimplifies the relationship and SYSTRA Scott Lister has derived an alternative model. SYSTRA Scott Lister assesses that the Queensland Rail linear interpolation provides a reasonable indication of the 9.1 mtpa maintenance cost, as the relationship approaches linear in this area, but does not accurately reflect the maintenance cost at lower tonnages, such as the 2.1 mtpa, where the relationship cannot be approximated as a straight line.

A summary of SYSTRA's assessment of maintenance costs under the three scenarios, compared with Queensland Rail's 9.1 mtpa without Inland Rail scenario, is shown in Table 1 opposite.

Table 2. Summary of SYSTRA Scott Lister maintenance assessment ($ million 2020/2021)

Item	Queensland Rail		SYSTRA Assessment			
	2.1 mtpa	9.1 mtpa (no Inland Rail)	2.1 mtpa	9.1 mtpa (with Inland Rail)	9.1 mtpa (without Inland Rail)	Note
Track Repair	47.788	65.226	37.958	65.226	65.226	4
Resurfacing	15.568	28.143	14.774	14.774	14.774	5
Structures	11.553	12.497	13.282	14.367	14.367	6
Track Lowering	5.148	9.536	0.000	0.000	0.000	7
Trackside Systems	7.336	7.336	7.336	7.336	7.336	8
Track Inspections	6.319	6.438	6.319	6.438	6.438	9
Planning & Technical Support	5.509	5.509	5.509	5.509	5.509	10
Rail Grinding	0.978	3.800	0.570	1.850	1.850	11
Other Track	1.244	2.058	1.244	2.058	2.058	12
Facilities/Other	0.438	0.438	0.438	0.438	0.438	13
MAINTENANCE TOTAL	101.825	140.921	87.430	117.996	117.996	

*A red number indicates that SYSTRA Scott Lister has reduced the Queensland Rail submission.
*A blue number indicates that SYSTRA Scott Lister has increased the Queensland Rail submission.
*A black number indicates that SYSTRA Scott Lister has accepted the Queensland Rail submission.

4. Track Repair: The Queensland Rail's submission for both 9.1 mtpa scenarios is assessed as reasonable. SYSTRA Scott Lister assess the Queensland Rail methodology used to predict a comparative scope of works for the 2.1 mtpa scenario could be enhanced, and have reduced this budget using an improved approach.

5. Resurfacing: SYSTRA Scott Lister finds the resurfacing works proposed by Queensland Rail for the AU2 period to be high. SYSTRA Scott Lister recommends the budget be reduced for these works and partially reallocated to repairing the formation; specifically to address areas that require multiple resurfacing deployments per year.

6. Structures: SYSTRA Scott Lister proposes the expedient repair of several timber bridges rather than concurring with Queensland Rail's recommendation for renewal. SYSTRA Scott Lister therefore recommends an increased budget to maintain assets that are not completely replaced and still have a requirement to be maintained.

7. Track Lowering: SYSTRA Scott Lister suggest this practice should be phased out in lieu of track reconditioning and formation rebuild capital projects.

8. Trackside Systems: SYSTRA Scott Lister assess that maintenance of the trackside infrastructure is essential to ensuring safe operations. SYSTRA Scott Lister concur with the scope of works proposed by Queensland Rail based on their FY16 operations.

9. Track Inspections: SYSTRA Scott Lister assess the Queensland Rail inspection frequency is consistent with CETS and CESS requirements, and their proposal is reasonable for all scenarios.

10. Planning and Technical Support: SYSTRA Scott Lister assess the Queensland Rail proposal for planning and technical support is reasonable and required to ensure the safe operation of the railway.

11. Rail Grinding: The Queensland Rail submission includes grinding on the J2C corridor that conforms with the CETS requirement, that is at 2.1 mtpa grinding for Rolling Contact Fatigue would be required approximately every 5 to 10 years depending on the horizontal alignment.. The proposed grinding frequency for the R2J corridor is in excess of CETS tonnage requirements. SYSTRA Scott Lister has adjusted the grinding allowance to align with CETS.

12. Other Track: SYSTRA Scott Lister determined the Other Track budget is reasonable for all scenarios.

13. Facilities/Other: SYSTRA Scott Lister assess the scope of works performed during the FY16 period is appropriate, and concur with Queensland Rail on the proposed AU2 budget.

CAPITAL

The Queensland Rail capital submission for the 9.1 mtpa without Inland Rail scenario is shown in Figure 3 below.

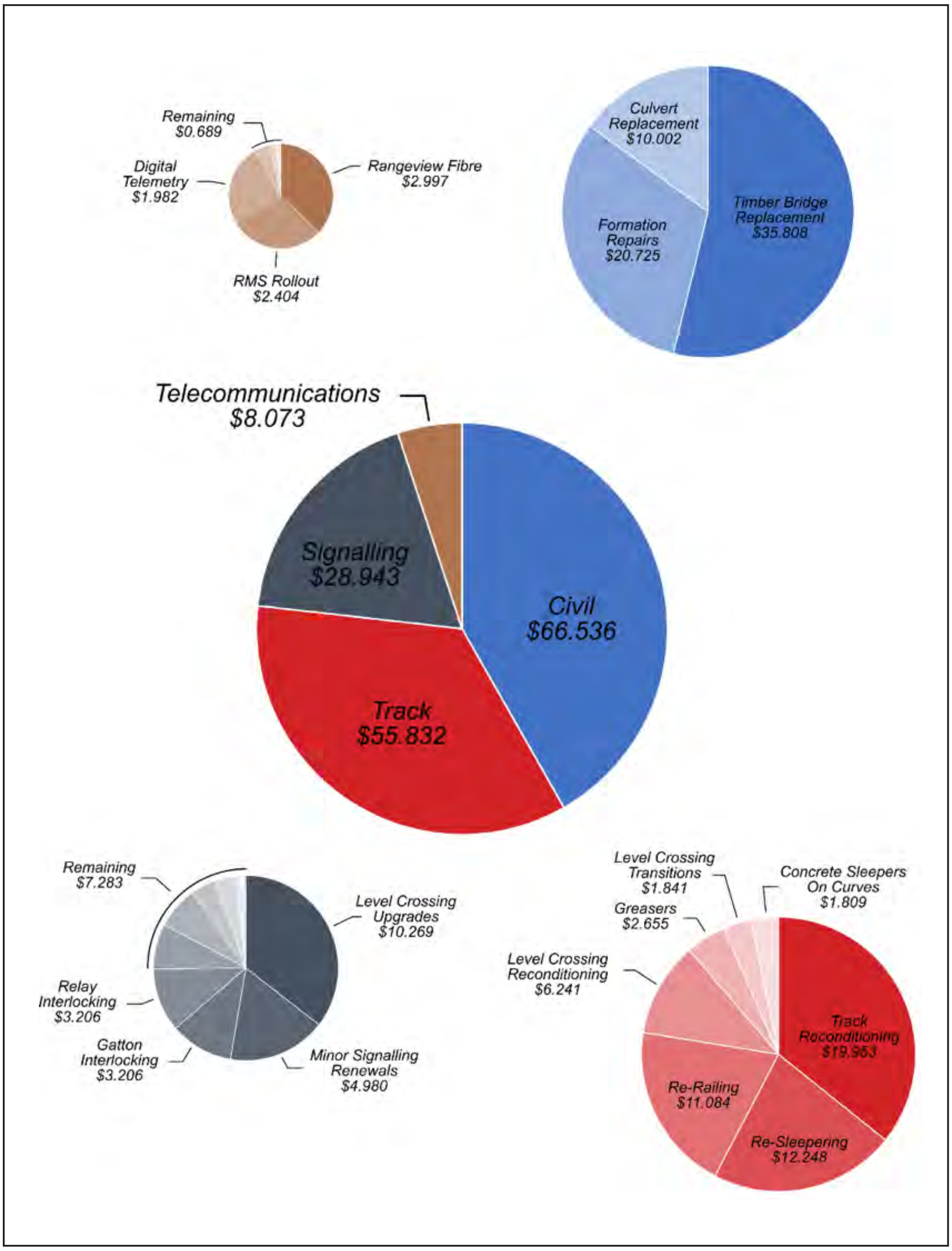


Figure 3. Breakdown of Queensland Rail capital works submission for AU2 ($ million 2020/2021)

Table 3. Summary of SYSTRA Scott Lister capital assessment ($ million 2020/2021)

Item	Queensland Rail		SYSTRA Assessment			
	2.1 mtpa	9.1 mtpa (no Inland Rail)	2.1 mtpa	9.1 mtpa (with Inland Rail)	9.1 mtpa (without Inland Rail)	Note
Timber Bridge Replacement	35.808	35.808	20.971	20.971	20.971	14
Formation Repairs	17.760	20.725	17.760	31.645	31.645	15
Culvert Replacement	10.002	10.002	5.001	5.001	10.002	16
CIVIL SUBTOTAL	63.570	66.536	43.732	62.618	62.618	
Track Reconditioning	11.577	19.953	11.577	19.953	19.953	17
Re-sleepering	12.248	12.248	9.051	9.051	12.248	18
Re-railing	7.537	11.084	5.542	5.542	11.084	19
Level Crossing Reconditioning	6.241	6.241	3.120	3.120	6.241	20
Greasers	2.655	2.655	2.655	2.655	2.655	21
Level Crossing Transitions	1.841	1.841	0.921	0.921	1.841	22
Concrete Sleepers on Curves	1.809	1.809	0.000	1.809	1.809	23
TRACK SUBTOTAL	43.908	55.831	32.866	43.051	55.831	
Level Crossing Upgrade	10.269	10.269	5.135	5.135	10.269	24

Table 3. Summary of SYSTRA Scott Lister capital assessment ($ million 2020/2021)

Item	Queensland Rail		SYSTRA Assessment			
	2.1 mtpa	9.1 mtpa (no Inland Rail)	2.1 mtpa	9.1 mtpa (with Inland Rail)	9.1 mtpa (without Inland Rail)	Note
Miscellaneous Works	7.283	7.283	3.874	3.874	7.283	25
Minor Signalling Renewal	4.980	4.980	2.490	2.490	4.980	26
Relay Interlocking	3.206	3.206	0.000	0.000	3.206	27
Gatton Interlocking	3.206	3.206	0.000	0.000	3.206	28
SIGNALLING SUBTOTAL	28.943	28.943	13.989	13.989	28.943	
Rangeview Fibre	2.997	2.997	0.000	0.000	2.997	29
RMS Rollout	2.404	2.404	0.000	0.000	2.404	30
Digital Telemetry	1.982	1.982	0.000	0.000	1.982	31
Miscellaneous	0.689	0.689	0.689	0.689	0.689	32
TELECOMS SUBTOTAL	8.073	8.073	0.689	0.689	8.073	
CAPITAL TOTAL	**144.495**	**159.384**	**91.275**	**115.345**	**155.465**	

14. Timber Bridge Replacement: The largest component of the $66.536 million civil works estimate is a program of planned timber bridge replacements at a total cost of $35.808 million.

SYSTRA Scott Lister reviewed engineering reports on bridges identified for replacement and inspected bridges in the Grantham and Rosewood areas. In addition, SYSTRA Scott Lister notes that 13 of the 27 bridges identified for replacement, at an estimated cost of approximately $16 million, are in the R2J Corridor. The probable diversion of this traffic on to the Inland Rail track[2], proposed to be circa 2024/2025, will render these bridges potentially redundant.

SYSTRA Scott Lister assesses that the bridge replacement program should be reviewed and redirected towards a strategy of expedient repairs to ensure safe operation at minimal cost rather than replacement where possible; with acknowledgement by stakeholders of any possible operational impact. SYSTRA Scott Lister acknowledges that some locations may require a bridge replacement; however this should be a last resort option supported by an engineering assessment.

15. Formation Rebuilds: The second largest civil component is formation repairs. SYSTRA Scott Lister analysed top and twist track geometry. SYSTRA Scott Lister assess that Queensland Rail's approach to formation repairs should be reviewed and a campaign to address areas requiring multiple resurfacing deployments per year should be initiated. Under the 2.1 mtpa scenario SYSTRA Scott Lister has accepted the Queensland Rail figure of $ 17.760 million; SYSTRA Scott Lister suggest this allowance should be reviewed if the 2.1 mtpa scenario is probable and an operating concept for this scenario is available.

16. Culvert Replacement: The remaining civil allowance is for culvert replacement. SYSTRA Scott Lister assess this as reasonable for an aging system and the 9.1 mtpa scenario without Inland Rail. For the scenarios of 9.1 mtpa with Inland Rail and 2.1 mtpa, SYSTRA Scott Lister assess that half of this allowance is appropriate due to the possibility of value engineering assets with limited required remaining service life or through applying targeted speed restrictions.

17. Track Reconditioning: SYSTRA Scott Lister assess that this is a reasonable allowance based on a review of track geometry data.

18. Re-sleepering: Queensland Rail's proposed sleeper replacement program is consistent with the CETS and a planned 20 year timber sleeper life on mixed steel and timber sleeper track. SYSTRA Scott Lister assess Queensland Rail submission is reasonable for the 9.1 mtpa scenario without Inland Rail. For the scenarios of 9.1 mtpa with Inland Rail and 2.1 mtpa, SYSTRA Scott Lister assess that half of this allowance is appropriate due to the possibility of value engineering assets with limited required remaining service life.

19. Re-railing: The re-railing scope represents replacement of 1.4km/year of rail on the R2J corridor. 35% of the proposed re-railing is on dual track. Under the low tonnage and Inland Rail scenarios the proposed re-railing in the dual track location work should be deferred. SYSTRA Scott Lister also assesses that due to the low tonnage or limited life under the 2.1 mtpa or Inland Rail scenarios some of the single track re-railing could be deferred. Consequently SYSTRA Scott Lister has reduced the estimate to a 50 % allowance to address essential safety related re-railing.

20. Level Crossing Reconditioning: SYSTRA Scott Lister suggest that the level crossing elements should be treated as one program of works. SYSTRA Scott Lister assess Queensland Rail submission is reasonable for the 9.1 mtpa scenario without Inland Rail. For the scenarios of 9.1 mtpa with Inland Rail and 2.1 mtpa, SYSTRA Scott Lister assess that half of this allowance is appropriate due to the possibility of value engineering assets with limited required remaining service life while still addressing safety critical level crossing issues.

21. Greasers: SYSTRA Scott Lister assess due to the high number of defects, 33 defects across 71 installations, and critical nature of greasers on the Toowoomba range the replacement of greasers is appropriate.

[2] The Inland Rail business case identifies coal from the Surat and Clarence-Moreton Basins as the second largest contributor to Inland Rail traffic (Inland Rail Programme Business Case, p130, ARTC/PwC, 2015).

22. Level Crossing Transitions: SYSTRA Scott Lister assess Queensland Rail's submission is reasonable for the 9.1 mtpa scenario without Inland Rail. For the scenarios of 9.1 mtpa with Inland Rail and 2.1 mtpa, SYSTRA Scott Lister assess that half of this allowance is appropriate due to the possibility of value engineering assets with limited required remaining service life.

23. Concrete Sleeper Replacement: Queensland Rail has proposed a program of works to replace concrete sleepers on tight curves over the Toowoomba Range. SYSTRA Scott Lister inspected one of these sites and under the low tonnage scenario this work could be deferred.

24. Level Crossing Upgrade: SYSTRA Scott Lister assess Queensland Rail submission is reasonable for the 9.1 mtpa scenario without Inland Rail. For the scenarios of 9.1 mtpa with Inland Rail and 2.1 mtpa, SYSTRA Scott Lister assess that half of this allowance is appropriate due to the possibility of value engineering assets with limited required remaining service life.

25. Miscellaneous Works: SYSTRA Scott Lister assess this as reasonable.

26. Minor Signalling Renewal: SYSTRA Scott Lister assess the Queensland Rail submission is reasonable for the 9.1 mtpa scenario without Inland Rail. For the scenarios of 9.1 mtpa with Inland Rail and 2.1 mtpa, SYSTRA Scott Lister assess that half of this allowance is appropriate due to the possibility of value engineering assets with limited required remaining service life.

27. Relay Interlockings: SYSTRA Scott Lister recommends that other than for the 9.1 mtpa scenario without Inland Rail this project should be deferred.

28. Gatton Interlocking: SYSTRA Scott Lister recommends that other than for the 9.1 mtpa scenario without Inland Rail this project should be deferred.

29. Rangeview Fibre Upgrade: SYSTRA Scott Lister recommends that other than for the 9.1 mtpa scenario without Inland Rail this project should be deferred.

30. RMS Rollout: SYSTRA Scott Lister recommends that other than for the 9.1 mtpa scenario without Inland Rail this project should be deferred.

31. Digital Telemetry: SYSTRA Scott Lister recommends that other than for the 9.1 mtpa scenario without Inland Rail this project should be deferred.

32. Miscellaneous: SYSTRA Scott Lister recommends that other than for the 9.1 mtpa scenario without Inland Rail this project should be deferred.

OPERATIONS

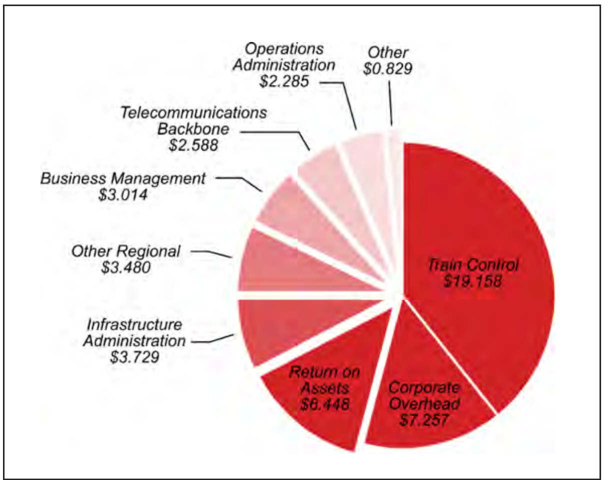


Figure 4. Breakdown of Queensland Rail operational expenditure submission for DAU 2020 (millions)

Table 4. Summary of SYSTRA Scott Lister operational assessment

Item	Queensland Rail		SYSTRA Assessment			
	2.1 mtpa	9.1 mtpa (no Inland Rail)	2.1 mtpa	9.1 mtpa (with Inland Rail)	9.1 mtpa (without Inland Rail)	Note
Train Control	19.158	19.158	17.361	19.004	19.004	34
Corporate Overhead	7.257	7.257	4.452	5.731	6.642	35
Return on Assets	6.427	6.427	3.943	5.075	5.882	36
Infrastructure Administration	3.718	3.718	2.281	2.936	3.403	37
Other Regional	3.469	3.469	2.128	2.739	3.175	38
Business Management	3.004	3.004	1.843	2.372	2.749	39
Telecoms Backbone	2.580	2.580	1.583	2.037	2.361	40
Operations Administration	2.278	2.278	1.398	1.799	2.085	41
Other	0.827	0.827	0.507	0.653	0.757	42
OPERATIONS TOTAL	48.717	48.717	35.497	42.346	46.057	

34. Train Control: SYSTRA Scott Lister assesses the Queensland Rail proposed budget as reasonable for both 9.1 mtpa scenarios.

SYSTRA Scott Lister suggest network planning resources can be reduced for the 2.1 mtpa scenario. SYSTRA Scott Lister recommends that Queensland Rail review its strategy of maintaining the Supply Chain South train control centre separately from the Rail Management Centre located at Mayne Yard under this low tonnage scenario.

35 to 42. Other Operational Costs: SYSTRA Scott Lister assesses that the operational costs equate to approximately 9% of the total of maintenance, capital and train control. SYSTRA Scott Lister assess this as reasonable and has applied this percentage across all scenarios.

Queensland Competition Authority | West Moreton System

INTRODUCTION & OBJECTIVE

INTRODUCTION & OBJECTIVE

1. INTRODUCTION

Located to the west of Brisbane, the West Moreton System is a 321km line connecting Rosewood at the edge of the South East Queensland suburban network with the Cameby Downs mine loop at Columboola to the west. The line extends further west as Queensland Rail's Western System.

Queensland Rail is the Rail Infrastructure Manager responsible for operating and maintaining the below rail assets.
The current access arrangement is governed by a QCA approved access undertaking, Access Undertaking (AU1). AU1 was approved by QCA on 11 October 2016 for a term of almost four years.

Access Undertaking 2 (AU2) is currently under development. This process includes stakeholder consultation and preparation of a Draft Access Undertaking 2 (DAU2). DAU2 progresses through a process of further consultation with stakeholders, before being amended and issued as the final AU2. It is planned that AU2 will be in effect in 2020 for a term of five years.

To aid the assessment of DAU2 the QCA engaged SYSTRA Scott Lister to perform a desktop study analysing Queensland Rail's proposed below rail maintenance, capital and operating costs for the West Moreton System for the AU2 period. SYSTRA's review included:

- Analysis of the current operational performance and asset condition using data provided by Queensland Rail against current and future requirements.
- Assessment of proposed maintenance and capital programs of works against current and future operational requirements and current asset condition in the context of Queensland Rail's Civil Engineering Track Standards (CETS), Civil Engineering Structural Standards (CESS), approaches by other rail agencies and good asset management practice.
- Site visits to areas of Rosewood and the Toowoomba Range, and the Queensland Rail Supply Chain South Control Centre at Rail Centre 1 in Brisbane City.
- Comments, where appropriate, on Queensland Rail's method and approach to asset management, and operating and maintaining the below rail infrastructure.

2. OBJECTIVE

The West Moreton System is a regulated asset and Access Undertaking 1 (AU1) currently applies. A new access undertaking will commence in 2020 for a five year term; this undertaking is in draft form as Draft Access Undertaking 2 (DAU2). This review of capital and maintenance costs is an element of the consultation process to finalise consultation and transition DAU2 into the final Access Undertaking 2 (AU2).

The objective of this study is to provide an assessment of the reasonableness and efficiency of the maintenance, capital, and operations cost estimate submission by Queensland Rail for the West Moreton System access agreement commencing in 2020, AU2 for a 9.1 mtpa scenario without Inland Rail in operation.

SYSTRA Scott Lister also completed concept level reviews of maintenance, capital and operation costs for a 2.1 mtpa scenario and a 9.1 mtpa scenario with Inland Rail operational. SYSTRA Scott Lister notes that Queensland Rail have made no formal submission in regards to cost estimates for these two scenarios.

Queensland Competition Authority | West Moreton System

THE WEST MORETON SYSTEM

3.1 GENERAL

The West Moreton System is the oldest railway in Queensland with sections progressively being opened between 1865 and 1898[3]. The system is narrow gauge, predominantly single track with passing loops and some duplicated track. The route length is 314.4km with track length of 407km[4].

The current system capacity is 87 return train paths allocated to coal[5]. The majority of train paths are taken by the privatised rail freight operator hauling coal on behalf of coal mine operators. The most westward of these, the Cameby Downs Mine, uses the entire length of the West Moreton System to carry coal to the Port of Brisbane. The New Acland mine joins the System at Jondaryan and further East the Jeebropilly mine joins almost at Rosewood. In FY2018 these mines produced a total of 7.4 million tonnes of coal (mtpa). Other users include a small number of trains hauling agriculture (livestock and seasonal grains and cotton); other generally non-containerized freight such as industrial consumables and equipment; and the Queensland Rail operated twice-weekly 'Westlander' long distance passenger service; a diesel train service connecting Charleville and Roma with Brisbane. The West Moreton System does not include the Glenmorgan line from Dalby to Meandarra, the Southern Line from Toowoomba, or the Ebenezer spur.

The West Moreton System is shown in Figure 3.1 below.

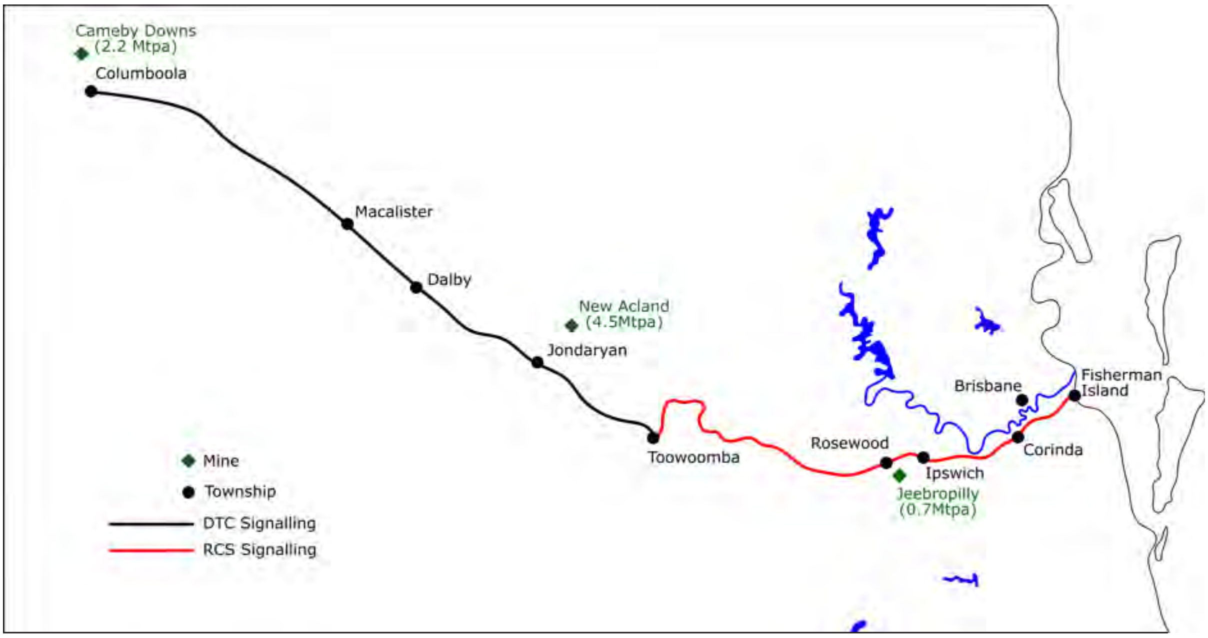


Figure 3.1. The West Moreton System

[3]http://www.qca.org.au/getattachment/be5f8316-a84d-4343-bd7f-071cbe1bb254/Secondary-Undertaking-Notice-attachment-QCA-De.aspx' p19-26
[4]Queensland West Moreton asset Management Plan 2018-19, p2
[5]Queensland West Moreton asset Management Plan 2018-19, p5

The West Moreton System is a narrow gauge railway, able to carry a maximum 15.75 tonne axle load (tal) and accommodate a reference train length of 673.8 m[6]. It consists of two corridors: Rosewood to Jondaryan (R2J) and Jondaryan to Columboola (J2C). The system is dual track for parts of R2J, and is single track with passing loops across the Toowoomba and Little Liverpool Ranges and for the Toowoomba to Jondaryan component of R2J. The system is single track with passing loops for all of the J2C corridor. The two corridors and major structures, bridges, and tunnels, are shown in Figure 3.2 below.

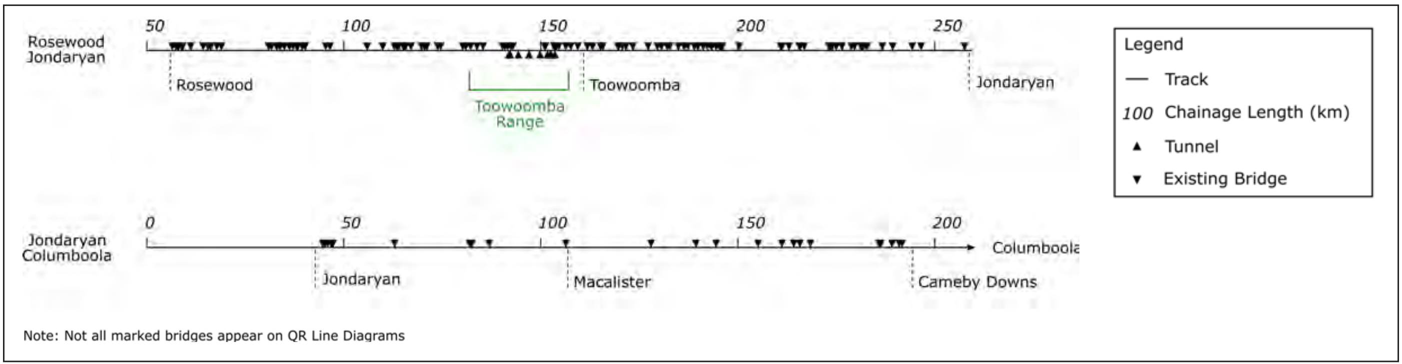


Figure 3.2. The two corridors of the West Moreton System

There are a number of constraints that limit the capacity of the West Moreton System:

- The sections of single track working and the steep grades across the Toowoomba Range.
- The original rail line was not originally built to carry coal traffic and was constructed across a black soil plain. The track was designed and constructed to a 12 tal for steam trains. Queensland Rail has assessed that the track is capable of 15.75 tal with modern diesel traffic. In comparison the Central Queensland Coal Network (CQCN) operates at 26.5 tal and iron ore are deigned to operate at loads of up to 43.5 tal[7].
- The length of passing loops at Fisherman Islands (PoB) and Kingsthorpe restrict train lengths to a maximum of 673.8m.

Queensland Rail have based the maintenance, capital and operations cost submission on 9.1 mtpa; relatively light in comparison to the CQCN which railed 212.4 tonnes in FY 2018[9].

[6] Queensland West Moreton asset Management Plan 2018-19, p3
[7] https://www.railjournal.com/in_depth/pilbaras-heavyweight-champion-flexes-its-muscles
[8] SYSTRA Scott Lister estimate that 9.1 mtpa would require 90 trains per week at 1,940 tonnes per train.
[9] Aurizon FY 2018 Investor Presentation, p44

3.2 CHRONOLOGY

The chronology of the development of the West Moreton System is shown in Figure 3.3 below.

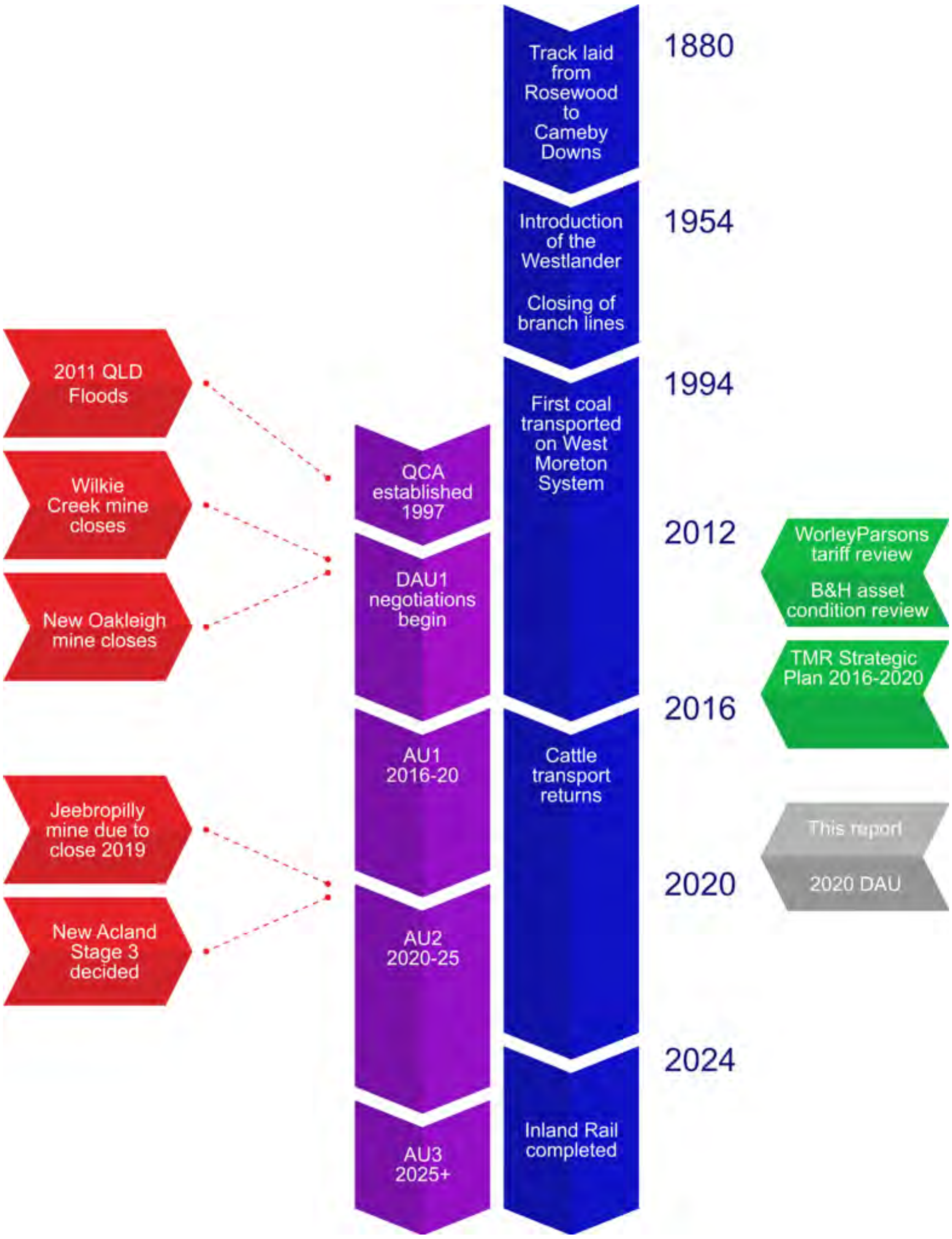


Figure 3.3. Chronology of the development of the West Moreton System

3.3 TOPOGRAPHY & CLIMATE

3.3.1 TOPOGRAPHY

As the West Moreton System passes from Rosewood in the East to Columboola in the West it crosses a number of different topographies. In general terms, these include:

- The system crosses the floodplains of the Fassifern Valley between Rosewood and the foothills of the Toowoomba Range, including the towns of Grantham and Laidley.
- The system then ascends 700m up the Great Dividing Range towards Toowoomba with many tight curves, the tightest at a radius of 88m, and steep grades, bridges and tunnels,
- From Toowoomba the system then crosses the black soil terrain of the Darling Downs towards Columboola and Cameby Downs Mine loading loop.

This difficult topography is reflected by the number of structures on the system. The West Moreton System has:

- 141 timber bridges with a total length of 4,302 m.
- 11 steel bridges with a total length of 500.51 m.
- 8 concrete bridges with a total length of 251.4 m.
- 11 tunnels with a total length of 1615.61 m.

3.3.2 CLIMATE

The Toowoomba Range is subject to landslides in extraordinary rain events, >Q100 levels[10]. Flooding of low lying areas occurs as an indirect result of cyclones and heavy coastal rains[11]. Major track reconstruction has been required in recent years following closures due to flooding in 2011, 2013, and 2017.

The West Moreton System is impacted by the high summer temperatures in western Queensland at one extreme and the below freezing temperatures that occur over the Toowoomba Range in winter.

“”

The West Moreton System passes from Rosewood in the East to Columboola in the West.

[10] Queensland Rail ‘West Moreton System, Asset Management Plan 2018-19’, 31 July 2018, page 6
[11] ‘West Moreton System, Information Pack, Rosewood to Macalister, Macalister to Miles, Version 3.1: 13/10/2016, page 7

3.4 CONFIGURATION

3.4.1 GENERAL

The key characteristics of the West Moreton System are shown in Table 3.1 below.

Table 3.1. Key characteristics of the West Moreton System, as sourced from the Queensland Rail West Moreton System Information Pack, 2016 (latest).

Characteristic	Rosewood to Toowoomba	Toowoomba to Dalby	Dalby to Columboola
Length (km) **Route** **Track**	104.75 157.061	83.86 83.86	126.494 126.494
Queensland Rail Track Category[12]	7	8	8
Maximum Speed	80km/h 60km/h (coal)	80km/h 60km/h (coal)	80km/h (all traffic)
Maximum Grade	1/50 (2%)	1/88 (1.1%)	1/50 (2%)
Maximum Tonnage[14]	7.0	4.5	4.0
OTCI Target[13]	Lower 34 Median 46	Lower 34 Median 46	Lower 34 Median 46
Curves **(% of total track)**	< 80km/hr – 27% < 60km/hr – 19%	< 80km/hr – 5% < 60km/hr – 2%	< 80km/hr – 0.4% < 60km/hr – 0.1%

3.4.2 TRACK SYSTEM

The track system is described in Table 3.2 below.

Table 3.2. Track system characteristics of the West Moreton System

Characteristic	Rosewood to Toowoomba	Toowoomba to Dalby	Dalby to Columboola
Tunnel	41/50/60 kg/m (Standard Carbon)	41/50/60 kg/m (Standard Carbon)	41/50/60 kg/m (Standard Carbon)
Jointed	Long Welded Rail (LWR)	LWR and Bolted (B)	LWR
Sleeper Type	Timber/ steel 1:2 /1:4 100% steel Concrete	Timber/ steel 1:2 /1:4 4km of 100% steel	Timber/steel 1:2 /1:3/1:4 6km of 100% steel

[12] Based on a route speed of 80km/hr. and CETS Table 9.1.
[13] CETS Table 9.9.
[14] Queensland Rail, West Moreton System Information Pack V3.1, 2016

3.4.3 RAIL LUBRICATION

There are 71[15a] rail greasers installed on the system. These are located on the tight curves across the Toowoomba Range in the R2J corridor.

3.4.4 STRUCTURES

There are a number of tunnels through the Toowoomba Range and a mix of timber, steel, and concrete bridges on the system. The locations of the structures on the West Moreton System are shown in Figure 3.3 below.

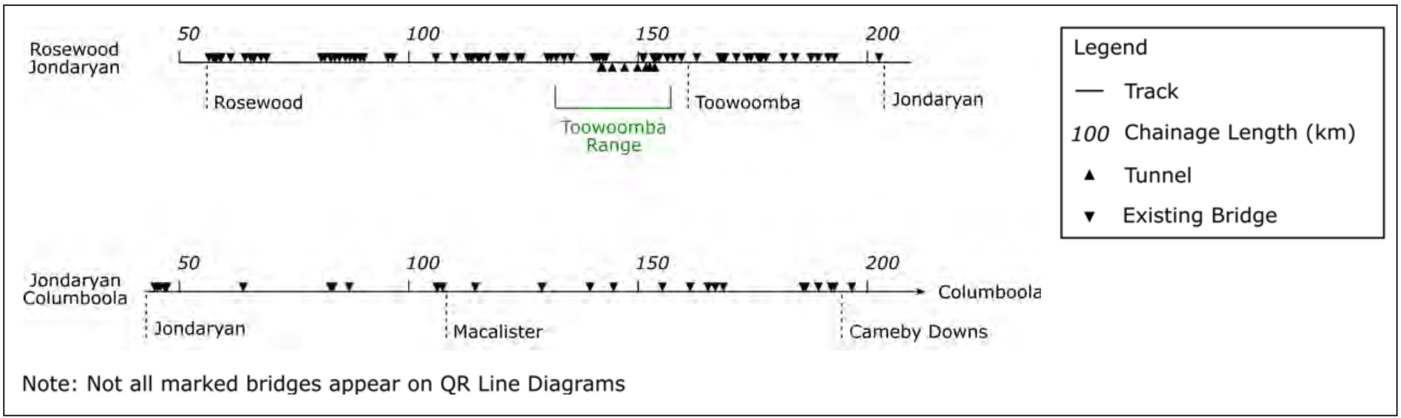


Figure 3.3. West Moreton System structures

In 2018, the Queensland government announced that 18 of the aging timber bridges are to be replaced along the West Moreton System to ease maintenance costs at a capital cost of $28 million[15b]. SYSTRA Scott Lister assume these bridge works are independent of the Queensland Rail DAU2 submission.

Details of the structures on the West Moreton System are listed in Table 3.3 and Figure 3.4 is a photo showing the original operation of one of the tunnels in 1894.

[15a] Verbal advice from Queensland Rail 29 January 2019
[15b] http://statements.qld.gov.au/Statement/2018/2/9/28-million-to-keep-west-moreton-rail-network-on-track.

Table 3.3. West Moreton System structures [16]

Structure	Rosewood to Toowoomba	Toowoomba to Dalby	Dalby to Columboola	Total
Timber Bridge	68 (1,717.6m)	22 (482.8m)	51 (2,101.8m)	141 (4,302.2m)
Steel Bridge	6 (308.7m)	4 (108.31m)	0	10 (417.01m)
Concrete Bridge	5 (174.03m)	3 (77.37m)	0	8 (251.4m)
Tunnel	11 (1,615.61m)	0	0	11 (1,615.61m)

Figure 3.4. Railway tunnel on the Toowoomba Range circa 1894 [17]

[16] Queensland Rail West Moreton System Information Pack – Version 3.1 October 2016
[17] State Library of Queensland

3.4.5 SIGNALLING AND TRAIN CONTROL

Train control is via Remote Controlled Signalling (RCS) for Rosewood to Toowoomba in R2J, then Direct Train Control (DTC) for Toowoomba to Jondaryan in R2J and all J2C. The section of line between Rosewood and Toowoomba is fitted with axle counters and track sections[18] .

Train control is provided from the Supply Chain South Control Centre at Rail Centre 1 near Central Station. The West Moreton System is controlled as part of the Southern Freight Operations team. The area west of Jondaryan is controlled using DTC by the Far West Network Control Officer (NCO), between Jondaryan and Rosewood is controlled by the West NCO, control of traffic then passes to the Rail Management Centre (RMC) to navigate the Brisbane urban network and finally the unloading at Port of Brisbane is controlled using DTC by the Port West NCO. Empty traffic reverses this sequence back to the appropriate mine.

3.4.6 LEVEL CROSSINGS

There are 100 public level crossings and 39 occupation crossings on the West Moreton System.

These are listed in Table 3.4 below.

Table 3.4. Level Crossings

Structure	Rosewood to Toowoomba	Toowoomba to Dalby	Dalby to Columboola	Total
Public	21	31	48	100
Occupation	11	15	13	39

3.4.7 TELECOMMUNICATIONS

Communications between Driver and Controller is via a UHF radio system using a number of Queensland Rail channels and frequencies. Transceivers “auto” switch channels to suit geographical location. Control phones are located at Staff Stations only.

The oldest element of the West Moreton System telecommunication asset is a copper connection between Toowoomba and Rangeview.

[18] ‘West Moreton System, Information Pack, Rosewood to Macalister, Macalister to Miles, Version 3.1: 13/10/2016, page 18

3.5 TRAFFIC

3.5.1 GENERAL

Current traffic on the West Moreton System includes:

- Coal traffic from Cameby Downs and New Acland Mine
- 2 services a week for the 'Westlander' passenger service
- A number of agriculture and other freight services.

As the traffic approaches 9.1 mtpa, the constraining section of track in the West Moreton System is the descent of loaded trains down the Toowoomba Range. Options to increase the capacity would require additional passing loops to be constructed in this section of the West Moreton System.

SYSTRA Scott Lister was informed by Queensland Rail that obtaining paths through the Brisbane urban network to PoB can be a constraint. This is outside the scope of SYSTRA's analysis but is important context for Queensland Rail strategic planning.

3.5.2 COAL

MINES

The greatest quantity of traffic on the West Moreton System is thermal coal from the mines of the southern Surat Basin. These mines, from West to East are:

- The Yancoal Cameby Downs mine produces 2.1 mtpa. It expects to continue producing coal on its current mine plan to 2038.
- New Hope's New Acland Mine is currently seeking approval to expand its operations from 4.5 mtpa to 7 mtpa and extend operations until 2029[18a]. Current commercially viable coal reserves, without approval of the expansion, are expected to depleted by 2020.
- The New Hope operated Jeebropilly mine produces 0.7 mtpa, is expected to cease operations on or before October of 2019, and is not considered relevant for the 2020 Access Undertaking.

Other mines in the region have at various times been proposed for construction or the resumption of operations, however these attempts have all suffered from a lack of funding. Remaining mines in the region are primarily used to feed nearby coal fired power stations via conveyor or by truck.

[18a] New Acland Coal Mine Stage 3 project, Coordinator-General's evaluation report on the environmental impact statement, 2014

FUTURE TONNAGES

The uncertainty in coal volume is a key area of concern raised by Queensland Rail, who correctly expects scaling of its maintenance and operational costs where these are dependent on the tonnage carried by the system. Queensland Rail has provided estimated costs for three scenarios depending on the New Acland Mine, for scenarios requiring 2.1 mtpa, 6.25 mtpa and a maximum of 9.1 mtpa. In the event that future Acland production is not approved, an option exists to increase tonnages from the Yancoal Cameby Downs mine from the current 2.1 mtpa; although this is not explored in this report.

WEST MORETON SYSTEM COAL SUPPLY CHAIN

The below rail asset is only one part of the coal supply chain that moves thermal coal from the mines to ships at the Port of Brisbane. As this is thermal coal, SYSTRA Scott Lister assume that this supply chain operates under an "even railing"[19] model as opposed to a "cargo assembly"[20] model. The other parts of the supply chain are the:

- Loading facilities at the mines
- Below rail track
- Rolling stock
- Unloading and stockpiling facilities at PoB, and
- Ship loaders.

Approval of Stage 3 of the Acland Mine will potentially increase the traffic on the West Moreton System to 9.1 mtpa. SYSTRA Scott Lister has not reviewed modelling analysis to support that 9.1 mtpa can be achieved; however, potential constraints could be:

- Capacity through the Toowoomba Range
- Above rail rolling stock resources
- Adequate paths through the South-East Queensland urban network to the Port of Brisbane.

The above rail operator maintains an appropriate fleet to achieve a sustainable economic operation. This consequently limits the amount of rolling stock available. During normal operations this is not a consideration; however, prior and post extended closures for maintenance this does become a consideration. Closures of 10 and 12 days have occurred and the above rail resources have managed; however, Queensland Rail's experience is that a maintenance closure of four days appears to be optimal.

The Queensland Bulk Handling Coal Terminal has a stockpile capacity of 909,000 tonnes[22]. This equates to approximately 19 days of full operation at the ship loaders optimum performance of 48,000 tonnes per day. To achieve the target of 9.1 mtpa the ship-loaders at the Port would be required to operate 189 days in a year, or at 52% utilisation. Reaching 100% utilization of the port facilities would require approximately 200 return paths each week. The stockpile at Port of Brisbane and the ship loaders are not constraining this system.

---

[19] An "even railing" model means rail traffic can be scheduled to suit optimum rail operations. The product is relatively homogenous and specific ships are generally not required to load a bespoke product. This type of model works where there is good stockpile area and for a product such as thermal coal.
[20] A "cargo assembly" model is where the railing of product is targeted at a specific shipload and has characteristics that are bespoke to that contracted shipload. This approach is suitable where products are sensitive to quality or composition and stockpile area is limited.
[21] Verbal advice from Queensland Rail given at Roma St Control Centre on 6 February 2019.

3.5.3 AGRICULTURE

Agriculture is the second largest market for the railway behind coal. The West Moreton System is an important link between the farmland and the pastures of the greater Western Queensland and the processing and shipping facilities in the East. Seasonal grain and cotton are often shipped via rail, and in 2016 beef has begun being transported to the Oakey abattoir via the railway.

A 2014 parliamentary committee report suggested the agricultural market was eager to make greater use of the railway, but cited inflexibility and unreliability in scheduling when compared to road transport, and competition for paths with coal and minerals as key detractors for its use[23] . The Darling Downs region is expected to rapidly expand its food production, given the Queensland Government's target of doubling agricultural production by 2040[24].

The Toowoomba Range rail upgrade project lowers the inverts of the 11 rail tunnels on the Toowoomba and Little Liverpool Ranges to create the clearance necessary to transport 9'6" high cube freight shipping containers via rail; which is increasingly being used to export goods, including agricultural produce. This enabled the transport of containerised freight, including agriculture, by rail from the Darling Downs and South West Queensland regions directly to the Port of Brisbane.

3.5.4 FREIGHT

The West Moreton System currently carries a relatively small amount of irregular non-containerised freight, such as industrial consumables and equipment for the mining and agricultural industry.

To the west of Toowoomba, construction has begun on the Interlink SQ global logistics centre to transfer goods from rail to the port of Brisbane, domestic and international airports, and to the nearby highways. The facility will be able to cater for an increase in rail freight traffic arising from increased goods supply via the West Moreton System and freight transported via the new Inland Rail line.

3.5.5 PASSENGER

The twice weekly 'Westlander' long distance passenger service runs from Roma St, Brisbane to Charleville. The journey is 777 kilometres and takes 17 hours. The "Westlander" only carries passengers. Prior to 2010 the "Westlander" could also carry some freight.

SYSTRA Scott Lister assesses that West Moreton System is currently not capacity constrained at a tonnage of 6.25 mtpa. As the system approaches the 9.1 mtpa scenario, the constraint for the West Moreton System coal supply chain is predominately obtaining paths through the Brisbane urban network. It is expected the below rail infrastructure on the Toowoomba range will introduce an additional operational limit; however, this limit has not been assessed by SYSTRA.

[23] Transport, Housing and Local Government Committee, Report No. 45, 2014
[24] Queensland Government, Queensland's Agriculture Strategy, 2013

3.6 FUTURE CONTEXT CONSIDERATIONS

3.6.1 ARTC INLAND RAIL

ARTC's Inland Rail route duplicates the West Moreton System between a location west of Toowoomba and Rosewood. This route is shown in Figure 3.4 below.

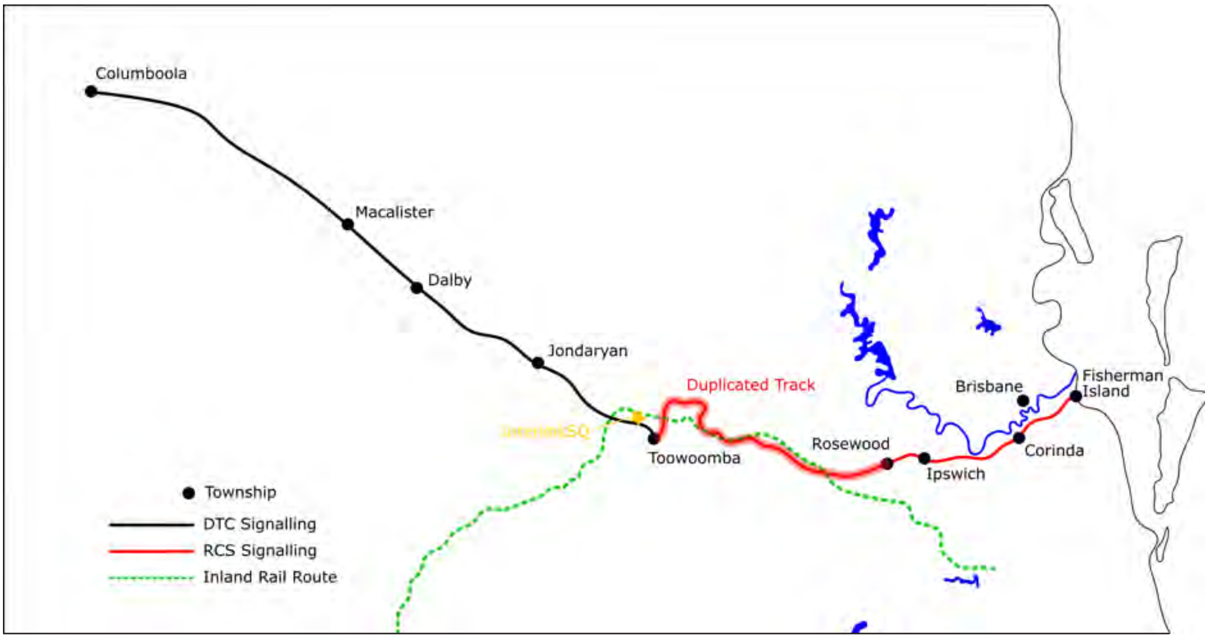
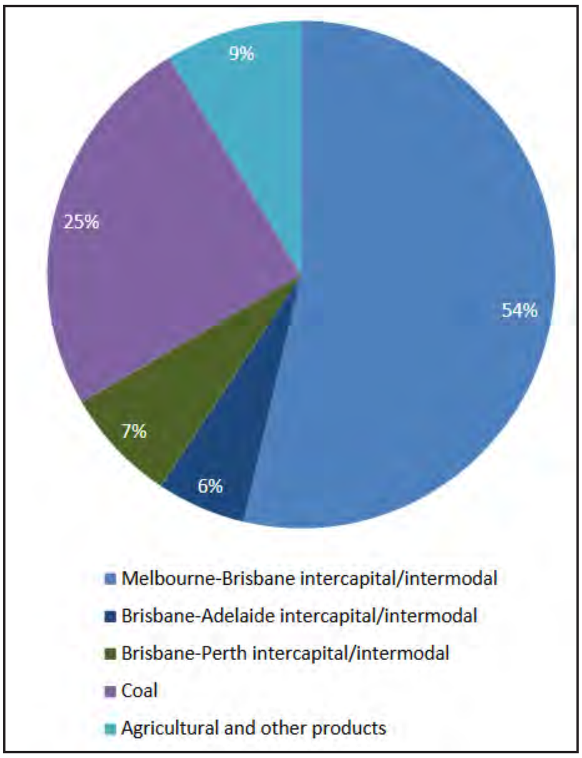


Figure 3.4. The System – Showing planning IR alignment

The West Moreton System coal traffic is a major consideration in the Inland Rail business case. However, there are a number of considerations with Inland Rail that influence Queensland Rail's planning for maintenance of the West Moreton System. These factors are confirmed and consistent understanding among stakeholders of:

- Inland Rail commissioning date
- Tariff structure and regulation for West Moreton System coal on Inland Rail
- Physical access arrangements to this element of Inland Rail
- Signalling and train control across this element of Inland Rail.

[25] Inland Rail, Melbourne to Brisbane Inland Rail, Attachment A: ARTC 2015 Inland Rail Programme Business Case, Table 7.3, page 128.



The Inland Rail Programme business case includes that, "Current coal exports of 8 million tonnes [per annum] are forecast to increase to 19.5 million tonnes[25]." Figure 3.5 on the opposite page from the business case shows West Moreton coal traffic is forecast to be 25% of the total traffic on the line that 9.1 mtpa would require 90 trains per week at 1,940 tonnes per train. Delivery of the full programme is planned for 2025.

Queensland Rail's perspective is that they are committed to providing a level of service on the West Moreton System, and in the absence of certainty on the factors above they must plan adequate maintenance to achieve these commitments without Inland Rail in place.

Figure 3.5. Inland Rail freight in 2049-50 based on combined north and southbound volumes by freight in 2049-50 (% of net tonne kilometres) [26]

SYSTRA Scott Lister assesses that, in the absence of a consistent understanding among stakeholders of some key aspects of Inland Rail, Queensland Rail is reasonable to plan for maintenance that will enable Queensland Rail to meet its commitments independently of Inland Rail in the medium term.

SYSTRA Scott Lister notes that transferring West Moreton System traffic to Inland Rail will address a number of current challenges facing the West Moreton System, including:

- ***The capacity constraint of the Toowoomba Range descent***
- ***The maintenance of structures on the R2J corridor, particularly on the Toowoomba Range***
- ***Formation issues on the Toowoomba Range.***

SYSTRA Scott Lister also notes that there are also advantages achieved by building only the eastern end of the R2J Inland Rail alignment, in the vicinity of Rosewood and Grantham. The Queensland Rail DAU2 submission has major capital works in this area which could be avoided if these Inland Rail works were expedited.

Review and comment on strategic planning of the interface aspects of Inland Rail and the West Moreton System is out of the scope of SYSTRA's review. However, SYSTRA Scott Lister notes the opportunity for capital and maintenance savings exist in this area.

The opportunities of savings for maintenance and capital costs for the West Moreton System exist even where only elements of inland rail are constructed. For example, expediting the construction and commissioning of the Inland Rail elements in the vicinity of Oakey, perhaps with temporary connections, would remove the need for some West Moreton System formation and bridge costs.

[26] Inland Rail, Melbourne to Brisbane Inland Rail, Attachment A: ARTC 2015 Inland Rail Programme Business Case, Figure 7.3, page 130.

3.7 URBAN DEVELOPMENT WEST OF IPSWICH AT RIPLEY & ROSEWOOD

Potential urban development is possible in the areas to the west of Ipswich as shown in Figure 3.6 below. Despite the expected increase in passenger demand, SYSTRTA assess that this development has had no influence on the budgets proposed by Queenland Rail in the 2020 DAU2.

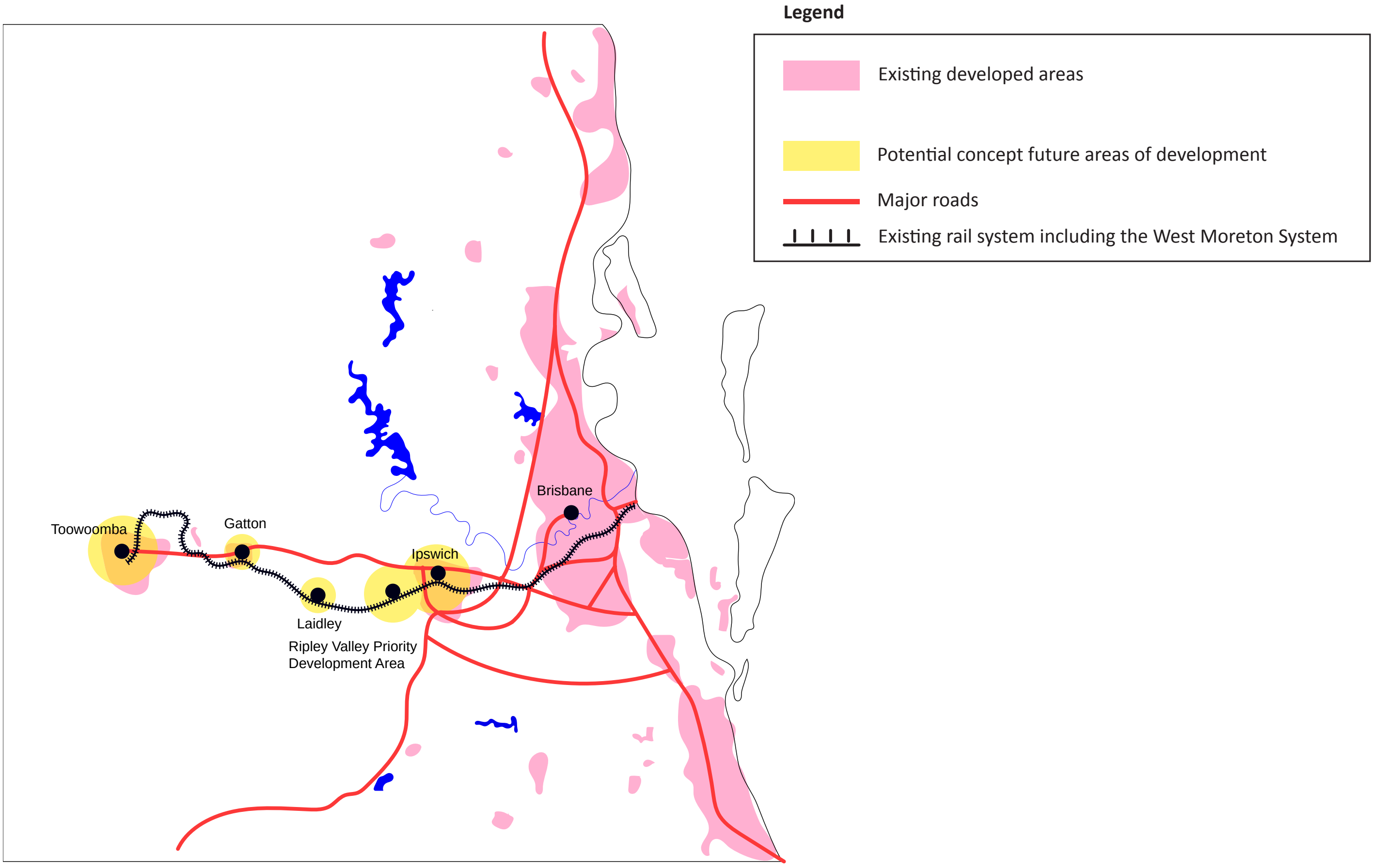


***Figure 3.6. Developments near Ipswich*[27]**

"The Ripley Valley Priority Development Area (PDA) was declared on 8 October 2010 and covers a total area of 4680 hectares. It is located approximately 5 kilometres south-west of the Ipswich CBD and south of the Cunningham Highway.

The Ripley Valley PDA is an opportunity to provide approximately 50,000 dwellings to house a population of approximately 120,000 people.

The Ripley Valley PDA is located in one of the largest industry growth areas in Australia and offers opportunities for further residential growth to meet the region's affordable housing needs."[28]

These types of development may lead to increasing passenger demand for the eastern part of the West Moreton System.

[27] Adapted from http://www.metrocology.com/ripley-valley/
[28] https://www.dsdmip.qld.gov.au/edq/ripley-valley.html

3.8 PERFORMANCE RELIABILITY

3.8.1 GENERAL

The European Commission body 'Platform of Railway Infrastructure Managers in Europe' (PRIME)[29], sets out the 13 categories of key performance indicators. This framework is shown in Figure 3.7 below.

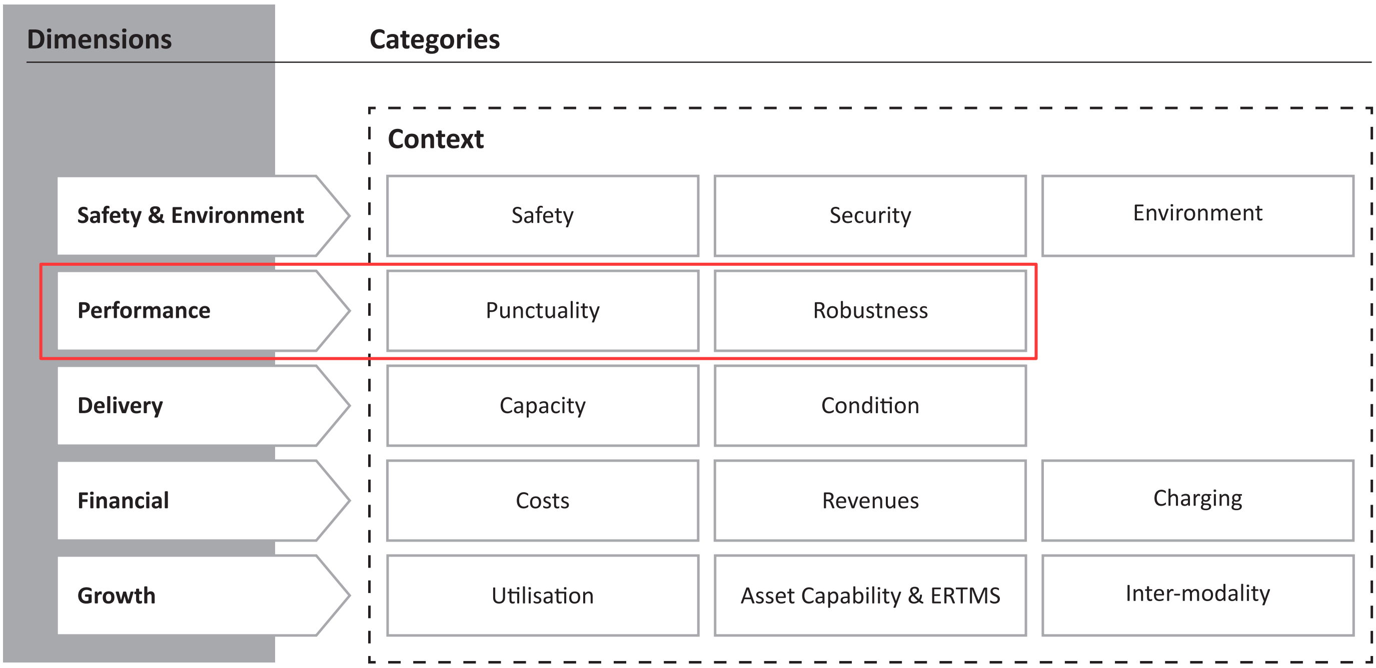


Figure 3.7. Prime KPI categories[30]

"On time running" and "transit time reliability" can be viewed for the West Moreton System as the equivalent of "Punctuality" and "Robustness". SYSTRA Scott Lister analysed "on time running" and "transit time reliability" to inform the assessment of Queensland Rail's submission for maintenance, capital, and operational costs for DAU2.
This analysis was aimed at addressing three questions:

- What is the current performance of the West Moreton System?
- Is this a reasonable performance for the system?
- Where are any performance issues on the system?

[29] A forum which enables benchmarking and exchange of best practice between railway infrastructure managers.
[30] Adapted from PRIME 'Key Performance indicators for performance benchmarking Draft version 1.0, 15th November 2016', page 7

3.8.2 CONTRACTUAL COMMITMENT

Queensland Rail provide sectional run times for the West Moreton System[31] and, [redacted] Access holders/rail operators also seek:

- A known cap on the number, location and time interval between track possessions
- Best possible response times to any network disruption (including force majeure events)
- Some spare capacity for peak production rates, or catch up capacity
- Coordinated supply chain shutdowns and track possessions.

SYSTRA Scott Lister is not aware of other contracted performance criteria for Queensland Rail for the West Moreton System.

3.8.3 ON TIME RUNNING

Queensland Rail track departure and arrival times of trains at the start and end of signal track sections. This data enables accurate details of departures against schedule to be determined.

3.8.4 TRANSIT TIME RELIABILITY

Queensland Rail publishes section run times for each track section. These section run times are the time it takes to transit between two distinct points on the network; normally the start and end of a signal track section. The four transit times are the time taken for:

1. **"Pass – Pass"** transit time - A moving train passing through the start of the section and passing through at the end of the section.
2. **"Pass – Stop"** transit time - A moving train passing through at the start of the section and stopping at the end of the section.
3. **"Start – Pass"** transit time - A stationary train starting at the start of the section and passing through at the end of the section.
4. **"Start – Stop"** transit time - A stationary train starting at the start of the section and stopping at the end of the section.

An example of these four transit times for coal trains for the Dalby to Tycanba track section is shown in Table 3.5 on the opposite page.

[31] 'West Moreton System, Information Pack, Rosewood to Macalister, Macalister to Miles, Version 3.1: 13/10/2016, Appendix F

Table 3.5. Transit times for the Dalby to Tycanba track section (minutes)

Control	Pass-Pass	Pass-Stop	Start-Pass	Start-Stop
Brisbane Far West	5	7	8	10

SYSTRA Scott Lister has bookended the transit time performance of the West Moreton System by analysing actual train performance against:

- A theoretical "through" transit time by setting a target of summing all "Pass-Pass" transit times, and,
- A theoretical "all stops" transit time by setting a target of summing all "Stop-Stop" transit times.

Although Table 3.5 details transit times, these transit times do not directly translate into a reasonable expectation of transit time for a stakeholder contracting Queensland Rail to maintain the West Moreton System. SYSTRA Scott Lister looked to the Aurizon approach for a possible acceptable approach to a reasonable stakeholder expectation of total system transit time. Aurizon bases target transit time on the theoretical "through" transit time plus an allowance for stopping and other events.
The Aurizon target transit times are shown in Table 3.6 below.

Table 3.6. Aurizon system transit time allowances[33]

Aurizon System	Target Transit Time (%) (Theoretical through transit plus allowance)
Newlands	160
Goonyella	123
Blackwater	127
Moura	130

On review of the Aurizon target transit times, SYSTRA Scott Lister determined that the Moura System is the most similar to the West Moreton System and that a transit time allowance, plus 30%, is a reasonable basis for a transit time allowance for the West Moreton System.

[33] Aurizon System Operating Parameters – Public Release 2016

3.8 PERFORMANCE RELIABILITY

3.8.5 ROSEWOOD TO JONDARYAN

These two performance curves for the “pass through” and “all stations are shown in Figure 3.8 below.

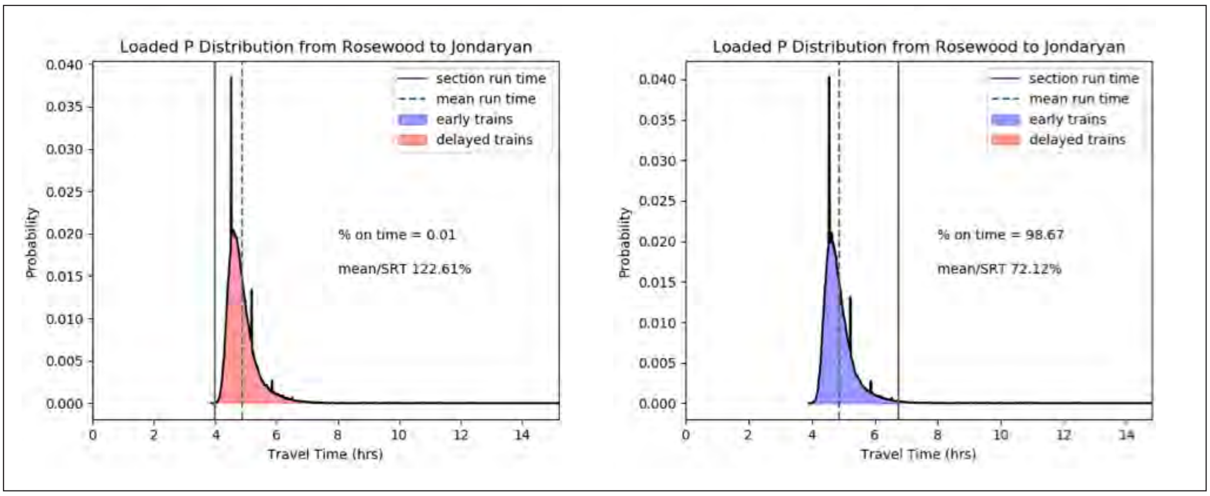


Figure 3.8. R2J - Probability distributions for the actual travel times of loaded trains, using the “pass through” target (left) and “stop all stations” target (right) section run time bookends

Figure 3.8 shows that 1% of loaded trains are achieving the “pass through” target transit time and 99% are achieving the “all stops” target transit time. This is not useful in assessing performance against customer expectation.

However, applying a transit time of 100% “pass through”, plus a 30% allowance, (similar to the Moura performance expectation), gives Figure 3.9. Against this target transit time loaded traffic achieves a 87% reliability of transit time.

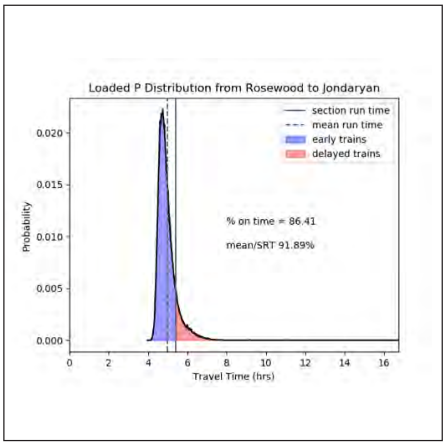


Figure 3.9. R2J - Probability distribution for the actual travel times of loaded trains against a 130% BRTT target

Figure 3.9 shows that 87% of loaded West Moreton System R2J traffic achieves a BRTT target of 130%. SYSTRA Scott Lister assess this as reasonable in regards to stakeholder expectations.

Figure 3.10 below shows the transit time reliability by section for the R2J corridor.

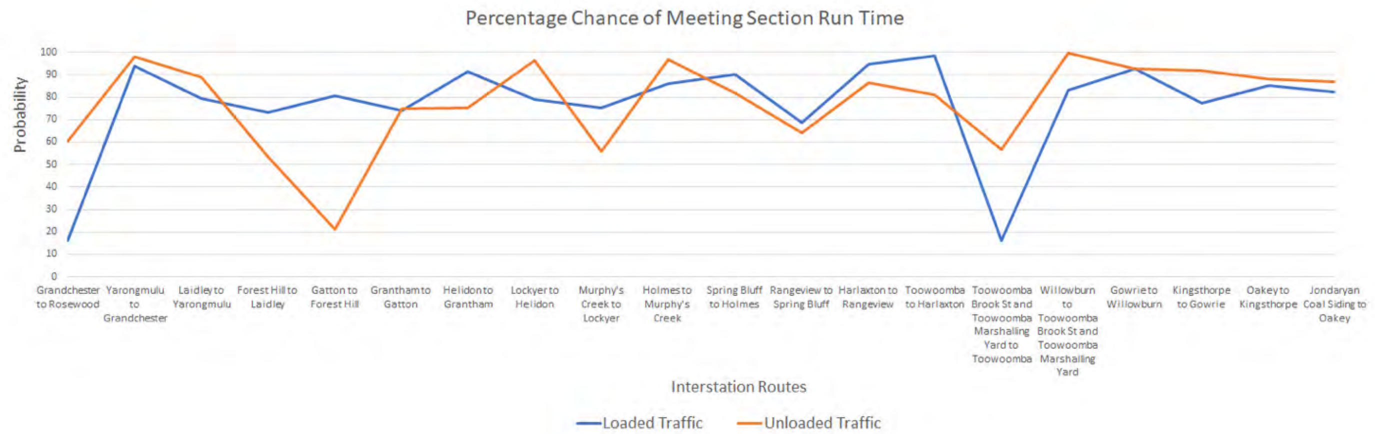


Figure 3.10. R2J Transit time reliability

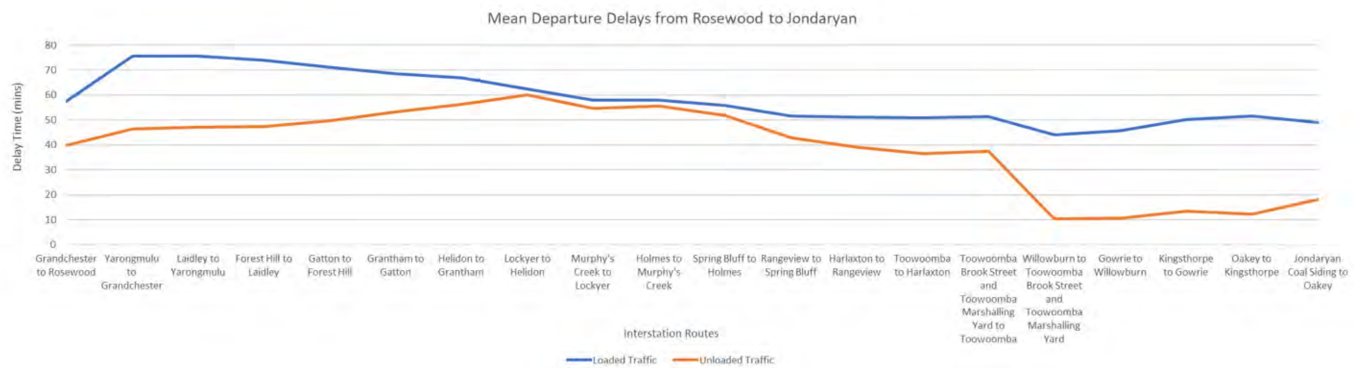


Figure 3.11. Delays with train departures

Analysing performance by section shows that most trains that are reliable depart within in an hour of the scheduled departure time.

3.8.6 JONDARYAN TO COLUMBOOLA (J2C)

The performance curves for the "pass through" and "all stations" for J2C are shown in Figure 3.12 below.

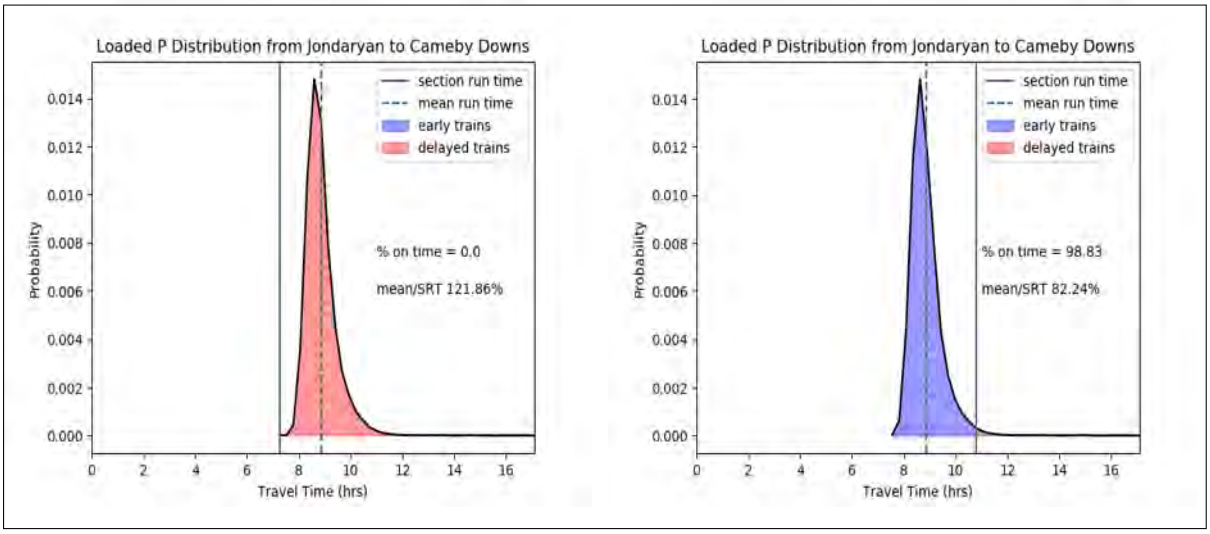


Figure 3.12. J2C - Probability distributions for the actual travel times of loaded trains, using the "pass through" target (left) and "stop all stations" target (right) section run time bookends.

Similarly to Figure 3.8, Figure 3.12 shows that no loaded trains are achieving the "pass through" target transit time and 99% are achieving the "all stops" target transit time. Again, this is not useful in assessing performance against customer expectation.

However applying a transit time of 100% "pass through", plus a 30% allowance (similar to the Moura performance expectation) gives Figure 3.9. Against this target transit time loaded traffic achieves a 93% reliability of transit time.

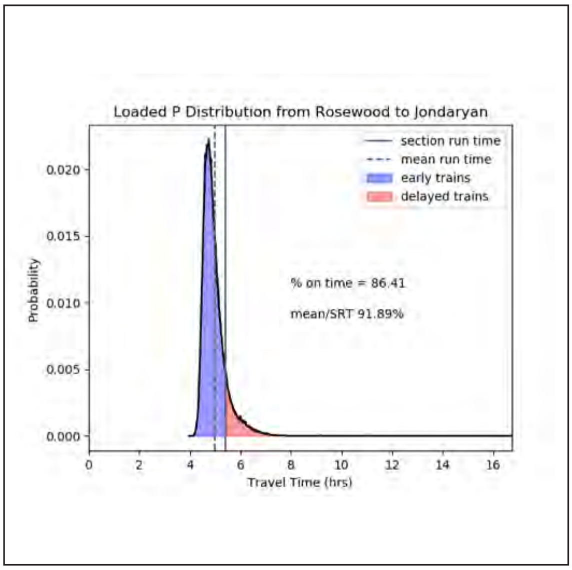


Figure 3.13. R2J - Probability distribution for the actual travel times of loaded trains against a 130% BRTT target

Figure 3.13 shows that 93% of loaded West Moreton System J2C corridor traffic achieves a BRTT target of 130%. SYSTRA Scott Lister assess this as reasonable in regards to stakeholder expectations.

Figure 3.14 below shows the transit time reliability by section for the J2C corridor.

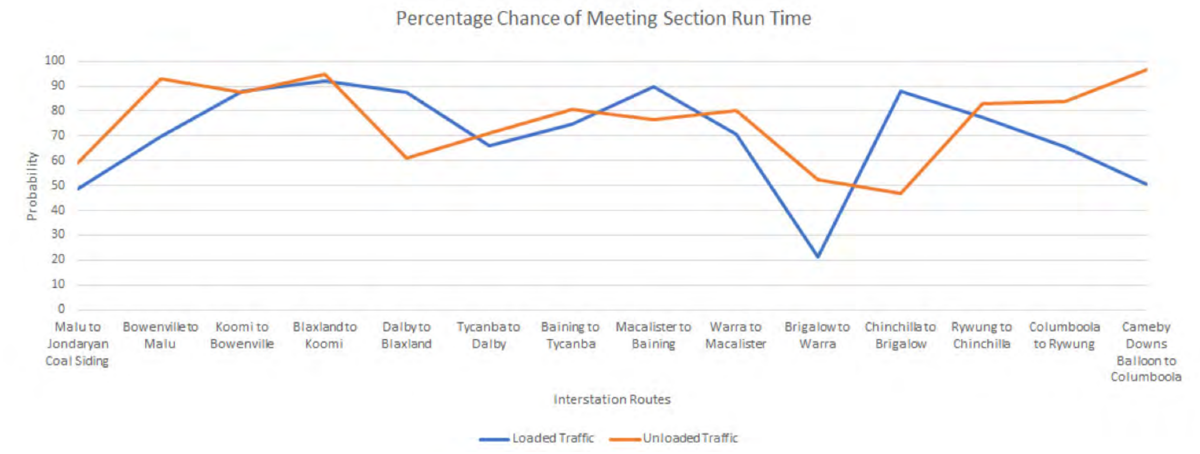


Figure 3.14. J2C Percentage chance of achieving section run time

Analysing performance by section shows that the probability of achieving section run times is generally good across the corridor. The most significant reductions in probability of achieving section run times[34] occur in the vicinity Brigalow, Chinchilla and Rywing.

Figure 3.15 below shows average delays in train departures for track sections for the J2C corridor.

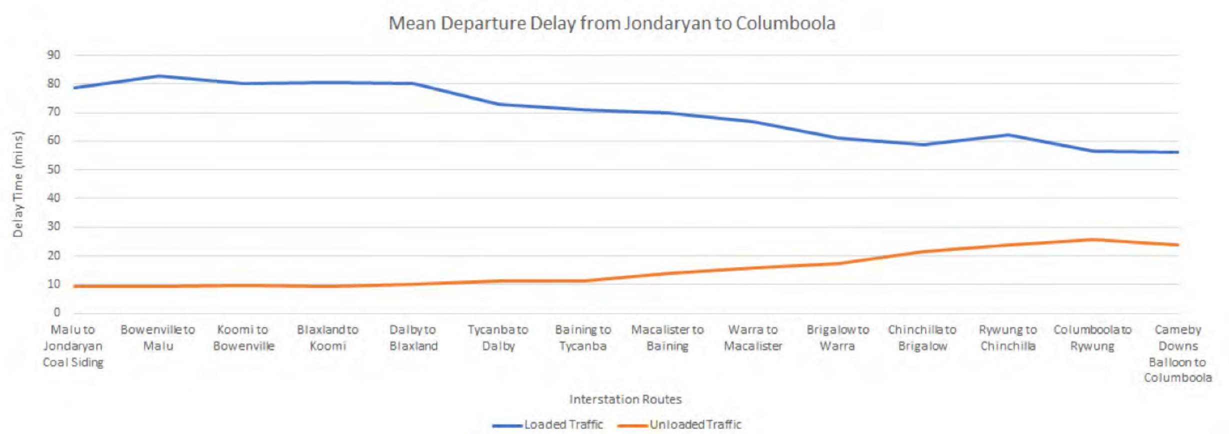


Figure 3.15. J2C Percentage difference between mean run time and section run time

Analysing performance by section shows that most trains are reliable and depart close to scheduled departure time.

[34] This is section run time based on 130% of theoretical "pass through" section run time similar to the Moura expectation.

3.8.7 OVERALL TRACK CONDITION INDEX (OTCI)

OTCI is a metric summarising the track geometry; it is a summary of seven different measurements taken at metre intervals along the length of the track. The components of OTCI are discussed in detail in Chapter 5. It is calculated as the aggregated value of the Track Condition Indices (TCI) over the full length of the railway system. Figure 3.16 below shows the average OTCI for the West Moreton System between 2009 and 2018.

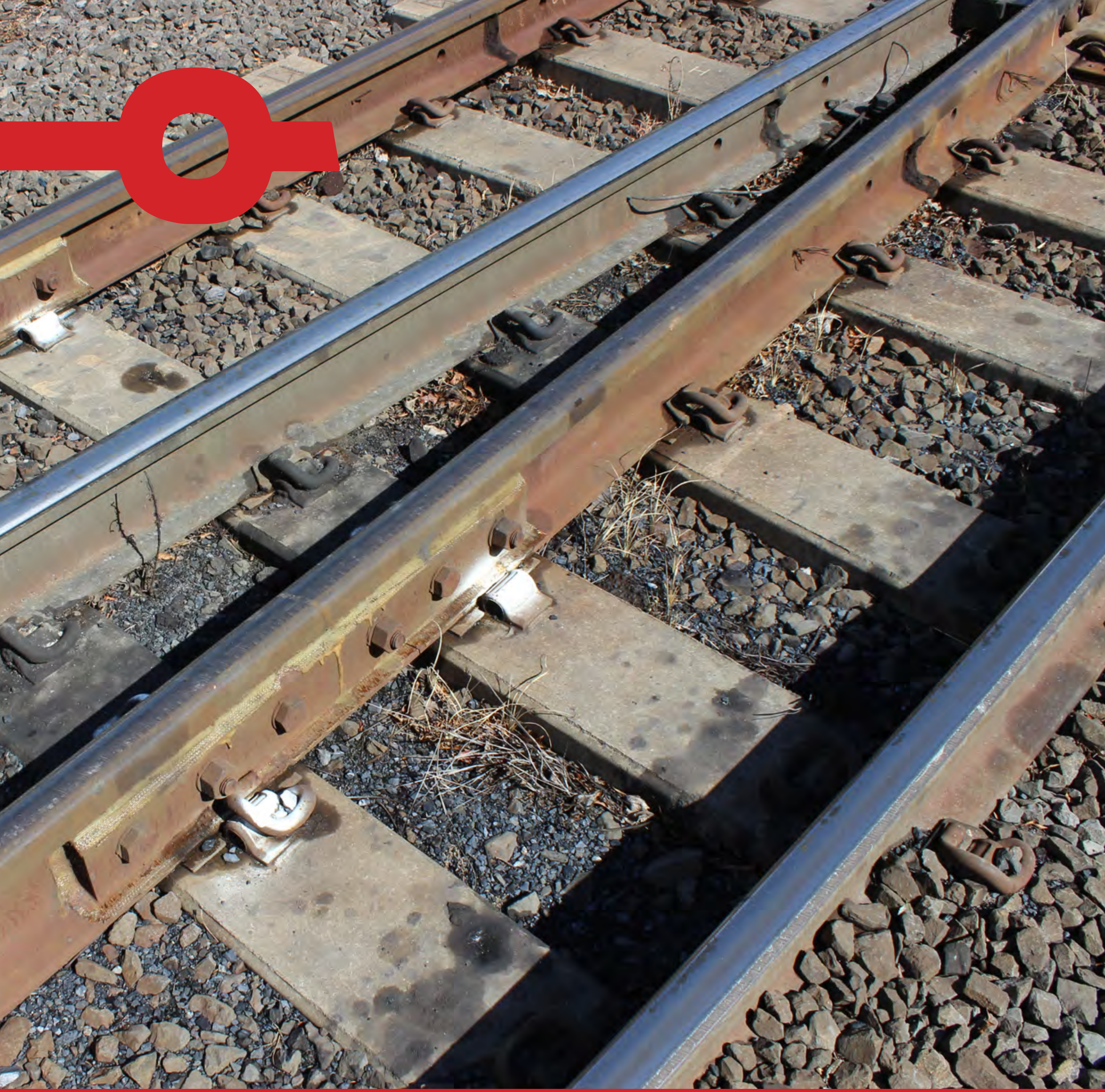
Figure 3.16. OTCI for the Aggregated West Moreton System[35]

Figure 3.16 shows the West Moreton System has maintained an OTCI value between 40 and 45. This achieves the target set by Queensland rail which is an OTCI better than the CETS median target of 46.

The specific West Moreton TCI data is explored in more detail in Chapter 6.

Queensland Rail is achieving target OTCI for the West Moreton System.

[35] Queensland Rail, West Moreton System DAU2 Maintenance Submission, p. 14



SYSTRA SCOTTLISTER

Queensland Competition Authority | West Moreton System

QUEENSLAND RAIL VISION, STRATEGY & ASSET MANAGEMENT PLAN

4.1 VISION & STRATEGY

The Queensland Rail rolling 10 year Asset Management Plan (AMP) for the West Moreton System includes the following vision:

"The vision for the West Moreton System is to provide a safe and reliable network that is trusted by customers, where performance is competitive with industry, and represents sound value for money for Queensland Rail's stakeholders[36]."

The asset strategies for the West Moreton System are based on the below Queenland rail standards:

- Signalling, Control, and Train Protection MD-15-181
- Track and Civil MD-15-182
- Above Rail Assets (stations, stabling yards, and supporting infrastructure) MD-15-183
- Traction Power MD-15-185
- Telecommunications MD-15-184 [37].

Queensland Rail's key strategies for the West Moreton System include[38].

- Predictive not reactive maintenance – to be achieved through better collection, analysis, and utilisation of asset condition data so that faults can be prevented instead of repaired.
- Undertake asset renewals that introduce modern, reliable, low maintenance, less disparate, and (where possible) future-proofed infrastructure assets.
- More effective planning of works delivery with the aim of minimising the impacts of capital works and major maintenance on the network to deliver improved productivity and network availability arising from closures.
- Focus on improved cost-effectiveness by reviewing internal works processes and cost contributors and more effective utilisation of industry through appropriate packaging and tendering of works and management of delivery.

[36] Queensland Rail 'West Moreton System, Asset Management Plan 2018-19', 31 July 2018, page 7
[37] Queensland Rail 'West Moreton System, Asset Management Plan 2018-19', 31 July 2018, page 7
[38] Queensland Rail 'West Moreton System, Asset Management Plan 2018-19', 31 July 2018, page 7

4.2 QUEENSLAND RAIL ASSET PLANNING FRAMEWORK

In the AMP, Queensland Rail also summarise the next level in their asset management decision making process, the Asset Planning Framework (APF) and Decision Matrix. This includes, 'understanding the level of intervention needed to keep an asset operating at its' required level of service' and 'understanding the impact that an asset failure would have on Queensland Rail'[39] . Queensland Rail's APF and Decision Matrix shown in Figure 4.1 and Figure 4.2 below.

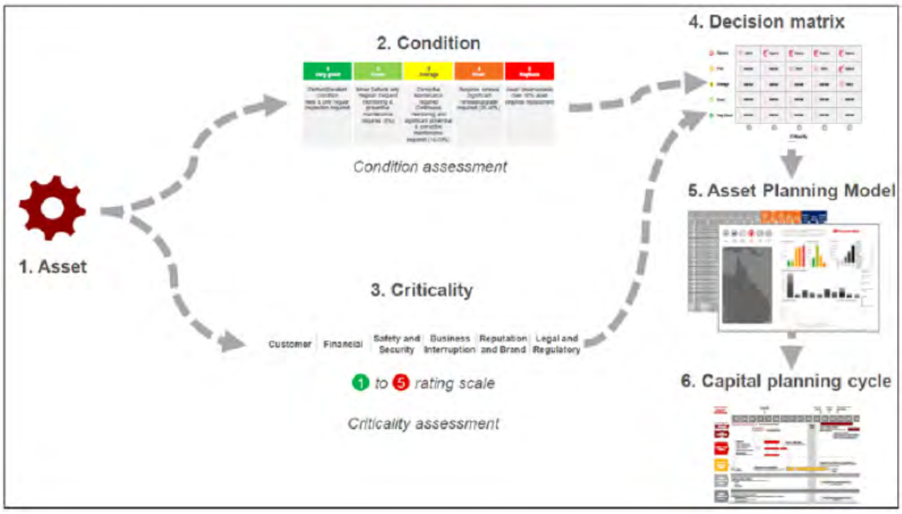


Figure 4.1. Queensland Rail Asset Planning Framework

Condition	Criticality 1	Criticality 2	Criticality 3	Criticality 4	Criticality 5
5 Replace	Overhaul	Replace	Replace	Replace	Replace
4 Poor	Maintain	Maintain	Overhaul	Overhaul	Replace
3 Average	Maintain	Maintain	Maintain	Maintain	Overhaul
2 Good	Maintain	Maintain	Maintain	Maintain	Maintain
1 Very Good	Maintain	Maintain	Maintain	Maintain	Maintain

Figure 4.2. Queensland Rail Decision Matrix

SYSTRA Scott Lister assess that the Queensland Rail APF is a sound framework for assessing maintenance effort based on asset condition and criticality.

SYSTRA Scott Lister notes that in the build up to the DAU2 submission Queensland Rail does not appear to have fully utilised the APF framework. Asset condition has been assessed and applied to the AMP and criticality of assets has been assessed separately - however the Decision Matrix appears to not have been used to guide the maintenance and capital submission.

[39] Queensland Rail 'West Moreton System, Asset Management Plan 2018-19', 31 July 2018, page 9

4.3 ASSUMPTIONS

Queensland Rail's West Moreton System AMP is based on a number of strategic assumptions, shown in Table 4.1 below[40].

Table 4.1. Queensland Rail West Moreton System strategic assumptions.

	Short Term 1-5 years	Medium Term 5-10 years	Long Term 10+ years
Coal	Short term tonnage uncertainty ranging from: ▪ 6.25 mtpa[41] to 2020 ▪ Ranging from 2.1 to 9.1 mtpa post 2020.	Tonnages ranges are: ▪ 9.1[42] mtpa coal ▪ Greater than 9.1 mtpa with development of Surat Basin coal reserves (infrastructure enhancement required to increase capacity on the Toowoomba Range track sections).	
Agriculture	Additional agricultural volumes possible, although planning is based on agricultural volumes for the 12 months ended September 2017		
Inland Rail	Uncertainty about potential scope, timing and funding.	Greater certainty about the potential scope and route.	Certainty and potential for new arrangements to be commencing.

Currently Queensland Rail assume the existing maintenance access regime will continue. This produces a total of 33 working days of track closure. This is a reduction of 6 days from the current 39 days.[42a] days.

This access regime allows per year the following maintenance windows:

- 5x 4 day closures;
- 2x 3 day closures;
- 2x 2 day closures; and
- 6x 12 hour closures per year.

SYSTRA Scott Lister notes that although Queensland Rail identify the assumptions in regard to the three horizons, the AMP does not individually address the challenges of each horizon. The scenario of 2.1 mtpa as a temporary position transitioning to a higher tonnage scenario was not analysed by SYSTRA.

[40] Queensland Rail 'West Moreton System, Asset Management Plan 2018-19', 31 July 2018, page 10
[41] Current tonnage
[42] SYSTRA Scott Lister did not test the ability of the West Moreton System under its current configuration to be able to transport 9.1 mtpa.
[42a] Explanatory Submission – Queensland Rail's Draft Access Undertaking 1 (2015) Volume 2, 2015

4.4 SHORT TERM - 1 TO 5 YEARS

Strategic options that directly influence maintenance effectiveness and efficiency in the one to five year horizon are limited. To an extent, short-term maintenance options available to Queensland Rail are limited by immediate requirements to keep the line operational. Notwithstanding this constraint, there are some inclusions in the AMP that could potentially improve the maintenance approach. These inclusions could be:

- An operating plan or concept of operations
- A summary of asset criticality including system constraints and bottlenecks
- A formation rebuild strategy aimed at minimising multiple resurfacings at specific locations.

Figure 4.3. Failed formation site at Kilometre 160.395 in Toowoomba already identified by Queensland Rail as a site requiring formation rebuild.

SYSTRA Scott Lister acknowledge the difficulty of developing an asset management strategy based on an uncertain planning horizon and tonnages.

This challenge could be mitigated by understanding the criticality of elements of the asset in the context of a current concept of operations. For example, in the event the low tonnage, 2.1 mtpa, scenario results , the dual track sections of R2J could be reconfigured as single track with passing loops to save maintenance; portions of the parallel track could be mothballed.

In the case of QR's West Moreton System, in the short term, the major asset management decisions will be related to whether or not to invest in capital renewal or continue to accept ongoing and increasing maintenance costs. SYSTRA Scott Lister assess that the current AMP provides limited guidance to the maintenance team in this regard.

4.5 MEDIUM TERM - 5 TO 10 YEARS

The AMP does not have a concept level summary of a five to ten year programme of planned capital works. Also, it is not clear from the currently available information to what extent the potential impact of Inland Rail will have.
This is constraining Queensland Rail in the medium term from:

- Taking capital investment decisions that, where appropriate, minimise capital expenditure on R2J assets that will be impacted by traffic moving to Inland Rail; and,
- Actively seeking to recycle future stranded R2J asset materials on to J2C after Inland Rail commissioning.

Figure 4.4. Pair of timber bridges at Kilometre 88.45, BRL_01140 and BRL_01141. Replacement of bridges will release spare components to maintain lower priority timber bridges.

Based on the currently available information, the opportunity for further integration between options arising due to Inland Rail and the current capital works proposed in DAU2 exists and could be further investigated.

Another consideration in the medium term for the low tonnage scenario, that is the scenario of no Acland coal and 2.1 mtpa from Cameby Downs, could be to consider increased tonnages from Cameby Downs to improve upon the high unit price for access at the low tonnage scenario compared with the high tonnage scenario.

4.6 LONG TERM - BEYOND 10 YEARS

The Queensland Rail AMP includes key assumptions regarding the ARTC Inland Rail Program, see Table 4.1 above, are that the System:

"…will be affected by Inland Rail in two ways:

- *Between Rosewood and Gowrie Inland Rail will directly compete with the existing rail corridor, therefore the design life of renewals should align to the expected remaining life of the line; and*
- *Between Gowrie and Miles the design life of renewals should take into account the potential for freight customers to cease operations (coal customers) or to change modes (bulk grain).*
- *The Queensland Rail asset renewal strategy has been revised to modify the loading requirements and design life requirements of new bridges in the West Moreton System. This change will reduce the amount of capital expenditure which is at risk from the impacts of future projects and changes in the freight market."* [43]

These comments partly address the potential impact of Inland Rail. However, SYSTRA Scott Lister suggest that the possibility that Inland Rail will not just directly compete with but replace the West Moreton System from Rosewood west should be considered. The rail traffic will probably be insufficient to cover the operating costs of two systems. This strategic aspect is outside of the scope of SYSTRA's report.

Figure 4.5. Steel bridge at kilometer 57.460km near Rosewood. Originally Queensland Rail planned to replace the timber bridge with a 30 tal concrete bridge; however, after considering Inland Rail installed a 20 tal steel bridge with a shorter life of 25 years.

It appears that beyond the ten year horizon it may be unsustainable to operate the West Moreton System in parallel with Inland Rail.

SYSTRA Scott Lister suggest that an integrated and aligned view on this should be adopted across all stakeholders. Such a consistent view would allow effective long term planning to occur - that is, facilitate informing "repair/rebuild" decisions. This consequently will lead to optimal maintenance effectiveness and efficiency in the short term.

[43] Queensland Rail 'West Moreton System, Asset Management Plan 2018-19', 31 July 2018, page 5

SYSTRA SCOTTLISTER

Queensland Competition Authority | West Moreton System

PROPOSED EXPENDITURE

5.1 GENERAL

5.1.1 OVERALL EXPENDITURE FOR A 9.1 MTPA BASE LINE

The Queensland Rail proposed expenditure is based on the scenario of 9.1 mtpa without Inland Rail operational. This reflects 2.1 mtpa travelling the full length of the system from the Cameby Downs mine combined with 7.0 mtpa from the New Acland mine, joining at Jondaryan with the combined 9.1 mtpa travelling through to Rosewood and beyond to Port of Brisbane.

Queensland Rail's estimate of funding required for the West Moreton System for the five year DAU2 period is divided into three areas:

- maintenance,
- capital, and
- operations.

The Queensland Rail estimate under the 9.1 mtpa scenario, assuming Inland Rail is not in operation, is ***$349.022 m***[44] as shown in Figure 5.1 below[45].

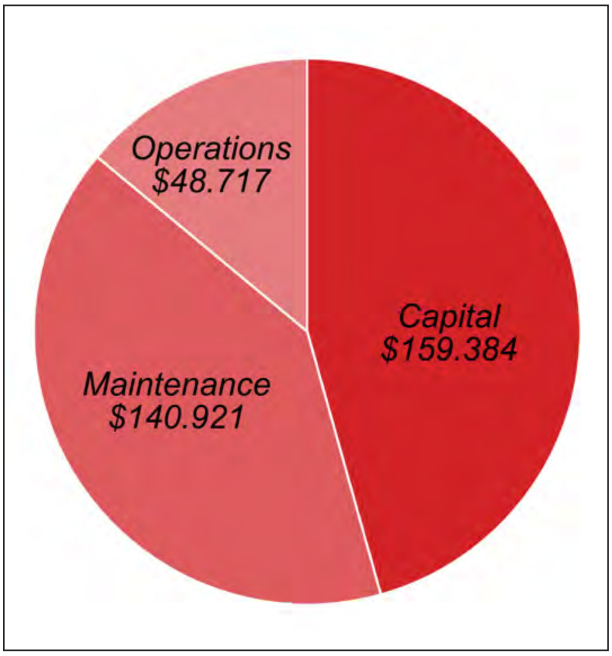


Figure 5.1. Queensland Rail estimated overall expenditure under the 9.1 mtpa scenario.

[44] In 2020/2021 AUD
[45] There are some minor inconsistencies in the Queensland Rail estimate which total about $ 0.057 m in the maintenance submission. This is not material as SYSTRA Scott Lister has determined an independent estimate.

5.1.2 MAINTENANCE COST ESTIMATE

The 9.1 mtpa scenario is subject to the environmental approval and mobilising of the New Acland mine. The alternative scenario, in the event approval doesn't eventuate for this mine, is that the only coal traffic on the system will be the 2.1 mtpa from the Cameby Downs mine.

Figure 5.2. illustrates that Queensland Rail assesses that under reduced tonnages there will only be a reduction in "tonnage dependent" track and structures maintenance costs on R2J. Queensland Rail's assessment of the reduction in maintenance, capital and operations for track and structures for the 2.1 mtpa from the 9.1 mtpa scenarios is shown indicatively below in Figure 5.2.

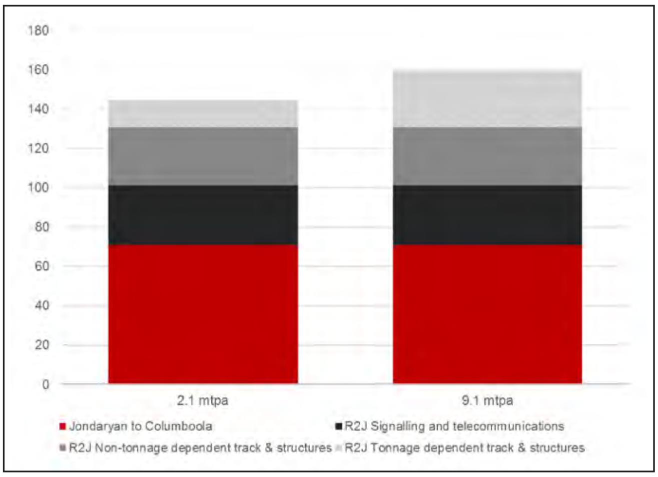


Figure 5.2. Impact of variable tonnages on maintenance costs

The basis of this assessment is that:

- J2C traffic remains unchanged under both scenarios
- Some R2J track and structures require intervention to meet minimum CETS or CESS standards and are not tonnage dependent
- R2J signalling and telecommunications infrastructure is the same for all tonnage scenarios.

In Chapter 6, SYSTRA Scott Lister analyses maintenance for the base 9.1 mtpa without Inland Rail scenario. SYSTRA Scott Lister has also completed concept assessments for a 2.1 mtpa scenario and a 9.1 mtpa scenario with Inland Rail operational. SYSTRA Scott Lister notes that Queensland Rail has not formally submitted proposals for the 2.1 mtpa scenario or the 9.1 mtpa scenario with Inland Rail operational.

5.1.3 CAPITAL

Queensland Rail's estimate of capital works required is based on the scenario of 9.1 mtpa with Inland Rail not operational. In Chapter 6, SYSTRA Scott Lister has assessed what capital works could be stranded at a low tonnage scenario, 2.1 mtpa, or a 9.1 mtpa scenario, if Inland Rail was operational and assessed a reasonable approach to capital investment.

5.1.4 OPERATIONAL COSTS

Queensland Rail has included organisation wide costs in the operational cost submission. In Chapter 6, SYSTRA Scott Lister has reviewed the "Train Control" aspect of the Queensland Rail operational cost estimate from a bottom-up perspective. SYSTRA Scott Lister has reviewed other operational costs from the perspective of a reasonable percentage of operational costs as a proportion of direct cost.

5.2.1 GENERAL

For the AU2, Queensland Rail has extrapolated their predicted costs based on their expenditure during the 2018-2019 'base year'. This base year has been reviewed to exclude expenses not predicted to be typical for the AU2 and for any maintenance activities not related to coal traffic. Using the 2018-2019 base year, which carried a net coal tonnage of 6.25 mtpa, costs were projected under the same tonnage scenario for the DAU2 period, from 2020 to 2025.

A percentage variability of maintenance cost impacted by tonnage for the 6.25 mtpa scenario was proposed by Queensland Rail for each maintenance activity, with an average of 54.4% estimated to be independent of traffic volume, and 45.6% variable. This percentage is based on a B&H report[46] that has estimated a range of percentage of maintenance cost that applies to the 6.25 mtpa scenario.

These percentages were used in the QCA's assessment of the 2015 DAU for a 6.25 mtpa scenario are listed in Table 5.2.

Table 5.2. Maintenance costs as impacted by tonnage variability for track defects for a 6.25 mtpa scenario[47]

Repair Type	Percentage of Maintenance Cost Dependent on Traffic	Repair Type
Earthworks (Non-formation)	0%	Earthworks (non-formation) includes drainage and maintenance can include clearance of vegetation and silting of the invert; independent of traffic.
Sleepers and Fasteners	60%	Sleepers and fasteners can fail through traffic or deterioration of timber sleepers.
Rail Repair	40%	This includes failures in welds, bolts, and joints. It includes the logistics of repairing rail as well.
Restressing	0%	Restressing requirements are generally a function of installed rail temperature and local temperature range.
Rail Joints	80%	Rail joints are damaged by impact loads from traffic.
Inspections	20%	A minimum level of inspection is required regardless of intensity of traffic.

Queensland Rail projected costs for 2.1 and 9.1 mtpa scenarios using the percentages for the 6.25 mtpa scenario. These projections down to 2.1 mtpa and up to 9.1 mtpa were based on a linear interpolation. This methodology has not been agreed by QCA. SYSTRA Scott Lister suggests that a linear interpolation of maintenance cost on tonnage variability oversimplifies the relationship and recommends an enhanced approach which is described in Chapter 6.

[46] Based on B & H Paper 2 – Maintenance Cost and Usage Relationship
[47] Queensland Rail West Moreton System DAU2 Maintenance Submission Table 7, p19, 14 July 2018

Figure 5.3 depicts the proposed maintenance expenditures for AU2 under the base scenario of 9.1 mtpa without Inland Rail operational.

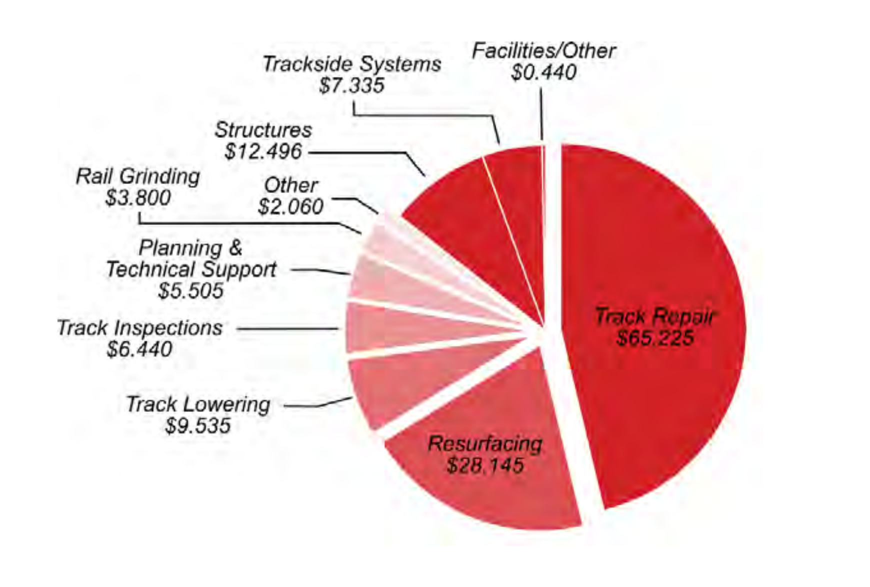


Figure 5.3. Queensland Rail estimated maintenance expenditure by activity in $2020-21 million

The largest asset component of maintenance works relates to track activities, comprising $113.145 million of the $140.921 million total. Thes activities include track repair, resurfacing, track lowering, track inspections, and grinding. A more detailed year by year breakdown of Queensland Rail's proposed maintenance expenditure appears in Table 5.3, with figures given for the base 9.1 mtpa without Inland Rail operational scenario.

Table 5.3. West Moreton 9.1mtpa Track Maintenance Costs ($2020-2021 million)

	2020-21	2021-22	2022-23	2023-24	2024-25	Total DAU2
Track Inspections	$1.288	$1.288	$1.288	$1.288	$1.288	$6.438
Planning & Technical	$1.101	$1.101	$1.101	$1.101	$1.101	$5.509
Track Repair	$12.878	$12.952	$13.039	$13.130	$13.226	$65.226
Rail Grinding	$0.760	$0.760	$0.760	$0.760	$0.760	$3.798
Resurfacing	$5.629	$5.629	$5.629	$5.629	$5.629	$28.143
Track Lowering	$1.907	$1.907	$1.907	$1.907	$1.907	$9.536
Other Track	$0.412	$0.412	$0.412	$0.412	$0.412	$2.058
Structures	$2.954	$2.718	$2.497	$2.287	$2.043	$12.497
Trackside Systems	$1.467	$1.467	$1.467	$1.467	$1.467	$7.336
Facilities/Other	$0.088	$0.088	$0.088	$0.088	$0.088	$0.438
Total	$28.483	$28.321	$28.177	$28.048	$27.891	$140.921

5.2.2 TRACK REPAIR

GENERAL

Track repair, at $65.225 million, is the largest single component of the maintenance budget. Track repair encompasses the repair of small scale defects in the track; this includes defects such as rail breaks, defective welds or wheel burns. This category encompasses a variety of works across several groups of assets. Queensland Rail did not provide a more detailed breakdown on this estimated figure. SYSTRA Scott Lister has identified trends through analysis of the Queensland Rail Enterprise Asset Management System (EAMS) defect entries for the 2017-2018 period[48]. Of these defect entries, track related works were isolated and grouped into a series of categories. Figure 5.4 illustrates the number of defect reports for each of these categories.

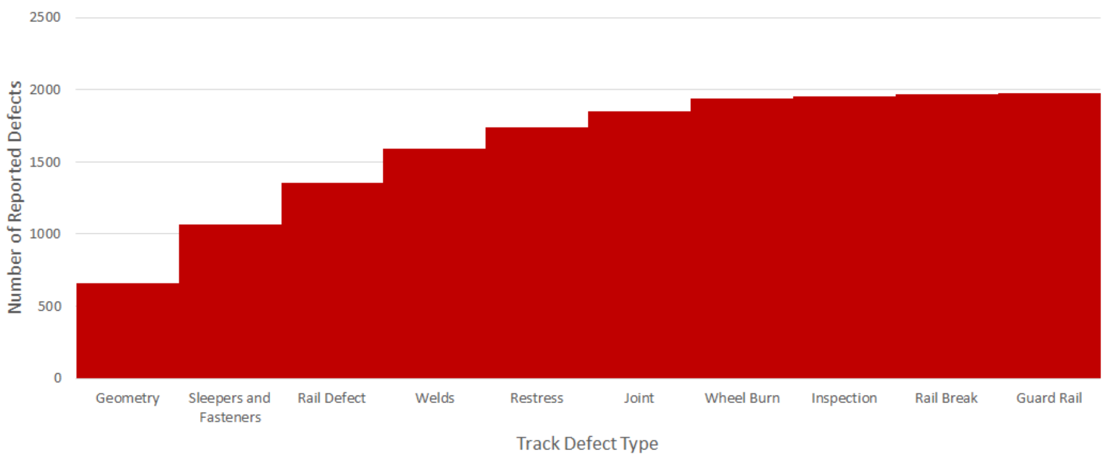


Figure 5.4. Track Defect Entries for the 2017-2018 Period

Deterioration of some assets is driven by the tonnage of traffic passing over the railway as opposed to the passage of time or environmental aspects. For example, in the case of rail wear and resurfacing the maintenance requirements are heavily tonnage dependant; while signals, telecommunication or facility type assets deteriorate independently of the tonnage of traffic.

This EAMS dataset provides some insight into the composition of the estimated $65.225 ($2020-21 million) budget for track repair. Contributing to approximately 89% of the total number of reported defects the most frequently observed defects appear on the left, with, in order of contribution:

- track geometry
- sleepers and fasteners
- rail defects
- welds, and restressing.

[48] EAMS data assessed was from January 2017 through to December 2018.

TRACK GEOMETRY

Defects in the track geometry are most frequently dealt with initially through resurfacing operations. In circumstances where a site requires frequent resurfacing ballast undercutting may be required, or where the formation is failing, a formation renewal or track reconditioning project may be the prudent maintenance action.

SLEEPERS AND FASTENERS

Repairs to sleepers and fasteners are performed following observation by inspection personnel based on guidance from the CETS. The CETS permits a maximum number of consecutive failed sleepers or fasteners in what is termed a cluster. The CETS additionally prescribes separate limits for defects that affect the different loading scenarios of the sleepers. These appear below, noting that a single defect may induce multiple failure modes.

- G - Defect reducing the gauge holding capacity (rail separation)
- S - Defect reducing the bearing holding capacity (vertical loading)
- L - Defect reducing the longitudinal holding capacity (rail creep).

CETS limits relevant to the West Moreton System[49] are shown in Table 5.4 below. Should a cluster of damaged sleepers exceed these limits, an intervention is triggered requiring immediate repair or a repair within 6 months.

Category of Failure	Cluster Limit			
	Curved Track		Straight Track	
	1 Day to 6 Months	Immediate	1 Day to 6 Months	Immediate
G	3	4	3	4
S	2	3	2	3
L	20	20	20	20

Table 5.4. Sleeper Cluster Limits Relevant to the West Moreton System

RAIL DEFECTS AND WELDS

Rail defects are considered localised damage to the rail itself. This may appear in the form of rail breakage, chipping or deviation from the rail profile. The repair process for rail defects is dependent on the form and extent of the damage, with the CETS prescribing the appropriate actions. Examples of these processes may include monitoring, rail grinding or the replacement of the defective length of rail.

Weld failures appear as rail pulled apart along the weld face. These may be the result of the degree of rail stress management and low temperature. Welds are tested for defects using ultrasound shortly after installation and regularly while in service with track-mounted ultrasound equipment.

[49] CETS requirements for 15.75 tal and 80km/h traffic as required by CETS Tables 3.12, 3.13 and 3.14.

RAIL RESTRESSING

The West Moreton System comprises sections of both continuously welded rail (CWR), long welded rail (LWR), and fishplate bolted (B) track. Track experiences compressive and tensile stresses along the longitudinal axis. These stresses have the potential to buckle the rail under compression or break the rail under tension.

These longitudinal stresses are influenced by installation method and ambient temperature. The rail will expand and contract with changes above or below the temperature at which it was originally installed. This 'design neutral temperature', or Stress Free Temperature (SFT)[50], is prescribed by the CETS for the installation of rail. This design SFT aims to reduce the likelihood of rail break or buckling, given the particular environmental conditions in the specific area the rail is installed.

An alternate mechanism for longitudinal stressing appears through rail creep, whereby accelerating or decelerating trains may move the rail. In the West Moreton System this may appear along the steep grades of the Toowoomba range, or in places trains are expected to start and stop.

Should sufficient creep or stress be observed in a section of rail, a track engineer may intervene by restressing the rail. This involves unclipping the rail from its sleepers, cutting and re-welding the rail and returning it to zero stress under the design neutral temperature. Typically, these tasks can be completed in approximately 24 hours.

OTHER TRACK REPAIRS

All other categories account for approximately 11% of the total number of reported track defects. These categories include joint defects, wheel burns, inspections, rail breaks, and guard rail defects. The appropriate methods for repairing these defects are described by the CETS, but may involve the replacement of the track, grinding and monitoring of the asset.

[50] Normally set at 38 degrees Celsius by Queensland Rail with some flexibility for adjustment to local conditions.

5.2.3 RESURFACING

Defects in track geometry refer to a measured deviation in the rails from their design position, given by one of the five different types of Track Condition Index (TCI). Figure 5.5 depicts the seven measures of track geometry monitored by Queensland Rail:

- Left [51] and right track top,
- Track gauge,
- Left and right versine,
- Twist 3m,
- Twist 10m.

These indicies are measured using a Track Recording Car (TRC), which typically samples every metre of track.
Each measurement may be permitted to deviate from their nominal values up to a maximum limit[52] specified in the Queensland Rail CETS.

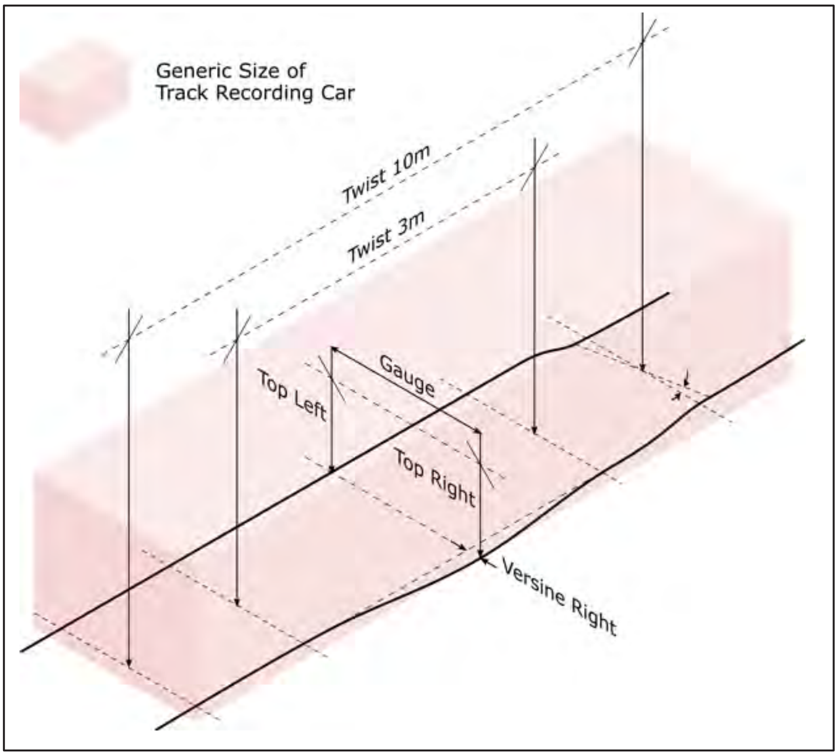


Figure 5.5 Geometry measures of a railway track

The methodology for repairing deviations in the track geometry is subject to some extent, to the discretion of maintenance personnel; however, the options available are constrained by access to availability of specific types of resources and track possessions. This typically involves lifting a section of rail and tamping the surrounding ballast to seat the rail at the correct geometry. This activity, classified as resurfacing, may be either a mechanised process using a specialised track car, or a manual process - in which case Queensland Rail refer to the repair as top and line resurfacing.

Queensland Rail has requested a budget of $28.143 ($2020-21 million) for their resurfacing maintenance under the 9.1 mpta scenario. This budget equates to resurfacing over 400 kilometres of track per year. This appears excessive and is analysed further by SYSTRA Scott Lister in Chapter 6.

[51] In the case of the West Moreton System left and right are based on looking towards the West.
[52] Table 9.2 of the CETS.
[53] Table 9.10 of the CETS.
[54] SYSTRA Scott Lister notes that the CETS does not provide guidance on triggers that can scope work for a access undertaking period of five years.

5.2.4 TRACK LOWERING

Queensland Rail define a maintenance activity called track lowering. Track lowering is the process of removing excess ballast underneath a track that is too high, and reseating it with a lesser depth of ballast. The track lowering activity consists of slewing the track system, grading of the contaminated ballast and formation and replacing the ballast. Track lowering does not construct a capping layer or include placement of geofabric or geotextile.

In the absence of a code for this in EAMS, the West Moreton Maintenance Team code this activity in EAMS as "ballast undercutting". This is not strictly accurate, ballast undercutting is the process of cleaning and replacing of contaminated ballast with no change in track level. Although Queensland Rail have asked for budget for track lowering, they have not asked for budget for ballast undercutting.

Queensland Rail has proposed a budget of $9.536 ($2020-21 million) for these works over the five years of the AU2. QCA has assessed this as being 10% variable with the volume of tonnage on the track at 6.25 mtpa. SYSTRA Scott Lister challenges the policy of track lowering and this is discussed further in Chapter 6.

5.2.5 TRACK INSPECTIONS

Inspections of track assets are required at intervals specified by their type in the CETS. These inspections may range from a simple examination, to detailed inspections of track geometry or welds. Environmental conditions, such as hot weather or heavy rain, may trigger additional inspections to ensure the recorded conditions are current with the real world assets. Queensland Rail has budgeted $6.438 million ($2020-21 million) over the AU2 period for track asset inspections. Track inspections are relatively inelastic to the quantity of traffic on the system.

5.2.6 PLANNING AND TECHNICAL SUPPORT

Expenses for the planning and technical support of maintenance projects include the staffing and contracting costs to ensure operations are performed successfully. Queensland Rail does not consider this cost to be tonnage dependant, and has proposed a total of $5.599 ($2020-21 million) for the DAU2 period to cover these expenses.

5.2.7 RAIL GRINDING

Rail grinding is performed on railways, typically after sufficient tonnage has passed over a section of track. Rail grinding is considered preventative maintenance and is used to target failures through two mechanisms:

- Deformation of the rail profile away from the optimal wheel rail interface profile
- Management of rolling Contact Fatigue (RCF).

Deformation and wear occurs in the rail head following the passage of trains. This deformation alters the contact interface between the rail and train wheel, resulting in a non-ideal load transfer; thus accelerated deformation, or stress concentration, in both the wheel and rail. Grinding returns the rail to its nominal profile, and thus restores the ideal wheel rail interface.

Fatigue in the rail head appears in the form of microscopic stress fractures under the surface of the rail in the area of highest stress concentration, termed as RCF. Given continued cyclic loading (train traffic), these cracks may propagate, resulting in the failure of the rail. Rail grinding moves the region of greatest stress away from the fatigued area. In this way, macroscopic failure may be avoided and the lifespan of the rail increased.

The Queensland Rail standards for rail grinding frequency as a measure of million gross tonnes (mgt) are found in the CETS, which are specifically stated for heavy haul lines carrying above 20 TAL. These appear in Table 5.5. Due to the low tal, 15.75, on the West Moreton System, rail grinding tends to be aimed at maintaining the correct rail profile.

Table 5.5. Rail Grinding Frequency for West Moreton System Rail

	Grinding Frequency
Tangent Tracks (Radii > 2500m)	40 mgt
Curved Tracks (2500m ≤ Radii < 1000m)	20 mgt
Curved Tracks (Radii ≤ 1000m)	10 mgt

Queensland Rail have requested a budget of $3.798 ($2020-21 million) and the QCA estimate rail grinding to be 95% variable with traffic tonnage. Of note is that grinding operations are predicted solely for the R2J corridor, with no grinding operations to be performed on the mainline in the J2C corridor during the AU2 period.

5.2.8 OTHER TRACK

$2.058 ($2020-21 million) has been budgeted by Queensland Rail for other track works outside the categories described previously. A breakdown for this figure was not provided by Queensland Rail, and a percentage variability has not been estimated by the QCA.

5.2.9 STRUCTURES

GENERAL

Queensland Rail has budgeted $12.497 ($2020-21 million) for structure maintenance over the AU2. This allowance is separated into inspection and repairs. Assets covered are:

- Culverts;
- Timber, steel, and concrete bridges; and,
- Tunnels along the Toowoomba and Liverpool Ranges.

STRUCTURE ASSET INSPECTIONS

Inspection of structural assets is specified in the CESS by their asset type and condition. This typically involves a visual inspection and recording of defects into the EAMS database. Complex inspections including underground or underwater assets are required periodically as specified in the CESS, and whenever a defect is predicted in an area requiring this. Queensland Rail proposed a budget of $2.782 ($2020-21 million) for asset inspections. These inspections are considered independent of the tonnage of traffic.

STRUCTURE REPAIRS

The repair methodology and timing of structures is dependent on the standards in the CESS. Typically an intervention timeline is specified for the severity of the defect and maintenance works performed to return the asset to nominal condition.

For timber bridges repairs may include, among others, the replacement of girders, piles, or fasteners. The replacement of timber structures is typically performed on a ‘beam by beam’ basis, with only the defective components replaced and the majority of the intact structure left. Periodic timber bridge maintenance is additionally performed independent of observed defects; typically to tighten and align fasteners or to treat the timber on site. The top three issues of concern on timber bridges are:

- Girders
- Piers
- Transoms.

Steel and concrete bridges, and tunnels additionally require periodic maintenance independent of observed defects. This maintenance may involve the treatment of cracks using epoxy techniques, painting of steel structures, or general cleaning.

Queensland Rail have proposed a budget of $9.715 ($2020-21 million) for the repair of structural assets. Queensland Rail have estimated this cost at 75% variable with traffic tonnage.

5.2.10 TRACKSIDE SYSTEMS

GENERAL

Trackside systems have been suggested by Queensland Rail to require $7.337 ($2020-21 million) in maintenance expenditure. This budget is allocated for signalling and telecommunications assets.

SIGNALLING

Signalling asset maintenance includes the repair and monitoring of trains detection systems, train control systems, level crossings, signalling cabling, pedestrian gates and other signalling assets. The majority of these assets are maintained under a 'fix on failure' basis, with their end of life replacement considered a capital project under Queensland Rail definitions.

The inspection and repair of signalling assets is considered under the proposed Queensland Rail budget of $5.472 ($2020-21 millions). Queensland Rail considers signalling maintenance to be independent of traffic tonnage.

TELECOMMUNICATIONS

Telecommunications assets facilitate the transfer of data, voice, and radio services along the West Moreton System. These include fibre optic and copper cabling, field stations, and the base network infrastructure. The maintenance of these services is typically performed once an inspection has identified a defect or on a cyclic basis for a select number of assets.

Inspections of telecommunication assets is included in the proposed Queensland Rail budget of $1.864 ($2020-21 million). Queensland Rail does not consider telecommunication asset maintenance to be tonnage dependant.

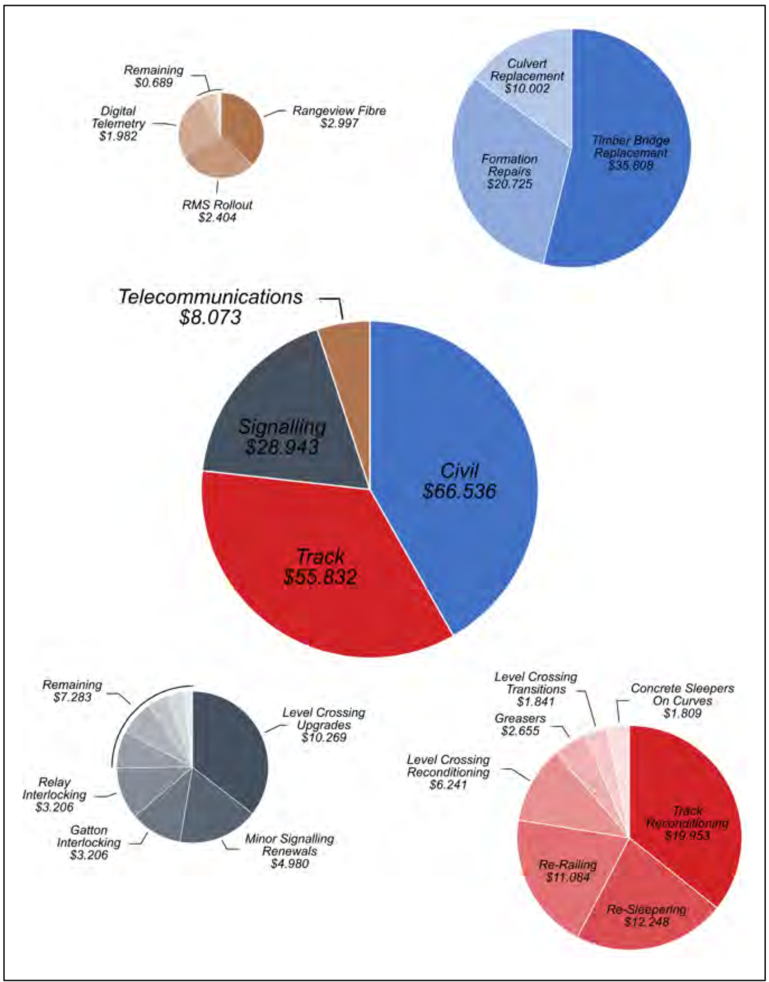
5.2.11 FACILITIES AND OTHER

The maintenance of Queensland Rail facilities and all other assets is conducted on a 'fix on failure' basis. Queensland Rail has budgeted a total of $0.438 ($2020-21 million) for the 2020 DAU. Queensland Rail does not consider this cost to be tonnage dependant.

5.3 CAPITAL

Capital works are considered major projects that lead to the replacement or introduction of new assets into the system. Queensland Rail differentiates capital works from maintenance activities by their scope of work and the intention of improving the nominal performance of an asset whereas maintenance works aim to return an asset to a base level of performance.

Queensland Rail separates capital projects into asset categories of civil, track, signalling, and telecommunications. Figure 5.6 depicts the budget allocation to each of these categories, and the individual projects. A total of $159.384 ($2020-21 million) has been proposed by Queensland Rail in the AU2 for the 9.1 mtpa without Inland Rail operational scenario. Table 5.6 details these costs in more detail, on a year by year basis.



Capital works can require an internal Queensland Rail approval process. This process adds to the mobilisation time for any proposed capital works. In addition, capital works must compete with other proposed capital works on the wider Queensland Rail network. Consequently, to mobilise capital works the West Moreton System maintenance team needs to:

- Prepare a business case
- Allow sufficient time for approvals
- Allow sufficient time to obtain resources
- Allow sufficient time and resources to establish required contracts
- Allow sufficient time to obtain sufficient track access.

These considerations make capital works projects more challenging to initiate and deliver than maintenance projects. An option may be for Queensland Rail to decouple the approval process of West Moreton System capital projects from the wider Queensland Rail network.

Figure 5.6. Proposed capital project expenditure by asset category ($2020-21 million)

Table 5.6. West Moreton 9.1 mtpa Track Capital Costs ($2020-2021 million)

	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	Total DAU2
Civil						
[redacted]						

5.3.1 CIVIL CAPITAL WORKS

GENERAL

Civil capital works proposed by Queensland Rail require a budget of $66.546 ($2020-21 million). Three groups of civil projects are planned by Queensland Rail for AU2:

- replacement of the historic timber bridges,
- formation repairs along the railway, and
- the replacement of existing culverts with modern concrete structures.

BRIDGE RENEWALS

Queensland Rail proposes a total of 27 timber bridge structures be replaced with modern concrete bridges. Queensland Rail states the existing timber bridges require increasing levels of maintenance expenditure and access to skilled timber structure tradesmen is becoming increasingly difficult. The bridge renewal project is expected to require a total of [redacted] over the AU2 period. Figure 5.7 illustrates the existing West Moreton bridges, and the locations of the proposed bridge upgrades.

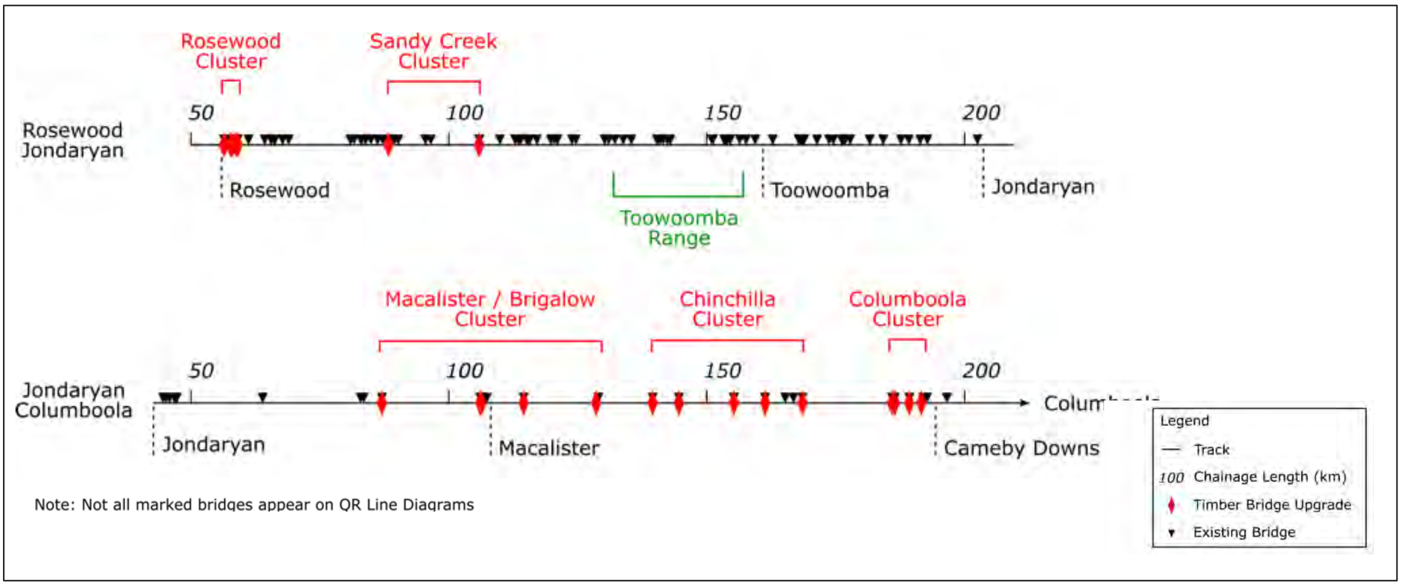


Figure 5.7. Timber Bridge Renewals in the West Moreton System

These have been grouped into clusters of bridges at similar locations. Concrete ballast deck structures are expected to replace these bridges, [redacted]. Although Queensland Rail may use less expensive, lower capacity and shorter life steel structures.

Queensland Rail anticipates the concrete bridges will require maintenance expenditure to maintain. Details of the proposed bridge renewals are listed in Tables 5.7 and 5.8 below[55].

[55] A 28th bridge, BRL_1116, features in the table in the Queensland Rail submission but no details are provided.

Table 5.7: Bridge renewals in the Rosewood to Jondaryan Corridor.

Site	Year	Km	Bridge Length (m)	Comments
1	2020/21	88.45	30.5	BRL_1140, Sandy Creek near Gatton. DN road.
2		88.45	30.5	BRL_1141, Sandy Creek near Gatton. UP road.
3		106.00	79.3	BRL_1147, Sandy Creek near Grantham. UP road
4		106.00	72.8	BRL_1148, Sandy Creek near Grantham. DN road.
5	2021/22	56.59	28.0	BRL_1105, Rosewood Gully near Rosewood. DN road
6		56.59	28.7	BRL_1106, Rosewood Gully near Rosewood. UP road.
7		57.83	29.0	BRL_1109, Rosewood Gully near Rosewood. DN road.
8		57.83	29.0	BRL_1110, Rosewood Gully near Rosewood. UP road.
9		59.22	58.9	BRL_1115, Brandy Gully near Rosewood. UP road.
10	2023/24	58.16	21.9	BRL_01111, BRANDY Gully near Rosewood. DN road.
11		58.16	21.9	BRL_01112, BRANDY Gully near Rosewood. UP road.
12		58.93	23.7	BRL_01113, BRANDY Gully near Rosewood. DN road.
13		58.93	23.7	BRL_01114, BRANDY Gully near Rosewood. UP road.

Table 5.8: Bridge renewals in the Jondaryan to Columboola Corridor.

Item	Year	Km	Bridge Length (m)	Comments
14	2020/21	106.24	20.8	BRL_02386, Jimbour Creek near Macalister.
15		161.46	4.6	BRL_02408, Cemetery Road near Chinchilla.
16		168.71	13.5	BRL_02415, Rocky Creek near Chinchilla.
17		186.62	4.5	BRL_02422, crossing near Cameby Downs.
18		189.42	13.8	BRL_02423, Columboola Creek near Cameby Downs.
19	2021/22	114.64	91.9	BRL_02390, Broadmead near Macalister.
20		128.72	46	BRL_02395, Cooranga Creek near Warra.
21	2022/23	106.48	86	BRL_02387, Jimbour Creek near Macalister.
22		144.77	26.3	BRL_02402, Brigalow Crossing.
23		186.09	26.3	BRL_02421, Cameby Downs.
24	2023/24	87.17	67.5	BRL_02383, Dalby gun club crossing near Baining.
25		139.66	54.9	BRL_02399, Ehlma Crossing near Cameby Downs.
26		155.42	20.8	BRL_02406, Ryan's Crossing near Cameby Downs.
27		191.76	183.6	BRL_02425, Columboola Creek near Cameby Downs.

FORMATION REPAIRS

Formation repairs involve removing sleepers and ballast, excavating the failed formation and constructing a new structure upon the subgrade. Normally geofabrics and geogrids are used to strengthen new formations over soft ground. The original rail, sleepers and ballast are normally replaced. Formation rebuilds improve the quality of the below rail structure and reduce the future maintenance requirements; specifically track resurfacing.

The Queensland Rail West Moreton System maintenance team have achieved 440m of formation rebuild in a 2 day closure. In a 4 day closure they can achieve approximately 1000m. It is estimated that in a 10 day closure it may be possible to achieve 3km.

Queensland Rail has proposed a total of [redacted] to rebuild 29.5km of track along the West Moreton System. This is largely planned for the J2C corridor. Queensland Rail propose the quantity of formation rebuilding in the R2J corridor is tonnage dependant.

Queensland Rail have used an estimated cost of [redacted] per km for the R2J corridor, and a [redacted] cost per km for the J2C corridor. The difference in price is driven by the proximity of suitable material for rebuilding, and the accessibility of the corridors for repair works.

Figure 5.9. Top and line defect at Kilometre 65.300. SYSTRA Scott Lister was advised that this site was resurfaced approximately 3 months previously; a top and line defect so soon after resurfacing indicates potential formation rebuild is required.

[56] Queensland Rail DAU2 Capital Expenditure Submission, Section 5.2.2

CULVERT REPLACEMENTS

Culverts are essential to avoid track washouts and are particularly important on the steep slopes of the Toowoomba range. Failure of a culvert may be through blockage of debris and, if structurally weakened, the collapse of the culvert. Culvert collapse could lead to a saturated formation and consequent formation failure or landslip.

Queensland Rail has proposed the replacement of 39 culverts along the West Moreton System over the AU2 period. 18 of these are proposed between R2J and 21 between J2C. These are to be replaced at an estimated cost of [redacted].

Queensland Rail specifically notes the replacement of these culverts is in response to the increased forecast tonnages of coal traffic on the West Moreton System (the 9.1 mtpa scenario)[56] . Queensland Rail have proposed the same culvert replacement project for the 2.1mtpa and 9.1mtpa scenario, and as such have allocated the same budget for each. Queensland Rail have therefore proposed the replacement of the 39 culverts regardless of the actual traffic during AU2.

Figure 5.10. Original culvert installed in the late 1800s at approximately Kilometre 145.000 near Tunnel 2. At the far end maintenance issues with the roof of the culvert can be seen. This type of defect would require some method of lining to control.

5.3.2 TRACK CAPITAL WORKS

GENERAL

Track capital works are defined by Queensland Rail as major projects that significantly replace or improve upon the track assets and are typically planned in advance. Track assets include rail, sleepers ballast, and formations. Queensland Rail has proposed a total of [redacted] for capital track projects under the 9.1mtpa scenario.

TRACK RECONDITIONING

Track reconditioning involves the construction of an entirely new section of track in place of existing assets. This includes the construction of a new formation from the subgrade, fresh ballast, sleepers, and new rail. Queensland Rail proposes new 50kg/m rail be laid with concrete sleepers.

Queensland Rail estimates this program to cost a total of [redacted] with works performed on the remaining timber and steel sleeper track between Helidon and Toowoomba, portions of the track between Rosewood and Helidon, and selected track in the J2C corridor. For this 9.1 mtpa estimate, a total of 14.95km of track is to be replaced.
Queensland Rail considers this project to be tonnage dependant, with only 8.68km of track to be replaced in the 2.1 mtpa scenario, at a proportionally lesser cost.

Specific locations and lengths of reconditioning activities are difficult to predict in advance, and Queensland Rail has not provided SYSTRA Scott Lister with this information. Queensland Rail report the cost breakdown for track reconditioning as follows in $2020-21 millions, at a total cost of [redacted]:

- Rail
- Plant and machinery hire
- Labour
- Sleepers
- Ballast
- Others

[redacted]

SYSTRA Scott Lister inspected a section of recently reconstructed track at Laidley. The quality of the finished product appeared high; SYSTRA Scott Lister noted the inclusion of the following in the completed reconstructed track:

- New track system
- Capping layer of CBR 45 material
- Inclusion of a geogrid layer
- Inclusion of a geofabric layer.

This reconstructed track site is shown in Figure 5.11 below.

Figure 5.11. Reconstructed track at Laidley.

RESLEEPERING

Resleepering on the West Moreton System is performed on a cyclic basis using a mechanised process. It involves the replacement of degraded regions of timber sleepers with new timber sleepers. Track sections in both corridors utilise a mixture of timber and steel sleepers, with interspacing patterns varying by location.

Queensland Rail has estimated a 5% degradation rate each year for timber sleepers. Queensland Rail have suggested that approximately 52,100 timber sleepers will require replacement over AU2. The sleeper replacement will be performed in two stages: 41,100 sleepers in 2020-21 and 11,000 sleepers in 2024-25. There are an estimated 244,000 timber sleepers in the West Moreton System and 5% equates to 12,200 per annum or 61,000 in the AU2 five year period. Under the proposed rate of 52,100 in the AU2 period, an average sleeper lifespan of 23.4 years can be derived [57]. A proposed budget of $[redacted] has been presented by Queensland Rail, at an average of [redacted] Queensland Rail determines this project is independent of traffic volume as it is driven by the durability of the timber sleeper.

RAIL RENEWAL

The renewal of rail is primarily driven by the CETS as a function of head loss area. This head loss may occur due to contact with the train wheel. However, head area is primarily lost due to grinding of the rail, which aims to restore the rail to its nominal profile and avoid stress fatigue cracking. Upon sufficient head loss the rail[58] must be renewed, with this typically occurring in significant lengths within capital projects.

Head loss triggers[59] for rail replacement are:

- 41 kg/m rail – 46% for tangent[60] track
- 50 kg/m rail – 55% for tangent track.

Queensland Rail has proposed a total of 31.237km of rerailing for the AU2 period under the 9.1mtpa scenario, with this occurring entirely in the R2J corridor of the track. Figure 5.12 illustrates the planned locations for these renewals, which are scheduled for an average of approximately 6km per year.

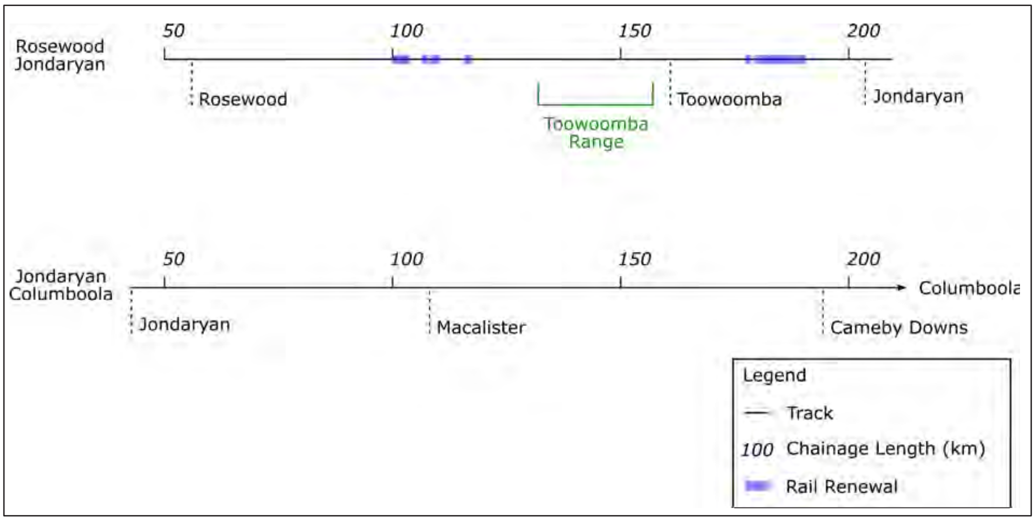


Figure 5.12 Rail Renewals in the West Moreton System. Note that all rail renewals are in the R2J corridor and relate to replacement of 41 kg/m rail.

[57] This is in contrast to Queensland Rail's estimated sleeper lifespan of 18 years given the poor quality of hardwoods available.
[58] CETS is prescriptive in the head loss triggers for rail replacement.
[59] CETS Module 2, Table 2.14
[60] Curved track has a reduced tolerance, for example a 300m radius curve has allowable head loss of 23 and 39% for 41kg/m and 50 kg/m rail respectively for the high rail.

The rerailing project is planned to replace selected sections of 41kg/m rail in the R2J corridor with 50kg/m rail, and renew locations of 50kg/m rail where further wear may result in gauge defects.

SYSTRA Scott Lister inspected sites proposed for rail replacement and noted that the head loss wear on 41 kg/m rail had not reached the CETS limits. Queensland Rail explained that the reason for replacing 41 kg/m rail was not solely head loss wear but also due to:

- the frequency of rail defects in the 41 kg/m rail including transverse defects, bolthole cracking and Vertical Split Head (VSH) defects
- the susceptibility of 41 kg/m rail to buckling in hot weather.

Sections of rail on the tight curves of the Toowoomba range that require replacement are assumed to be covered under the smaller scale maintenance renewal scope.

Queensland Rail has proposed a cost of [redacted] for the renewal of rail under the 9.1mtpa scenario, at a rate of [redacted]. This is considered variable with the tonnage of traffic.

LEVEL CROSSING RECONDITIONING

Queensland Rail has proposed a budget of [redacted] for the replacement of defective track assets in selected level crossings of both corridors. This will involve the rebuilding of formations and the replacement of ballast and rail. Queensland Rail does not consider these works to be tonnage dependant.

SYSTRA Scott Lister inspected a level crossing at Toowoomba and noticed issues with the interface of rail with bitumen. SYSTRA Scott Lister note that other below rail operators have successfully used flange ways to manage this risk.

[61] Queensland Rail DAU2 Capital Expenditure Submission, Section 6.5.2

CONCRETE SLEEPERS ON THE TOOWOOMBA RANGE

Concrete sleepers that have been laid on the Toowoomba range have been found to be deteriorating at a higher rate than expected. Queensland Rail expects this is due to the forces of traffic travelling around the tight radius curves on the Toowoomba range. Queensland Rail suggests these sleepers will require replacement during the AU2 before their expected lifespan of 50 years.

Queensland Rail estimates a cost of [redacted] to replace unsuitable sleepers with full depth sleepers. Queensland Rail does not consider this project to be tonnage dependant. Queensland Rail has proposed this project for both the 2.1mtpa and 9.1mtpa scenarios. Despite this, Queensland Rail have stated they do not consider this project necessary within the AU2 period should coal traffic not increase to the 9.1mtpa scenario.

SYSTRA Scott Lister inspected a site potentially requiring sleeper replacement, Figure 5.13. Queensland Rail explained that these older sleepers and the current range of spacers available had limited ability to manage rail adjustment as the gauge approaches the CETS limit for gauge widening for these types of curves. This potentially could lead to the need for premature rail replacement or track reconstruction. The Queensland Rail proposal would address this constraint by creating more flexibility to deal with gauge defects and widening.

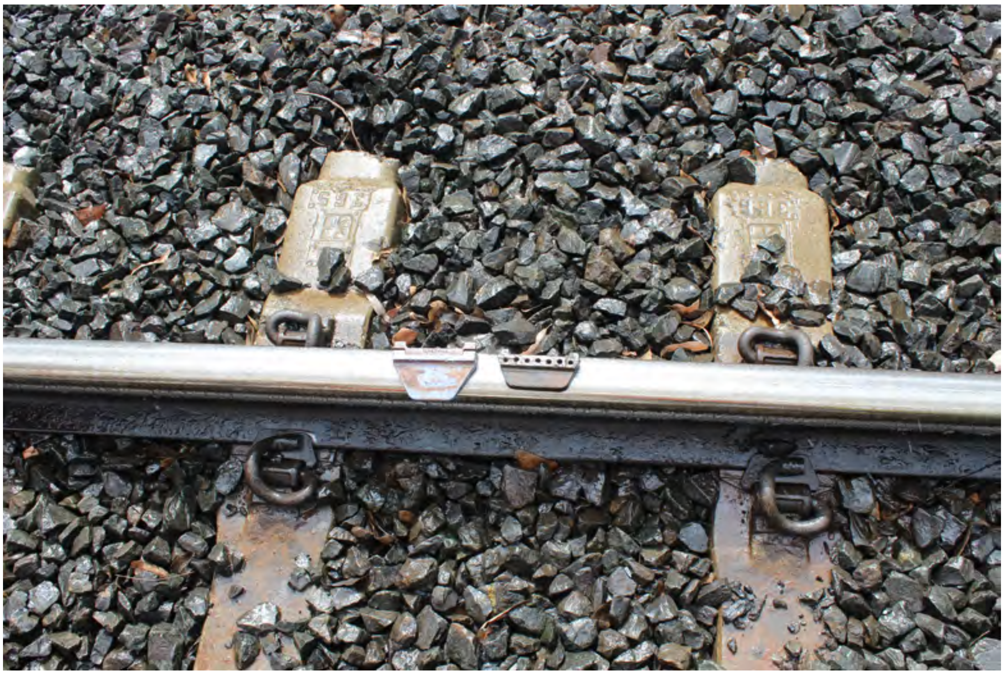


Figure 5.13. Location of proposed sleeper replacement on the Toowoomba Range. Current spacers used to manage gauge widening are placed on top of the rail. Evidence of movement of the rail is clear on the left hand pandrol clip.

LEVEL CROSSING TRANSITIONS

Queensland Rail have found that weld failures have occurred frequently where 41kg/m rail has been connected to the 50kg/m rail used in level crossings. Queensland Rail have proposed concrete sleepers and 50kg/m rail be extended to a minimum of 20 sleepers on either side of the level crossings. This project is to occur only on the J2C corridor.

A budget of [redacted] has been proposed for these works, which Queensland Rail suggest is independent of the tonnage of traffic. This is primarily driven by the coal carrying traffic, without which Queensland Rail state this project would not be required in the AU2 period[62].

LUBRICATOR UPGRADES

Lubricators are primarily used on the Toowoomba and Little Liverpool ranges to reduce rail wear on the gauge faces of curves. Queensland Rail expects the existing lubricators are to become life expired during the AU2 period, and as a result will require replacement. There are 71 lubricators on the West Moreton System.

Queensland Rail estimate a budget of [redacted] to replace these over the AU2 period, at an average rate of [redacted] per year. These lubricators are considered tonnage independent by Queensland Rail.

5.3.3 SIGNALLING CAPITAL WORKS

GENERAL

Signalling assets include all of those that facilitate the signalling control of both railway traffic and that of road going vehicles at level crossings. Queensland Rail has proposed a total of [redacted] for signalling track projects under the 9.1mtpa scenario.

LEVEL CROSSING SIGNALLING UPGRADE

Queensland Rail has proposed the upgrading of 18 level crossings signalling infrastructure. This work ranges from:

- the replacement of signalling huts at 7 sites, to the
- replacement of Queensland Rail Flasher Modules
- upgrading to LED lights at 8 sites, and
- the removal of level crossing infrastructure at 3 sites.

Queensland Rail estimate a budget of [redacted] for these works, with the majority occurring in the R2J corridor. Queensland Rail does not consider this project tonnage dependant.

[62] Queensland Rail DAU2 Capital Expenditure Submission, Section 6.6.2

MINOR SIGNALLING RENEWAL

Queensland Rail have proposed a budget of [redacted] for the renewal of various life-expired signalling infrastructure along the R2J corridor. This includes the renewal of solar equipment, boom mechanisms and alternators. Queensland Rail does not consider this project to be tonnage dependant.

GATTON INTERLOCKING

Queensland Rail have proposed a budget of [redacted] for the replacement of the Siemens Westrace Mk1 interlocking in Gatton. Queensland Rail have assessed this project as not dependent on tonnage.

The EAMS defect records are not showing that this asset is a cause of delays impacting system performance.

RELAY INTERLOCKING

Queensland Rail have proposed a budget of [redacted] for the refurbishment of 12 interlockings on the R2J corridor. Queensland Rail have assessed this project as not dependent on tonnage.

The EAMS defect records are not showing that these assets are not a cause of delays impacting system performance.

OTHERS

Other signalling projects proposed by Queensland Rail include the renewal of:

- Trailable facing points detection.
- Signalling pole route Yarongmulu – Laidley.
- Location case renewal.
- Signalling LED upgrade.

These account for a total of [redacted], and are all considered tonnage independent by Queensland Rail.

5.4 OPERATIONAL EXPENDITURE

5.4.1 GENERAL

Queensland Rail propose a total budget of $48.717 ($2020-21 million) for operational expenses over the DAU2 period. This is predominantly comprised by the direct costs of train control, but includes allowances for:

- corporate overhead
- Weighted Average Cost of Capital (WACC) returns, and
- other administration and management expenses.

An illustration of these costs may be seen in Figure 5.14 below.

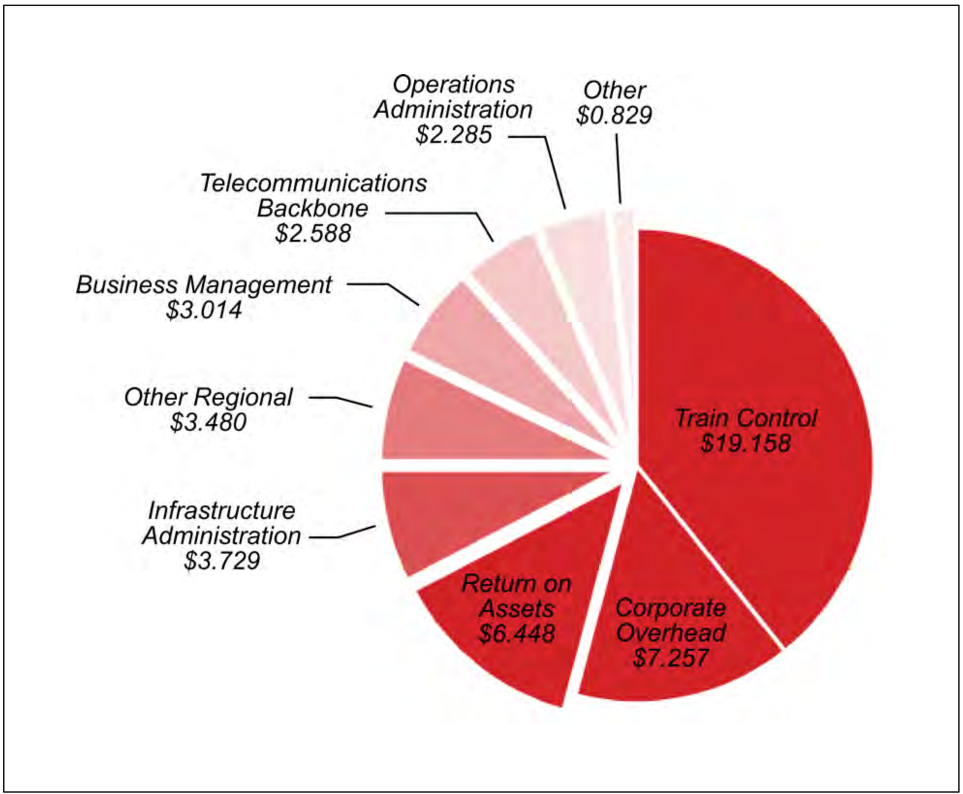


Figure 5.14. Operational expenditure by activity ($2020-21 million)

5.4.2 TRAIN CONTROL

Train control involves:

- the direct costs of staffing the two control boards responsible for the West Moreton System
- operational planning for the system
- monitoring the performance, and
- any safety issues on the network.

For AU2, operations management has been excluded from this category.

Queensland Rail have proposed a bottom up approach for estimating the train control figure, based on historic expenditure in the 2016-17 period. Table 5.9 depicts the estimated costs for two controllers for both control boards 24 hours a day, 7 days a week, 365 days a year, which Queensland Rail proposes will require a total of 12 controllers and 2 supervisors; independent of the volume of traffic.

The total of $3.498 ($2016-17 million) has been escalated by Queensland Rail at 2.5% per annum to a AU2 estimated cost of $3.861 ($2020-21 million).

Table 5.9: Proposed Train Control Cost Build Up ($2016-17) per Annum.

Function	No.	Cost	On-Costs	Total West Moreton
[redacted]				
Total				$3,498,200

5.4.3 OTHER OPERATIONAL COSTS

Other operational costs include:

- Corporate overhead
- Return on assets
- Other administration and management
- Telecommunications backbone
- Other regional, and
- Other unallocated.

Corporate overhead includes the cost of accounting, legal, human resources, and sales and marketing staff. Queensland Rail does not include operations or infrastructure administration staff within.

Queensland Rail proposes a total of $7.257 ($2020-21 million) for corporate overhead during the DAU2 period. Queensland Rail considers this tonnage independent, and is common to both scenarios.

Queensland Rail proposes a total budget of $6.448 for WACC returns on buildings, plants, software, and inventory.

Business, infrastructure, and operations administration expenses include the staffing costs to operate these supervisory positions. Queensland Rail have proposed a total of $12.508 ($2020-21 million) for these roles over the DAU2 period, and does not consider this dependant on the tonnage of traffic.

The remaining operational expenditures include staffing costs for the following groups of activity:

- Telecommunications Backbone
- Other Regional (allocated)
- Other (unallocated).

Queensland Rail has proposed a total of $6.89 ($2020-21 million) for these roles, which is not considered dependant on the tonnage of traffic.

Queensland Competition Authority | West Moreton System

ANALYSIS

6.1 GENERAL

SYSTRA Scott Lister analysed the Queensland Rail submission from the perspectives of three scenarios:

1. 2.1 mtpa
2. 9.1 mtpa with Inland Rail commissioning in 2024/2025
3. 9.1 mtpa scenario with a delayed Inland Rail commissioning.

The 2.1 mtpa scenario has 2.1 mtpa coal being transported from the Yancoal Cameby Downs mine at the far west of the system through to PoB, with no additional tonnage joining at Jondaryan from the Acland mine. The two 9.1 mtpa scenarios reflect 2.1 mtpa travelling the full system and an additional 7.0 mtpa joining at Jondaryan.

As discussed in Section 5.1 Queensland Rail's estimate of funding required for maintenance, capital and operations for the West Moreton System for the five year DAU 2 period for traffic of 9.1 mtpa is $ 349.022 as shown below in Figure 6.1.

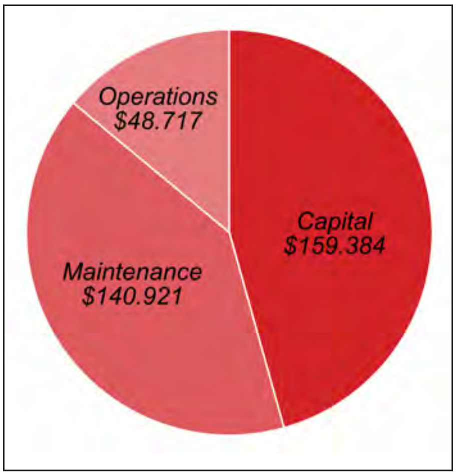


Figure 6.1. Queensland Rail overall submission under the 9.1 mtpa scenario without Inland Rail.

6.2 IMPACT OF VARIABLE TONNAGES – 2.1 MTPA VERSUS 9.1 MTPA

Queensland Rail assesses that under reduced tonnages there will only be a reduction in tonnage dependent track and structures maintenance costs on R2J; with no reduction on J2C. Queensland Rail estimate the the capital and operations costs are independent of tonnage.

The basis of this assessment is that:

- J2C traffic remains unchanged under both scenarios
- R2J signalling and telecommunications infrastructure is to be maintained and renewed the same for all tonnage scenarios
- Some R2J track and structures are to meet minimum CETS or CESS standards and are not tonnage dependent.

Queensland Rail have estimated the scope of works required in the DAU2 based on the historical maintenance costs in the 2016/17 FY for a net coal tonnage of 6.25mtpa. These costs have been projected through the AU2 period based on their history of recorded defects. From this established 6.25mtpa baseline, Queensland Rail have then varied the cost of works using a percentage variability proposed by QCA for the 6.25 mtpa scenario.

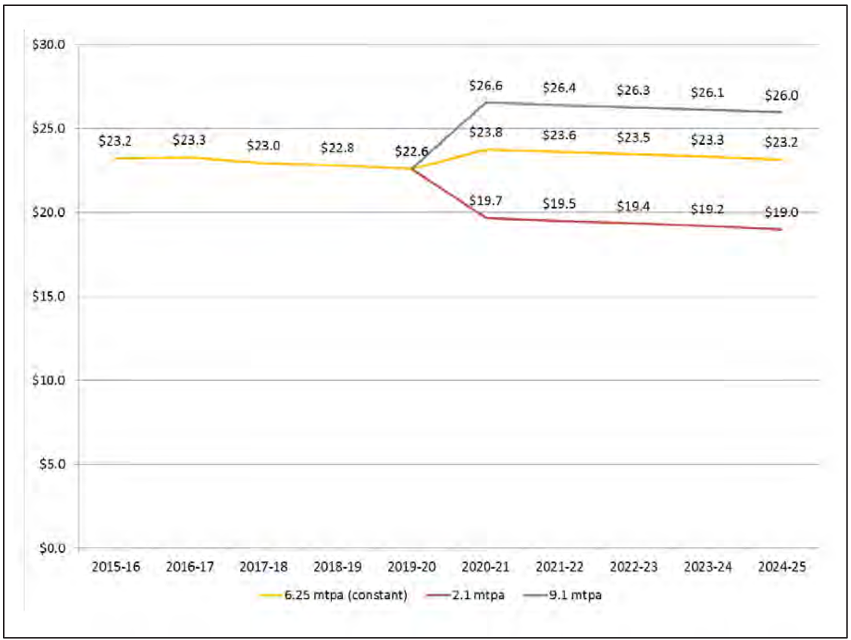


Figure 6.2. AU1 maintenance allowance and proposed AU2 maintenance allowance (excluding ballast undercutting) by tonne scenario ($ 2020-21 million).

Under the Queensland Rail approach, it is assumed the percentage of variation and fixed costs are constant across the range of traffic tonnage. In this way, the projection of costs for the 2.1mtpa and 9.1mtpa scenario follow a linear model. These percentages describe the fraction of cost which remains fixed (independent of tonnage) and those costs that vary with the tonnage of traffic. These are listed in Section 5 for specific types of works.

The Queensland Rail methodology shown in Figure 6.3 leads to an estimated 'zero tonne limit' or cost to maintain the West Moreton System railway under no traffic of approximately $17 million per year. This would predict a zero tonne maintenance cost of $54,140 per km per year.

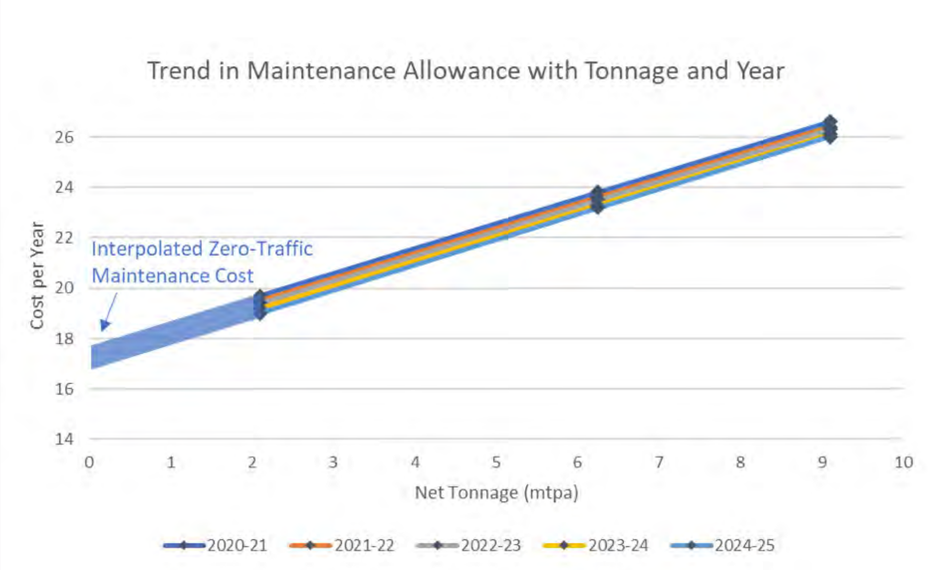


Figure 6.3. Variation in the maintenance expenditure across a range of traffic net tonnage ($2020-21 million).

SYSTRA Scott Lister understands QCA's original intent of the percentage of variable costs as described in Queensland Rail's DAU2 submission was that this strictly applied for the specific tonnage of 6.25mtpa. In the context of the restriction that the quoted percentages can only be applicable at 6.25 mtpa on the use of the fixed/variable percentage, SYSTRA Scott Lister proposes an alternative costing method for projecting the required cost estimate for works for higher and lower tonnage scenarios from the 6.25mtpa Queensland Rail baseline.

SYSTRA Scott Lister proposes an alternative mathematical relationship based on benchmarking against three[64] other coal systems:

1. Mt Isa
2. Newlands System
3. Moura System.

The mathematical function can be termed function f_((x)). This function returns the cost per annum, dependant on the tonnage of traffic; which is denoted by the variable x, the tonnage[65] on the track. This function can be used to compare to rail system; to achieve this it must be normalized by the length of track. The resulting units of this function are therefore cost per track km per year.

[64]Data is available for the Blackwater and Goonyella systems. However, these systems are bi-directional duplicated and electrified track. Townsville to Mt Isa, Newlands and Moura are all single track with passing loops and are not electrified.
[65] The relationship can be applied to net or gross tonnes, however account must be taken of different axle loadings when comparing systems. Queensland Rail have used net tonnes in the linear relationship model.

The derivative of this function $\frac{\partial f_{(x)}}{\partial x}$ or its rate of change per tonnage of traffic may similarly be defined by units of: Cost per track km per year per tonne. A series of 'rules' can now be described that apply at high and low tonnages. These rules are:

$\lim_{x\to\infty} f_{(x)} = \infty$	Large traffic volumes require large expenditures
$\lim_{x\to 0} f_{(x)} = a$	A fixed cost is required regardless of traffic volume, which at zero traffic volume we define by the variable *a*
$\lim_{x\to\infty} \frac{\partial f_{(x)}}{\partial x} = b$	A minimum work cost per tonne *b* is required, which we expect to approach at very large traffic volumes
$\lim_{x\to 0} \frac{\partial f_{(x)}}{\partial x} = \infty$	We expect the works cost per tonne to become large at low traffic volumes.

Using these limits, the function appearing below was derived. The Queensland Rail 6.25 mtpa baseline cost can be used as a fixed point for the analysis. In addition a line of best fit with ranging envelopes can be derived using historical comparable railways as a data set. This determines the coefficient values a,b and c. The resulting equation of the line of best fit is:

$$f_{(x)} = a\sqrt{x} + bx + c$$

Figure 6.4 illustrates the this approach using net tonnes.

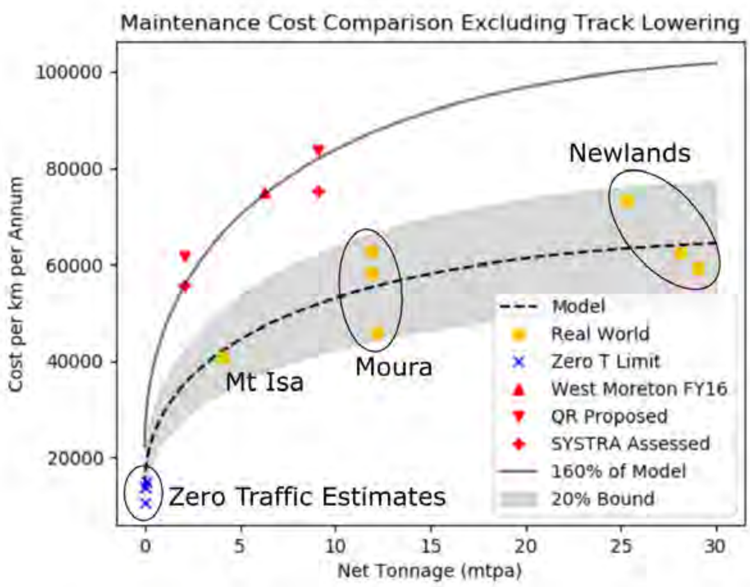


Figure 6.4. SYSTRA Scott Lister maintenance expenditure model fit using traffic tonnage in net tonnes per annum ($2020-21 million).

SYSTRA Scott Lister has omitted track lowering from the maintenance costs proposed by Queensland Rail for this fit from the West Moreton System and Mt Isa line. SYSTRA Scott Lister assesses the scope of track lowering work for these systems to not be comparable to the works performed on the other track systems, this will be discussed later in Section 6.3.3. SYSTRA Scott Lister understands the comparative rail networks costs may include a component for ballast undercutting or ballast cleaning, which is a similar process, but performed for different intentions. SYSTRA Scott Lister has not omitted these costs, and expects the points in the graph would appear at a lower cost per km, should these scope of works be considered equivalent to the track lowering performed by Queensland Rail.

The West Moreton system shows as relatively expensive to maintain in comparison to the other systems and the line of best fit. However it must be noted that Moura and Newlands operate at 26.5 tal whereas Mt Isa operates at 20 tal and the West Moreton System operates at 15.75 tal; 15.75 tal is a less efficient axle load in terms of payload to total weight ratio. Alternatively applying gross tonnes, instead of net tonnes, for comparison between these systems, results in Figure 6.5.

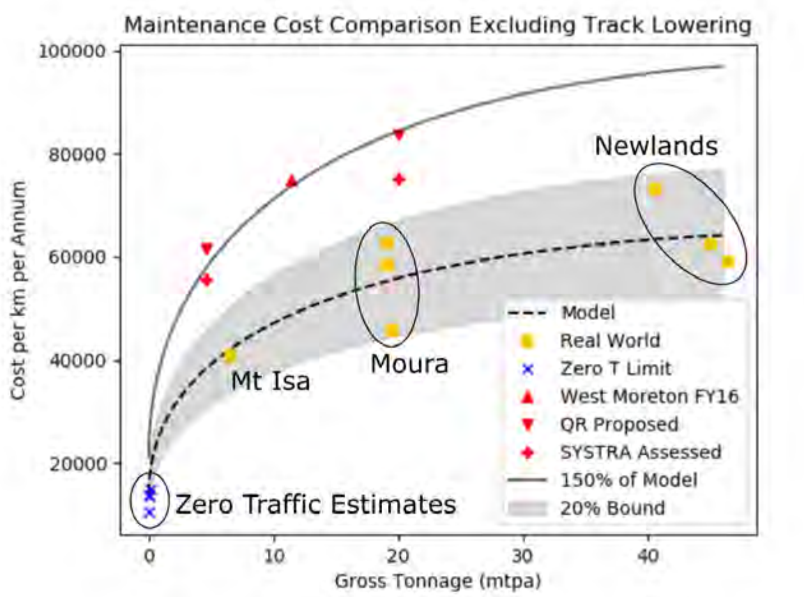


Figure 6.5. SYSTRA Scott Lister maintenance expenditure model fit using traffic tonnage in gross tonnes per annum ($2020-21 million).

In this specific case coefficients for this fit are:

a = 11505
b = 441.19
c = 11353.544

In this case the 9.1 mtpa scenario maintenance cost proposed by Queensland Rail appears better aligned with the SYSTRA Scott Lister model as at higher tonnages the model approaches the linear relationship used by Queensland Rail. The 2.1 mtpa maintenance cost proposed by Queensland Rail however appears high in comparison to the SYSTRA Scott Lister model as at lower tonnages the linear model appears to not be applicable.

In both Figures 6.4 and 6.5, estimates, in blue, have been added for the zero tonnage maintenance cost of several railways, including the West Moreton System. These are in $2020-21:

- West Moreton System - $14,863/km [67]
- West Moreton System - $13,846/km [68]
- WestNet Rail - $10,456/km [69]
- Victorian Freight Network - $13,736/km [70]

These represent indicators of the accuracy of the model under lower tonnage operations. SYSTRA Scott Lister assesses good model fit to these points whereas the linear model is significantly higher at $74,469 per km. This supports that the SYSTRA Scott Lister model is more accurate at lower tonnages than the linear interpretation used by Queensland Rail.

SYSTRA Scott Lister acknowledges the West Moreton System should not be expected to appear in the lower range of the model, given its difficulties with geography and legacy railway construction. This is converse to the Newlands system, which largely consists of modern, recently renewed assets.

SYSTRA Scott Lister recommends the adjustment of the 2.1 mtpa maintenance figure to align with the proposed projection of the SYSTRA Scott Lister model. This 150% line has been selected to align with the Queensland Rail proposed costs for the 6.25mtpa scenario.

It is important to note that this model has been prepared by SYSTRA Scott Lister specifically for the West Moreton System. SYSTRA Scott Lister uses this model to scale the track repair and other track budgets only.

[67] B&H, Paper 2 – Maintenance Cost and Usage Relationship, 2019
[68] Queensland Rail, Working Paper 2, 2018
[69] ERA of WA, WestNet Rail's Floor and Ceiling Costs Review, 2009
[70] Essential Services Commission of Victoria, Maintenance Cost Benchmarking for the Victorian Freight Network, 2006

Under the SYSTRA Scott Lister proposed approach, high level baseline figures for the 2.1mtpa and 9.1 mtpa scenarios were developed to assess the reasonableness of Queensland Rail's submission. This assessment is summarised in Table 6.1 below. Specific activities will be reviewed in the following sections of Chapter 6.

Table 6.1. Comparison of total projected maintenance costs for the DAU2 period excluding resurfacing and track lowering ($2020-21 million).

	0 mtpa (extrapolated)	2.1 mtpa	6.25mtpa	9.1mtpa
Queensland Rail	$74.469	$81.109	$94.327	$103.242
SYSTRA Model	$22.693	$69.578	$94.327	$103.242
SYSTRA's assessment		*Queensland Rail estimate is too high*	*Anchored on AU1 performance*	*Queensland Rail estimate is reasonable*

SYSTRA Scott Lister concurs with Queensland Rail that J2C costs will remain unchanged under the 2.1 mtpa and 9.1 mtpa scenarios. SYSTRA Scott Lister assesses that all other costs could potentially be impacted by different tonnage scenarios and need to be assessed on a case by case basis.

SYSTRA Scott Lister concurs with Queensland Rail that:

- ***Anchoring on proven maintenance costs of FY16/17 is valid.***
- ***There are fixed maintenance costs that must be incurred even with zero traffic.***

SYSTRA Scott Lister assesses that the Queensland Rail methodology for interpolating 2.1 mtpa and 9.1 mtpa maintenance costs can be improved upon. The use of a linear relationship for predicting the maintenance cost of the 2.1 and 9.1 mtpa scenario simplifies the changing incremental cost with increasing or decreasing tonnage.

SYSTRA Scott Lister recommends the use of a benchmarked non-linear model for projecting costs under different tonnage scenarios.

6.3 MAINTENANCE

6.3.1 GENERAL

The total Queensland Rail submission for maintenance under the 9.1 mtpa scenario with no Inland Rail is $ 140.921 m. The breakdown of proposed maintenance costs is shown in Figure 6.6 below.

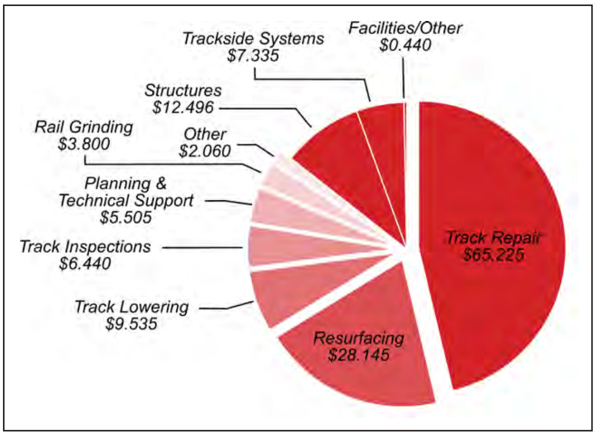


Figure 6.6. Break down of maintenance costs

This maintenance submission is described in Queensland Rail's DAU2 Explanatory Document.

6.3.2 TRACK REPAIR

GENERAL

Track repair at $ 65.225 million is the largest component of the maintenance budget.

As discussed in Section 6.2, SYSTRA Scott Lister assess the projection methodology used by Queensland Rail to estimate the 9.1 mtpa scenario is reasonable however the 2.1mtpa scenario maintenance cost is overestimated. SYSTRA Scott Lister has estimated a track repair figure which remains proportionate to the scope of works performed at 6.25mtpa in FY16/17 using the non-linear model described earlier in Chapter 2.

An analysis of the different components of the track repair budget is shown below in Figure 6.7 below.

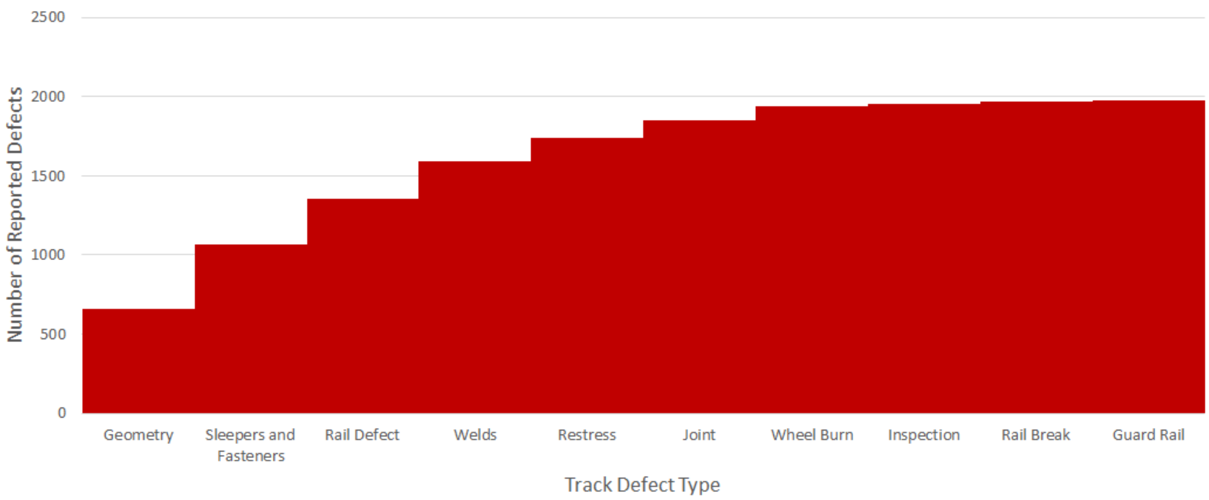


Figure 6.7. Break down of track repair defect type by frequency

Figure 6.7 exhibits a pareto pattern; that is approximately 20 % of the types of defects yield 80 % of defect numbers. EAMS provided a total of 1,977 track defects in the reporting period. The top five defects, in order of priority, are:

- Track geometry defects - 658 defects - 33.28 %
- Sleeper & fastener defects - 410 defects - 20.74 %
- Rail defects - 283 defects - 14.31 %
- Weld defects - 243 defects - 12.29 %
- Stress Free Temperature (SFT) - 146 defects - 7.38 %.

The total of the remaining types of defects is 237 defects or 11.99 % of the total.

TRACK GEOMETRY

SYSTRA Scott Lister assess that it is reasonable that track geometry defects is the major contributor to track defects on the West Moreton System.

SYSTRA Scott Lister suggest the root cause for many of these defects is the legacy formation which may not have been constructed with a suitable capping layer engineered and installed as part of the profile. This poor formation and lack of capping would lead, over time, to ponding of water beneath the ballast and consequently mixing of ballast at the top of formation level.

The immediate action to rectify a geometry defect would be a resurfacing operation to hold the top and line by tamping ballast and topping up with additional ballast as required. A failure to hold the top and line after a resurfacing operation indicates that the problem originates below the ballast layer and it is likely a formation rebuild or track reconstruction is required.

SYSTRA Scott Lister has analysed the track geometry through a review Track Condition Index data and identified the exceedances of TCI limits requiring a 7 day intervention as 849 m and 253 m of track on R2J and J2C respectively. These exceedances are on the 10m Twist TCI.

Notwithstanding the effort Queensland Rail is putting into maintaining track geometry; SYSTRA Scott Lister suggest maintaining acceptable track geometry is being done through an emphasis on resurfacing, where a formation rebuild may be a better whole of life solution. SYSTRA Scott Lister suggest that Queensland Rail review the balance of resurfacing and track reconstruction/formation rebuild projects. This will be discussed later in the report. Figure 6.8 shows a track geometry defect on the West Moreton System.

Figure 6.8. Track geometry defect

SLEEPERS AND FASTENERS

The sleepers and fastener defects are predominantly occurring on the J2C corridor as opposed to the R2J corridor. Figure 6.9 below shows missing Pandrol clips at a site on the R2J corridor.

Much of the R2J corridor, specifially over the Toowoomba Range comprises 50kg/m rail on concrete sleepers. This configuration requires minimal maintenance; with the exception of some work required at tight curves which is treated as a specific project in capital works.

The J2C corridor comprises a mix of steel and timber sleepers. The proportion of steel to timber varies between 1:2 steel, timber ratio to 1:4 timber to steel. This is an acceptable approach according to the CETS and minimises maintenance costs. It is understandable that this type of construction would have a heavy spot sleeper replacing demand and fasteners would require continual and demanding inspection and maintenance.

Figure 6.9 Sleeper and fastener defect

RAIL DEFECTS

SYSTRA Scott Lister could not obtain details of the specific nature of the rail defects but assume they are the standard types of rail defects heavy haul systems identified visually or through ultrasound. There are total of 283 rail defects which is an average of less than 1 per kilometre. These defects would include:

- Corrugations
- Rolling Contact Fatigue (RCF) defects
- Squats
- Horizontal and vertical split heads
- Plastic flow
- Gauge corner checking or cracks.

Figure 6.10 shows rail defects. Common causes of rutting on curve low rails is excessive cant, insufficient rollingstock speed or an asymmetric rail profile on the two rails. This results in the slipping of one wheel, typically the high rail, and a resulting wear oscillation.

Figure 6.10. Rail defects; left photo shows a squat and right photo shows corrugations with a wavelength of approximately 50mm on the Toowoomba Range.

STRESS FREE TEMPERATURE OR RAIL TEMPERATURE MANAGEMENT

The region around Toowoomba has a wide temperature range; with highs above 40 degrees Celsius in the summer and below freezing in winter. Successful maintenance of this track requires careful rail stress and temperature management.

This management includes ensuring adequate and suitable shoulder and crib ballast to control buckling and careful management of weld and rail stress to avoid pull apart rail breaks. The Queensland Rail maintenance team have on occasion used water to cool rails in extreme situations [71].

SYSTRA Scott Lister assess that is reasonable in the extreme temperature ranges of the West Moreton System that this is a major aspect of rail maintenance.

OTHER TRACK REPAIRS

Less common track repairs include:

- Joint replacement
- Wheel burns
- Rail breaks.

SYSTRA Scott Lister assess the scope of works proposed by Queensland Rail for the baseline FY16/17 period to be reasonable.

Queensland Rail have requested $ 140.979 million in their total submission for maintenance for a 9.1 mtpa scenario and $ 101.881 million for a 2.1 mtpa scenario.

SYSTRA Scott Lister assessed under the three scenarios:

- ***9.1 mtpa with Inland Rail: $ 117.996 million***
- ***9.1 mtpa with no Inland Rail: $ 117.996 million***
- ***2.1 mtpa: $ 87.430 million.***

In all scenarios SYSTRA Scott Lister has:

- ***Removed the track lowering activity and increased the formation rebuild allowance in the capital works budget***
- ***Reduced the resurfacing allowance and increased the formation rebuild allowance in the capital works budget***
- ***Reduced the rail grinding allowance to align with CETS***
- ***Increased the bridge maintenance allowance.***

[71] Reported in the EAMS database.

6.3.3 RESURFACING

ASSET CONDITION

Earlier in the report it was mentioned that SYSTRA Scott Lister suggest that Queensland Rail is potentially using resurfacing to hold top of line in lieu of initiating a formation renewal project.

During the FY16/17 period SYSTRA Scott Lister calculate that Queensland Rail performed a total of approximately 138 km of resurfacing between Jondaryan and Columboola. The Queensland Rail submission of $1.798m for the DAU2 period is stated as being projected for the same scope of works as the previous undertaking. Based on these figures SYSTRA Scott Lister have assessed unit cost of $13,016/km for mechanised resurfacing.

Figure 6.11 below shows the frequency of resurfacing operations at specific locations in calendar year FY 17/18 for R2J.

Significant points to note are that:

- Some locations have been resurfaced in one financial year three, four, five or, in one location near Laidley, six times
- Slightly more than one quarter of the track has been resurfaced twice
- A little less than one third of the track had no resurfacing completed.

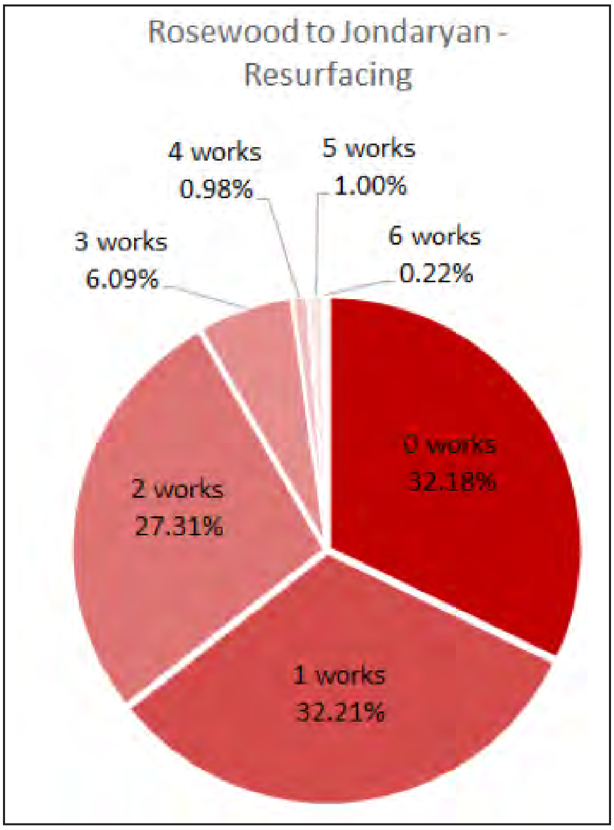


Figure 6.11. Frequency of resurfacing operations at specific locations on R2J.

The specific locations of these resurfacing projects is shown in Figure 6.12 below. Clear peaks of activity are visible at Laidley, west of Toowoomba and just East of Jondaryan. SYSTRA Scott Lister suggest some of these locations may be potential formation rebuild locations.

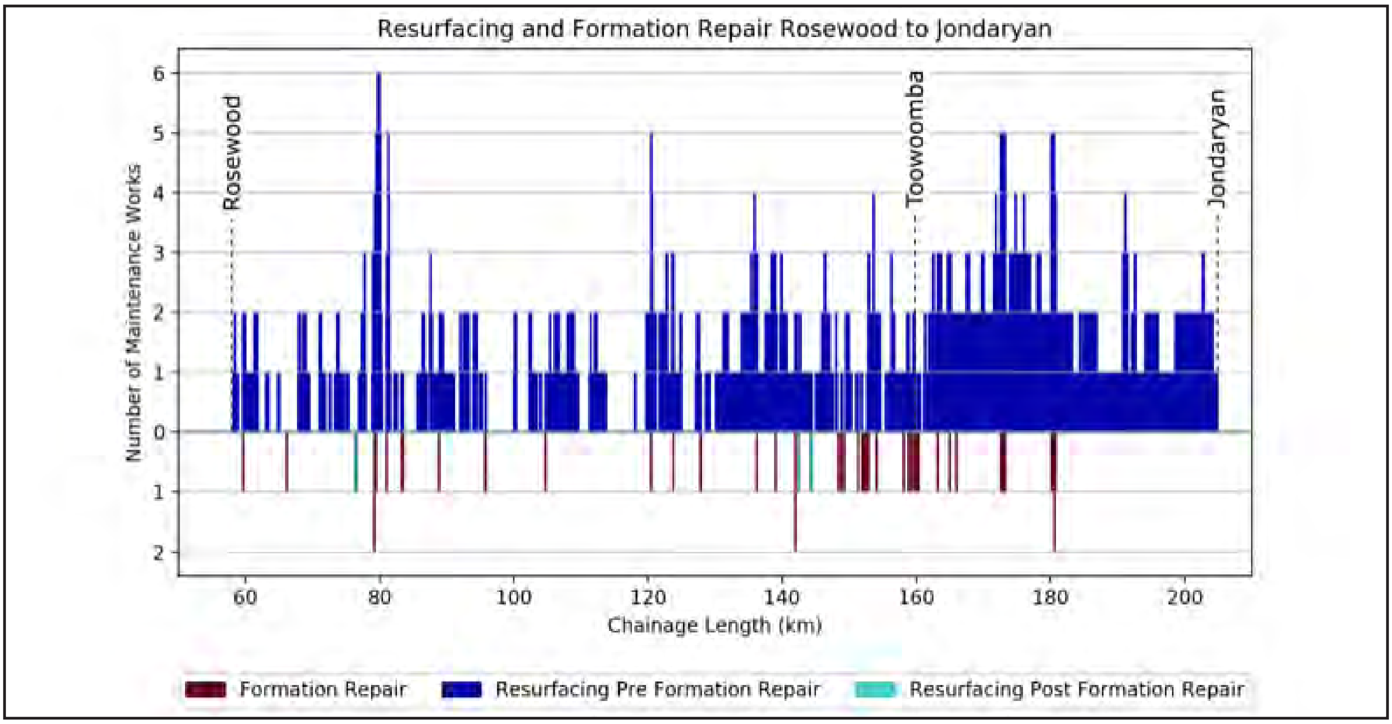


Figure 6.12. Location of resurfacing operations at specific locations on R2J (FY 2017/2018). Light blue bars indicate regions that have been resurfaced following a formation repair in the same year. Chainage is given relative to Roma St in Brisbane; as is illustrated in this figure past Toowoomba, despite the break in chainage for the section west of Toowoomba.

Queensland Rail appear not to use speed restrictions strategically to defer maintenance or capital works. SYSTRA Scott Lister obtained the daily list of speed restrictions in place on 5 February 2019. On this day eight speed restrictions were in place. Of these speed restrictions:

- Four related to tunnel capital works
- Two related to bridge top and line issues
- Two related to rough track or formation issues.

In the Queensland Rail response to the QCA Request For Information (RFI) *"Queensland Rail acknowledges that there is greater scope for potential speed restrictions in a lower tonne environment, however, speed restrictions should not be used in a manner that would compromise the safe or efficient operation of the network"*. SYSTRA Scott Lister agree with this statement and note that Queensland Rail acknowledge that with careful application there is scope for greater use of speed restrictions to defer or remove the requirement for capital or maintenance expense.

The Queensland Rail approach is sound for the West Moreton System under the 9.1 mtpa scenario where some sections are approaching capacity; however, under a lower tonnage scenario SYSTRA Scott Lister suggest a review of this policy in the interests of making the railway more economic for a low traffic scenario. SYSTRA Scott Lister suggest that Queensland Rail should be preparing contingency plans for these types of initiatives to be incorporated into the AMP should the 2.1 mtpa scenario eventuate.

Figure 6.13. Formation failure R2J

Figure 6.14. Formation rebuild R2J

Figure 6.15 below shows the frequency of resurfacing operations at specific locations in calendar year FY 17/18 for J2C. Significant points to note are that:

- Some locations have been resurfaced in one financial year three, four or five times.
- More than one tenth of the track has been resurfaced twice.
- A little more than one third of the track had no resurfacing completed.

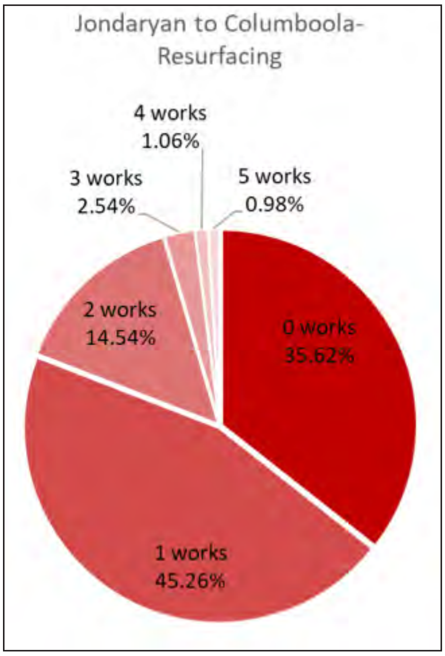


Figure 6.15: Frequency of resurfacing operations at specific locations on J2C (FY 2017/2018)

SYSTRA Scott Lister examined the Queensland Rail CETS, and found it to not prescribe a set trigger for resurfacing operations. As such SYSTRA Scott Lister assumes these works are being performed on an 'as-required' basis.

Queensland Rail are assumed by SYSTRA Scott Lister to be required to perform these works to maintain the safe condition of the track. SYSTRA Scott Lister proposes a more reasonable strategy to address poor track stability is the rebuilding of the formation, which would reduce the frequency of required resurfacing.

The specific locations of these resurfacing projects is shown in Figure 6.16 below.

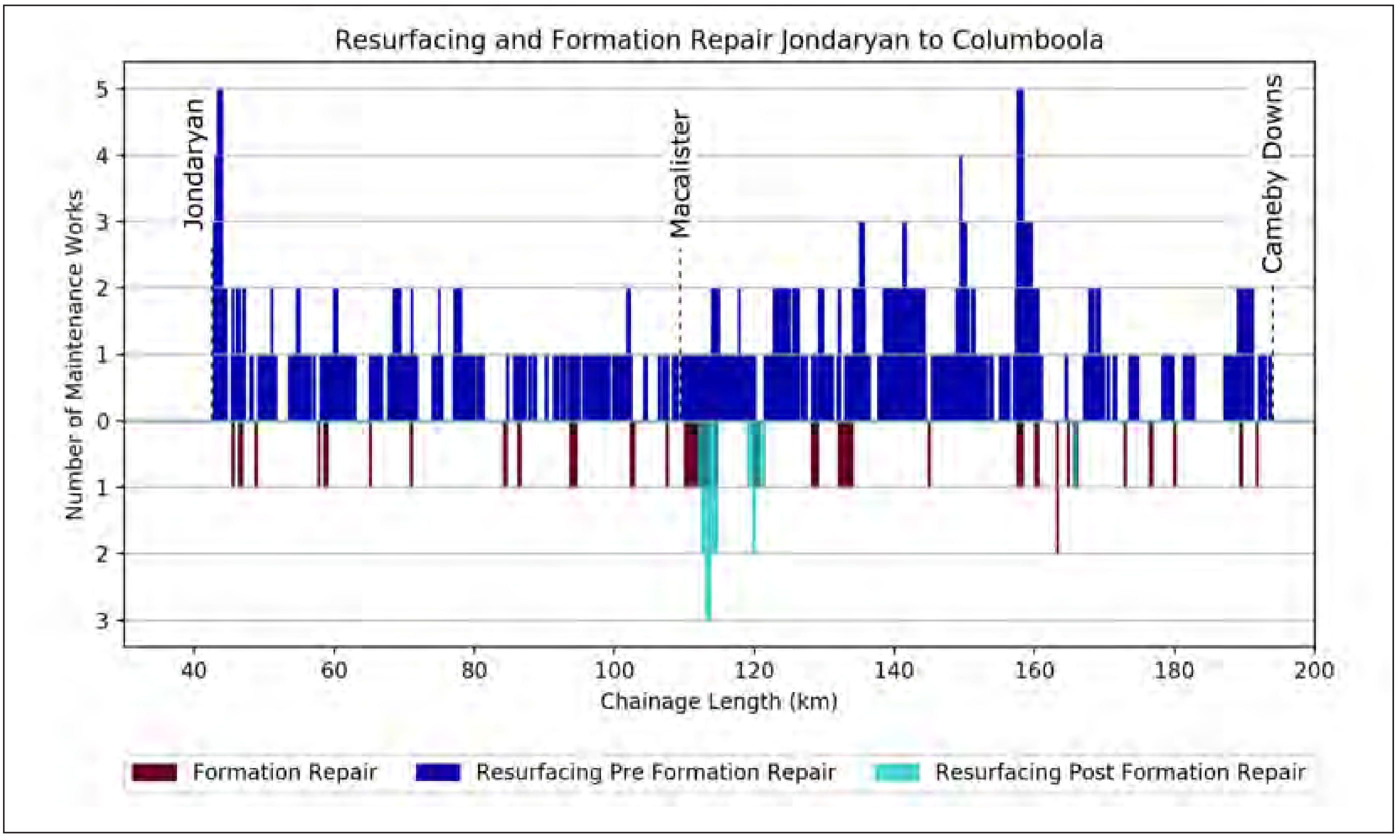


Figure 6.16: Location of resurfacing operations at specific locations on J2C (FY 2017/2018). Light blue bars indicate regions that have been resurfaced following a formation repair in the same year.

Clear peaks of activity are visible at Jondaryan and mid-way between Macalister and Cameby Downs. SYSTRA Scott Lister suggest some of these locations may be potential formation renewal locations. The resurfacing near Macalister highlighted in light blue is stated by Queensland Rail as being due to the resurfacing activity immediately post the formation rebuild being coded as a separate activity.

TRACK SYSTEM AND FORMATION REBUILD STRATEGY

The concept of this formation rebuild campaign approach is illustrated in Figure 6.17.
A combined view of resurfacing, formation rebuilds, track reconstruction and track lowering is required to achieve an optimal holistic outcome.

In the Queensland Rail submission, the major cost components relate to track system and formation maintenance. SYSTRA Scott Lister have assessed a reallocation of budget on the basis of transitioning the current reactive maintenance approach, towards achieving a long term steady state, of balanced resurfacing, formation repair and track reconditioning activities. This approach requires:

- An increase in formation rebuild activities during the early years of the AU2 period
- Phasing out of track lowering activities
- Reducing the frequency of resurfacing activities
- Maintaining the current level of track reconditioning activities.

SYSTRA Scott Lister assess the Queensland Rail approach is to complete each year:

- 3.000 km of track reconditioning
- 5.9 km of formation rebuild
- Approximately 7.816 km of track lowering
- 432.425 km of resurfacing.

The SYSTRA Scott Lister strategy is based on targeting areas in the first two years of AU2 that require multiple annual resurfacing visits with a "formation rebuild campaign" and also phasing out track lowering as shown in Figure 6.17 below.

It consists of:

- 3.000 km of track reconditioning annually
- 5.9 km of formation rebuild annually
- Additional 14.616 km of formation renewal in the first two years.
- Resurfacing of approximately 223 km annually.

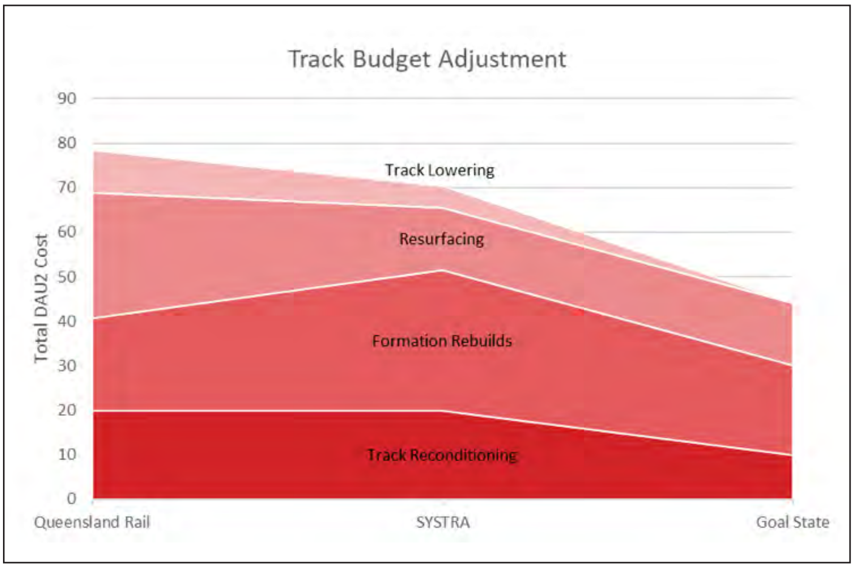


Figure 6.17. Restructuring of track budget to formation rebuild campaign approach ($ 2020/2021 million)

[72]Aurizon Network, FY2018 Maintenance Cost Report, 2018

A comparison of the cost of the two approaches is shown in Table 6.2 below. This table indicates that a potential gain of approximately $ 10m is possible.

Table 6.2. Comparison of Queensland Rail and SYSTRA Scott Lister holistic track strategy costs ($2020-21 million)

Strategy	1	2	3	4	5	Total
Queensland Rail	15.671	15.671	15.671	15.671	15.671	78.357
SYSTRA	16.270	14.439	11.063	10.896	10.729	***63.396***

The SYSTRA Scott Lister formation rebuild strategy is described in detail in Table 6.3 below. The concept of the strategy is to aim to rebuild the formations in the locations that have historically required three or more resurfacings in the first two years of the AU2 period.

Table 6.3 : SYSTRA Scott Lister formation rebuild campaign strategy (km)

	Start	1	2	3	4	5
Track Reconditioning		3.000	3.000	3.000	3.000	3.000
Formation Rebuilds (QR)		[redacted]				
Formation Rebuilds (Extra)		6.336	4.474	3.806	0.000	0.000
Track Lowering		0.000	0.000	0.000	0.000	0.000
Resurfacing X6	0.326	0.000	0.000	0.000	0.000	0.000
Resurfacing X5	2.964	0.000	0.000	0.000	0.000	0.000
Resurfacing X4	3.046	0.000	0.000	0.000	0.000	0.000
Resurfacing X3	12.844	4.474	0.000	0.000	0.000	0.000
Resurfacing X2	62.370	61.920	53.030	40.144	31.344	28.120
Resurfacing X1	116.183	116.183	116.183	116.183	116.183	110.547
Resurfacing X0.5 (New)	0	15.156	28.520	41.406	50.206	59.066
Total resurfacing km		***261***	***237***	***217***	***204***	***196***
Total Cost		***16.270***	***14.439***	***11.063***	***10.896***	***10.729***

The formation rebuild strategy is straightforward; the overall intent is early in the AU2 period, that is the first two years, the formation rebuild allowance has been increased such that all sites that have historically required three or more resurfacings in the previous year have been rebuilt. In more detail:

- In Year 1 of the AU the following sites, totalling 6.336 additional formation rebuild, will be targeted:

  - 0.326 km of sites that required six resurfacings
  - 2.964 km of sites that required five resurfacings
  - 3.046 km of sites that required five resurfacings.

- In Year 2 of the AU the following sites, totalling 4.474 additional formation rebuild, will be targeted:

  - 4.474 km of sites requiring three resurfacings.

- In Year 3 of the AU the following sites totalling 3.806 km of additional formation rebuilds will be targeted:

  - 3.806 km of sites requiring two resurfacings.

- In Year 4 the West Moreton System should be starting to approach a balanced optimal mix of resurfacings and formation rebuilds.

The formation rebuild strategy provided by SYSTRA Scott Lister is an example only. SYSTRA Scott Lister acknowledges the complexity of this challenge; particularly over the expansive black soils and the nature of development of some of these failure sites. SYSTRA Scott Lister also acknowledges that other methods exist to address these issues such as lime stabilisation, geocells or slotted aggregate filled trench drains perpendicular to the formation.

SYSTRA's intent in raising this issue in this report is to suggest that Queensland Rail should document into the AMP a total cost approach (or total expenditure, sometimes called 'totex') to the formation issues on the West Moreton System. This approach should, in an integrated way, drive the maintenance planning (resurfacing, ballast lowering and drainage maintenance) with proposed capital projects (track reconstruction and formation rebuild). SYSTRA Scott Lister acknowledges that Queensland Rail internal processes may need to be modified for the West Moreton System to arrive at this 'totex' perspective.

SYSTRA Scott Lister assess the scope of works proposed by Queensland Rail of 2,162 km or [redacted] for resurfacing during AU2 is excessive. SYSTRA Scott Lister has based their assessment on the 308 kilometres of resurfacing performed by Queensland Rail in the FY 16/17 period, not the 432 km proposed by Queensland Rail in the 2020 DAU submission. SYSTRA Scott Lister propose that budget be reallocated from maintenance resurfacing into formation rebuilds. As such SYSTRA Scott Lister has reduced the resurfacing budget for all scenarios to [redacted] which equates to approximately 1115 km of resurfacing over the 5 years at approximately [redacted] as estimated in Section 6.3.3.

SYSTRA Scott Lister has removed the budget for track lowering and suggests these sites should be targeted for formation rebuild.

The reduction in the resurfacing and removal of track lowering is part of a formation rebuild campaign. Later in the capital assessment SYSTRA Scott Lister has maintained the Queensland Rail budget for track reconditioning and increased the formation repair budget.

SYSTRA Scott Lister suggests that Queensland Rail should investigate a recommended resurfacing interval be documented in the AMP asset management policy.

6.3.4 STRUCTURES

SYSTRA Scott Lister accept that the timber bridges on the West Moreton System are maintenance intensive. SYSTRA Scott Lister acknowledges Queensland Rail's view that materials and tradespersons skilled in maintenance of these structures are becoming more difficult to source. In cases where SYSTRA Scott Lister has reduced a capital budget for a bridge replacement allowance has been made for the increased maintenance of old components in the maintenance costs.

However SYSTRA Scott Lister assess that the context of the West Morton System on J2C and under a low tonnage scenario from R2J is not approaching capacity and there is the opportunity to rationalise bridge maintenance costs without impacting system capacity through:

- Bridge criticality
- Imposing speed restrictions on bridges
- In some dual track locations concentrating maintenance on one bridge and either decommissioning the other or restricting it to unloaded traffic.

Most of the R2J bridges will potentially become redundant on the commissioning of Inland Rail. Inland Rail is currently scheduled for commissioning in 2024/2025. Even considering some program slippage these bridges are likely to have less than 10 years life and should be managed accordingly to minimise the value of stranded assets on the commissioning of Inland Rail.

The J2C bridges have a longer term horizon with coal tonnages from Yancoal expected to be produced at least to 2038 and possibly beyond. The option of recycling bridge components from R2J after Inland Rail commissioning should feature in Queensland Rail's medium term asset planning.

SYSTRA Scott Lister assesses that the structures maintenance budget should be increased. In the capital section SYSTRA Scott Lister will suggest that some bridges should not be fully replaced, just individual spans with identified defects.

There is a total length of 4,302 m of timber bridge on the West Moreton System. Queensland Rail has requested to replace 1,133 m with new bridges. SYSTRA Scott Lister has assessed that 665 metres should be replaced; this leaves an additional 473 m to be maintained that Queensland Rail has not allowed maintenance for. SYSTRA Scott Lister increased the Queensland Rail allowances o [redacted] for 9.1 mtpa and [redacted] for 2.1 mtpa to [redacted] for 9.1 mtpa and [redacted] for the 2.1 mtpa.

6.3.5 TRACK LOWERING (BALLAST UNDERCUTTING)

Queensland Rail have included an allowance for track lowering in the maintenance submission. In the submission they have explained this work is allocated under "ballast undercutting" as there is no suitable code in EAMS.

Queensland Rail states track lowering is typically performed once excessive ballast depth has been identified as causing track instability, or a deviation in nominal track geometry.

Figure 6.18 depicts a standard track profile in fill. The ballast rests on a capping layer capable of resisting penetration due to its engineered shear properties. The capping layer is a high quality material and in many cases manufactured at a quarry [73]. Beneath this capping layer is the formation which distributes the load onto a wider area of the normally weaker subgrade. The capping layer is sloped, either symmetrically or to one side, to avoid water pooling. This engineered track solution would appear on sections of track that have had modern formation rebuilds; possibly with geogrid and geofabric reinforcement.

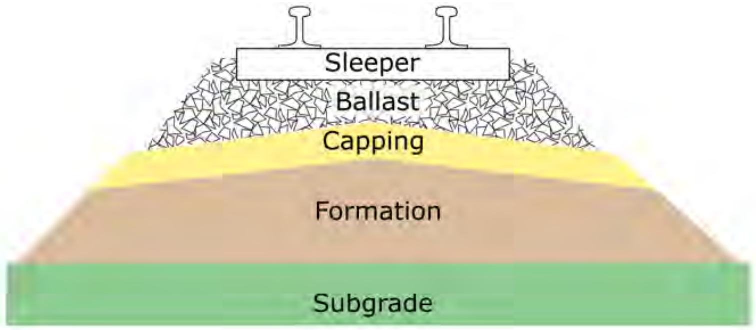


Figure 6.18. Engineered track design

Figure 6.19 depicts a legacy profile with minimal or no capping layer; used in early rail constructions because of engineering, resource or material limitations. Mechanically this design may be suitable for some traffic provided the formation is sufficiently capable of resisting penetration of the ballast and drainage is maintained.

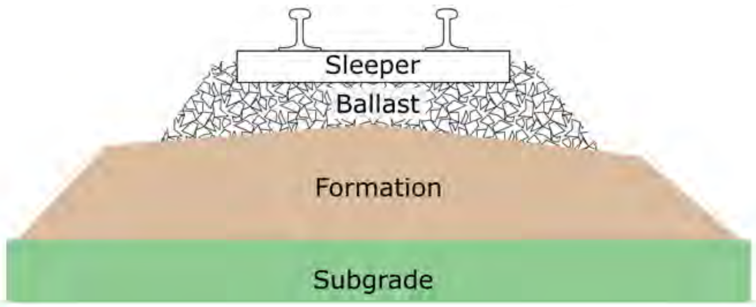


Figure 6.19. Legacy track construction

However, over time and under traffic, subsidence of the formation is likely, the profile on the formation will no longer drain and the ballast will start to mix with the formation. Figure 6.18 illustrates the ballast mixing with the formation. This results in contaminated and weakened ballast; further increasing the rate of track geometry change. During an inspection, the exposed outside edge of the ballast may not appear contaminated and could be measured as excessively deep, triggering a track lowering exercise.

[73] During ballast production the fraction of material below 40 mm nominal diameter can be used as a source material for a well graded suitable capping layer.

The process of track lowering in such a scenario would involve lowering the track onto a shallower bed of ballast. In the case illustrated in Figure 6.20, potentially the uncontaminated ballast would be removed, and the track laid on a contaminated mixture of ballast and formation material. This would exacerbate the defect, and require additional intervention within a short period.

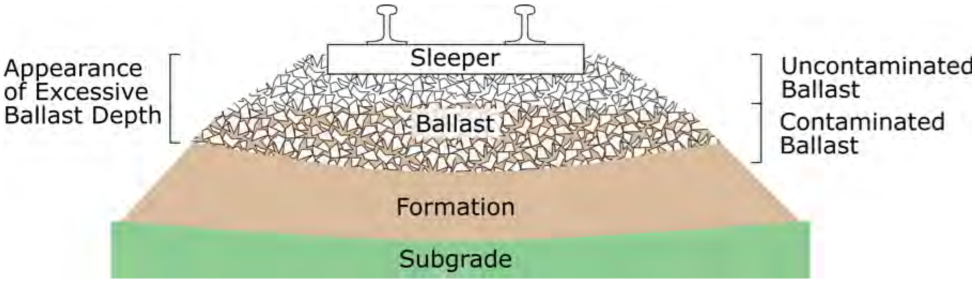


Figure 6.20. Ballast Contamination Due to Weak Formation Strength

This particular failure mode for tracks has been acknowledged by Queensland Rail. In the latest version of the CETS, March 2018, there is a new section 4.6.2 “Ballast depth”:

“The maximum depth of ballast should be limited to 600 mm to ensure track stability. Where the ballast depth exceeds this limit, the Rail Infrastructure Manager shall assess the track condition to identify any wider issues that may be contributing to the excess ballast and determine and implement any required actions to ensure continued safe operations.”

SYSTRA Scott Lister assess the most prudent means of repairing ballast intermixing with formation is the rebuilding of the formation, with a modern engineered design as illustrated in Figure 6.18.

As described earlier SYSTRA Scott Lister has removed the allowance for track lowering in favour of additional formation rebuilds in the capital budget.

6.3.6 TRACKSIDE SYSTEMS

Trackside system maintenance allows for the maintenance of signalling and telecommunications equipment. This is based on inspection, maintenance and "fix on failure" activities. Resources are required to maintain a 24 hour, 7 day a week and 365 day a year coverage. The maintenance of signalling and telecommunications assets is not tonnage dependent.

Assets include:

- Train detection[74]
  - Axle counters
  - Track circuits.
- Monitoring and measuring equipment
  - Dragging Equipment Detectors
  - Wheel Impact Load Detectors
  - Weather monitors
- Level crossing equipment
- Other field equipment
  - Troughing
  - Cables.
- Telecommunications assets.

Figure 6.21. Axle counter

SYSTRA Scott Lister assess the Queensland Rail estimate of $ 7.336 million as a reasonable allowance for the AU2 period for signalling and telecommunication equipment. This assessment is based on an understanding of signalling and maintenance costs for a similar system.

[74] The only axle counters and track circuits systems on the West Moreton System are between Rosewood and Jondaryan.

6.3.7 TRACK INSPECTIONS

THE CETS Module 1 details the following requirements for track inspections:

- Patrol inspections
- General inspections
- Detailed inspections
- Track Recording Car (TRC) inspections
- Rail mounted Non Destructive Testing (NDT)
- Hand held NDT.

Patrol inspections are to be conducted at least every 96 hours.

General inspections include front of train inspections, conducted every 4 months, and an annual engineering inspection.
A detailed inspection includes a walking inspection of straight track every 12 months and curves every 6 months for the interspersed timber/steel sleeper track; for concrete track it must be at least every two years. Yards, points and crossing are to be inspected at least annually.

A TRC run is required at least every six months.

Rail mounted NDT runs are to occur once every 10 million gross tonnes. Under the current tonnages of 6.25 million net tonnes this means approximately annually. Under the 2.1 million net tonne scenario it is approximately once every two years.

SYSTRA Scott Lister was advised by Queensland Rail during the site inspection that track mounted NDT inspections are being conducted approximately every 3 months on the 41 kg/m rail due to the frequency of rail defects

SYSTRA Scott Lister assess the Queensland Rail estimate of $ 6.438 million as a reasonable allowance for the five year AU2 period for track inspections.

6.3.8 RAIL GRINDING

SYSTRA Scott Lister assessed the rail grinding operations of Queensland Rail over the West Moreton System for the FY17/18 period.
SYSTRA Scott Lister found the majority of operations occurring in the R2J section with only minor grinding of some turnouts occurring in the J2C corridor. Figure 6.22 illustrates these works in green.

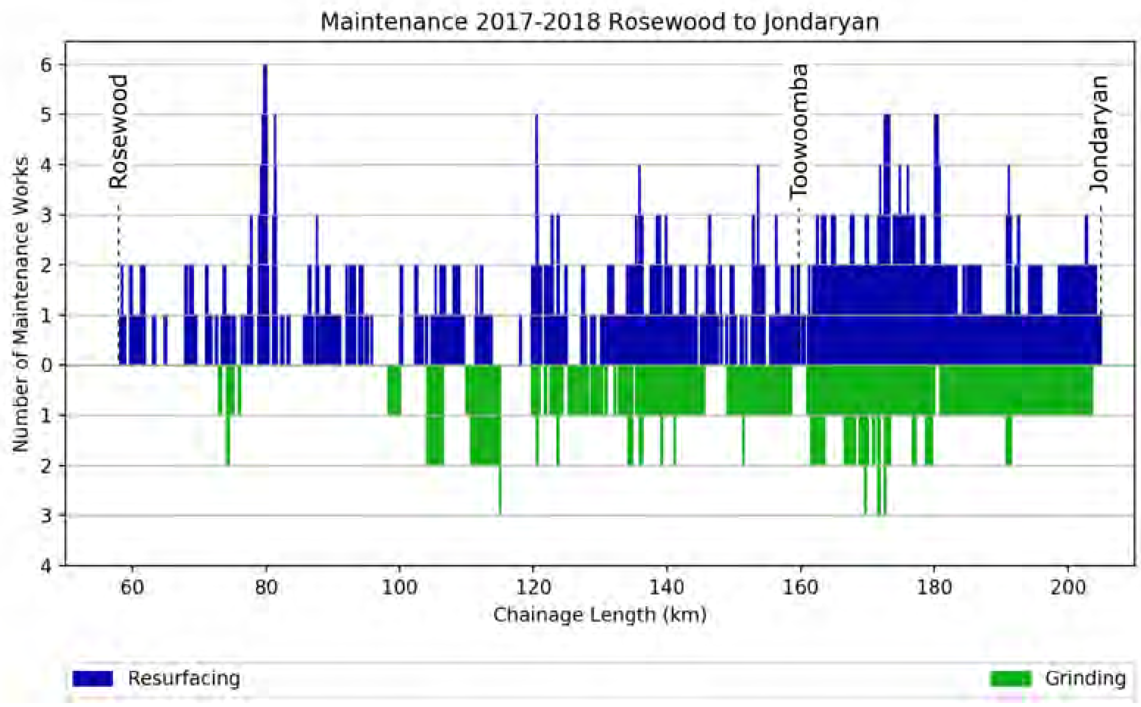


Figure 6.22. Grinding operations by chainage for the R2J corridor FY17/18.

Resurfacing has been included in Figure 6.22 as it was observed that there may be some correlation between the requirement for grinding and resurfacing.

SYSTRA Scott Lister finds under the FY17/18 works the frequency of grinding to occur is above the tonnage requirements described by the CETS, as seen in Table 6.3, given the 6.25mtpa traffic in FY17/18. SYSTRA Scott Lister acknowledges that grinding is required by the CETS should the rail deviate from its nominal profile, which may justify the 2 or 3 repeated grindings of rail in the FY17/18 period. Queensland Rail has not provided evidence of profile defects requiring repeated grindings.

SYSTRA Scott Lister performed a benchmark of the CETS tonnage requirements against international operators, summarised in Table 6.4 below.

Table 6.4. Asset renewal triggers for grinding for a range of heavy haul rail operators

	General	Straight track	Curves
Queensland Rail[75]	No comment	40Mgt	Radii < 2500m: 20Mgt Radii < 1000m: 10Mgt
ARTC[76]	No comment	40Mgt	Radii <900m: 20Mgt Radii <450m: 10Mgt
Scandinavia[77]	No comment	100Mgt (every 3 years)	33Mgt (yearly)
Voest Alpine[78]	Applies to R260 standard rail grade and R350 HT (head hardened)	700m to 1500m curve Standard Carbon - 60 Mgt 350 HT - 180 Mgt	

Queensland Rail CETS appear to prescribe a greater frequency of grinding in comparison to these operators. Given the comparatively lower axle loading of the West Moreton System, SYSTRA Scott Lister suggest Queensland Rail review these tonnage triggers to ensure against premature renewal of the rail; acknowledging that this would require an amendment to CETS.

Given the limited volume of traffic on the J2C corridor, the relatively straight track, and the CETS grinding frequencies given in Table 6.3, SYSTRA Scott Lister concur with Queensland Rail that no, or little grinding will be required on this track during the AU2 period.

SYSTRA Scott Lister assess the scope of works proposed by Queensland Rail of $ 3.798 million for rail grinding is excessive.

Based on CETS guidance of once every 20 Mgt for R2J and once every 40 Mgt for J2C and a rate of $ 4,820/km gives allowances of $ 1.850 million for a 9.1 mtpa scenario and $ 0.570 million for a 2.1 mtpa scenario.

[75] Queensland Rail, Civil Engineering Track Standard – Version 3.1, 2014
[76] ARTC, Rail Grinding Manual for Plain Track – Version 1.1, 2008
[77] Khouy, Et. Al, Evaluation of Track Geometry Maintenance for a Heavy Haul Railroad in Sweden: A Case Study, 2011
[78] Innotrack, Definitive guideline on the use of different rail grades, Voest Alpine, Austria, 2009

6.3.9 OTHER TRACK AND FACILITIES/OTHER

Queensland Rail requires some budget to maintain facilities and miscellaneous assets such as access roads and lubricators.

Although the relative contribution to all defects is quite small for greasers/lubricators, 33 out of 4,069 defects (or 0.81 %), it needs to be viewed in terms of the actual quantity of greasers/lubricators. There are 71 greasers/lubricators on the West Moreton System and they are all in the area of the Toowoomba Range. Replacing the greasers/lubricators will have a positive impact on rail wear, wheel wear and a reduction in maintenance cost.

Figure 6.23 below shows a greaser/lubricator on the Toowoomba Range.

Figure 6.23. Greaser

SYSTRA Scott Lister assesses that the allowance of <u>$ 2.058 million</u> for track other and <u>$ 0.438 million</u> for facilities other is assessed as reasonable for a five year period.

Given that the Toowoomba Range is the system capacity constraint and a high proportion of lubricators are showing defects maintenance costs are to be expected. However, after replacement of these assets maintenance costs should reduce.

6.4 CAPITAL

The total Queensland Rail capital submission for DAU 2 is $ 159.384 m. The Queensland Rail capital submission consists of the components shown below in Figure 6.24.

[redacted]

Figure 6.24. Queensland Rail capital submission for DAU2 ($ 2020-2021 million).

6.4.1 CIVIL CAPITAL WORKS

OVERVIEW

There are three items to be reviewed under civil capital works:

- Timber bridge replacement
- Formation repairs
- Culvert replacement

[redacted]

TIMBER BRIDGE REPLACEMENT

The bridges on the West Moreton system are designed for 12 tal steam locomotive traffic and have been assessed by Queensland Rail as suitable for 15.75 tal traffic.

The submission requests [redacted] for capital work upgrades of the 27 bridges at 21 sites[79].
The bridge renewal work distribution by bridge number and total length across the three corridors is:

- Rosewood to Jondaryan Corridor - 13 bridges - 532 m
- Jondaryan to Columboola Corridor - 14 bridges - 660 m.

SYSTRA Scott Lister reviewed the details of these bridges including their location and defect records. SYSTRA Scott Lister also inspected bridges in the Rosewood and Grantham areas.

A number of points worth noting are:

- The Rosewood to Gowrie Corridor would become duplicate, and potentially redundant if the West Moreton connects into ARTC's Inland Rail project west of the Toowoomba Range.
- The bridge renewals can be grouped into five clusters as shown in Figure 6.25 on the opposite page. These clusters are:
  - Rosewood
  - Sandy Creek
  - Macalister/Brigalow
  - Chinchilla
  - Columboola.

[79] Some sites are double track with separate UP and DOWN bridges to be addressed.

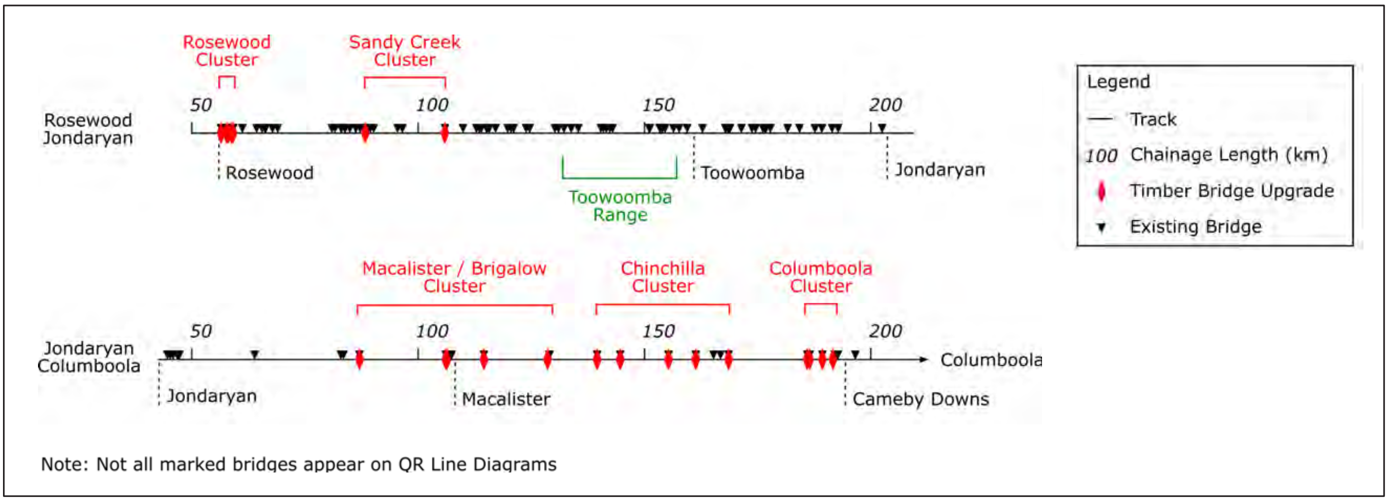


Figure 6.25. Queensland Rail proposed bridge renewal locations and existing bridges.

The supporting case for bridge renewals is inconsistent. There are a number of parts of the submission that indicate that bridges are in reasonable shape and do not require replacement. On the other hand SYSTRA Scott Lister acknowledge that the skills and materials for repairing timber bridges are becoming hard to source and the trigger for a capital replacement as to ongoing maintenance is influenced by this. There is also the wider context impact of the commissioning of Inland Rail sometime within the next ten years as an influencing factor.

The main inconsistency is between the scope of work and the AMP. The scope of work identifies the full replacement of 27 bridges. Queensland Rail's estimated cost of this is [redacted] at a replacement cost of [redacted] a linear metre of bridge. On the one hand the AMP does not support that these bridges require replacement stating:

The current defect situation shows that the bridges in the system are in a reasonable condition for current loading[80].

[80] West Moreton Asset Management Plan 2018-19, p14.

The AMP also includes high level assessments of the condition of the bridges and culverts. This high level assessment is shown in Figure 6.26 below.

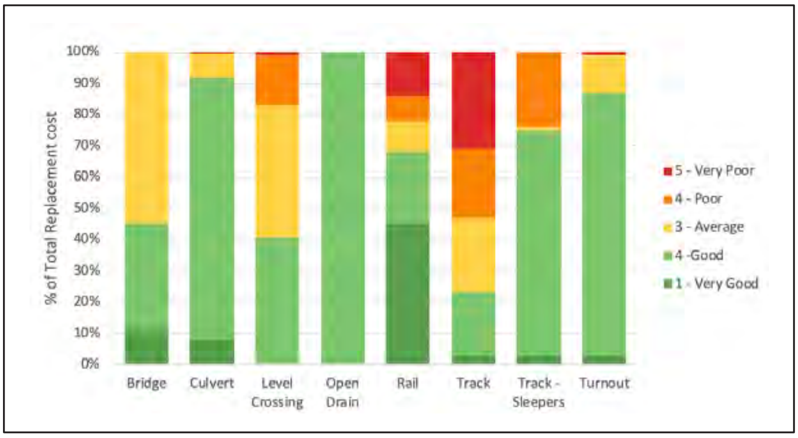


Figure 6.26. High level assessment of West Moreton System civil and track asset condition.

Queensland Rail commissioned AECOM to review some of the bridges on the system. This review recommended further detailed investigation into a selection of bridges. The AMP states:

"The analysis showed that the timber bridges were structurally deficient when assessed against the Australian Standard but have proven to have sufficient capacity to support the existing trains. To allow these bridges to remain in service a performance-based assessment is used which requires that the train loadings do not increase and that a maintenance program is in place to preserve their condition."[81]

It appears the commentary in the AMP does not support a blanket strategy of replacement of the bridges. The Queensland Rail submission and the accompanying GHD prudency review apply a blanket linear rate equating to full replacement of the full lengths of the 27 bridges. SYSTRA Scott Lister believe this approach should be reviewed in the light of four considerations:

- The Civil Engineering Structures Standard (CESS) allows renewal of piles, capsills, piers, and potted piles[82].
- Capital decisions to replace bridges in the R2J corridor must be assessed within the context that this length of track may become redundant in five to ten years upon the commissioning of Inland rail and the consequent diversion of traffic on to Inland Rail.
- Each bridge must be assessed individually as to whether interim expedient repairs can achieve the required life under the required traffic; in this scenario SYSTRA Scott Lister suggest reasonable target life and traffic is:
  - R2J: up to 9.1 mtpa for five to ten years.
  - J2C: up to 2.1 mtpa for up to 20 years.
- The option of slowing traffic over a bridge should be considered in lieu of bridge replacement where possible.

[81] West Moreton Asset Management Plan 2018-19, p14.
[82] Section 2.7 of the CESS

This analysis of individual bridges is in Table 6.5 and 6.6, for R2J and J2C respectively, is below. In these tables 'expedient' refers to repairs short of a full asset replacement. These repairs can be replacement of one or a number of components; or temporary works to make the bridge safe. Photographs of some of the R2J bridges are shown in Figures 6.27, 6.28 and 6.29.

Table 6.5. Bridge renewals in the R2J Corridor

Site	Km	Length (m)	ID	Comments
1	88.45	30.5	BRL_01140	Bridge _01140 has four defects recorded against it. One defect record is a moderate defect with a 90 day action period against it. The other three defects are noted as to be monitored over five years. However these three defects relate to issues with piers and substructure. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**.
2	88.45	30.5	BRL_01141	Bridge_01141 has nine defects recorded against it. Four piers have defects recorded against them and both abutments are defective. The top and line of the track is out of tolerance. Given the extent of substructure defects on this bridge SYSTRA assess that bridge should be **RENEWED**. However, it should be noted that BR_01141 is adjacent to BR_01140 at Sandy Creek and under a low tonnage scenario two crossings may not be required. Queensland Rail should replace one of these two bridges and only repair the other after the high tonnage scenario is confirmed.
3	106.00	79.3	BRL_01147	Bridge_01147 has fourteen defects recorded against it. Eight piers are showing defects and four girders are defective. Top and line is defective. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**.
4	106.00	72.8	BRL_1148	Bridge_01148 has ten defects recorded against it. Four piers are showing defects and six girders are defective. Top and line is defective. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**. However, it should be noted that BR_01148 is adjacent to BR_01147 at Sandy Creek and under a low tonnage scenario two crossings may not be required. Queensland Rail should replace one of these two bridges and only repair the other after the high tonnage scenario is confirmed.
5	56.59	28.0	BRL_01105	Two girders are identified to be replaced. SYSTRA assess that this bridge should have **EXPEDIENT** repairs. Girders from the renewed BR_01140/41 or BR_01147/48 may be recycled on to this bridge.

Table 6.5. Bridge renewals in the R2J Corridor (CTD)

Site	Km	Length (m)	ID	Comments
6	56.59	28.7	BRL_01106	This bridge has a faulty transom and three girders in poor condition. SYSTRA assess that this bridge should have **EXPEDIENT** repairs. A transom and girders from the renewed BR_01140/41 or BR_01147/48 may be recycled on to this bridge.
7	57.83	29.0	BRL_01109	Three piers have defects recorded against them and both abutments are defective. The bridge has active termites. The top and line of the track is out of tolerance. SYSTRA assess this bridge should be **RENEWED**.
8	57.83	29.0	BRL_01110	This bridge has two defective piers, two defective girders and defective top and line. SYSTRA assess that this bridge should have **EXPEDIENT** repairs. Note that with the provision of more detail re the substructure the bridge may require replacing.
9	59.22	58.9	BRL_01115	This bridge has some defective substructure (no detail provided), two defective girders and defective top and line. SYSTRA assess that this bridge should have **EXPEDIENT** repairs
10	58.16	21.9	BRL_01111	This bridge has a damaged transom and corbel and defective top and line. SYSTRA assess that this bridge should have **EXPEDIENT** repairs
11	58.16	21.9	BRL_01112	This bridge has one defective corbel, one defective girder and defective top and line. SYSTRA assess that this bridge should have **EXPEDIENT** repairs
12	58.93	23.7	BRL_01113	This bridge has two girders identified as defective. SYSTRA assess that this bridge should have **EXPEDIENT** repairs
13	58.93	23.7	BRL_01114	This bridge has one girder identified as defective and issues with holding the top and line. SYSTRA assess that this bridge should have **EXPEDIENT** repairs

Figure 6.27. Bridge R2J Superstructure

Figure 6.28. Bridge R2J Superstructure

Figure 6.29. Bridge R2J - Substructure

Table 6.6. Bridge renewals in the J2C Corridor

Item	Km	Length (m)	ID	Comments
14	106.24	20.8	BRL_02386	This bridge has one pile identified to be replaced. SYSTRA assess that this bridge should have **EXPEDIENT** repairs.
15	161.46	4.6	BRL_02408	This bridge is identified as having 4 piles and a girder requiring replacement. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**.
16	168.71	13.5	BRL_02415	This bridge has two girders and one head stock identified to be replaced. SYSTRA assess that this bridge should have **EXPEDIENT** repairs.
17	186.62	4.5	BRL_02422	This bridge has two girders identified to be replaced. SYSTRA assess that this bridge should have **EXPEDIENT** repairs.
18	189.42	13.8	BRL_02423	This bridge has two girders identified to be replaced. SYSTRA assess that this bridge should have **EXPEDIENT** repairs.
19	114.64	91.9	BRL_02390	This bridge requires seven girders replaced, an abutment rebuilt and two headstocks repaired. However it appears that are no major defects in the substructure. SYSTRA assess that this bridge should have **EXPEDIENT** repairs.
20	128.72	46	BRL_02395	This bridge is exhibiting issues with 4 piers. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**.
21	106.48	86	BRL_02387	This bridge is exhibiting issues with 2 piers and has signs of termite damage. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**.

Table 6.6. Bridge renewals in the J2C Corridor (CTD)

Item	Km	Length (m)	ID	Comments
22	144.77	26.3	BRL_02402	This bridge is exhibiting issues with 2 piers and one girder. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**.
23	186.09	26.3	BRL_02421	Three girders are identified to be replace. SYSTRA assess that this bridge should have **EXPEDIENT** repairs.
24	87.17	67.5	BRL_02383	This bridge is exhibiting issues with 3 piers and one girder. SYSTRA assess with this extent of substructure damage this bridge should be **RENEWED**.
25	139.66	54.9	BRL_02399	This bridge is exhibiting issues with 4 girders, one headstock and a tieback. SYSTRA assess the extent of damage combined with replacing the tieback means this bridge should be **RENEWED**.
26	155.42	20.8	BRL_02406	This bridge requires reassessment of a temporary support at one of the piers. SYSTRA assess that this bridge should have **EXPEDIENT** repairs.
27	191.76	183.6	BRL_02425	Seven girders are identified to be replaced. SYSTRA assess that this bridge should have be **RENEWED**.

SYSTRA Scott Lister accept that the Queensland Rail proposed, and GHD endorsed, rate of [redacted] is a reasonable for bridge replacement. SYSTRA Scott Lister also concurs with Queensland Rail in that multiplying this rate by the bridge length is a reasonable approach to obtaining a concept estimate in the absence of any design information. In situations where only one or two spans require replacement SYSTRA Scott Lister has used the Queensland Rail rate multiplied by 6m for a defective span as an allowance.

In the section between Laidley and Helidon, the four Sandy Creek bridges are proposed by Queensland Rail for renewal, the necessity of which SYSTRA Scott Lister concur with. However under the 2.1 mtpa scenario, there may be no requirement to maintain dual track. SYSTRA Scott Lister recommend Queensland Rail investigate the feasibility of reducing costs by renewing a single bridge at each of these two locations and operating a single track with passing loops over these sections.

Figure 6.30 illustrates potential methods for this. Subfigure C depicts the current track configuration, which utilizes dual tracks over two bridges at each of the Sandy Creek crossings. Turnouts could be installed on either side of the single renewed bridge, as is illustrated in subfigure B. Alternatively, as per subfigure A, a large section of track could be closed between Gatton and Helidon. This would produce a single track system with a passing loop at Helidon using the existing infrastructure and a single bridge renewal.

These options may be expanded to create a single track system across both bridges between Laidley and Helidon, further reducing the maintenance cost of track, and removing the renewal cost of two of the four bridges. SYSTRA Scott Lister recommends Queensland Rail assess the operational impact of this approach, which SYSTRA Scott Lister expects only to be feasible under the 2.1 mtpa scenario.

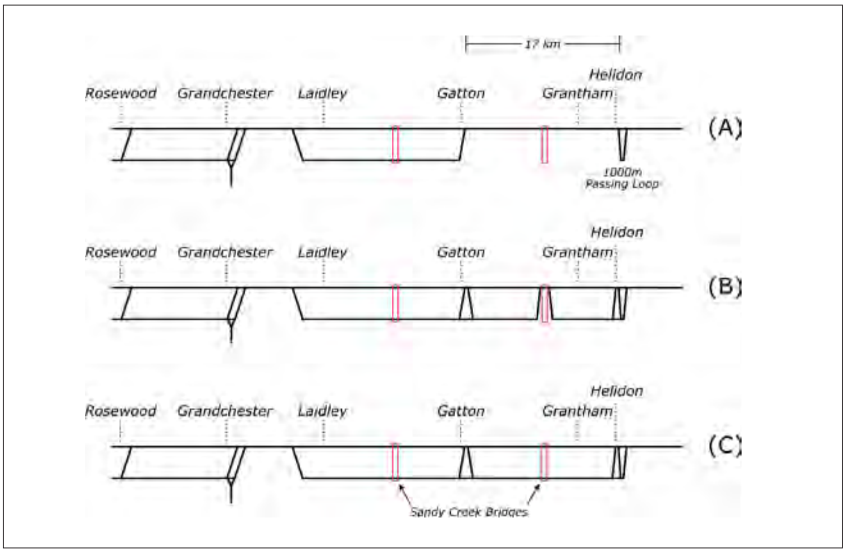


Figure 6.30. Potential bridge and track closures under the 2.1 mtpa scenario.

SYSTRA Scott Lister determine that not all bridges require complete renewal and replacement with concrete bridges. SYSTRA Scott Lister recommends the renewal of these bridges be deferred until there is certainty on the tonnage of traffic, and Inland Rail route.

SYSTRA Scott Lister assess the Queensland Rail submission o [redacted] ***for all scenarios should be reduced to*** [redacted] ***for the 9.1 mtpa scenarios and*** [redacted] ***for the 2.1 mtpa scenario. SYSTRA Scott Lister suggests that Queensland Rail develop contingent strategies to minimise the potential for stranded assets in the event that the Inland Rail or 2.1 mtpa scenarios occur. These strategies could include speed restrictions on bridges or reconfiguring Rosewood to Helidon as single track with passing loops instead of dual track.***

FORMATION REBUILD

Identifying, scoping, and scheduling formation rebuilds can be challenging. It is challenging because many factors contribute to the development of locations requiring formation rebuild including: ground conditions, quality of construction, weather, quality of rolling stock, axle load, total traffic, and speed of traffic. The CETS provides some guidance to Queensland Rail in the form of track categories (CETS Table 9.1), track geometry limits (CETS Table 9.2) and parameter limits for maintenance planning (CETS Table 9.10) which can guide identification of sites for formation repair.

According to CETS Table 9.1 the following track categories apply with both corridors maintaining a 15.75 tonne axle load:
- R2J (9.1mtpa scenario) - > 10 Mgt/a - 80km/hr line speed – Category 7.
- R2J (2.1mtpa scenario) - > 5 Mgt/a - 70km/hr line speed – Category 8.

CETS Table 9.10 provides guidance on maintenance triggers for action to avoid exceeding track geometry limits on a three month horizon. The complication in applying this trigger to the DAU assessment is that the DAU is attempting to quantify formation rebuild requirements five years into the future; clearly the use of the 3 month triggers described in CETS table 9.10 are not adequate for this purpose.

SYSTRA's suggested way forward is based on a number of assumptions:

- The objective is to maintain a steady state of track geometry with no deviations beyond acceptable targets
- The maintenance regime has achieved this to date
- Establishing an interim maintenance trigger can adjusted as required in future to achieve the steady state.

SYSTRA Scott Lister proposes an interim maintenance trigger to apply to the DAU based on the Queensland Rail submission for formation rebuild work. Table 6.7 on the opposite page shows this proposed trigger and also current Queensland Rail CETS limits for top, 3m twist and 10m twist in the CETS. At any point in time the quantity of track assessed as lying between the maintenance trigger and the parameter limit should be a steady state with no occurrences over the parameter limit as detailed in CETS Table 9.2.

Although the Queensland Rail CETS provides a sound framework for managing track geometry, SYSTRA Scott Lister suggest that the Queensland Rail CETS do not provide an adequate framework to assess appropriate scheduling of formation renewals over a five year access undertaking period. SYSTRA Scott Lister suggests an enhancement to the CETS approach by identifying a maintenance trigger for formation renewal and track reconditioning with annual monitoring against this trigger.

Table 6.7. Queensland Rail CETS track geometry limits and SYSTRA's proposed DAU intermediate maintenance trigger.

Track Category	Trigger Description	Track Geometry Parameter Limits		
		Top	3m Twist	10m Twist
7	Action priority 1 day	+/- 31mm	+/- 22mm	+/- 30mm
	Action priority 7 days	+/- 21mm	+/- 19mm	+/- 25 mm
	Parameter limit for maintenance planning 3 months	+/- 14mm	+/- 13mm	+/- 22mm
	SYSTRA suggested interim intervention trigger for DAU period planning (5 years) by using the 10m Twist TCI. The quantity of track exceeding this trigger should be the estimated budget for the DAU period for formation renewal and track reconditioning. ***This quantity of track exceeding this trigger should be checked annually. A decreasing quantity indicates the trigger could be increased. An increasing quantity indicates the trigger needs to be tightened.***			***+/- 8mm***
8	Action priority 1 day	+/- 34mm	+/- 25mm	+/- 30mm
	Action priority 7 day	+/- 24mm	+/- 22mm	+/- 25mm
	Parameter limit for maintenance planning 3 months	+/- 16mm	+/- 15mm	+/- 22mm
	SYSTRA suggested interim intervention trigger for DAU period planning (5 years) by using the 10m Twist TCI. The quantity of track exceeding this trigger should be the estimated budget for the DAU period for formation renewal and track reconditioning.			***+/- 8mm***

Although SYSTRA's suggested triggers appear low compared to the triggers for three month action they align with the current TCI results and proposed formation rebuild and track reconstruction scope.

There is currently limited evidence to support whether these are the right triggers. SYSTRA Scott Lister suggest adopting these as an interim trigger and, on a yearly basis, monitor the change in percentage of the track recording TCI greater than these triggers. If the percentage of track exceeding the trigger is increasing year on year then the trigger is too high; conversely if the quantity is decreasing then the trigger is too low. After a few years a trend should be identifiable and the trigger should be adjusted if required.

SYSTRA Scott Lister tested this approach against the current TCI data and Queensland Rail's submission.

An analysis of the TCI results shows that Queensland Rail is generally maintaining the track geometry of the West Moreton System in accordance with the CETS requirements for Category 7 and 8 track for R2J and J2C respectively.

There are some minor exceedances of 3m and 10m twist parameters that should be investigated by Queensland Rail.

Figure 6.31. Failed formation R2J.

TOP TCI FOR R2J

The distributions of top TCI for the two rails on the R2J corridor are shown in Figure 6.32 below.

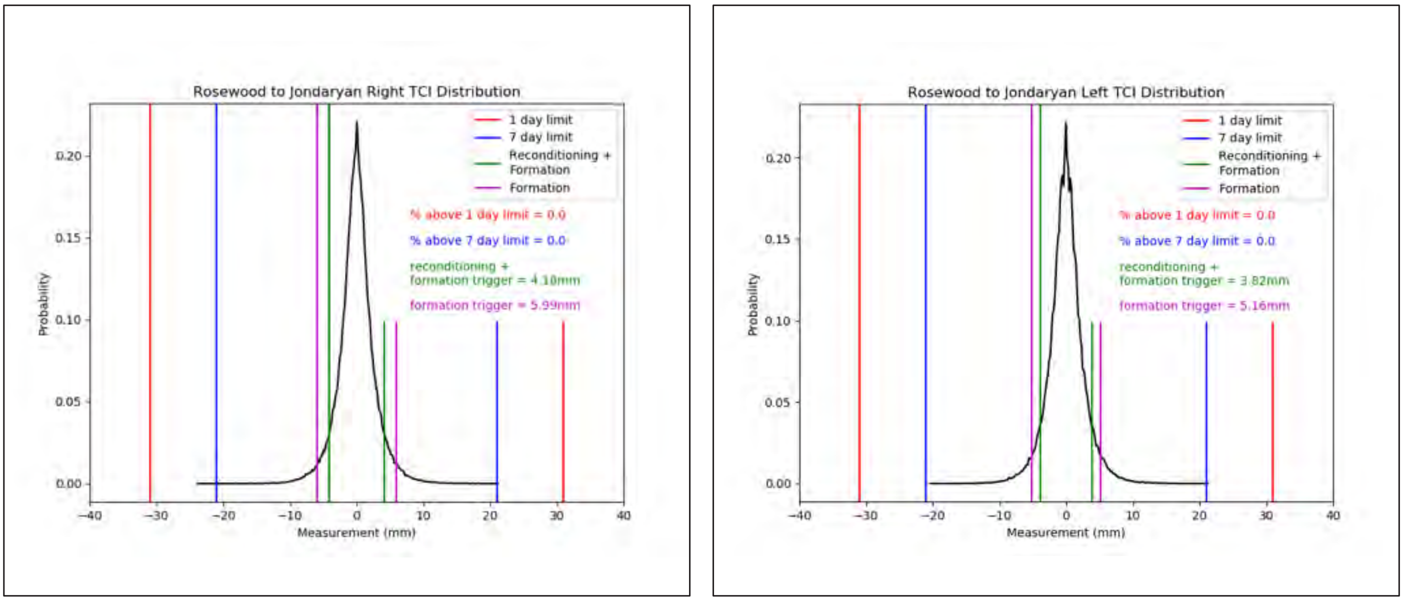


Figure 6.32. Top TCIs for R2J corridor.

Some important things to note about Figure 6.32:

- Left and right is based on facing the direction of increasing chainage (i.e in this case the north rail is the “right” rail).
- There are no exceedances of the CETS limits.
- The TCI’s exhibit a tight normal distribution.
- The quantity of formation renewal proposed by Queensland Rail equates to setting a AU2 5 year period intervention trigger of 5.16mm and 5.99mm.

TOP TCI FOR J2C

The distributions of top TCI for the two rails on the J2C corridor are shown in Figure 6.33 below.

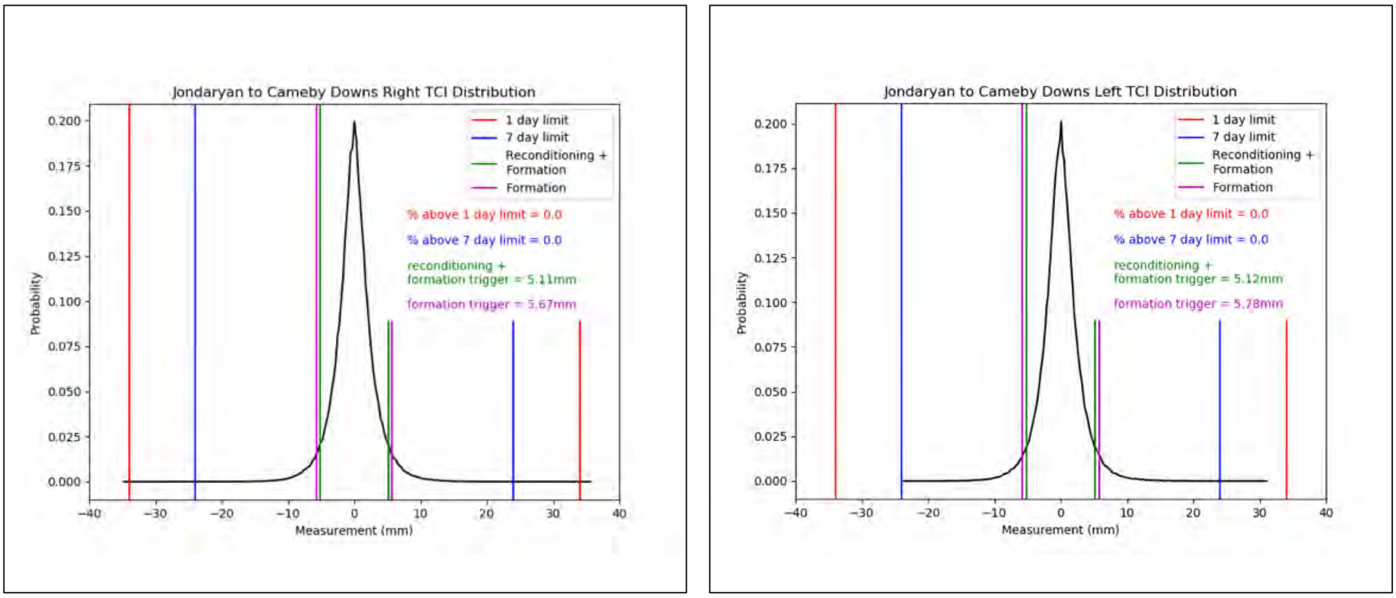


Figure 6.33. Top TCIs for J2C corridor.

Some important things to note about Figure 6.33:

- There are no exceedances of the CETS limits for 1 day response.
- A small exceedance exists in the 7 day response category, approximately 19m.
- The TCI's exhibit a tight normal distribution.
- The quantity of formation renewal proposed by Queensland Rail equates to setting a DAU intervention trigger of 6.24mm and 6.66mm.

3M AND 10M TWIST TCI FOR R2J

The distributions of 3m and 10m Twist TCIs for the track on the R2J corridor are shown in Figure 6.34 below.

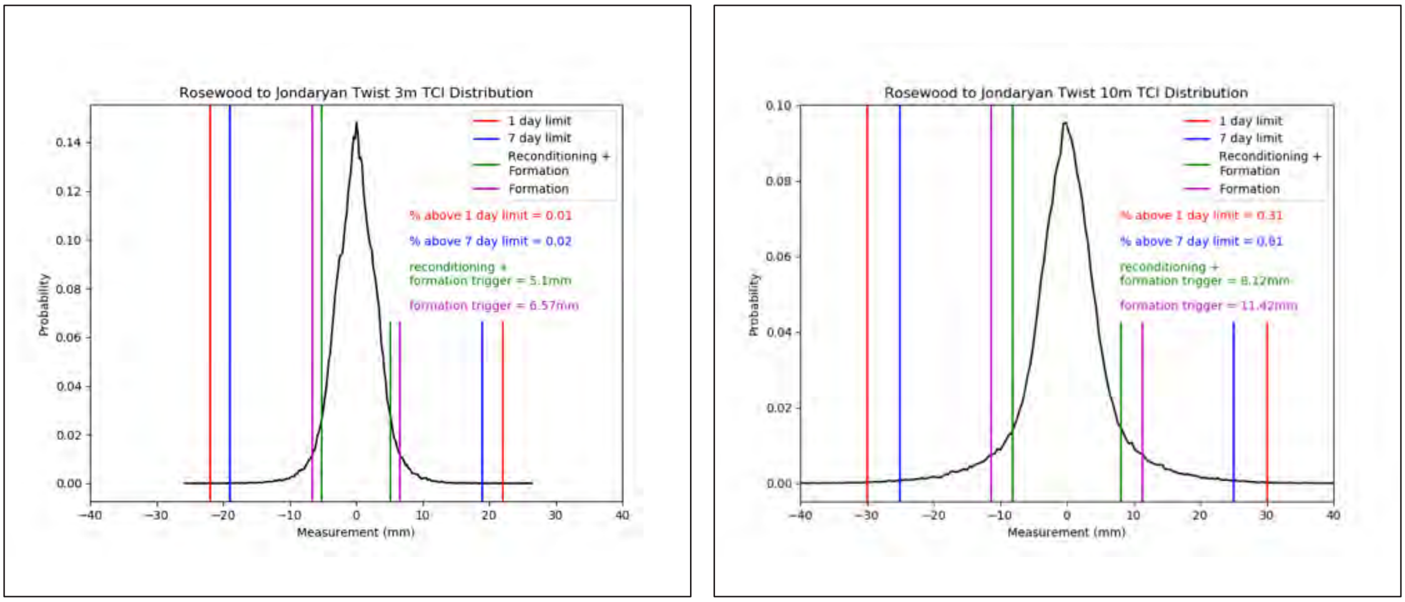


Figure 6.34. Twist TCIs for R2J corridor.

Some important things to note about Figure 6.34:

- 0.31% of the track, approximately 325m, exceeds the CETS limits for a defect for the 10m twist parameter requiring a one day response.
- 0.81% of the track, approximately 849m, exceeds the CETS limits for a defect for the 10m twist parameter requiring a seven day response.
- There are some smaller quantities for track not meeting the 3m Twist parameter, 10 and 39 m for one day and seven day defects respectively.
- The quantity of formation renewal and track reconditioning proposed by Queensland Rail equates to setting a DAU intervention trigger of 5.1mm and 8.12mm for 3m and 10m twist respectively.

SYSTRA Scott Lister propose an intervention trigger of +/- 8mm on the 10m Twist TCI.

3M AND 10M TWIST TCI FOR J2C

The distributions of 3m and 10m Twist TCIs for the track on the C2J corridor are shown in Figure 6.36 below.

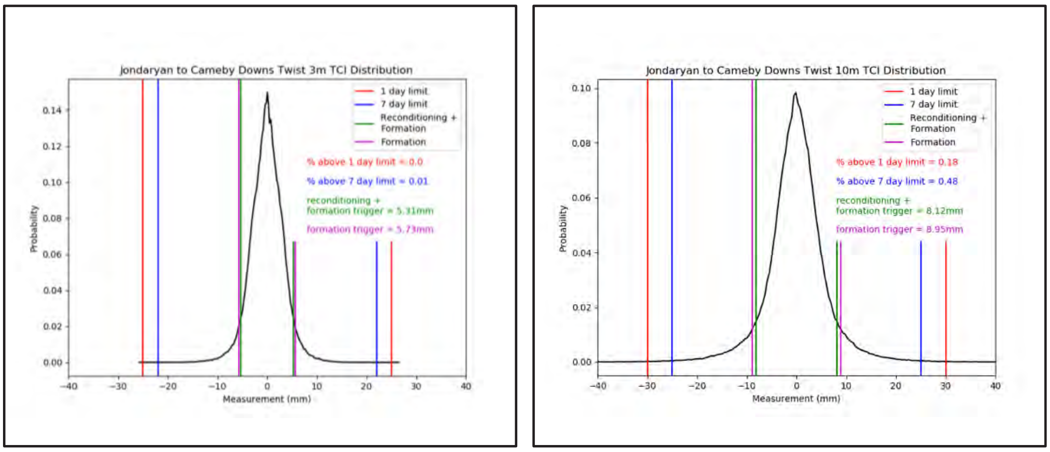


Figure 6.36. Twist TCIs for J2C corridor.

Some important things to note about Figure 6.36:

- 0.04% of the track, approximately 78m, exceeds the CETS limits for a defect for the 10m Twist parameter requiring a one day response.
- 0.13% of the track, approximately 253m, exceeds the CETS limits for a defect for the 10m twist parameter requiring a seven day response.
- The quantity of formation renewal and track reconditioning proposed by Queensland Rail equates to setting a DAU intervention trigger of 5.73mm and 8.95mm for 3m and 10m twist respectively.

SYSTRA Scott Lister propose an intervention trigger of +/- 8mm on the 10m Twist TCI.

SYSTRA Scott Lister acknowledge that addressing formation issues on legacy rail systems through difficult terrain is challenging and requires a balance of theoretical engineering, experience, and trialling options. SYSTRA Scott Lister suggest that Queensland Rail nominate a "trigger" point for intervention based on the 10m twist TCI of 8mm, and that success of the formation renewal and track conditioning programs be monitored through annual tracking of the percentage of track length that exceeds this trigger TCI.

SYSTRA Scott Lister assesses Queensland Rail's requested allowance for formation rebuild and track reconditioning be adopted in DAU2. A trigger of 8mm for the 10m twist parameter equates to the requested Queensland Rail submission for formation rebuild and track conditioning; plus an additional allowance recommended by SYSTRA

SYSTRA Scott Lister assess that there is an impact on track geometry through increased or decreased traffic. However, this impact can be evidenced over a medium to long time frame and is also influenced by a number of factors, including weather, formation design, and drainage. In this context SYSTRA Scott Lister suggest a more effective means of assessing effectiveness of a formation rebuild strategy is to monitor the percentage of track between the trigger point or CETS limit for the 10m twist[83] TCI.

SYSTRA Scott Lister assess that the formation rebuild requirement is impacted by increased or decreased traffic, that it is variable, but monitoring the 10m twist TCI will provide visibility of the impact of this factor as well as other factors. SYSTRA Scott Lister suggest the formation repair budget should be increased from the Queensland Rail submission of $20.725 million to $31.645 million for the 9.1 mtpa scenario.

SYSTRA Scott Lister assesses that the requested budget of $17.760 million for the 2.1 mtpa scenario is reasonable at a concept level but requires further review and value engineering in the event the 2.1 mtpa scenario eventuates. In this scenario there is the opportunity to apply speed restrictions in lieu of formation repairs.

[83] SYSTRA's analysis of the West Moreton TCI data showed that the 10m Twist TCI was the TCI most commonly approaching the CETS track geometry limits.

6.4.2 TRACK CAPITAL WORKS

GENERAL

Track capital works are typically performed at the end of an assets life to reduce maintenance costs, to increase the performance of the railway or to correct the unsafe nature of a group of assets.

TRACK RECONDITIONING

Track reconditioning works are triggered by similar factors as a formation reconstruction. Both types of project are expensive and have operational impacts. However, they are a preferable option to ongoing and frequent resurfacing operations to address a track that fails to hold top and line. SYSTRA Scott Lister detailed a combined approach to formation reconstruction and track reconditioning in Section 6.3.5.

SYSTRA Scott Lister assess that the Queensland Rail proposed scope of works for track reconditioning is reasonable and at locations where multiple resurfacing operations are required annually as a prudent maintenance action. Track reconditioning projects significantly reduce maintenance cost.

RESLEEPERING

SYSTRA Scott Lister concur with Queensland Rail that timber sleepers require periodic replacement at the end of their lives. SYSTRA Scott Lister reviewed the Queensland Rail proposed quantity of resleepering, and found this to produce a mean lifespan for a timber sleeper of approximately 20 years[84]. SYSTRA Scott Lister assess this lifespan to be appropriate, and therefore determine the proposed scope of works to be reasonable.

SYSTRA Scott Lister assess the Queensland Rail proposed scope of works for resleepering is reasonable.

[84] This is based on a sleeper spacing.

LEVEL CROSSING RECONDITIONING

SYSTRA Scott Lister understand the importance of well-constructed and maintained level crossings. However, with the 9.1 mtpa with Inland Rail and 2.1 mtpa scenarios, SYSTRA Scott Lister suggest Queensland Rail review propose budgets from a risk perspective in the context of either a potentially shorter asset life, in the case of Inland Rail, or light traffic, in the case of the 2.1 mtpa scenario.

SYSTRA Scott Lister assess under the different scenarios:

- ***A 9.1 mtpa scenario without Inland Rail requires the full budget requested by Queensland Rail.***
- ***A 9.1 mtpa scenario with Inland Rail may not require all level crossings to be reconditioned during the AU2 period. SYSTRA Scott Lister has reduced the Queensland Rail submission by 50%, reflecting Queensland Rail approaching a risk-based approach to level crossing sites with a limited life on the R2J corridor.***
- ***A 2.1 mtpa scenario may not require all level crossings to be reconditioned during the AU2 period. SYSTRA Scott Lister has reduced the Queensland Rail submission by 50%, reflecting Queensland Rail approaching a risk-based approach to level crossing sites based on the light 2.1 mtpa traffic.***

REPLACING CONCRETE SLEEPERS ON TIGHT RADIUS CURVES

The tight curves of the Toowoomba Range can be demanding on assets. They require a careful balance of rolling stock speed, track system cant, and gauge widening; different rolling stock travelling at different speeds complicate this challenge. Queensland rail have proposed the project for the replacement of these sleepers in both the 9.1mtpa and 2.1mtpa senarios. This project is likely to require refinement in the case of a formal Queensland Rail proposal for the 2.1mtpa scenario, as it is stated in the DAU2 submission, section 6.5.1 as the replacement of these sleepers is only necessary for high coal traffic.

SYSTRA Scott Lister assess under the different scenarios:

- ***Both 9.1 mtpa scenarios requires the full budget requested by Queensland Rail.***
- ***A 2.1 mtpa scenario does not require replacement of these sleepers.***

Figure 6.37. Tight curves on the Toowoomba Range; the tightest curve on the Range has an 88m radius.

GREASERS/LUBRICATOR REPLACEMENT/UPGRADES

Greasers/lubricators are essential to reducing rail wear on the Toowoomba range. SYSTRA Scott Lister reviewed the frequency of defects in the West Moreton System greasers, as appears in Section 6.3.9. SYSTRA Scott Lister assesses the rate of defects in the greasers as high, and considers their replacement prudent.

SYSTRA Scott Lister assess the Queensland Rail proposed scope of works for replacing greasers/lubricators is reasonable under all scenarios.

LEVEL CROSSING TRANSITIONS

Queensland Rail have proposed the same level crossing transition replacement project for the 2.1mtpa and 9.1mtpa scenario. This project would require refinement in the case of a formal Queensland Rail submission for a 2.1mtpa scenario, as it is suggested in their DAU2, section 6.6.1 as work on the level crossing transitions is only required for high coal tonnages.

SYSTRA Scott Lister assess under the different scenarios:

- ***A 9.1 mtpa scenario without Inland Rail requires the full budget requested by Queensland Rail.***
- ***A 9.1 mtpa scenario with Inland Rail may not require all level crossing transitions to be repaired during the AU2 period. SYSTRA Scott Lister has reduced the Queensland Rail submission by 50% reflecting Queensland Rail approaching a risk-based approach to level crossing sites with a limited life on the R2J corridor.***
- ***A 2.1 mtpa scenario does not require reconstructing these level crossing transitions.***

RAIL RENEWAL

Queensland Rail have identified 6.33km of rail to be renewed in the vicinity of Rosewood.

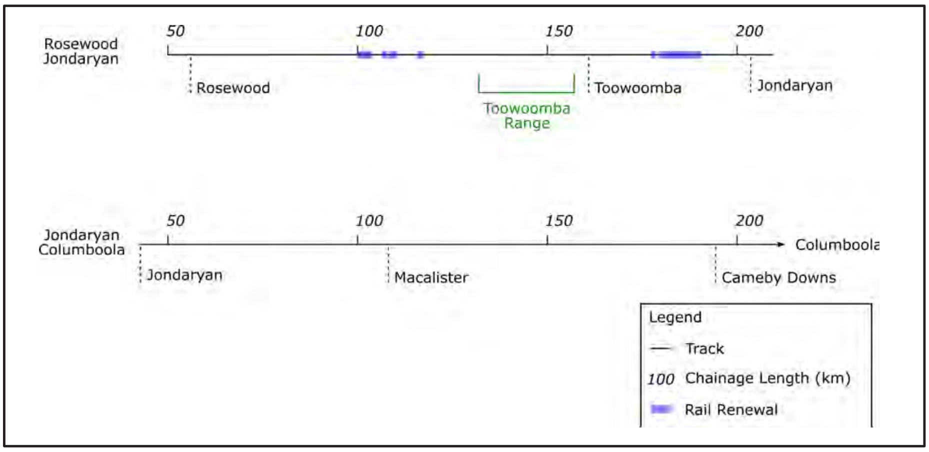


Figure 6.38. Rail renewal locations.

This rail is 41 kg/m rail, some manufactured as early as 1945, on what is currently used as the track for unloaded traffic. The installation date for this particular section of track is unknown. Figure 6.39 shows a site of a proposed rail replacement.

Figure 6.39. Site of proposed rail replacement; rail designed in 1937 and maufactured in 1945.

Rail wear is not approaching CETS limits for 41 kg/m rail and TCIs for this length of track reflect acceptable track geometry.

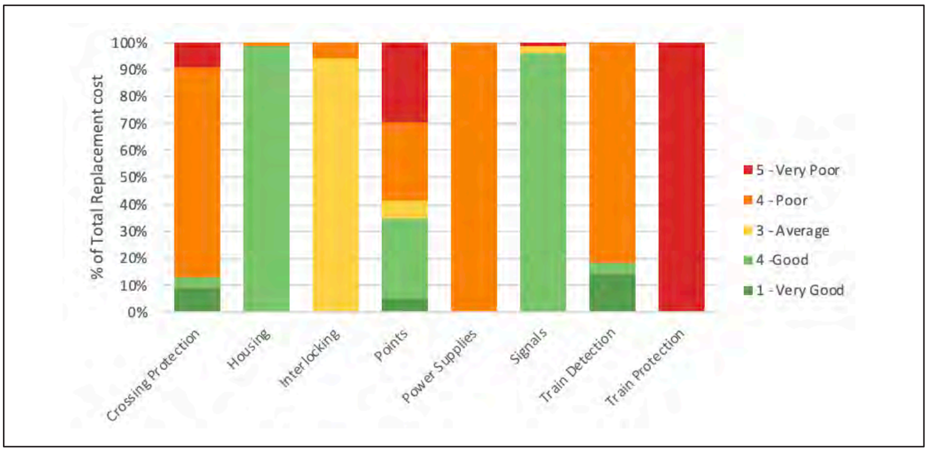
SYSTRA Scott Lister assess under the different scenarios:

- ***A 9.1 mtpa scenario without Inland Rail requires this rail to be replaced***
- ***A 9.1 mtpa scenario with Inland Rail may not require all of this rail to be replaced. SYSTRA Scott Lister has reduced the Queensland Rail submission by 50% reflecting the amount of rail that is scheduled to be replaced in dual track areas and value engineering of other proposed rail replacement areas***
- ***A 2.1 mtpa scenario may not require all of this rail to be replaced. SYSTRA Scott Lister has reduced the Queensland Rail submission by 50% reflecting the amount of rail that is scheduled to be replaced in dual track areas and value engineering of other proposed rail replacement areas.***

6.4.3 SIGNALLING CAPITAL WORKS

Queensland Rail proposed signalling asset renewals primarily on the basis of life expiry of the existing systems. SYSTRA Scott Lister examined each of these capital investments, and made an assessment on the prudency of their renewal or replacement.

Figure 6.40 depicts the condition of existing signalling assets on the West Moreton System.



LEVEL CROSSING SIGNALLING UPGRADE

SYSTRA Scott Lister assess the poor condition of level crossing assets represents a safety risk to the public and train controllers. In addition, a number of the proposed work sites have issues of compliance, and therefore must be renewed.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed upgrading of level crossings is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***A 9.1 mtpa scenario with Inland Rail may not require the full scope. SYSTRA Scott Lister has reduced the Queensland Rail submission by 50% reflecting value engineering of this capital work.***
- ***A 2.1 mtpa scenario with Inland Rail may not require the full scope SYSTRA Scott Lister has reduced the Queensland Rail submission by 50% reflecting value engineering of this capital work.***

MINOR SIGNALLING RENEWALS

SYSTRA Scott Lister assess the removal of asbestos and replacement of track circuits, boom mechanisms, and alternators will result in improved safety of the railway. As such, SYSTRA Scott Lister assess that this is necessary to ensure the ‘as safe as is reasonably practical’ operation of the railway, and is therefore prudent. operation of the railway, and is therefore prudent.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed minor signalling renewals is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***A 9.1 mtpa scenario with Inland Rail may not require the full scope. SYSTRA Scott Lister has reduced the Queensland Rail submission by 50% reflecting value engineering of this capital work.***
- ***A 2.1 mtpa scenario with Inland Rail may not require the full scope SYSTRA Scott Lister has reduced the Queensland Rail submission by 50% reflecting value engineering of this capital work.***

GATTON INTERLOCKING

The replacement of interlockings at Gatton is expected to be duplicated once Inland Rail is completed. Given the current condition assessment of interlockings in Figure 6.40, SYSTRA Scott Lister assesses the renewal of this interlocking is unnecessary for the 2.1 mtpa tonnage scenario, and should be deferred until certainty of Inland Rail is established.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed Gatton interlocking upgrade is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

RELAY INTERLOCKINGS

SYSTRA Scott Lister assess that the need for more modern interlockings is unnecessary for the low volume of traffic in the 2.1mtpa scenario. Additionally, these interlockings are to be duplicate to the infrastructure of Inland Rail.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed relay interlockings upgrade is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

TRAILABLE FACING POINTS DETECTION

SYSTRA Scott Lister assess the requirement for detecting the position of turnouts in DTC areas west of Toowoomba as an important safety feature. Given the majority of track in this area would not be affected by the commission of Inland Rail, SYSTRA Scott Lister assess the proposed scope of works as reasonable.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed trailable facing points detection project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

SIGNALLING POLE ROUTE YARONGMULU-LAIDLEY

Given the importance of signalling circuits and the reasonably short lengths of aerial routes proposed for renewal (1.890km), SYSTRA Scott Lister assess this scope of works as reasonable.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed signalling pole route Yarongmulu-Laidley project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

LOCATION CASE RENEWAL

SYSTRA Scott Lister assess the replacement of damaged signalling boxes as necessary, as the maintenance cost for these assets would likely be comparable, with added risk of damage to internal components. SYSTRA Scott Lister concurs with the need for additional barriers to prevent repeats of the damage.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed location case renewal project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

RANGEVIEW SER/PER UPGRADE

SYSTRA Scott Lister assess the replacement of signalling and power equipment rooms is excessive under the low traffic of the 2.1 mtpa scenario. Additionally, the renewed station buildings are expected to become duplicate assets with the commissioning of the Inland Rail alignment.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed Rangeview SER/PER upgrade project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

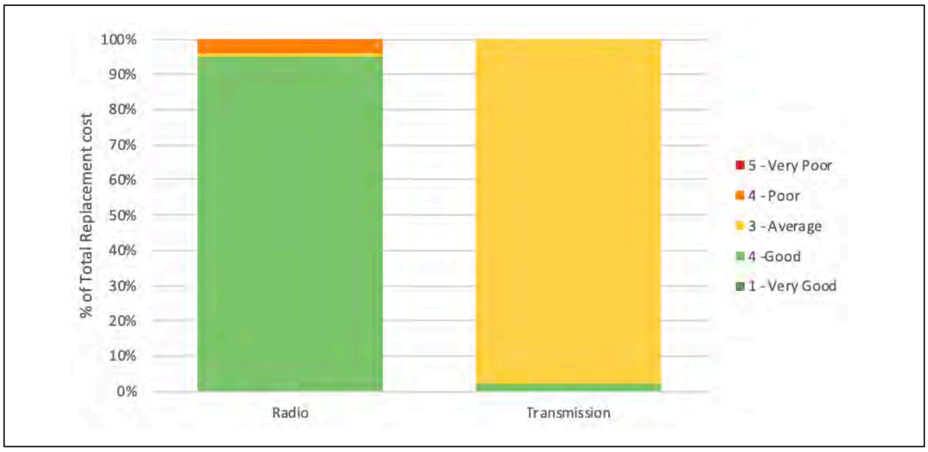
SIGNALLING LED UPGRADE

SYSTRA Scott Lister assess the replacement of incandescent signalling lamps between Rosewood and Jondaryan would become duplicate assets with the commissioning of Inland Rail. Under the low tonnage scenario, the reduced reliability of incandescent lamps is expected to be sufficient for the required operating performance.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed signalling LED upgrade project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

6.4.4 TELECOMMUNICATIONS CAPITAL WORKS

SYSTRA Scott Lister reviewed the prudency of replacing telecommunication assets, whose condition Queensland Rail report in Figure 6.41 below. SYSTRA Scott Lister acknowledge the renewal of telecommunications assets is not only driven by their condition, but also the obsoleteness of their technology given the fast pace of innovation in this sector.



RANGEVIEW FIBRE ROLLOUT

SYSTRA Scott Lister assess the requirement for fibre as reasonable between Rangeview and Toowoomba. SYSTRA Scott Lister suggest, however, that this communication link could become duplicated with Inland Rail likely to roll out its own fibre and Long-Term Evolution radio assets once commissioned. As such, SYSTRA Scott Lister recommend deferring this project until certainty of the Inland Rail alignment is established. SYSTRA Scott Lister assess the requirement for increased communication ability under a lower tonnage scenario is unnecessary, and therefore recommends deferring its rollout under the low tonnage scenario.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed Rangeview fibre rollout project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

RMS ROLLOUT

SYSTRA Scott Lister assess the existing RMS-V1 system is obsolete, and will require renewal in order to interface with future Queensland Rail systems. The majority of the proposed renewal sites would not be duplicated under Inland Rail, and SYSTRA Scott Lister therefore concurs with Queensland Rail's proposal.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed RMS rollout project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

DIGITAL TELEMETRY

SYSTRA Scott Lister assess that while obsolete, the current analogue system manages trains only between Rosewood and Willowburn. This system could become duplicate under the Inland Rail alignment, and therefore should be deferred. SYSTRA Scott Lister assess under the low tonnage scenario the volume of traffic does not warrant the use of more sophisticated systems, and recommends this project be deferred.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed digital telemetry project is reasonable under the 9.1 mtpa scenario without Inland Rail.***
- ***Under the 9.1 mtpa scenario with Inland Rail and 2.1 mtpa scenarios this capital work should be deferred.***

MISCELLANEOUS

The remaining Queensland Rail proposed telecommunications assets are assessed by SYSTRA Scott Lister as being reasonable to ensure the safe operation of the railway. These are all expected to be installed west of Jondaryan, and therefore are unlikely to be made redundant under the Inland Rail alignment. In addition, their use is required for safe operation under all tonnage scenarios.

- ***SYSTRA Scott Lister assess the Queensland Rail proposed miscellaneous works is reasonable under all scenario Inland Rail.***

6.5 OPERATIONS

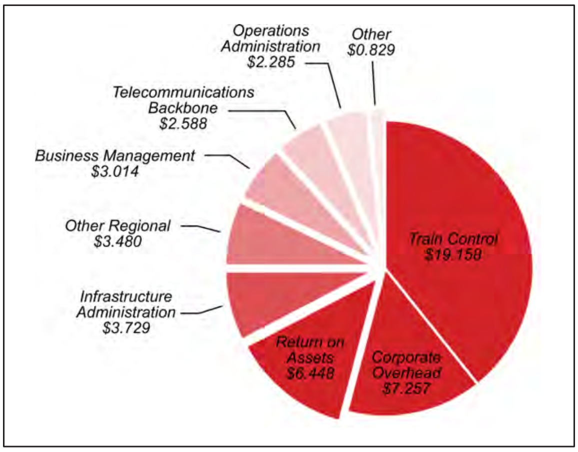


Figure 6.42. Budget breakdown of operational line items.

6.5.1 TRAIN CONTROL

Traffic on the West Moreton System is controlled by Queensland Rail's Supply Chain South Train Control. Traffic must travel from Cameby Downs to the Port of Brisbane and must transit through four controllers:

- Loaded trains depart Cameby Downs for Jondaryan, and Jondaryan for Toowoomba under the control of the Far West NCO. The journey is completed under DTC arrangements; the route is entirely controlled by radio directions from the NCO. The Far West NCO also controls passenger and agricultural traffic that travels beyond Columboola/Cameby Downs.
- Traffic from Toowoomba to Rosewood is controlled by the West NCO. This part of the network is RCS. The traffic here increases with the Acland mine traffic joining at Jondaryan. This NCO also manages the Toowoomba Range track sections
- After departing Rosewood, traffic is passed to the Rail Management Centre (RMC) at Bowen Hills to navigate the urban area. This can take careful coordination to minimise disruption to passenger traffic, particularly during peak hours. Trains that cannot obtain paths through the urban area must hold on the tracks at Tennyson, Darra or Rosewood until a path is available. There are no marshalling yards on the route.
- The final leg of the journey is the coordination of the trains towards an unloader at the port. This is completed by the Port West controller. Port of Brisbane is again DTC signal territory and all train movements are controlled by radio.

Queensland Rail based forecasts for their AU1 submission on reported expenditure. The B&H review for QCA concluded that the "Proposed Operating costs are within a reasonable range with the exception of Train Control which is clearly outside similar network benchmarks."[85] The review also included that an alternative 'bottom up' approach to developing the budget based on workload and required resources might be a more suitable alternative approach[86]. The DAU2 'bottom up' forecast includes 30% on costs and allocation of 40% of the costs of the 10 FTEs employed in Supply Chain South Train Control responsible for Network Planning, possession, and operational planning.

[85]B&H 'Review of the Queensland Rail (QR) West Moreton System Maintenance Costs Capital Costs (CAPEX) Operations Cost Depreciated Optimised Replacement Cost (DORC) for the Queensland Competition Authority, May 2014, page ix.
[86]B&H 'Review of the Queensland Rail (QR) West Moreton System Maintenance Costs Capital Costs (CAPEX) Operations Cost Depreciated Optimised Replacement Cost (DORC) for the Queensland Competition Authority, May 2014, page 53.

The Queensland Rail submission is for $3,498,200 in 2016/2017, or $3.861 million in 2020/2021 escalated at 2.5% per annum. The Queensland Rail DAU2 submission over five years is $19.305 million in 2020/2021.

This estimate is shown in Table 6.8 below:

Table 6.8. Queensland Rail submission for train control for DAU2.

Resources	Number	$ million Cost(per annum)	On-costs	$ million Totals (per annum)
[redacted]				
TOTAL/ANNUM ($ million 2016/2017)				3.498
TOTAL/ANNUM ($ million 2020/2021)				3.861
TOTAL FOR THE FIVE YEAR AU2 PERIOD ($ million 2020/2021)				19.305

As shown in Figure 6.39 and Table 6.8 above, the DAU2 submission includes $19.305 million for train control operating costs. This is a 58% increase to those approved by the QCA for the AU1 period (based on $2020-21). The Queensland Rail Below Rail Financial Statements reported $3.573 million annual expenditure in 2016/17 for train control [87].

[87] Queensland Rail's Draft Access Undertaking 2 (DAU2) Explanatory Document, 14 August 2018, page 38.

SYSTRA Scott Lister reviewed train control costs and inspected the Supply Chain South Control Centre. SYSTRA Scott Lister assessed three scenarios:

- 9.1 mtpa without Inland Rail - 93 paths per week.
- 9.1 mtpa with Inland Rail - 93 paths per week.
- 2.1 mtpa - 21 paths per week.

SYSTRA Scott Lister found the two 9.1 mtpa scenarios required the same train control resources. SYSTRA Scott Lister estimates $3,443,700 per annum in 2016/2017, or $3,800,848 in 2020/2021 escalated at 2.5 % per annum. Over five years this equates to $19.004 million in 2020/2021. This estimate is shown in Table 6.9 below.

Table 6.9. SYSTRA Scott Lister estimate for train control for DAU2 under the two 9.1 mtpa scenarios.

Resources	Number	$ million Cost(per annum)	On-costs	$ million Totals (per annum)
[redacted]				
TOTAL/ANNUM ($ million 2016/2017)				3.444
TOTAL/ANNUM ($ million 2020/2021)				3.801
TOTAL FOR THE FIVE YEAR AU 2 PERIOD ($ million 2020/2021)				19.004

SYSTRA Scott Lister did not analyse a scenario involving a relocation of the Supply Chain South train control centre at Rail Centre 1 to the Rail Management Centre at Mayne Yard with a view to reducing cost. SYSTRA Scott Lister recommends that this may be an option for Queensland Rail subject to wider strategic consideration.

[88]This allows for coverage of 24/7 on a 5 day on 2 day off roster plus a 20% Relief Pool. This roster would require mainly full time staff but also some casual. This also allows for a 20% relief pool.
[89]It takes 6 months to train an NCO. Two are trained each year. SYSTRA Scott Lister has assumed 50% of this cost should be covered by the West Moreton System.

SYSTRA Scott Lister reviewed the current operational setup and how it may apply to 2.1mtpa scenario with only 21 trains a week from Cameby Downs to Rosewood. SYSTRA Scott Lister found that for the 2.1 mtpa NCO resources are the same; mainly due to the distances involved and the DTC nature of the Far West NCO operation. However, SYSTRA Scott Lister assess that there is no requirement for 4 network planning FTEs, as two would be sufficient for 21 paths per week. SYSTRA Scott Lister estimates $3,145,900 per annum in 2016/2017, or $3,472,163 in 2020/2021 escalated at 2.5% per annum. Over 5 years this equates to $17.361 million in 2020/2021. This estimate is shown in Table 6.10 below:

Table 6.10. SYSTRA Scott Lister estimate for train control for DAU2 under the 2.1 mtpa scenario.

Resources	Number	$ million Cost(per annum)	On-costs	$ million Totals (per annum)
[redacted]				
TOTAL/ANNUM ($ million 2016/2017)				3.146
TOTAL/ANNUM ($ million 2020/2021)				3.472
TOTAL FOR THE FIVE YEAR AU 2 PERIOD ($ million 2020/2021)				17.361

[90] This allows for coverage of 24/7 on a 5 day on 2 day off roster plus a 20% Relief Pool. This roster would require mainly full time staff but also some casual.

In SYSTRA's view this train control requirement for such a small tonnage is excessive and suggest that for a tonnage this low Queensland Rail needs to rethink its strategy for train control to reduce the West Moreton System costs. Under this scenario there can be as few as three coal trains per day on the West Moreton System.

An option worth considering is co-locating the Supply Chain South with the Rail Management Centre at Mayne and incorporating the RCS train control system out to Rosewood into the Queensland Rail urban operation.
This revised operation could look like the scenario in Table 6.11 below.

Table 6.11. SYSTRA Scott Lister estimate for train control for DAU2 under the 2.1mtpa scenario operating from RMC.

Resources	Number	$ million Cost(per annum)	On-costs	$ million Totals (per annum)
[redacted]				
TOTAL/ANNUM ($ million 2016/2017)				2.371
TOTAL/ANNUM ($ million 2020/2021)				2.617
TOTAL FOR THE FIVE YEAR AU 2 PERIOD ($ million 2020/2021)				13.085

The scenario described in Table 6.11 would require a capital commitment to enable the move. Assuming a $5 million relocation cost at 5% cost of capital this means the impact would be approximately $1.25 million over the AU2 period, giving a total of approximately $15 million for train control under this approach.

[91] This allows for coverage of 24 hours, 7 days a week, and all year on a 5 day on 2 day off roster plus a 20% Relief Pool. This roster would require mainly full time staff but also some casual.

6.5.2 OTHER ITEMS

The Queensland Rail submission includes allowances for “on costs”:

- Corporate overhead
- Return on assets
- Infrastructure administration
- Office regional
- Business management
- Other items.

It is reasonable to expect these costs to be a percentage of the direct costs of completing works. The percentage of these costs in comparison to the cost of capital, maintenance and train control in the QR submission is:

- Cost of maintenance - $140.921m
- Capital expenditure - $159.384m
- Cost of train control - $19.158m
- Total for maintenance, capital and train control - $319.463m
- On costs - $29.560m
- On cost percentage - 9.25%.

Evans & Peck completed a study in 2009 (extract included in Table 6.12 below) which indicates that a percentage of 9.25% is a reasonable percentage for on costs.

Table 6.12. SYSTRA Scott Lister breakdown of oncost percentages.

Activity	Roads and Transport
Master planning	0 to 2%
Project management and contract administration	4 to 7%
Environmental	0 to 1%
TOTAL	4 to 10%

Based on this analysis SYSTRA Scott Lister will apply a percentage of 9.25% to the other scenarios. This is shown in Table 6.13 below.

Table 6.13. Extract from unpublished QCA report on On-costs and Contingency.

Item	2.1 mtpa	9.1 mtpa (with Inland Rail)	9.1 mtpa
Total Maintenance	87.430	117.996	117.996
Total Capital	91.275	115.345	155.465
Train Control	17.361	19.004	19.004
TOTAL Directs	**196.006**	**252.345**	**292.464**
Corporate Overhead	4.452	5.731	6.642
Return on Assets	3.943	5.075	5.882
Infrastructure Administration	2.281	2.936	3.403
Office Regional	2.128	2.739	3.175
Business Management	1.843	2.372	2.749
Telecommunications Backbone	1.583	2.037	2.361
Operations Administration	1.398	1.799	2.085
Other (unallocated)	0.507	0.653	0.757
TOTAL Operational Expenditure	**35.497**	**42.346**	**46.057**
ON COST %	***9.25%***	***9.25%***	***9.25%***

Queensland Competition Authority | West Moreton System

CONCLUSION

7.1 GENERAL

Key figures for the Queensland Rail and SYSTRA Scott Lister budgets appear in tables at the end of this section. Red values in these tables indicate a reduction in the Queensland Rail proposal, while blue numbers denote an increase. Black figures are those in which SYSTRA Scott Lister concur with the Queensland Rail proposal.

7.2 MAINTENANCE

Track Repair
Track repair appears high, however this is due to the legacy nature of the track which leads to relatively high cost expedient maintenance. SYSTRA Scott Lister concur with the scope of works proposed by Queensland Rail, however SYSTRA Scott Lister have better aligned the 2.1 mtpa scenario with the FY16 works using an improved costing model.

Resurfacing
The high resurfacing number is an indication of the poor quality of the formation. SYSTRA Scott Lister recommend a reduction in the scope of resurfacing works, with budget instead allocated to improving the underlying formation.

Structures
SYSTRA Scott Lister has increased the allowance for the repair of timber bridges, given SYSTRA Scott Lister recommends the deferral of replacing several of these.

Track Lowering
SYSTRA Scott Lister suggest that track lowering, as opposed to ballast undercutting, is a last resort type measure to maintain top and line. SYSTRA Scott Lister recommend the phasing out of this practise in favour of track reconstruction or formation rebuild.

Rail Grinding
SYSTRA Scott Lister suggest the frequency of rail grinding in the R2J corridor is excessive to what is prescribed by the CETS.

7.3 CAPITAL

Timber Bridge Renewal
SYSTRA Scott Lister reviewed defect records on bridges identified for replacement. SYSTRA Scott Lister inspected bridges in the Grantham and Rosewood areas. In addition, SYSTRA Scott Lister notes that 13 of the 27 bridges identified for replacement, at an estimated cost of [redacted], are in the R2J Corridor. The probable diversion of this section of track on to the Inland Rail[92] track circa 2024/2025 will render these bridges potentially redundant.

SYSTRA Scott Lister assesses that the bridge replacement program should be reviewed and redirected towards a strategy of expedient repairs to ensure safe operation at minimal cost rather than replacement; with acknowledgement by stakeholders of the operational impact. SYSTRA Scott Lister acknowledges that some locations may require a bridge replacement; however this should be a last resort option supported by an engineering assessment.

Formation Repair and Track Reconditioning
SYSTRA Scott Lister assess the frequency of resurfacing of the track is required is excessive for the West Moreton System. In addition, SYSTRA Scott Lister analysed top and twist track geometry indicators and determined that Queensland Rail's planned formation repair scope of works should be increased. SYSTRA Scott Lister assess this increase will address areas of poor track condition which require multiple resurfacing anually.

Culvert Replacement
SYSTRA Scott Lister assess that Queensland Rail should consider extending the life of these culverts until certainty of Inland Rail and traffic volume is established.

Track Capital Works
The largest track capital works in the submission is track reconditioning. SYSTRA Scott Lister assess the prudency of these works is necessary to repair formation on frequently resurfaced track sections.

Sleeper Replacement
Proposed sleeper replacement is consistent with a 20 year timber sleeper life on a 1:2 mixed steel and timber sleeper track. SYSTRA Scott Lister assesses that Queensland Rail's sleeper replacement submission is reasonable.

Re-railing
The re-railing scope represents replacement of 1.4 km/year of rail on the R2J corridor. There is no rail replacement planned for the J2C corridor. SYSTRA Scott Lister reviewed rail wear data. SYSTRA Scott Lister assesses that Queensland Rail's rail replacement submission is reasonable for the 9.1mtpa scenario without Inland Rail, however, should be reduced by 50% for safety critical rail only for the low tonnage 2.1 mtpa scenario and the scenario where Inland Rail will be operational in the medium term.

[92] The Inland Rail business case identifies coal from the Surat and Clarence- Moreton Basins as the second largest contributor to Inland Rail traffic (Inland Rail Programme Business Case, p130, ARTC/PwC, 2015).

Queensland Rail proposes major works on level crossings in the AU2 period. It is split over three expenditure elements in the submission for a total value of $18 million. These components are:

- Track - Level crossings reconditioning
- Track - Level crossing transitions
- Signals - Level Crossing upgrades

[redacted]

SYSTRA Scott Lister suggest that these elements should be treated as one program of works. SYSTRA Scott Lister assess that these works appear reasonable as level crossings are high-risk infrastructure, with exception for level crossing transitions, which are unnecessary under the 2.1 mtpa scenario.

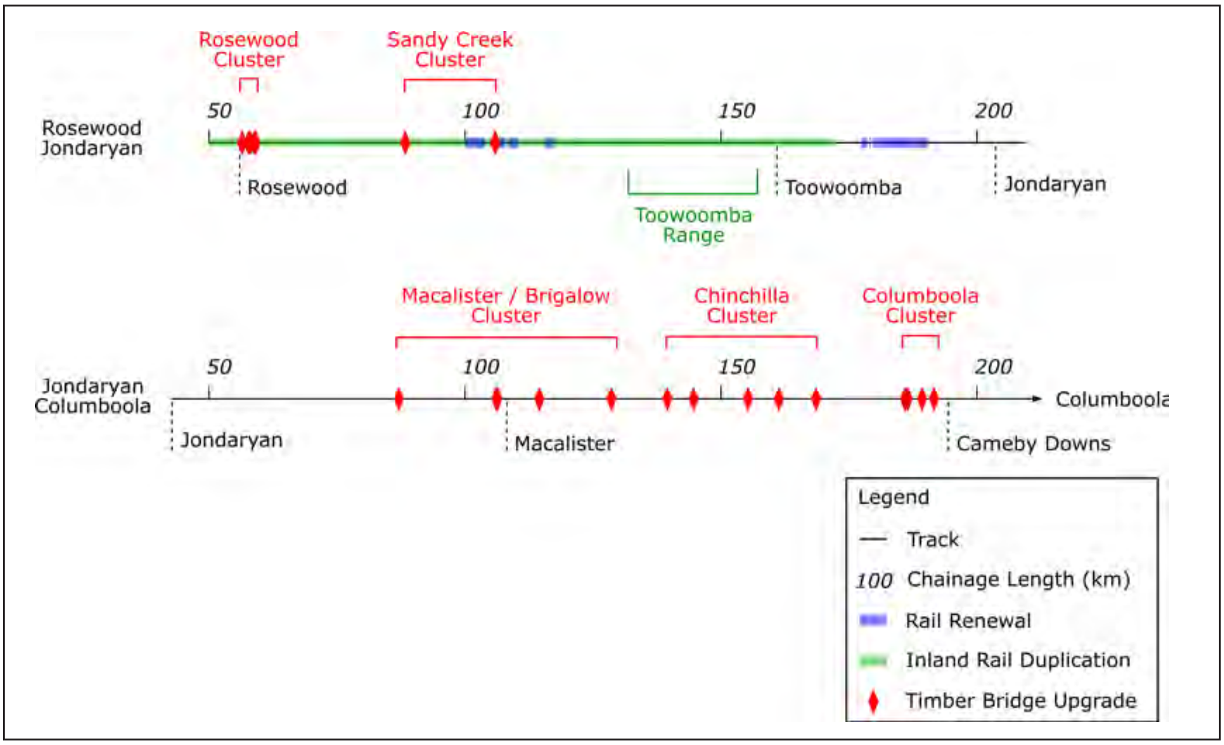


Figure 7.1. Summary of Key Capital Projects.

7.4 OPERATIONS

SYSTRA Scott Lister find the train control expenditure to be reasonable for the 9.1 mtpa scenario. However, SYSTRA Scott Lister suggest a reduction in allowance for the lower tonnage scenario.

SYSTRA Scott Lister assess the administration and overhead costs be reduced for the 2.1 mtpa scenario to remain in proportion to the scope of works performed on the railway.

7.5 SUMMARY

Type	Line	Item	Queensland Rail		SYSTRA Assessment			
			2.1	9.1	2.1	9.1 (with Inland Rail)	9.1 (no Inland Rail)	Comments
Maintenance	1	Track Repair	$47.788	$65.226	*$37.958*	***$65.226***	***$65.226***	• Scope of work performed in 2016 reasonable. • Projection to 9.1 mtpa and 2.1 mtpa found to be flawed. • SYSTRA estimates these costs using a more accurate model.
	2	Resurfacing	$15.568	$28.143	*$14.774*	*$14.774*	*$14.774*	• SYSTRA finds Queensland Rail's submission for resurfacing excessive. It equates to 2,162km of resurfacing over the AU2 period. • SYSTRA recommends a campaign of formation rebuilds reducing the resurfacing requirement over the AU2 period to 1115km. SYSTRA has maintained this for the 2.1mtpa scenario as this resurfacing is partly driven by current track condition. • SYSTRA use a rate of $13,016/km in 2020/2021 AUD based on historical performance.
	3	Structures	$11.553	$12.497	*$13.282*	*$14.367*	*$14.367*	• SYSTRA added a pro-rata increase to the maintenance budget based on 473m of the Queensland Rail submission for 1,138m replacement of existing timber bridges being maintained until clarity on the traffic volume and timeline for inland rail is established. Total length of timber bridges on the network is 4,302m.
	4	Track Lowering	$5.148	$9.536	*$0.000*	*$0.000*	*$0.000*	• SYSTRA determines this operation should be recategorized as capital works if used to lower track on either side of tunnels. • If used to stabilize track having excessive ballast depth, SYSTRA considers this work ineffective and should be omitted in favour of formation rebuilds.
	5	Trackside Systems	$7.336	$7.336	***$7.336***	***$7.336***	***$7.336***	• SYSTRA assesses this cost as reasonable.
	6	Track Inspections	$6.319	$6.438	***$6.319***	***$6.438***	***$6.438***	• To remain in line with CETS and CESS requirements. • Assume Queensland Rail is performing these inspections as per these requirements.
	7	Planning and Technical Support	$5.509	$5.509	***$5.509***	***$5.509***	***$5.509***	• SYSTRA assesses this cost as reasonable.
	8	Rail Grinding	$0.978	$3.798	*$0.570*	*$1.850*	*$1.850*	• Grinding estimated based on CETS requirements and applying 20Mgt to R2J and 40Mgt for J2C. • SYSTRA use a rate of $4,820/km in 2020/2021 AUD based on historical performance.
	7	Other Track	$1.244	$2.058	***$1.244***	***$2.058***	***$2.058***	• SYSTRA assesses this cost as reasonable.
	10	Facilities/Other	$0.438	$0.438	***$0.438***	***$0.438***	***$0.438***	• SYSTRA assesses this cost as reasonable.
SUBTOTAL MAINTENANCE			**$101.825**	**$140.921**	*$87.430*	*$117.996*	*$117.996*	

93 SYSTRA assessed based on a $1.798 resurfacing budget and 138,134km between J2C in FY17/18

7.5 SUMMARY

Type	Line	Item	Queensland Rail		SYSTRA Assessment			Comments
			2.1	9.1	2.1	9.1 (with Inland Rail)	9.1 (no Inland Rail)	
[redacted]								

7.5 SUMMARY

Type	Line	Item	Queensland Rail		SYSTRA Assessment			Comments
			2.1	9.1	2.1	9.1 (with Inland Rail)	9.1 (no Inland Rail)	
Operations	36	Train Control	$19.158	$19.158	$17.361	$19.004	$19.004	• SYSTRA assess under the 2.1 mtpa scenario this cost is excessive.
	37	Corporate Overhead	$7.257	$7.257	$4.452	$5.731	$6.642	• Pro-rata based on total of maintenance, capital, and train control.
	38	Return on Assets	$6.448	$6.448	$3.943	$5.075	$5.882	• Pro-rata based on total of maintenance, capital, and train control.
	39	Infrastructure Administration	$3.729	$3.729	$2.281	$2.936	$3.403	• Pro-rata based on total of maintenance, capital, and train control.
	40	Other Regional (allocated)	$3.480	$3.480	$2.128	$2.739	$3.175	• Pro-rata based on total of maintenance, capital, and train control.
	41	Business Management	$3.014	$3.014	$1.843	$2.372	$2.749	• Pro-rata based on total of maintenance, capital, and train control.
	42	Telecommunications Backbone	$2.588	$2.588	$1.583	$2.037	$2.361	• Pro-rata based on total of maintenance, capital, and train control.
	43	Operations Administration	$2.285	$2.285	$1.398	$1.799	$2.085	• Pro-rata based on total of maintenance, capital, and train control.
	44	Other (unallocated)	$0.829	$0.829	$0.507	$0.653	$0.757	• Pro-rata based on total of maintenance, capital, and train control.
SUBTOTAL OPERATIONS			$48.717	$48.717	$35.497	$42.346	$46.057	
TOTAL MAINTENANCE, CAPITAL, AND OPERATIONS BUDGET – DAU2			$295.037	$349.022	$214.202	$275.687	$319.517	

Contact

Any comments or questions in regard to this report should be addressed to:

SYSTRA Scott Lister Scott Lister
15/2 Chifley Square
SYDNEY NSW 2000
Tel: (02) 9229 8100
www.scottlister.com