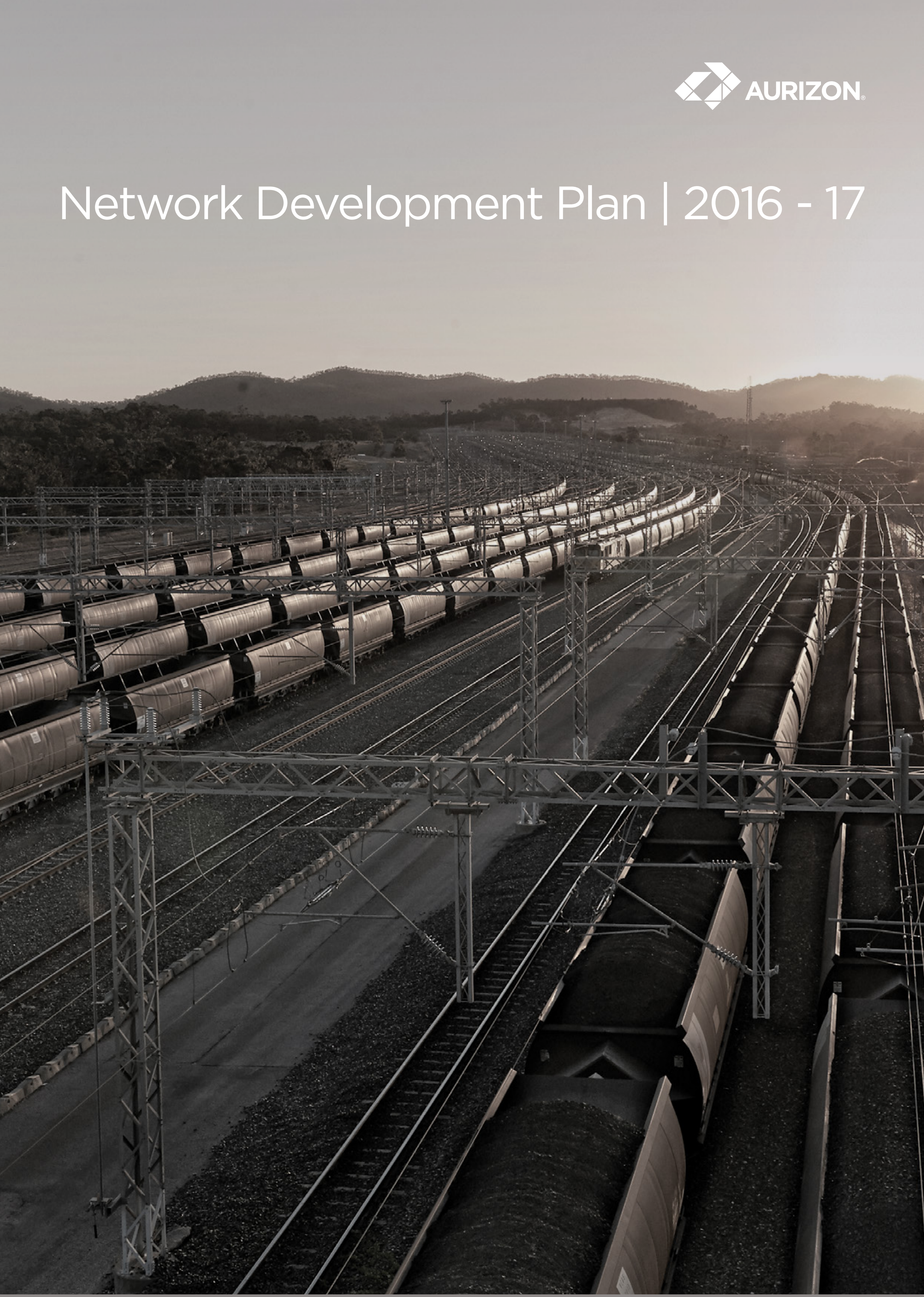
Network Development Plan | 2016 - 17



Manager, Planning & Development message.

Demand for growth in the coal export market during 2016 has continued to be fairly subdued while throughput volumes have remained close to forecast. Towards the end of 2016 we saw a rebound in both metallurgical and thermal coal prices, however, we expect this to stabilise towards the long-term averages during 2017. The scale of future growth projects remains consistent with the previous Network Development Plan (NDP), however, we have revised the timing to more accurately reflect current market growth expectations.

In the past expansion plans have focused on large step increases of 25 – 30 million tonnes per annum (mtpa) driven by the development of additional shiploading infrastructure. Future expansions may be smaller, driven by incremental expansions in existing port facilities. The NDP will continue to focus on identifying the most cost-effective options for expansion pathways, including finding the best means of facilitating these smaller expansions.

The Bowen Basin, together with both the Galilee and Surat basins, remain a potential source of export coal expansion in the Queensland market. Aurizon Network, through the NDP, identifies linking the Galilee and Surat basins to the existing Central Queensland Coal Network (CQCN) as the most cost-effective means of providing for growth, as well as a means to take up latent rail and port capacity. Importantly, these options reduce the initial capital required enabling more measured growth to occur.

Aurizon Network has continued to focus on improved productivity and efficiency in the Central Queensland Coal Network (CQCN) through the development and release of the first edition of the Technical Strategy.

The Technical Strategy is a collaborative process between supply chain participants. It seeks to align above and below rail and identify the conditions where value can be created by progressing the standard of the railway and adopting innovative technical solutions. These solutions will not only identify lower cost opportunities to support growth, they also provide opportunities to reduce the total cost of rail transportation throughout the CQCN. The Technical Strategy has provided input to this edition of the NDP by assessing the implementation of higher axle load capability to the CQCN.

I would welcome any feedback to the Network Development Plan at NDP@aurizon.com.au. I look forward to continuing to develop the Central Queensland Coal Network to meet our customers' needs through both the NDP and the Technical Strategy.

Mike Backhouse
Manager, Planning & Development (Acting), Aurizon Network

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SUPPLY CHAIN CONTEXT

Aurizon Holdings Limited is a leading national provider of rail and road-based freight transport and infrastructure solutions across Australia.

Aurizon Network manages, owns and maintains the 2,670 kilometre Central Queensland Coal Network (CQCN).

Growth is a key strategic pillar for the company, and coal transport in central Queensland is central to its plans and expectations for long-term growth opportunities.

In conjunction with its supply chain customers and partners, Aurizon Network is committed to expanding rail capacity to meet customer demand and to fulfilling its commitments under the 2016 Access Undertaking (UT4). It will actively participate in initiatives to improve supply chain performance for the benefit of all.

The purpose of the Network Development Plan (NDP) is to identify and evaluate options to meet potential future demand. This is intended to provide the basis for concept (and later) studies as and when Access Seekers request additional capacity.

This NDP is the outcome of a proactive assessment and definition of growth scenarios that may satisfy potential future demand for access over the medium and long term.

Aurizon Network believes that the most cost-effective expansion paths lie in planning through a holistic, integrated approach, engaging all parts of the supply chain.

The focus of the NDP is on integrated rail solutions by corridor at pre concept study level. More specific supply chain planning encompassing specific port terminals, mines and above rail operators will be aligned through the concept and pre-feasibility phases of project definition. These activities will be heavily informed by the NDP.

APPROACH

TAKING A SUPPLY CHAIN APPROACH

To create long-term efficiencies across the coal supply chain, Aurizon Network believes a number of actions are required:

- A shift from the single step, project-only approach when planning system expansions.
- Assessing changes to existing operating paradigms and practices involving above and below rail, mines and ports, to efficiently create additional throughput capacity.
- Integrated planning for coal supply chain growth via a strategic collaborative process that considers the key objectives and timeframes of all stakeholders.
- Further investigation and continued implementation of enhancements to existing operating systems that facilitate:
  - higher system velocity
  - higher system availability
  - improved network utilisation.
- Development of new track infrastructure aligned with operational enhancements to meet future volumes.

LOOKING BEYOND THE SHORT TERM

The NDP shifts the planning spectrum well beyond the short-term, incremental approach that has characterised Central Queensland capacity expansions in recent years.

Short-term planning is unlikely to incorporate the building blocks necessary for achieving more efficient states in the medium to long term.

By taking a 10 to 15 year view in the planning phase, developments can be aligned to future higher capacity states with consideration of innovation and future technologies. These can achieve more cost effectiveness and efficiency than have previously resulted through incremental investments.

The NDP provides scenarios over this longer-term view that can guide the short to medium-term pre-feasibility study options.

SUPPORTING COMPETITIVENESS

If cost-effective capacity expansions are adopted, the industry's unit rail transport costs may fall in real terms due to economies of scale, aiding the Queensland coal industry's competitive position.

INVESTIGATING OPTIONS FOR GROWTH

The NDP identifies a range of medium to long-term development options for achieving future higher tonnages across the CQCN.

These high-level options are intended to guide future studies and, as such, are not proposals to be adopted without further analysis and justification.

Options for the major corridors of Newlands, Goonyella, Blackwater and Moura are markedly different as a result of their capacity, condition and varying levels of current development.

Each corridor has been assessed for its uniqueness and potential growth pathways. The options reflect their relative costs at different levels of higher tonnage.

FUTURE CAPACITIES

The high growth outlook for coal exports which was prevalent in the first half of 2012 has waned considerably. The increase in price of metallurgical coal and more recently thermal coal indicates that there may still be requirements for growth, albeit at a more measured pace.

The outlook for Queensland coal exports indicates growth potential remains over the medium to long term.

The NDP evaluates the potential for increased capacity requirements that could be realised in the next 10-15 years at each of the major port precincts.

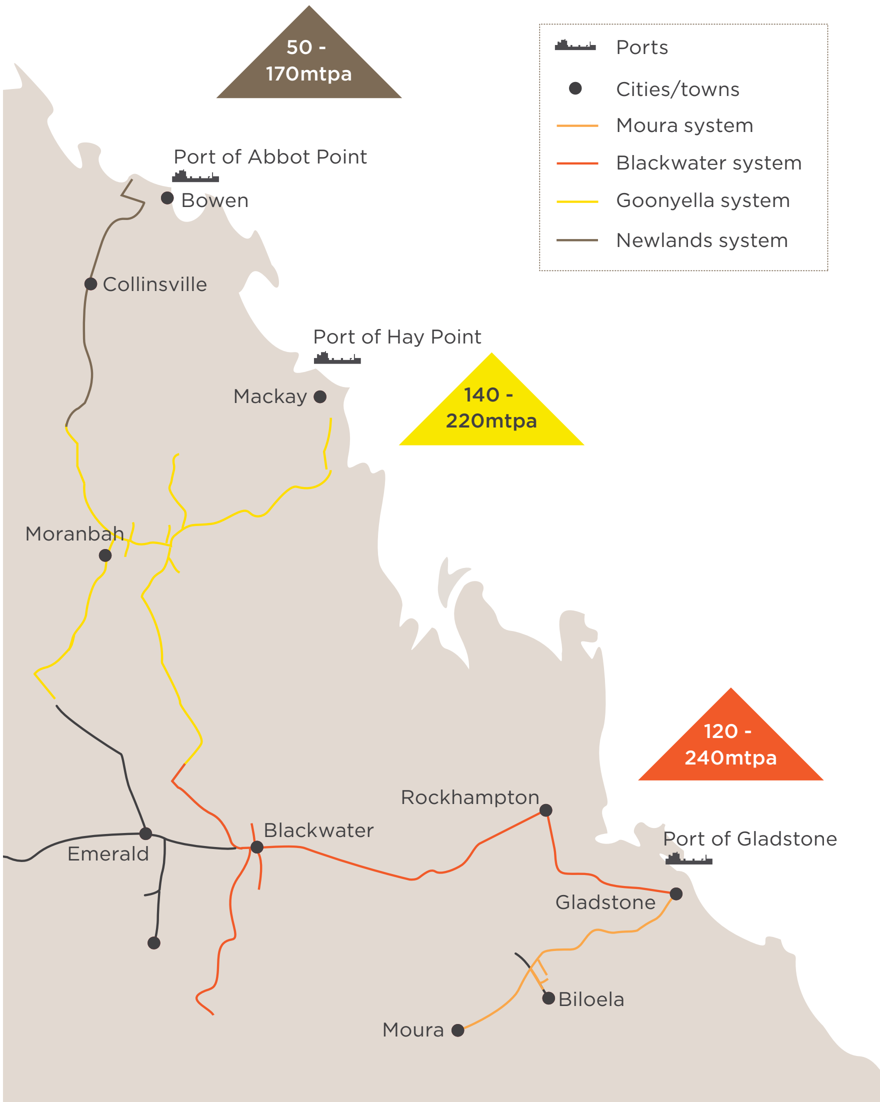
Aurizon Network does not expect all of these demand increases to occur simultaneously, however, the NDP does not attempt to prioritise one corridor over another, so all corridors have been studied with growth over similar timeframes.

POTENTIAL TONNAGES HAVE BEEN ASSUMED AS ILLUSTRATED IN FIGURE 1:

- **Newlands system:** 170mtpa at the Port of Abbot Point.
- **Goonyella system:** 220mtpa at the Port of Hay Point.
- **Blackwater and Moura systems:** 240mtpa at the Port of Gladstone.

As expansions are further defined through the concept and pre-feasibility study phases, in conjunction with mine and port terminal developers, prioritisation may emerge.

Figure 1: Future capacities scenarios



NDP MAPS THE FUTURE OF THE CQCN

EXPANSION PLANNING

The expansion planning process, as described in the 2016 Access Undertaking (UT4), utilises outcomes from the NDP as the basis for studies.

Figure 2 describes the process which commences with an Access Request which includes a Concept Operating Plan.

This Access Request is tested in the CQSCM to determine if there is sufficient network capacity to support the access request. The Central Queensland Supply Chain Model (CQSCM) is operated using the System Operating Parameters (SOP) published on the Aurizon Network website[1], together with the requirements of the COP.

Where there is sufficient capacity (and other access requirements are satisfied), then the Access Request is progressed to negotiation of an Access Agreement.

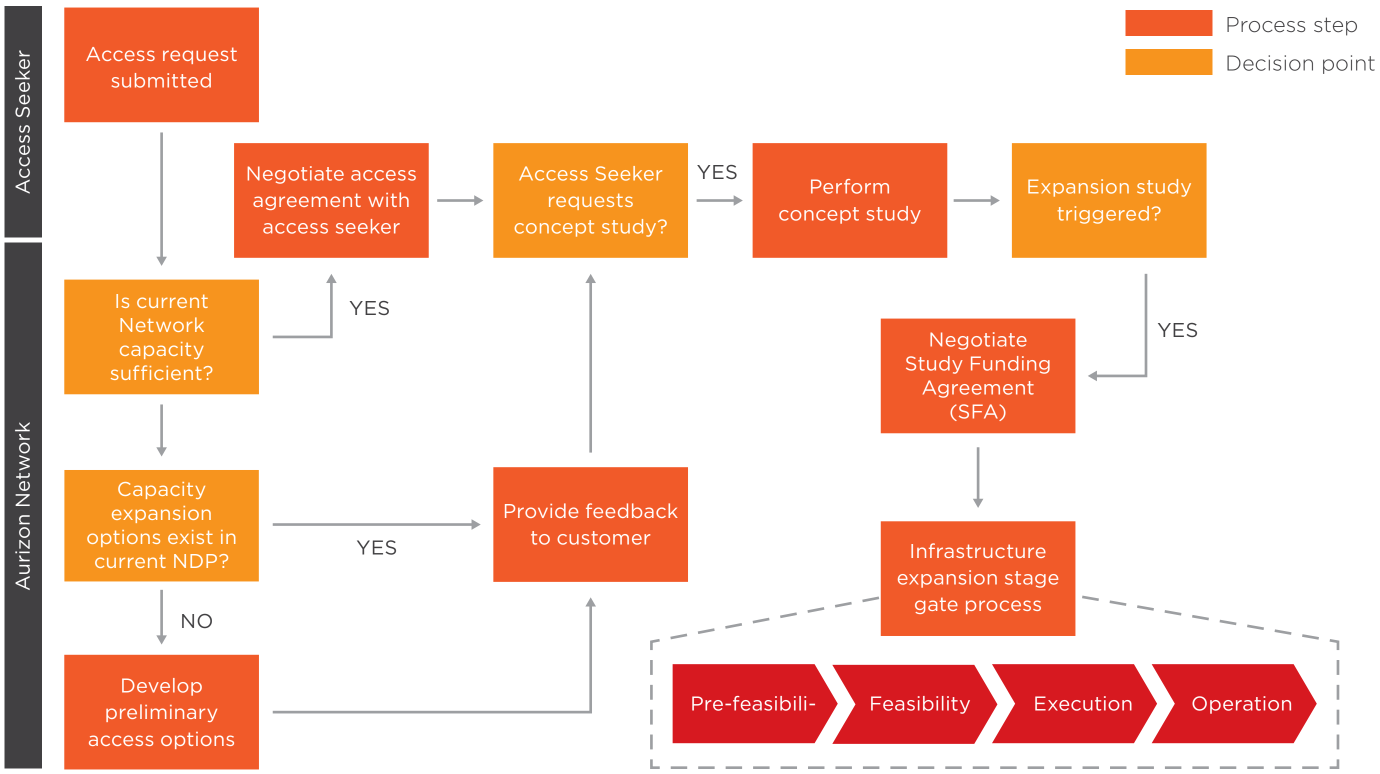
If there is insufficient capacity, then the NDP is reviewed to identify if there are relevant scenarios that have been studied. Where there are, these options are provided to the Access Seeker.

For requests that do not have relevant studies, preliminary options are generated and consulted with the Access Seeker.

Where appropriate, further concept studies are undertaken to meet Aurizon Network Concept Study governance requirements. This stage includes the development of a Concept of Operations (COO) describing how the options would operate.

Where the Access Seeker requests the study to continue to pre-feasibility a Study Funding Agreement (SFA) is implemented to cover the pre-feasibility stage (and further stages when appropriate).

Figure 2: Expansion planning process



1 www.aurizon.com.au/network/development

HOW PLANS ARE MADE

Aurizon Network Planning & Development use a range of planning tools to support inputs to the expansion process through the project lifecycle. To provide greater context to the planning process described previously, an overview of the tools is provided below.

INTEGRATED DEVELOPMENT MODEL (IDM)

The IDM is a tool developed by Aurizon Network to support pre-concept and concept studies. The IDM undertakes a static analysis of each section of the rail network to determine the infrastructure requirements to meet the capacity scenario.

The approach used in the IDM is illustrated in Figure 3.

The analysis is undertaken using input parameters defining:

- Train configuration (various may be tested)
- Availability and utilisation
- Demand requirements
- Existing network

The IDM calculates the headway requirements to meet each demand step and identifies if the existing infrastructure configuration supports the headway. Where demand exceeds capacity, new infrastructure is added such as:

- Adding a passing loop
- Duplicating a section
- Augmenting the signalling

Where train lengths are not supported by the infrastructure, these are identified.

This provides an output of the infrastructure required for each step in demand.

This infrastructure definition is then used to derive the level of congestion across each component of the rail network and applies that to each individual service to determine a cycle time by service, including assumed crew change, provisioning and inspection requirements.

The cycle time defines the rollingstock fleet requirements, which is used to determine the yard requirements based on length of trains and frequency of servicing. The IDM outputs include:

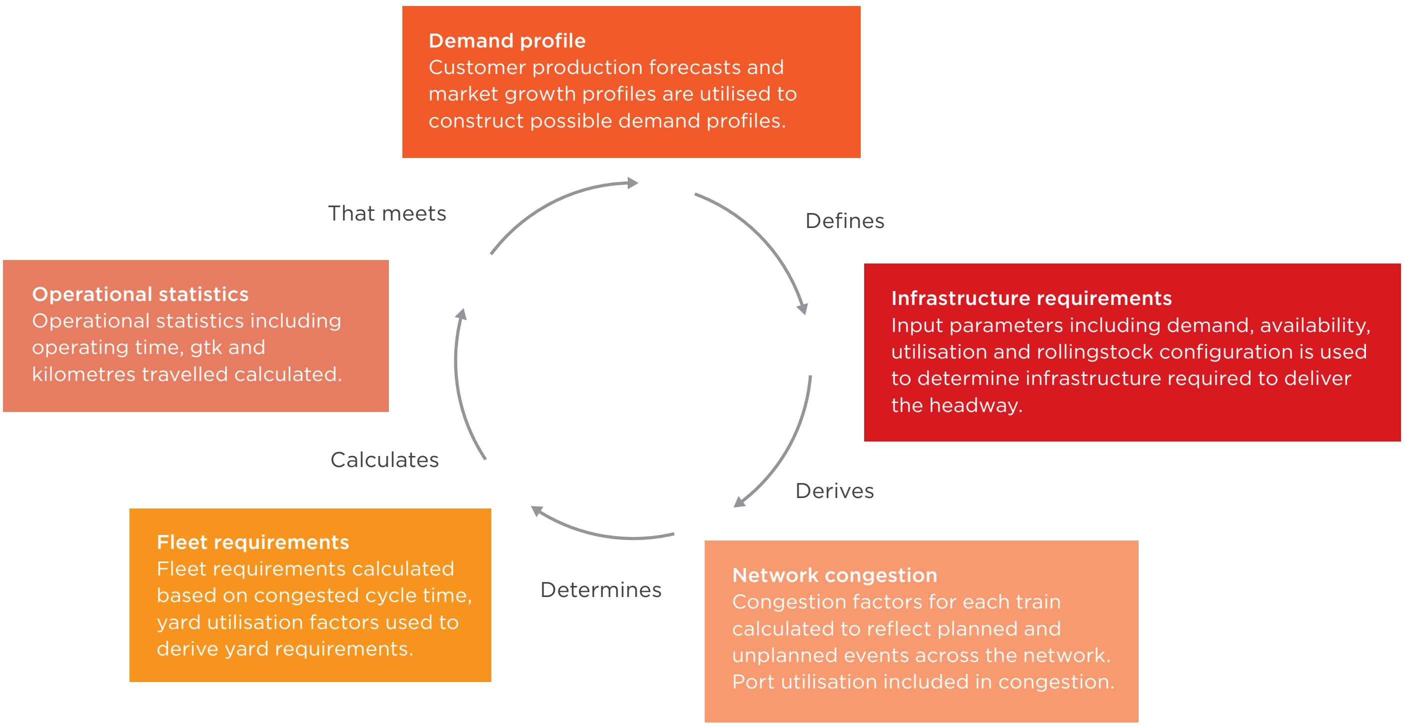
- Operational hours
- Distance travelled
- Net and gross tonne kilometres.

This information is imported into the Cost of Transportation Model (CTM), described below.

The IDM does not identify all infrastructure requirements, such as grade separations, interface requirements (level crossings) and power system upgrades.

These items are identified through more detailed analysis during the concept and pre-feasibility stages of a project.

Figure 3: Integrated Development Model



COST OF TRANSPORTATION MODEL (CTM)

The CTM is used to undertake financial analysis of the cost of transportation using the outputs from the Integrated Development Model.

The Cost of Transportation Model utilises outputs from the IDM to develop a total cost of transportation for each option developed. The primary purpose of the CTM is to provide a means of comparing options on a common basis.

It is built up of 4 cost components:

- Below rail Opex
- Below rail Capex
- Above rail Capex
- Above rail Opex

Each cost component is determined for each year of the analysis period based on the tonnage profile and the resulting output of the IDM.

The CTM then generates a net present cost for each option, allowing a comparison to assess which provides the lowest cost base for the supply chain.

An overview of the relationship with the IDM and the breakdown of the costs is provided in Figure 4.

CENTRAL QUEENSLAND SUPPLY CHAIN MODEL (CQSCM)

The CQSCM is a discrete event dynamic capacity simulation model. It is used where more detailed operating parameters are known including assessing specific access requests.

It simulates the entire CQCN system including the following components defined in the System Operating Parameters:

General System Parameters

- Supply chain operating mode
- Day of operation losses
- Dispatching and train control logic

Mine Parameters

- Mine loadout capability
  - Load rate
  - Recharge time
  - Max throughput (trains/day)
- Mine closures (maintenance)

Port Parameters

- Unload rate
- Pit availability and other closures
- Push or pull demand

Below Rail Infrastructure Parameters

- Configuration
  - Layout
  - SRTs
  - Signalling systems
- Maintenance closures
- Speed restrictions

Above Rail Parameters

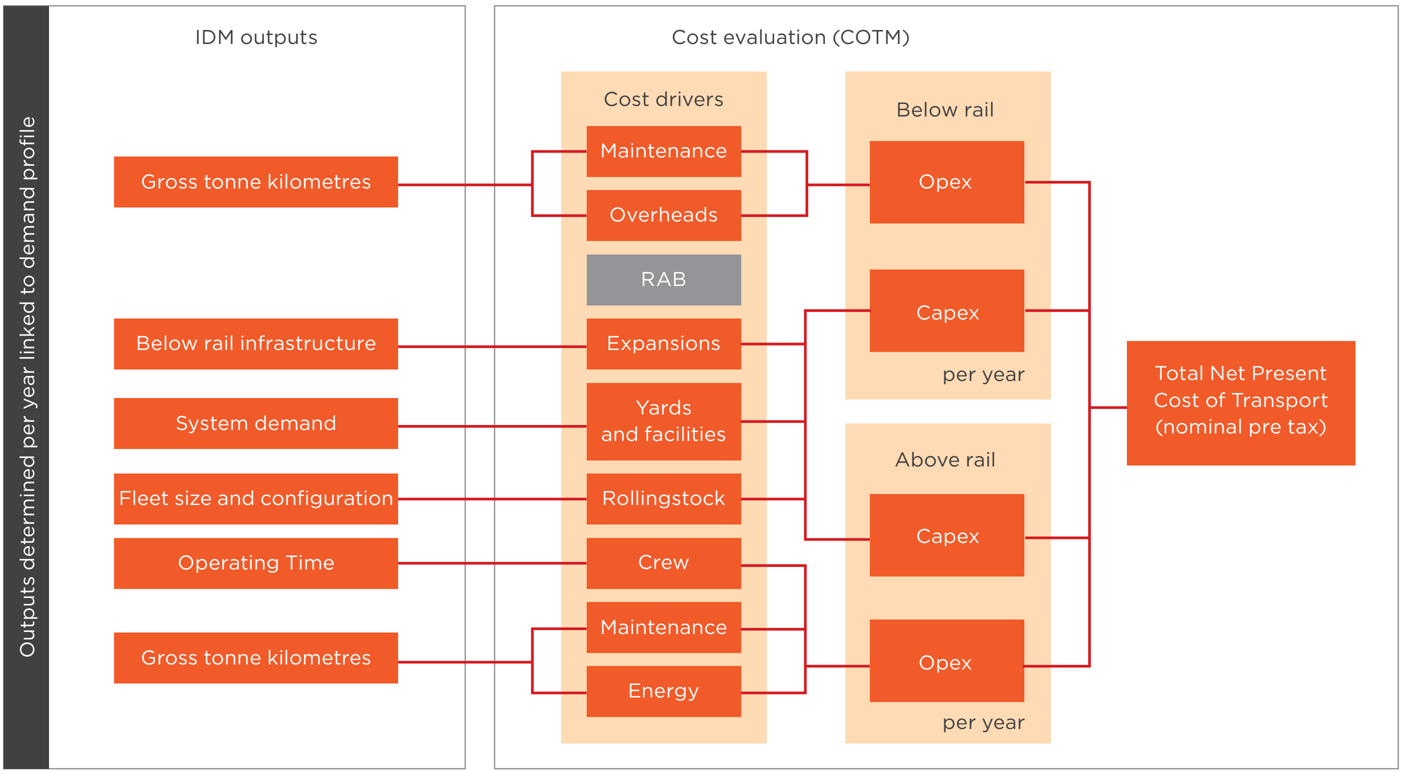
- Train length, payload and performance
- Train stop and start performance
- Train operations
  - Crew change
  - Provisioning
  - Rollingstock maintenance
- Non-coal traffic

The CQSCM performs Monte Carlo simulations based on probability and random variations to events to understand how well the system meets its performance requirements.

The performance requirements measured include:

- Throughput achieved
- Below Rail Transit Time Ratio
- Cycle time
- Section utilisation

Figure 4: Cost of Transportation Model configuration



INTRODUCTION

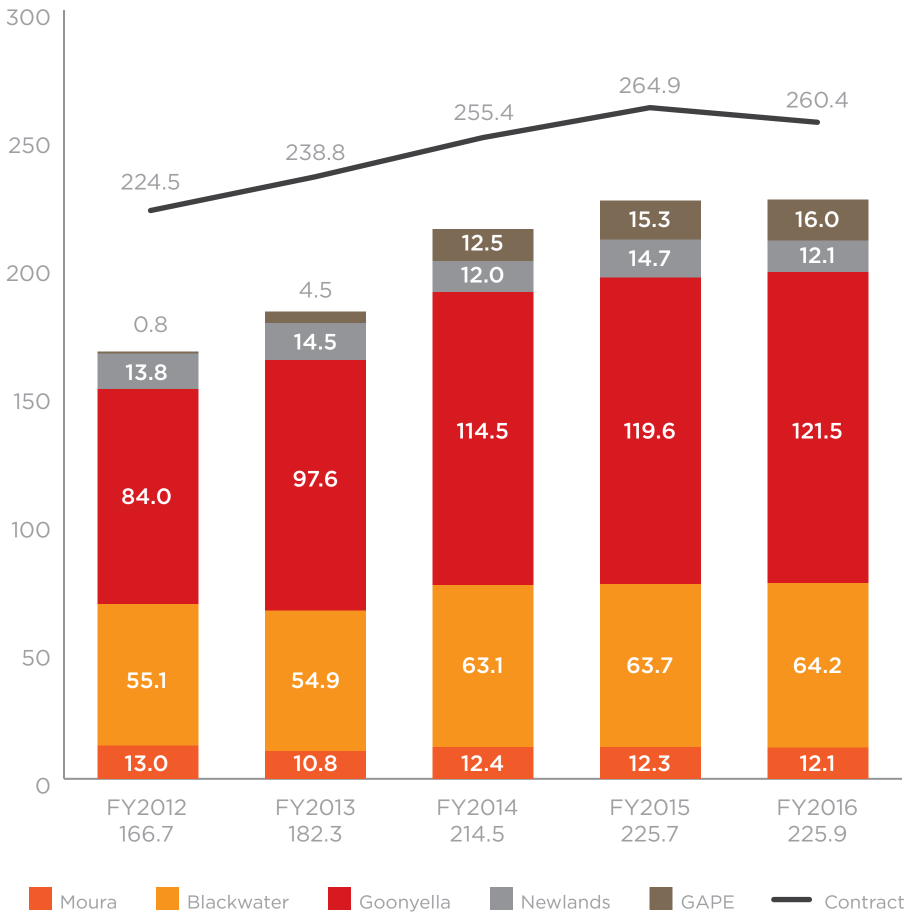
The throughput achieved in the last financial year is reviewed in Existing Network. The capacity of each section of the network is also reviewed to identify where there is spare capacity.

This review provides a basis for identifying constraints and examining growth opportunities.

THE CURRENT STATE IN CONTEXT

In FY2016, 225.9mtpa of coal was railed through the CQCN, an increase of 0.1% from FY2015 and 5% and 24% from FY2014 and FY2013 respectively, as illustrated in Figure 5.

Figure 5: Actual throughput and contract capacity (mtpa) FY2012 – FY2016



EXISTING NETWORK CAPACITY AND CONSTRAINTS

CAPACITY ANALYSIS

Aurizon Network undertakes a capacity analysis in line with 2016 Access Undertaking.

The capacity review describes the CQCN's ability to meet the contracted Train Service Entitlements (TSEs[2]).

The capacity review is conducted using the CQSCM described in the *How plans are made* section.

NDP STATIC ANALYSIS

Further to the capacity review, the NDP contains a static review of each section of the network utilising the IDM.

The intention of this static analysis is to:

- Identify where there is remaining capacity on the network.
- Describe which locations are expected to be capacity constraints for future growth.

This is provided so that customers are aware of upcoming constraints that may initiate expansions of the network to provide the next tranches of capacity.

PRESENTATION OF ANALYSIS

The capacity utilisation of each section of the network has been calculated to determine the remaining train paths (within target utilisation levels).

The unused train paths have been converted into available capacity using the payloads listed in the reference train criteria in Schedule F of the 2016 Access Undertaking.

- Newlands: 6,871 tonnes
- Goonyella: 10,055 tonnes
- Blackwater: 8,211 tonnes
- Moura: 6,269 tonnes

The remaining capacity on each section is presented with colour codes depicting when augmentation to that section may be required.

This analysis is not intended to be definitive as there may be other triggers that require additional infrastructure that would be identified during more detailed analysis.

2 Capacity on the Network is provided on the basis of Train Service Entitlements, 2 of which are required for a cycle from port to mine to port.

NEWLANDS

Assumptions

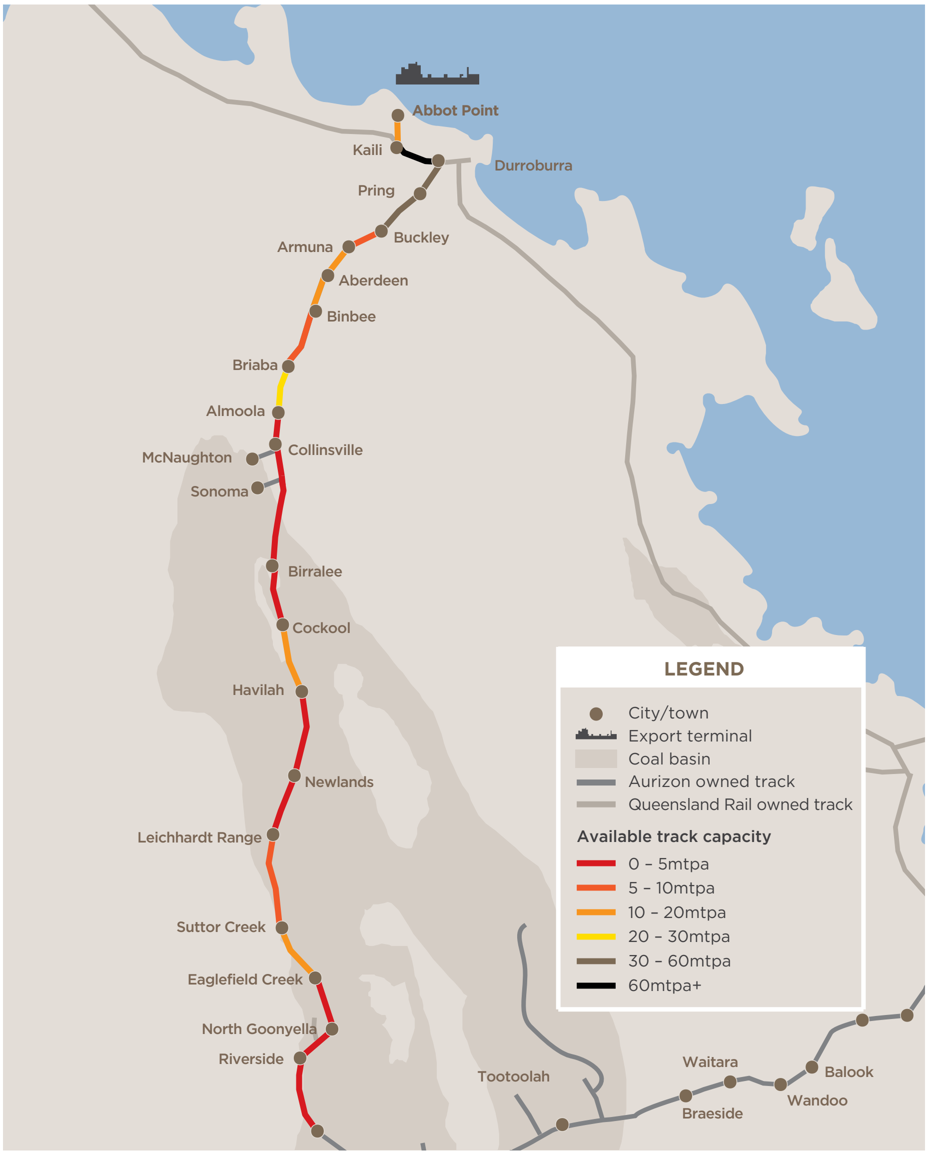
The Newlands system capacity (Figure 6) has been assessed based on the current infrastructure with the following infrastructure and operational assumption amendments:

- **Remote Control Signalling**
  The Newlands system currently operates with a mix of RCS and DTC-MLPI signalling. Full RCS installation has been deferred while system demand is lower than contract. As this infrastructure will be in place prior to full contracted capacity being reached, the assessment assumes RCS to be installed across the entire Newlands system.

- **Collinsville**
  Constraints on passing trains at Collinsville are assumed to be resolved as part of the baseline capacity of the system.

- **Capacity and constraints**
  The Newlands system, with the GAPE[3] infrastructure and the above assumptions, provides sufficient capacity to meet the contracted capacity. Incremental capacity beyond this is achieved through the addition of passing loops, duplications, deviations and operational changes.

Figure 6: Newlands system available capacity and constraints



3 Goonyella to Abbot Point expansion

GOONYELLA

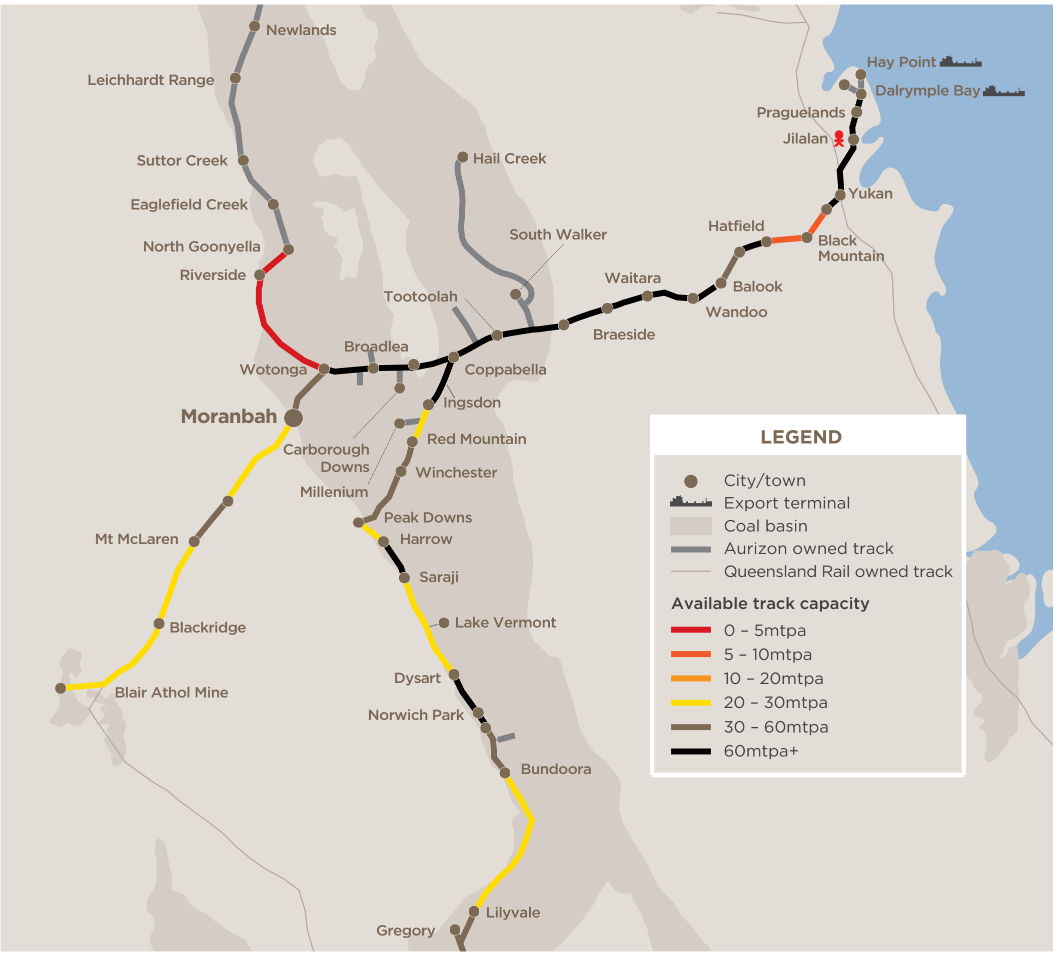
Assumptions

The Goonyella system capacity (Figure 7) has been assessed based on the current infrastructure.

Capacity and constraints

The Goonyella system meets all contracted capacity requirements and has only limited remaining capacity on the trunk.

Figure 7: Goonyella system available capacity and constraints



BLACKWATER/MOURA

Assumptions

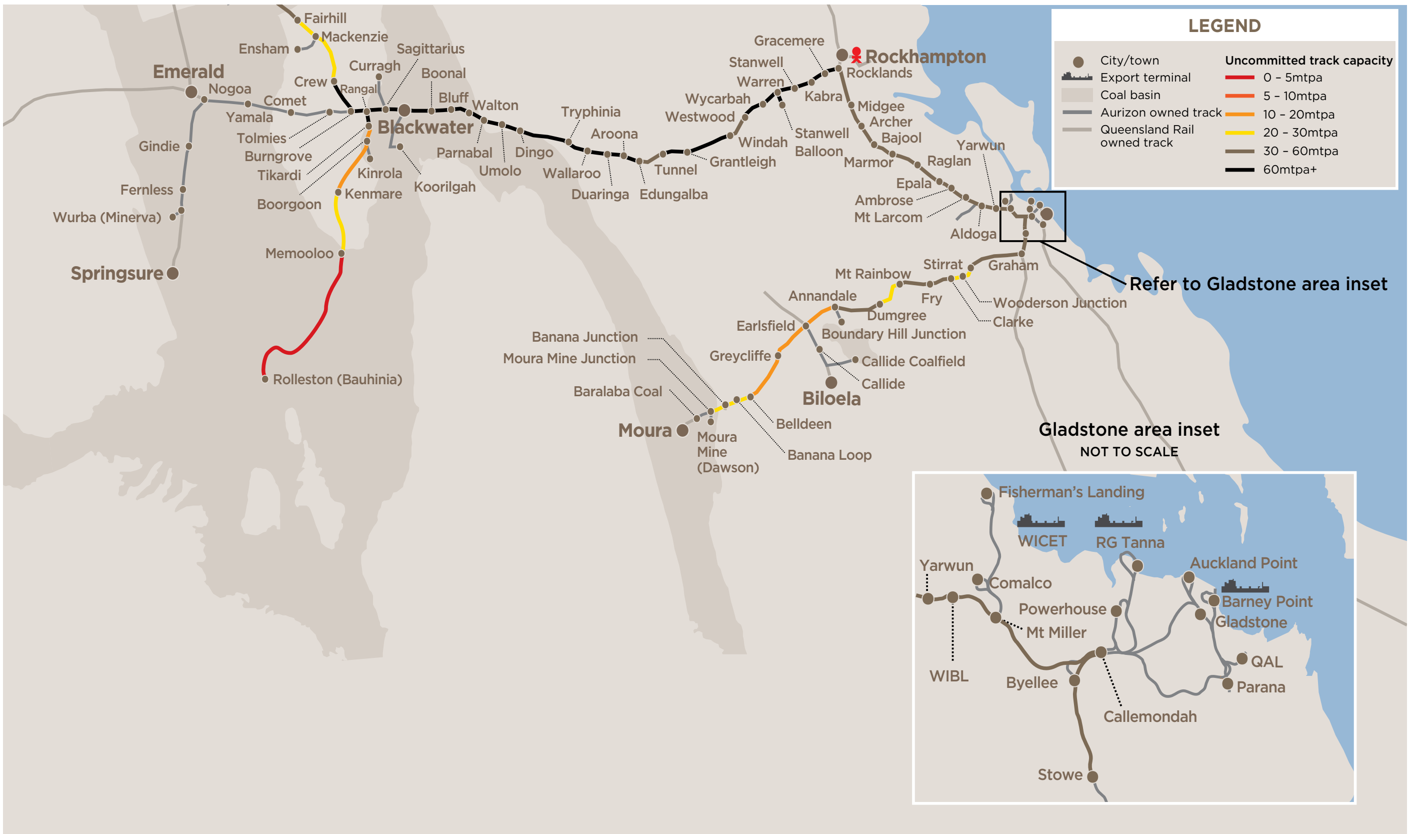
The Blackwater and Moura system capacity (Figure 8) has been assessed based on the current infrastructure including the recently commissioned:

- Blackwater duplications
- Kabra and Aldoga holding roads
- WICET spur and balloon loop

Capacity and constraints

The Blackwater and Moura systems both provide sufficient capacity to support contracted capacity.

Figure 8: Blackwater and Moura system available capacity and constraints



03 Option Identification.

INTRODUCTION

This section describes the approach taken to identify options for the future state of each rail corridor which are applied in the Corridor Development Plans section.

KEY ASSESSMENT CRITERIA

The key assessment criteria for identifying the options for the future state of each rail corridor are:

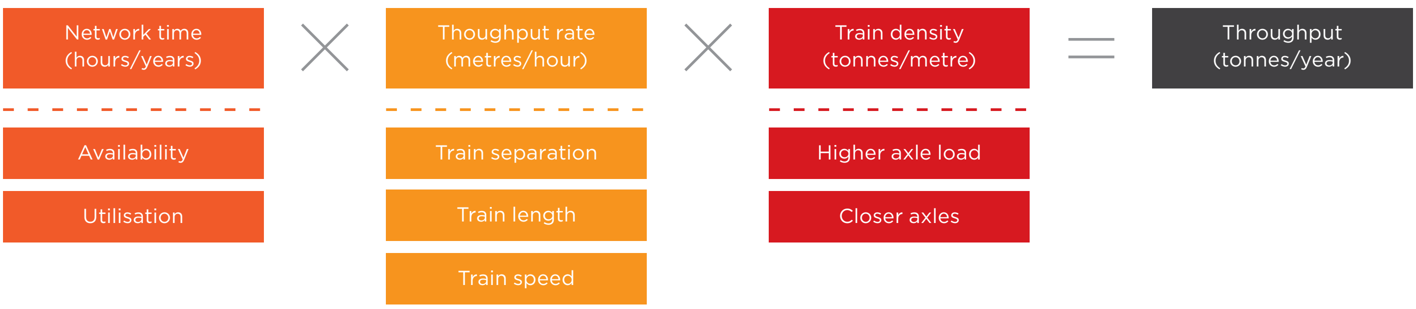
- achieving the future capacity needed
- delivering the lowest total cost of operation accounting for all above rail and below rail capital and operating expenses
- enabling sustainable solutions from an environmental and community perspective.

THROUGHPUT DIMENSIONS

The capacity of a rail network can be defined in terms of three key dimensions as shown in the following equation (Figure 9). Identifying the components of railway capacity in this way enables a clear understanding of the changes that can be made, how the changes affect capacity and how they relate to each other.

The parameters that relate to each of the dimensions are identified below each dimension and are discussed in further detail in this section.

Figure 9: Throughput dimensions



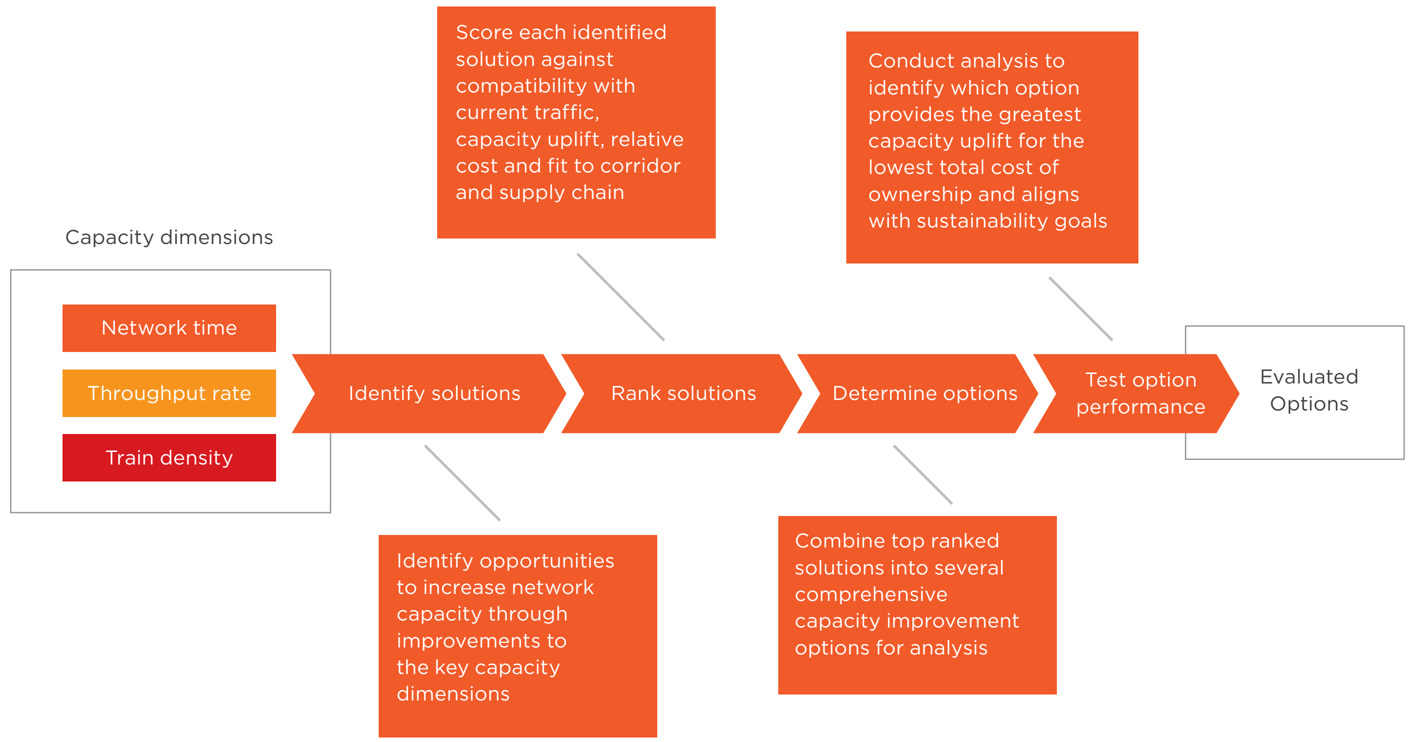
APPROACH

The process for developing options for a future state of a rail corridor is described in Figure 10.

The Network Technical Strategy process provides more detailed development of improvement opportunities and the associated costs and benefits.

This approach has been utilised during the development of the 2016 NDP, with the outcomes described in the section *Option Selection and Corridor Development Plans*.

Figure 10: Option Identification process



NETWORK TIME

The parameters governing the amount of network time used for running train services are availability and utilisation.

The availability and utilisation of the rail network are key factors that drive the need (or otherwise) for infrastructure investment.

This is illustrated in Figure 11 which describes the relationship between infrastructure requirements (measured in headway) against throughput (mtpa) for availability and utilisation scenarios.

AVAILABILITY

A proportion of the total theoretical capacity of the rail network must be allocated to carrying out maintenance and asset renewals activities to ensure ongoing reliable and economic operation.

The remaining time is referred to as the availability of the railway. These allocations are shown in Figure 12.

High-level system design is based on a yearly average availability figure expressed as a percentage. The nominal planning value is 85% availability.

As the volume of traffic increases, the quantity of maintenance required goes up.

Actual availability of the railway will fluctuate daily due to variations in the maintenance plan driven by:

- the cyclic nature of maintenance activities
- responsiveness of the maintenance plan to variations in traffic demand
- alignment with other maintenance activities in the supply chain.

Train paths are then allocated to the remaining time. These train paths represent the capacity available for running trains.

Historic availability

A review of the availability achieved across the CQCN has been performed.

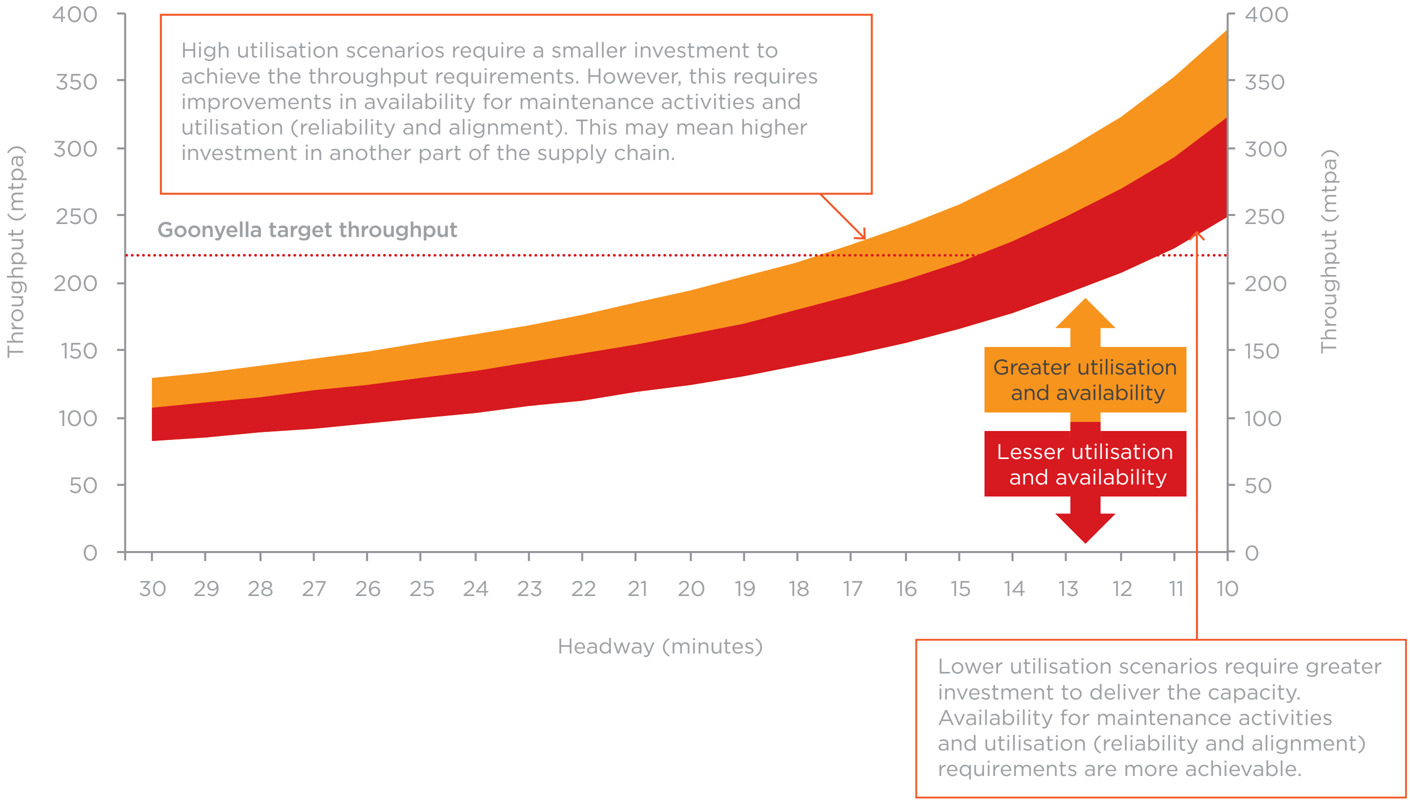
This preliminary review has identified that the availability achieved in each corridor is higher than the 85% used in system design.

Table 1: FY2016 system availability

System	Availability
Newlands	92%
Goonyella	86%
Blackwater	82%
Moura	91%

As would be expected, those systems with lower tonnage throughput have higher availability reflecting the smaller maintenance task required.

Figure 11: Achieving capacity gains through headway and path utilisation trade-offs



Availability opportunities
Improving the availability of the railway, while retaining the level of reliability and achieving cost-effective maintenance delivery, provides an option for improving the network time dimension.

The amount of time required for maintenance and renewal activities is a function of:

- **The scope of work required**
  The majority of maintenance and renewals requirements are a function of the tonnage carried.

  The scope of work required is driven by the design of the infrastructure, the traffic volume, the length of the railway and its complexity.

- **How the scope is planned**
  The level of sophistication of maintenance and renewals planning and scheduling to provide the maximum coordination of activities.

  This includes requirements for relocating equipment and supply of resources.

- **The amount of resources available**
  More resources increases the amount of work that can be carried out within a short timeframe.

  This may result in a higher unit cost to undertake the same scope of work.

UTILISATION

Rail system capacity planning sets a target level of utilisation of available capacity. The design of the railway is then carried out to deliver total contracted demand within this utilisation limit.

The difference between the utilisation limit and the available capacity is described as the headroom. This represents the additional capacity that is used to provide the ability to recover from variations in the performance of the supply chain and needs to be sufficient to provide for these variations.

The variations are a result of:

- the need to provide for varying levels of demand for rail services due to peaks and troughs in the demand for coal
- limits to the reliability of above rail, below rail, port and mine equipment
- limits to on time performance to schedule
- other variances in the supply chain that affect the ability of trains to meet their schedule
- alignment of capacity in the rail, mine and port systems
- interruptions to operations from unplanned events and incidents which are beyond the control of the supply chain such as level crossing accidents.

An appropriate utilisation level will provide the required level of robustness without compromising efficiency by building excess unnecessary capacity.

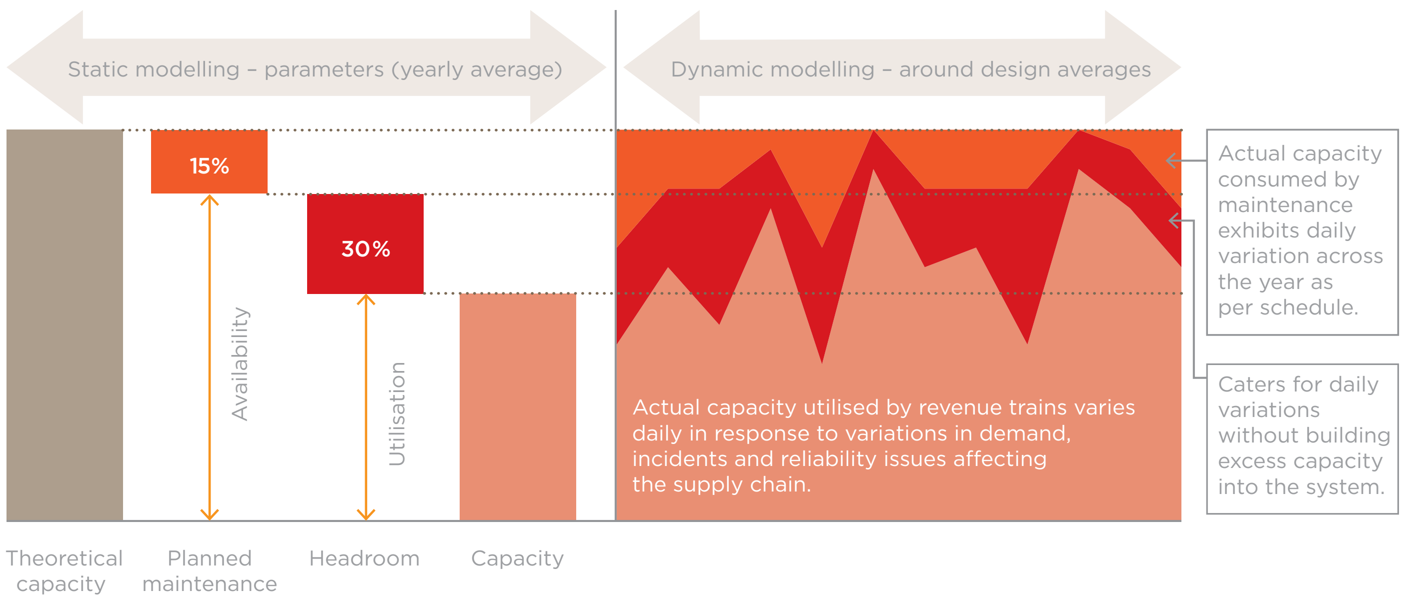
A robust system has the ability to function properly when operating parameters vary within a defined range. The amount of variation that the system can cope with is a function of its design.

Setting utilisation levels too high will result in excessive train queuing times and poor above rail asset performance.

There needs to be an appropriate balance between robustness and efficiency that meets the expectations of the supply chain in terms of cost and performance.

Understanding the amount and effect of variations in the supply chain allows for a realistic utilisation level to be set.

Figure 12: Availability and utilisation relationship



THROUGHPUT RATE

TRAIN SEPARATION

Train separation is one of the opportunities for improving the throughput rate dimension.

Train separation, or how close together trains can operate, is defined as the headway.

Headway (Figure 13) is a function of:

- train length
- signal positioning
- train speed
- braking distance.

Solution – signalling alterations

Typically, existing signal positioning on duplicated track is defined by the original placement of passing loops (or other physical constraints such as grades) when the systems were single tracks.

Sections can be split with additional signals, reducing the time (headway) between trains, increasing the capacity of the system. This is shown in Figure 14.

Constraints

The primary parameters governing the headway are train length and braking distance. Headways can be reduced but there is a practical limit as train length and braking distance limits are approached.

Reducing headways is a practical solution to increasing network throughput rate, however, caution needs to be exercised so they are not reduced to the point where it limits the opportunity to increase train lengths.

Figure 15 indicates the relationship between the minimum practical headway and increasing train length. As it is desirable to maintain consistent headways throughout the rail corridor, the steepest down gradient sections are likely to define the practical minimum headways. Figure 15 indicates that the practical limit for train lengths up to 3000m is 10 minutes and for train lengths up to 4200m the limit is 13 minutes.

Figure 13: Headway

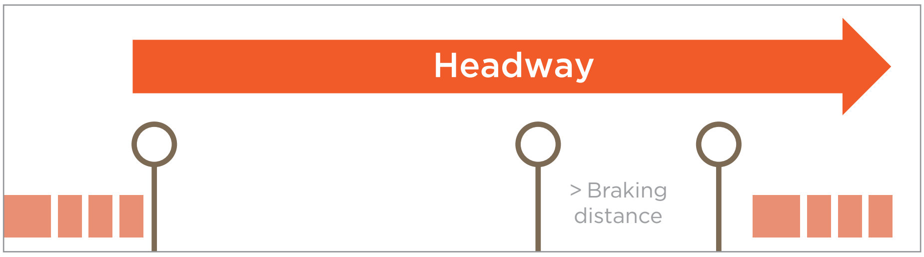


Figure 14: Headway improvements through signalling alterations

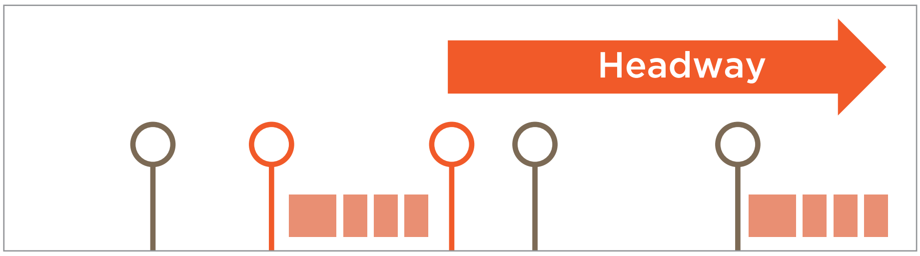
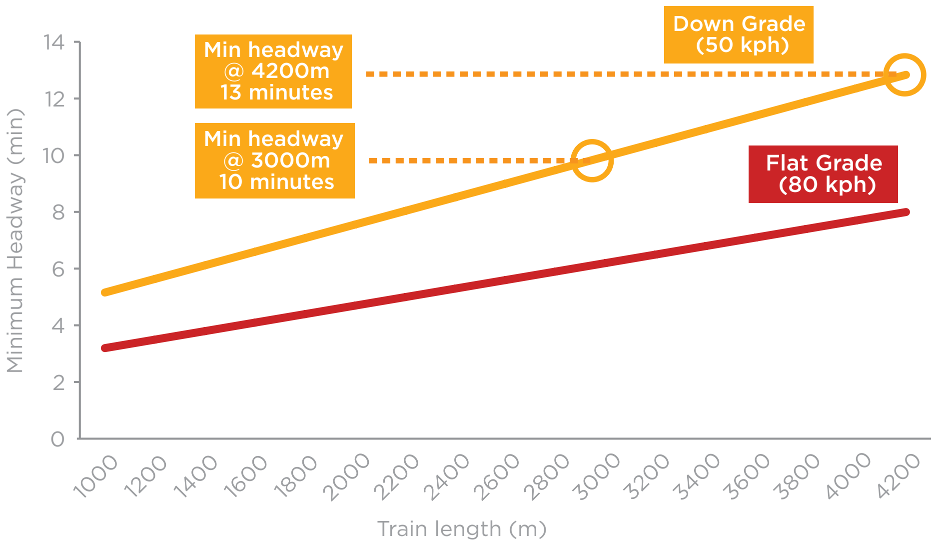


Figure 15: Limitations on headway improvements



Solution – infrastructure alterations
Signalling alterations may not be achievable on sections with steep grades due to safety considerations and the inefficiency of stopping and restarting trains on steep gradients (both uphill and downhill).

If the grade is too steep one alternative solution is to provide a parallel track enabling trains to be routed on alternate tracks (Figure 16).

By alternating the routing of trains between the existing track and new track then the train separation is reduced by almost half of the original value.

This option involves significant capital costs.

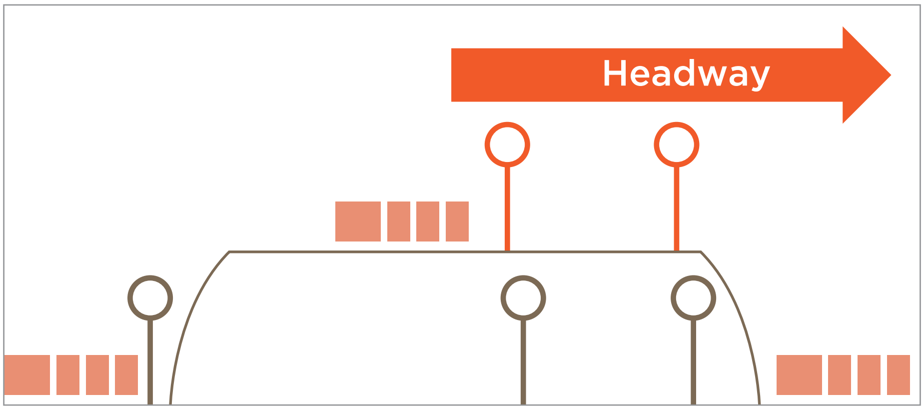
Solution – grade easing
In some scenarios it may not be possible to split long steep uphill sections as trains may not be able to restart on the uphill grade or it may result in very long restart times.

An alternative, flatter alignment may be necessary in this scenario which may have the additional benefit of increasing the speed at which trains operate through the section, reducing the travel time. There are usually significant capital costs with grade easing.

Solution – changes in train design
Where steep downhill grades make it difficult for trains of conventional design to restart from a stop, train operating procedures and braking technology may provide the opportunity for trains to restart on the grade.

This would enable trains to be held on the grade, enabling lower cost signalling alterations to be implemented rather than infrastructure alterations such as the addition of parallel track.

Figure 16: Headway improvements through infrastructure alterations



Solution – increased power-to-weight ratio
Some sections have long run times due to long, steep uphill grades. Increasing the power-to-weight ratio of trains may increase the speed, reducing the travel time through the section and reducing the headway.

This reduces the cost effectiveness of the above rail operation by less efficient use of locomotive capital investment and has not been considered as a solution within the NDP.

Solution – in-cab signalling
Analysis performed indicates that existing lineside signalling technology provides sufficient capacity for the throughput scenarios considered within the NDP, hence in-cab signalling is not considered for capacity benefits within the NDP.

However, in-cab signalling has been identified as a potential study to be undertaken in future, due to the potential efficiencies that may be realised across the supply chain.

Application within the NDP
The reduction of train separation can bring significant capacity benefits to the existing rail infrastructure. The implementation of reduced train separation can be delivered through a range of solutions, dependent on the existing infrastructure layout.

This is considered as a viable option within the NDP and is applied within the corridor development plans.

TRAIN LENGTH

Overview

Train length is the second aspect that can affect the throughput rate.

The length of the train affects the amount of coal that can be transported within each train. The longer the train, the better the use of below rail capacity on the network.

Solution – train lengthening

Increasing train length provides capacity benefits due to increased payload.

However, implementation of longer trains may be dependent on capital expenditure across the supply chain. Refer to Figure 17 for the effect of longer trains.

Within current infrastructure length constraints

Over the past two years operators have optimised their train lengths to make maximum use of current infrastructure capability.

This can be achieved by a reassessment of the necessary tolerances to allow for safe and efficient train handling .

Minor infrastructure works have been carried out to resolve relatively low cost issues.

Beyond current infrastructure length constraints

Significant increases in train length require that infrastructure length constraints be resolved. These issues include the following:

Mines

- Longer balloon loops
- Increased stockpiles and improved loading rates and recharge capability

Below rail

- Longer passing loops (smaller impact on duplicated infrastructure)
- May require changes to level crossings or other interfaces if trains overhang changes to yard facilities

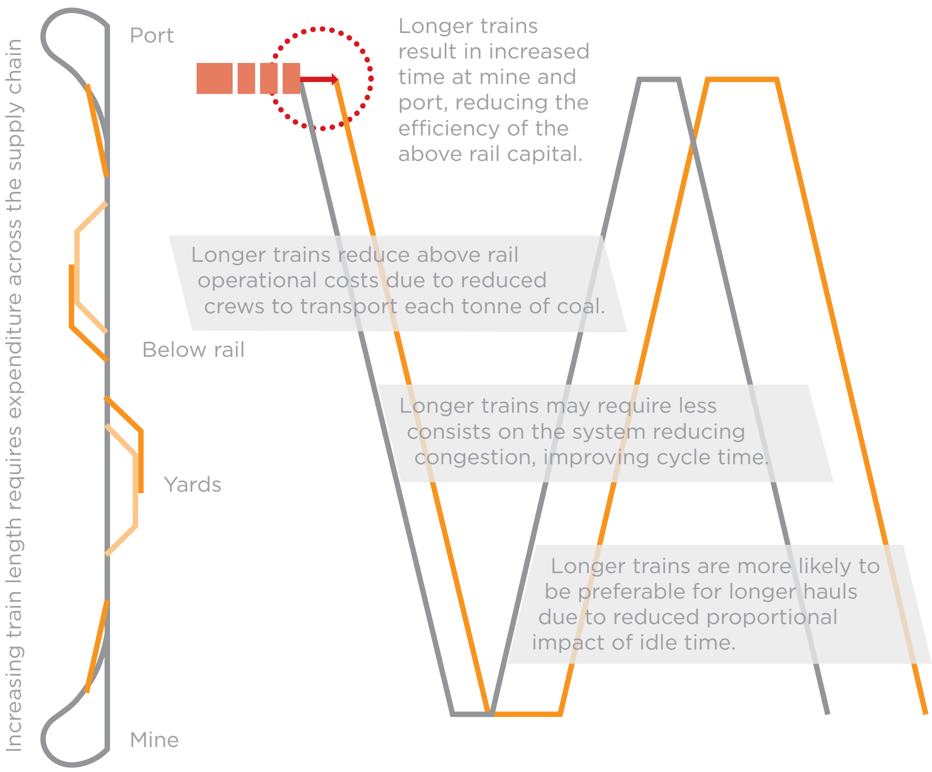
Above rail

- Changes to yard facilities

Ports

- Longer balloon loops
- Improved unloading rates.

Figure 17: Effect of longer trains



System analysis
A desktop study has been carried out across the Blackwater and Goonyella corridors (Figure 18) to assess the below rail impact to signalling, turnouts and level crossings of increasing the length of a consist by increments of two wagons (approximately 32m).

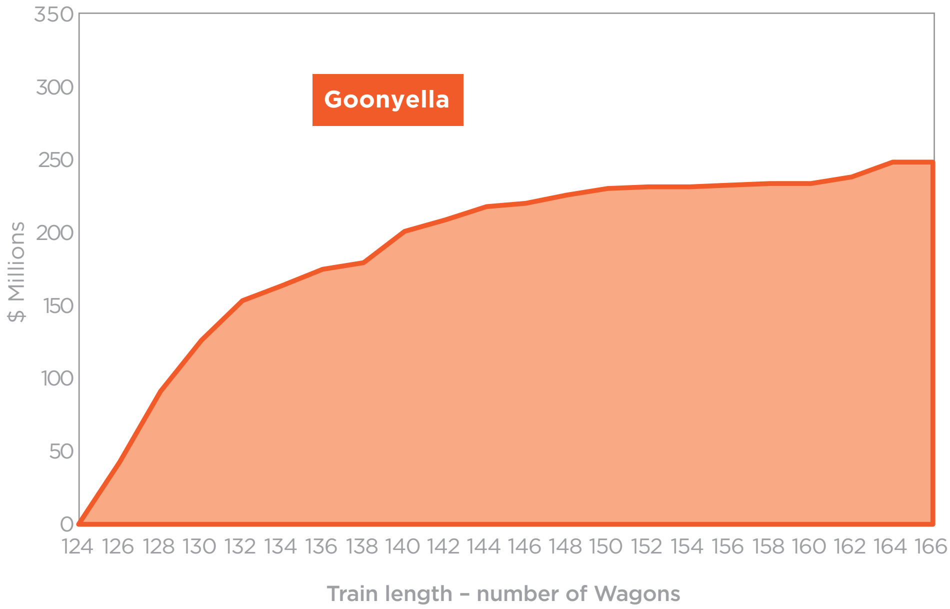
For the Goonyella system a baseline 124 wagon consist was used and a 166 wagon consist was the maximum length considered. In the Blackwater system a baseline 100 wagon consist (1.691km) was used and a 150 wagon consist (2.491 km) was the maximum length considered.

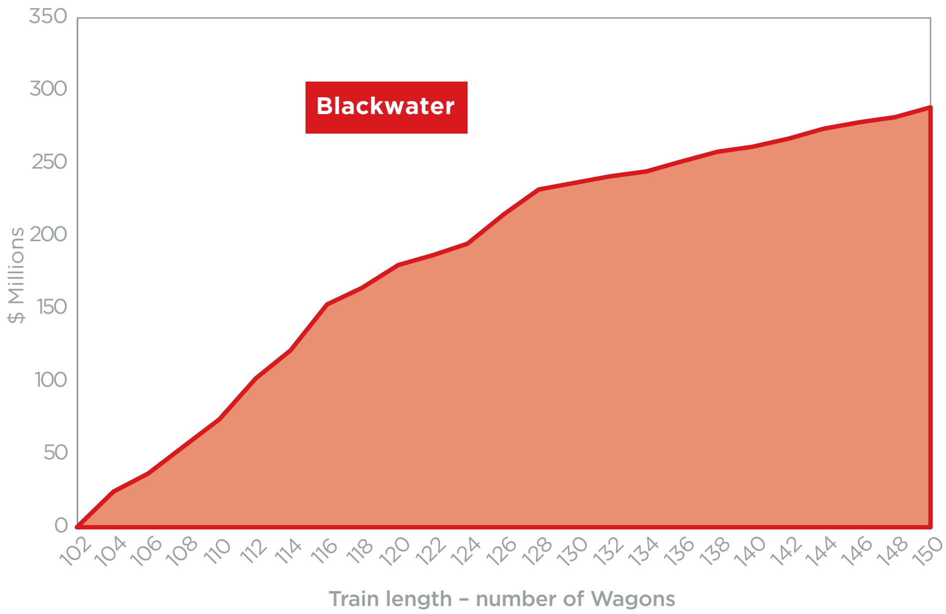
These capital estimates are at a pre-concept level but provide guidance to the potential costs of this solution.

The other significant cost element is the additional track length required at passing loops, balloon loops and yard roads. These costs have been included in assessments of longer trains undertaken in Corridor Development Plans.

Application within the NDP
Increasing train lengths can require investment across the supply chain and may impact the cost effectiveness of the above rail operation, dependent on the length of haul. However, it may negate the need for significant additional track infrastructure and have operating cost benefits; therefore train lengthening opportunities are considered within the NDP.

Figure 18: Below rail capital cost for signalling, turnout and level crossing alterations for longer trains





TRAIN SPEED

Overview

Empty and loaded coal trains currently operate at a maximum speed of 80km/h. The speed at which trains operate impacts the time a train takes over each section of the network and hence the cycle time.

Solution – increasing train speed

Increasing the speed at which trains operate:

- reduces cycle time
- creates more efficient use of above rail resources (due to reduced cycle time)
- reduces time occupying track sections, increasing capacity on the network
- can only be implemented where signalling, track curvature and cant allows, unless investment in track realignment is made.

Implementing higher speeds needs to consider the constraints and impact on existing infrastructure.

This includes:

- Higher speeds have a greater impact on infrastructure degradation
- An increase in the braking distance (due to higher speeds) may require an increase in signal spacing interfaces with roads (through level crossings) may require alteration as trains traverse detection points more quickly
- Where there are particular congestion nodes (i.e. in and around yards) any journey time savings may be negated by the congestion
- Increases energy consumption
- Requires rollingstock capable of operating at higher speeds.

Solution – improve constrained sections

Opportunities to improve the performance of constrained track sections by increasing speed can provide overall improvement to corridor throughput.

The Connors Range in the Goonyella system is a key location under investigation. Due to its steep gradient, low speed (40km/h) and length it limits the Goonyella throughput. A moderate increase in speed will yield significant improvements in system throughput.

Revisions to speed and cant standards have identified a number of areas where speeds may be increased without changes to track alignment.

Solution – mixed traffic capacity

Degradation of capacity occurs when trains operate at different speeds on the network (Figure 19). Increasing the speed of slowest traffic to match quicker traffic (i.e. homogenising journey time) can unlock significant capacity. Faster trains 'catch-up' to the path/train in front of them resulting in the utilisation of two paths to traverse a section.

North Coast Line

Until recently, mixed traffic on the North Coast Line (NCL) was operating at different speeds – with coal operating slower than non-coal traffic. This led to non-coal traffic occupying a disproportionately large amount of capacity.

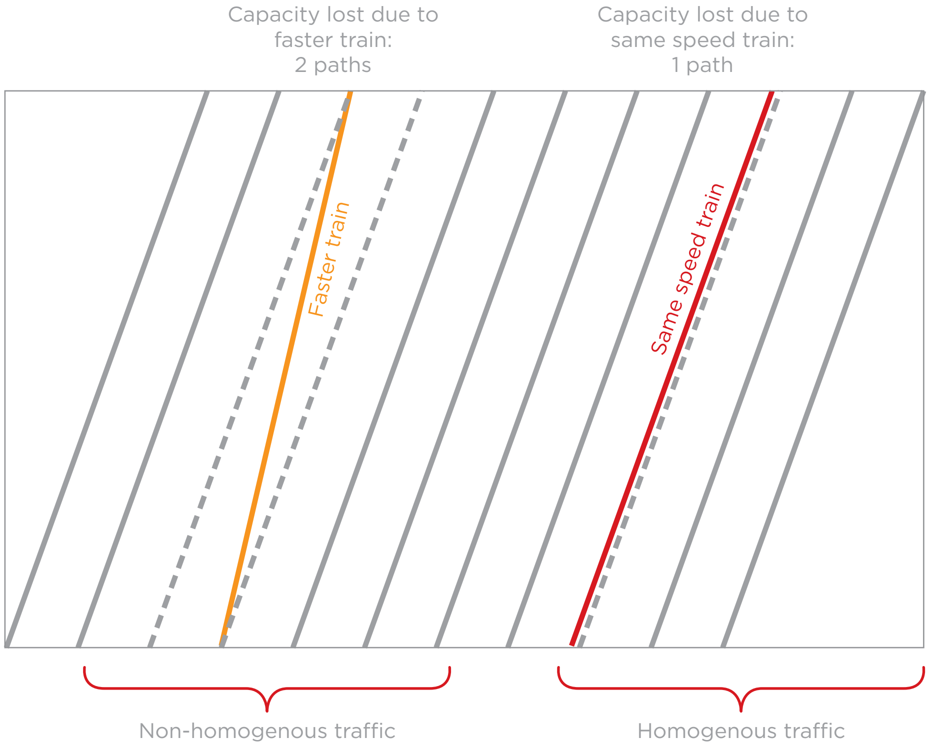
An agreement was reached between Aurizon Network and non-coal access holders that has homogenised traffic by slowing down non-coal services on the NCL to match coal traffic.

This results in fewer coal paths being used by non-coal traffic unlocking more than 10 mtpa for Blackwater.

Application within the NDP

The result of homogenising journey time on the NCL has been incorporated within the Corridor Development Plans for the Blackwater system. This release of capacity delays (or removes) the need for capital intensive infrastructure to support growth.

Figure 19: Effect of mixed train speeds on capacity



TRAIN DENSITY

Train density is the measurement of the quantity of coal that can be transported per linear metre of train. Higher density operations reduce longitudinal investment in the rail infrastructure (i.e. extension of passing loops and yards). Existing train density on the CQCN is compared to train densities on other networks (Figure 20).

There is potential to provide for higher axle load capability and/or closer axle spacing through track capability improvement.

The process to understand this opportunity and the benefits are described in Figure 21.

This process has been completed and documented in the Network Technical Strategy specifically for increasing network infrastructure capability to 30 tonne axle load with rollingstock of current axle configuration.

The results of this analysis have been incorporated in the cost analysis of options reported in the Corridor Development Plans section of this document.

Figure 20: International comparison of train density and axle load

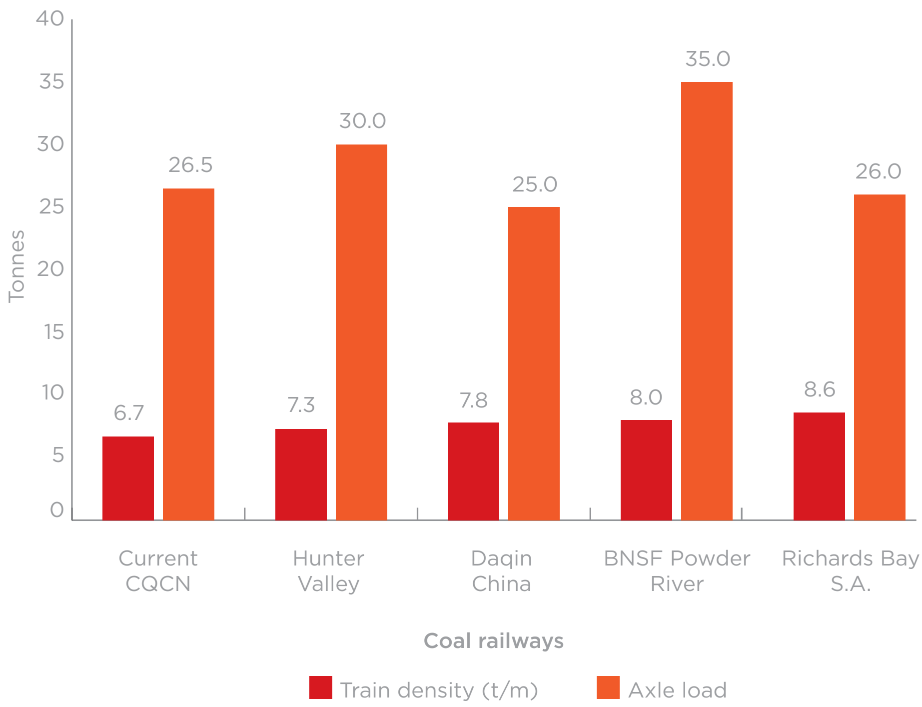


Figure 21: Process for understanding higher train density opportunities

	Improved clearances		Improved track and supporting structures capability	
Benefits	Allows higher and/or wider rollingstock Allows for larger higher power locomotives Alignment of rollingstock design requirements with other railways, broadens supplier base, reduces bespoke design needs Potential to reduce rollingstock capital costs		Provides more payload per wagon for the same length, increasing train density	
Potential constraints	Overhead wire height in a limited number of locations Loader/unloader structures Above rail facilities, crew change platforms		Culverts Bridges Older sleepers Formation Rail	
	Milestones	Timeframes	Milestones	Timeframes
Pathway	Omnicom Lidar survey of current clearances Identify optimum future clearances requirements Assess constraints Assess costs to fix constraints Develop concept implementation plan coordinated with asset renewals, expansion plans and above rail operators fleet replacement plans.	Complete Complete 80% 2018 2018	NAMS civil asset data collection Assess optimum future axle load and axle spacing requirements Assess constraints Assess costs to fix constraints Develop concept implementation plan coordinated with asset renewals, expansion plans and above rail operators fleet replacement plans.	Complete Complete Complete Complete Complete

04 Corridor Development Plans.

The demand scenarios considered for each corridor, potential responses to that demand and a comparison of the effectiveness of the response through a cost of transportation analysis is provided in Corridor Development Plans.

INTRODUCTION

SCENARIO DEFINITION

For each of the CQCN corridors a demand scenario has been generated which is described in the Scenario Definition.

This sets out the origin and destination of the coal and the ramp up period.

OPTION SYNTHESIS

A range of options is identified for each corridor, including implementing changes to availability, utilisation, and train length.

COST DRIVERS

The Integrated Development Model is used to evaluate each of the options. This model, described in Planning Tools, determines the below and above rail requirements to meet the demand scenario.

The below rail infrastructure requirements for each of the options is presented, including the tonnage trigger and the increase on the specific branch line.

The provision of a branch trigger is intended to provide customers with an understanding of when infrastructure may be required on a branch, irrespective of the specific tonnage scenarios considered.

ROLLINGSTOCK FLEET

All currently contracted tonnages are assumed to be serviced by the existing rollingstock fleet.

All expansion tonnes are assumed to be serviced by new rollingstock fleet with upgraded performance as noted in each option.

COST EVALUATION

The Cost of Transportation Model is used to develop net present costs. The approach to the CTM is described in the section *How plans are made*, and is intended to provide insight into the relevant merits of each option. Costs have been developed at a pre-concept level for information purposes. These corridor plans will act as a guide for more detailed studies, supporting tonnage increases in each system. Additional tonnage scenarios may be considered by Aurizon Network in concept and pre-feasibility studies as appropriate.

Table 2: Corridor Development Plans process

Scenario definition
Source mines
Destination port
Ramp up profile
Option synthesis
Availability and Utilisation
Rollingstock types and Consist sizes
Headways and train speed
Cost drivers (IDM)
Tonnage task
Train consist options
Cost evaluation (CTM)
Capital costs above and below rail
Operational costs above and below rail
Inflation and discount rates

NEWLANDS

SCENARIO DEFINITION

This scenario builds on the existing capacity of 50mtpa through the Newlands system.

1. 30mtpa from the Galilee Basin to Abbot Point with a 3-year ramp up from 2020–2022.
2. This is immediately followed by a further 30mtpa from the Galilee basin to Abbot Point from 2023–2025.
3. In 2026 15mtpa of capacity is required for mine(s) on the North Goonyella branch, in the following year a further 15mtpa from the Blair Athol branch, both feeding Abbot Point.
4. Finally, a further 30mtpa from the Galilee basin is assumed in 2028–2029, reaching a total of 170mtpa.

Figure 22: Newlands growth scenario

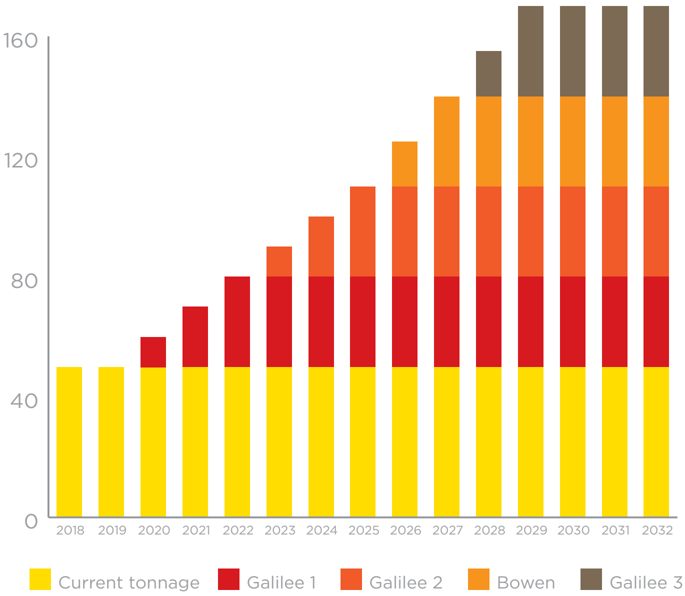


Table 3: Newlands scenario definition

Stage	Port Expansion	Branch	Tonnage	Years
1	Abbot Point T3	Galilee	30	2020-2022
2	Abbot Point T3	Galilee	30	2023-2025
3	Abbot Point T2	North Goonyella	15	2026
		Blair Athol	15	2027
4	Abbot Point T2	Galilee	30	2028-2029
Total			120	

Figure 23: Newlands source tonnes

2 LOCO

INTRODUCTION

The operational design applied for each service group is described in Table 4.

This option does not require existing infrastructure to be extended for longer trains but requires augmentation (additional loops, duplications, yard expansions) earlier than for the longer train scenarios considered.

Table 4: Newlands 2 loco operational design

Source tonnage	Rollingstock	Notes
Existing Newlands	H-82	3 loco, 82 wagon configuration to meet existing diesel loco and infrastructure capability.
Existing Goonyella	H-82	
Expansion Galilee	2 loco/80 wagon	New diesel locos expected to have capability to haul 40 wagons per loco. 2 loco configuration will fit within existing infrastructure constraints.
Expansion Goonyella	2 loco/80 wagon	

INFRASTRUCTURE REQUIREMENTS

Table 5: Newlands 2 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct Galilee Railway incl. mine loop and 3 passing loops	2020	1,050	Galilee	10	A
Construct Collinsville Deviation and passing loop	2020	110	Newlands trunk	10	B
Duplicate Binbee – Briaba	2020	100	Newlands trunk	10	C
Construct 3rd port loop	2020	35	Newlands trunk	10	D
Construct passing loop – Newlands Jct	2020	20	Newlands trunk	10	E
Construct passing loop – Station Creek	2020	20	Newlands trunk	10	F
Construct 3 passing loops on Galilee Railway	2021	50	Galilee	20	G
Duplicate Buckley – Armuna	2021	100	Newlands trunk	20	H
Duplicate Armuna – Aberdeen	2021	100	Newlands trunk	20	I
Duplicate Abbot Point – Kaili	2021	60	Newlands trunk	20	J
Construct passing loop – Stoney Creek	2021	20	Newlands trunk	20	K
Construct 6 passing loops on Galilee Railway	2022	100	Galilee	30	L
Duplicate Newlands Jct – Leichhardt Range	2022	110	Newlands trunk	30	M
Duplicate Collinsville Deviation – Birralee	2022	150	Newlands trunk	30	N
Duplicate Aberdeen – Binbee	2022	100	Newlands trunk	30	O
Construct 12 passing loops on Galilee Railway	2023	190	Galilee	40	P
Construct 2nd Galilee mine loop	2023	70	Galilee	40	Q
Duplicate Birralee – Havilah	2023	340	Newlands trunk	40	R
Duplicate Pring – Buckley	2023	50	Newlands trunk	40	S
Duplicate Almoola – Collinsville Deviation	2023	50	Newlands trunk	40	T
Construct 4th port loop	2023	35	Newlands trunk	40	U
Duplicate Havilah – Newlands Jct	2024	110	Newlands trunk	50	V
Duplicate Durroburra – Pring	2025	40	Newlands trunk	60	W
Construct passing loop – Loop 1	2026	20	GAPE	15	X
Construct 5th port loop	2026	35	Newlands trunk	75	Y
Duplicate Loop 3 – Riverside	2026	65	North Goonyella	15	Z
Duplicate Eaglefield Creek – Loop 3	2027	65	GAPE	30	AA
Construct passing loop – Loop 2	2027	20	GAPE	30	BB
Additional signalling Briaba – Almoola	2027	12	Newlands trunk	30	CC
Duplicate Riverside – Wotonga	2027	170	North Goonyella	30	DD
Duplicate Galilee Railway	2028	700	Galilee	75	EE
Construct 3rd Galilee mine loop	2028	70	Galilee	75	FF
Additional signalling Newlands Jct – Leichhardt Range	2028	6	Newlands trunk	105	GG
Construct 6th port loop	2028	35	Newlands trunk	105	HH
Additional signalling Abbot Point – Kaili	2028	6	Newlands trunk	105	II
Additional signalling Buckley – Armuna	2028	6	Newlands trunk	105	JJ
Additional signalling Binbee – Briaba	2028	6	Newlands trunk	105	KK
Additional signalling Kaili – Durroburra	2029	6	Newlands trunk	120	LL
Additional signalling Coral Creek – Birralee	2029	6	Newlands trunk	120	MM

Figure 24: Newlands 2 loco infrastructure requirements

3 LOCO

INTRODUCTION

The operational design applied for each service group is described in Table 6.

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation.

Table 6: Newlands 3 loco operational design

Source tonnage	Rollingstock	Notes
Existing Newlands	H-82	3 loco, 82 wagon configuration to meet existing diesel loco and infrastructure capability.
Existing Goonyella	GLT (D)	Reconfigured as a 4 loco, 122 wagon consist within existing Goonyella system constraints.
Expansion Galilee	3 loco/120 wagon	New diesel locos expected to have capability to haul 40 wagons per loco. 3 loco configuration will fit within existing Goonyella system constraints.
Expansion Goonyella	3 loco/120 wagon	

INFRASTRUCTURE REQUIREMENTS

Table 7: Newlands 3 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct Galilee Railway incl. mine loop and 2 passing loops	2020	1,050	Galilee	10	A
Construct 3 passing loop extensions – GAPE	2020	20	GAPE	10	B
Construct Collinsville Deviation	2020	90	Newlands trunk	10	C
Construct 10 passing loop extensions – Newlands System	2020	60	Newlands trunk	10	D
Construct 3rd port loop	2020	45	Newlands trunk	10	E
Construct port loop extensions	2020	25	Newlands trunk	10	F
Construct 2 passing loops on Galilee Railway	2021	45	Galilee	20	G
Construct passing loop – Newlands Jct	2021	20	Newlands trunk	20	H
Construct passing loop – Collinsville Deviation	2021	20	Newlands trunk	20	I
Construct 4 passing loops on Galilee Railway	2022	90	Galilee	30	J
Duplicate Buckley – Armuna	2022	100	Newlands trunk	30	K
Duplicate Binbee – Briaba	2022	100	Newlands trunk	30	L
Construct passing loop – Station Creek	2022	20	Newlands trunk	30	M
Construct passing loop – Stoney Creek	2022	20	Newlands trunk	30	N
Construct 4 passing loops on Galilee Railway	2023	90	Galilee	40	O
Construct 2nd Galilee mine loop	2023	70	Galilee	40	P
Duplicate Armuna – Aberdeen	2023	100	Newlands trunk	40	Q
Duplicate Abbot Point – Kaili	2023	60	Newlands trunk	40	R
Construct 4th port loop	2023	45	Newlands trunk	40	S
Duplicate Newlands Jct – Leichhardt Range	2024	110	Newlands trunk	50	T
Duplicate Aberdeen – Binbee	2024	100	Newlands trunk	50	U
Duplicate Coral Creek – Birralee	2024	100	Newlands trunk	50	V
Construct 12 passing loops on Galilee Railway	2025	270	Galilee	60	W
Duplicate Birralee – Station Creek	2025	90	Newlands trunk	60	X
Duplicate Collinsville Deviation – Coral Creek	2025	60	Newlands trunk	60	Y
Duplicate Station Creek – Havilah	2026	260	Newlands trunk	75	Z
Duplicate Pring – Buckley	2026	50	Newlands trunk	75	AA
Duplicate Almoola – Collinsville Deviation	2026	50	Newlands trunk	75	BB
Construct 5th port loop	2026	45	Newlands trunk	75	CC
Construct passing loop – Loop 1	2027	20	GAPE	30	DD
Duplicate Havilah – Newlands Jct	2027	110	Newlands trunk	90	EE
Duplicate Durroburra – Pring	2027	40	Newlands trunk	90	FF
Duplicate Loop 3 – Riverside	2027	60	North Goonyella	30	GG
Construct 3rd Galilee mine loop	2028	45	Galilee	105	HH
Construct 6th port loop	2028	70	Newlands trunk	105	II

Figure 25: Newlands 3 loco infrastructure requirements

3 LOCO – DEMAND OFFSET

INTRODUCTION

The operational design applied for each service group is described in Table 8.

In this scenario demand growth from the Galilee basin is partly offset by a reduction in demand from existing access holders. This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation.

Table 8: Newlands 3 loco operational design

Source tonnage	Rollingstock	Notes
Existing Newlands	H-82	3 loco, 82 wagon configuration to meet existing diesel loco and infrastructure capability.
Existing Goonyella	GLT (D)	Reconfigured as a 4 loco, 122 wagon consist within existing Goonyella system constraints.
Expansion Galilee	3 loco/120 wagon	New diesel locos expected to have capability to haul 40 wagons per loco. 3 loco configuration will fit within existing Goonyella system constraints.

INFRASTRUCTURE REQUIREMENTS

Table 9: Newlands 3 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct Galilee Railway incl. mine loop and 2 passing loops	2020	1,050	Galilee	10	A
Construct 3 passing loop extensions – GAPE	2020	20	GAPE	10	B
Construct port loop extensions	2020	25	Newlands trunk	10	C
Construct 10 passing loop extensions – Newlands System	2020	60	Newlands trunk	10	D
Construct 2 passing loops on Galilee Railway	2021	45	Galilee	20	E
Construct 4 passing loops on Galilee Railway	2022	90	Galilee	30	F
Construct passing loop – Newlands Jct	2022	20	Newlands trunk	30	G
Construct passing loops – Stoney Creek and Station Creek	2022	40	Newlands trunk	30	H

In this scenario the partial offset of demand from existing access holders negates the need for some of the infrastructure required in the 3 loco scenario. This scenario reduces the capital required to open the Galilee Basin, utilising the benefits of investments previously made by Aurizon.

As with all of the other scenarios, investment in yard facilities will be required to support above rail operations. These costs are not included in the below rail infrastructure requirements described above, consistent with the other scenarios in the NDP.


DANGER
HIGH VOLTAGE
DO NOT CLIMB

4 LOCO

INTRODUCTION

The operational design applied for each service group is described in Table 10.

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation.

Table 10: Newlands 4 loco operational design

Source tonnage	Rollingstock	Notes
Existing Newlands	H-82	3 loco, 82 wagon configuration to meet existing diesel loco and infrastructure capability.
Existing Goonyella	GLT (D)	Reconfigured as a 4 loco, 122 wagon consist within existing Goonyella system constraints.
Expansion Galilee	4 loco/160 wagon	New diesel locos expected to have capability to haul 40 wagons per loco. 4 loco configuration approximately double the length of existing Newlands fleets.
Expansion Goonyella	3 loco/120 wagon	3 loco configuration will fit within existing Goonyella system constraints.

INFRASTRUCTURE REQUIREMENTS

Table 11: Newlands 4 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct Galilee Railway incl. mine loop and a passing loop	2020	1,030	Galilee	10	A
Construct 3 passing loop extensions – GAPE	2020	20	GAPE	10	B
Construct 10 passing loop extensions – Newlands System	2020	120	Newlands trunk	10	C
Construct Collinsville Deviation	2020	90	Newlands trunk	10	D
Construct 3rd port loop	2020	60	Newlands trunk	10	E
Construct port loop extensions	2020	50	Newlands trunk	10	F
Construct passing loop – Newlands Jct	2020	30	Newlands trunk	10	G
Construct 2 passing loops on Galilee Railway	2021	60	Galilee	20	H
Construct 4 passing loops on Galilee Railway	2022	120	Galilee	30	I
Construct passing loop – Collinsville Deviation	2022	30	Newlands trunk	30	J
Construct passing loop – Station Creek	2022	30	Newlands trunk	30	K
Construct 2nd Galilee mine loop	2023	70	Galilee	40	L
Duplicate Buckley – Armuna	2023	100	Newlands trunk	40	M
Duplicate Binbee – Briaba	2023	100	Newlands trunk	40	N
Construct 4th port loop	2023	60	Newlands trunk	40	O
Construct passing loop - Stoney Creek	2023	30	Newlands trunk	40	P
Duplicate Abbot Point – Kaili	2024	60	Newlands trunk	50	Q
Construct 8 passing loops on Galilee Railway	2025	230	Galilee	60	R
Duplicate Newlands Jct – Leichhardt Range	2025	110	Newlands trunk	60	S
Duplicate Armuna – Binbee	2025	200	Newlands trunk	60	T
Duplicate Collinsville Deviation – Station Creek	2026	240	Newlands trunk	75	U
Construct 5th port loop	2026	60	Newlands trunk	75	V
Construct passing loop – Loop 1	2027	20	GAPE	30	W
Duplicate Station Creek – Havilah	2027	250	Newlands trunk	90	X
Duplicate Pring – Buckley	2027	50	Newlands trunk	90	Y
Duplicate Almoola – Collinsville	2027	50	Newlands trunk	90	Z
Duplicate Loop 3 – Riverside	2027	60	North Goonyella	30	AA
Construct 3rd Galilee mine loop	2028	70	Galilee	105	BB
Duplicate Havilah – Newlands Jct	2028	110	Newlands trunk	105	CC
Construct 6th Port Loop	2028	60	Newlands trunk	105	DD
Duplicate Durroburra – Pring	2029	40	Newlands trunk	120	EE

Figure 26: Newlands 4 loco infrastructure requirements

6 LOCO

INTRODUCTION

The operational design applied for each service group is described in Table 12.

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation.

Table 12: Newlands 4 loco operational design

Source tonnage	Rollingstock	Notes
Existing Newlands	H-82	3 loco, 82 wagon configuration to meet existing diesel loco and infrastructure capability.
Existing Goonyella	GLT (D)	Reconfigured as a 4 loco, 122 wagon consist within existing Goonyella system constraints.
Expansion Galilee	6 loco/240 wagon	New diesel locos expected to have capability to haul 40 wagons per loco. 6 loco configuration approximately double the length of existing Goonyella fleets.
Expansion Goonyella	3 loco/120 wagon	3 loco configuration will fit within existing Goonyella system constraints.

INFRASTRUCTURE REQUIREMENTS

Table 13: Newlands 6 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct Galilee Railway incl. mine loop	2020	1,000	Galilee	10	A
Construct 3 passing loop extensions – GAPE	2020	20	GAPE	10	B
Construct 10 passing loop extensions – Newlands System	2020	240	Newlands trunk	10	C
Construct port loop extensions	2020	100	Newlands trunk	10	D
Construct Collinsville Deviation	2020	90	Newlands trunk	10	E
Construct 3rd port loop	2020	80	Newlands trunk	10	F
Construct passing loop on Galilee Railway	2021	40	Galilee	20	G
Construct passing loop – Newlands Jct	2021	40	Newlands trunk	20	H
Construct 2 passing loops on Galilee Railway	2022	80	Galilee	30	I
Construct 2 passing loops on Galilee Railway	2023	80	Galilee	40	J
Construct Galilee 2nd mine loop	2023	70	Galilee	40	K
Construct 4th port loop	2023	80	Newlands trunk	40	L
Construct passing loop – Collinsville Deviation	2023	40	Newlands trunk	40	M
Construct passing loop – Station Creek	2024	40	Newlands trunk	50	N
Construct 4 passing loops on Galilee Railway	2025	160	Galilee	60	O
Duplicate Buckley – Armuna	2025	100	Newlands trunk	60	P
Duplicate Binbee – Briaba	2025	100	Newlands trunk	60	Q
Construct passing loop – Stoney Creek	2025	40	Newlands trunk	60	R
Duplicate Newlands Jct – Leichhardt Range	2026	110	Newlands trunk	75	S
Duplicate Arumuna – Binbee	2026	200	Newlands trunk	75	T
Construct 5th port loop	2026	80	Newlands trunk	75	U
Duplicate Abbot Point – Kaili	2026	60	Newlands trunk	75	V
Construct passing loop – Loop 1	2027	20	GAPE	30	W
Duplicate Collinsville Deviation – Station Creek	2027	240	Newlands trunk	90	X
Duplicate Loop 3 – Riverside	2027	60	North Goonyella	30	Y
Construct 3rd Galilee mine loop	2028	70	Galilee	105	Z
Duplicate Station Creek – Havilah	2028	250	Newlands trunk	105	AA
Construct 6th port loop	2028	80	Newlands trunk	105	BB
Duplicate Almoola – Collinsville Deviation	2028	50	Newlands trunk	105	CC
Duplicate Pring – Buckley	2029	50	Newlands trunk	120	DD

Figure 27: Newlands 6 loco infrastructure requirements

4 LOCO IMPROVED AVAILABILITY UTILISATION

INTRODUCTION

The operational design applied for each service group is described in Table 14.

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation. To evaluate the benefits of increased availability and utilisation the impact of maintenance has been reduced from 15% to 10% and utilisation from 25% to 20%. This is offset by an increased cost of maintenance by 50% per gtk.

Table 14: Newlands 4 loco improved availability operational design

Source tonnage	Rollingstock	Notes
Existing Newlands	H-82	3 loco, 82 wagon configuration to meet existing diesel loco and infrastructure capability.
Existing Goonyella	GLT (D)	Reconfigured as a 4 loco, 122 wagon consist within existing Goonyella system constraints.
Expansion Galilee	4 loco/160 wagon	New diesel locos expected to have capability to haul 40 wagons per loco.
Expansion Goonyella	3 loco/120 wagon	3 loco configuration will fit within existing Goonyella system constraints.

INFRASTRUCTURE REQUIREMENTS

Table 15: Newlands 4 loco improved availability infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct Galilee Railway incl. mine loop and 2 passing loops	2020	1,060	Galilee	10	A
Construct 3 passing loop extensions – GAPE	2020	20	GAPE	10	B
Construct 10 passing loop extensions – Newlands System	2020	120	Newlands trunk	10	C
Construct Collinsville Deviation	2020	90	Newlands trunk	10	D
Construct 3rd port loop	2020	60	Newlands trunk	10	E
Construct port loop extensions	2020	50	Newlands trunk	10	F
Construct 2 passing loops on Galilee Railway	2021	60	Galilee	20	G
Construct 2 passing loops on Galilee Railway	2022	60	Galilee	30	H
Construct 2nd Galilee mine loop	2023	70	Galilee	40	I
Construct 4th port loop	2023	60	Newlands trunk	40	J
Construct passing loop – Newlands Jct	2023	30	Newlands trunk	40	K
Construct 6 passing loops on Galilee Railway	2024	170	Galilee	50	L
Construct passing loop – Collinsville Deviation	2024	30	Newlands trunk	50	M
Construct passing loop – Station Creek	2024	30	Newlands trunk	50	N
Duplicate Binbee – Briaba	2025	100	Newlands trunk	60	O
Construct passing loop – Stoney Creek	2025	30	Newlands trunk	60	P
Duplicate Buckley – Aberdeen	2026	240	Newlands trunk	75	Q
Construct 5th port loop	2026	60	Newlands trunk	75	R
Duplicate Abbot Point – Kaili	2026	60	Newlands trunk	75	S
Duplicate Newlands Jct – Leichhardt Range	2027	110	Newlands trunk	90	T
Duplicate Aberdeen – Binbee	2027	100	Newlands trunk	90	U
Duplicate Coral Creek – Birralee	2027	100	Newlands trunk	90	V
Construct 3rd Galilee mine loop	2028	70	Galilee	105	W
Duplicate Birralee – Cockool	2028	180	Newlands trunk	105	X
Construct 6th port loop	2028	60	Newlands trunk	105	Y
Duplicate Collinsville Deviation – Coral Creek	2028	60	Newlands trunk	105	Z
Duplicate Cockool – Havilah	2029	160	Newlands trunk	120	AA
Duplicate Almoola – Collinsville Deviation	2029	50	Newlands trunk	120	BB

Figure 28: Newlands 4 loco improved availability infrastructure requirements

4 LOCO WITH 30TAL

INTRODUCTION

The operational design applied for each service group is described in Table 16.

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation.

This option introduces 30tal operation from the Galilee basin to understand what cost savings may be achieved through heavier axle loads.

Table 16: Newlands 4 loco 30tal operational design

Source tonnage	Rollingstock	Notes
Existing Newlands	H-82	3 loco, 82 wagon configuration to meet existing diesel loco and infrastructure capability.
Existing Goonyella	GLT (D)	Reconfigured as a 4 loco, 122 wagon consist within existing Goonyella system constraints.
Expansion Galilee	4 loco/140 wagon	New diesel locos expected to have capability to haul 25 30tal wagons per loco.
Expansion Goonyella	3 loco/120 wagon	Fits into current Goonyella infrastructure.

INFRASTRUCTURE REQUIREMENTS

Table 17: Newlands 4 loco 30tal option infrastructure requirements

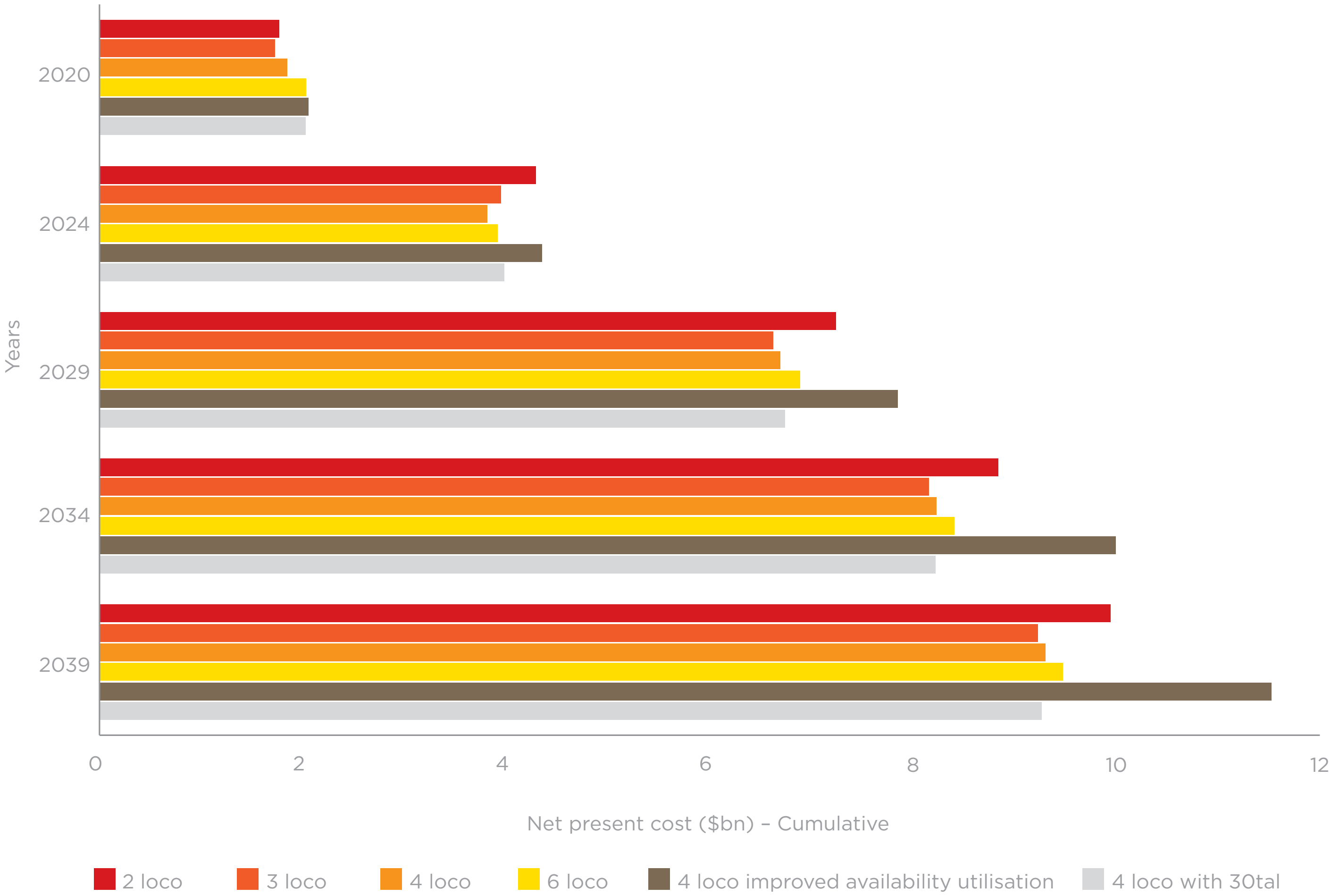
Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct Galilee Railway incl. mine loop and 2 passing loops	2020	1060	Galilee	10	A
Construct 3 passing loop extensions – GAPE	2020	20	GAPE	10	B
Upgrade network for 30tal	2020	230	Newlands & GAPE	10	C
Construct Collinsville Deviation	2020	90	Newlands trunk	10	D
Construct 10 passing loop extensions – Newlands System	2020	90	Newlands trunk	10	E
Construct 3rd port loop	2020	50	Newlands trunk	10	F
Construct port loop extensions	2020	40	Newlands trunk	10	G
Construct passing loop on Galilee Railway	2021	25	Galilee	20	H
Construct passing loop – Newlands Jct	2021	25	Newlands trunk	20	I
Construct 3 passing loops on Galilee Railway	2022	80	Galilee	30	J
Duplicate Binbee – Briaba	2022	100	Newlands trunk	30	K
Construct passing loop – Collinsville Deviation	2022	25	Newlands trunk	30	L
Construct passing loop – Station Creek	2022	25	Newlands trunk	30	M
Construct 3 passing loops on Galilee Railway	2023	80	Galilee	40	N
Construct 2nd Galilee mine loop	2023	70	Galilee	40	O
Duplicate Buckley – Armuna	2023	100	Newlands trunk	40	P
Duplicate Abbot Point – Kaili	2023	60	Newlands trunk	40	Q
Construct 4th port loop	2023	50	Newlands trunk	40	R
Construct passing loop – Stoney Creek	2023	25	Newlands trunk	40	S
Duplicate Armuna – Aberdeen	2024	100	Newlands trunk	50	T
Construct 7 passing loops on Galilee Railway	2025	180	Galilee	60	U
Duplicate Newlands Jct – Leichhardt Range	2025	110	Newlands trunk	60	V
Duplicate Aberdeen – Binbee	2025	100	Newlands trunk	60	W
Duplicate Almoola – Cockool	2026	380	Newlands trunk	75	X
Construct 5th port loop	2026	50	Newlands trunk	75	Y
Duplicate Loop 3 – Riverside	2026	60	North Goonyella	15	Z
Construct passing loop – Loop 1	2027	20	GAPE	30	AA
Duplicate Cockool – Havilah	2027	160	Newlands trunk	90	BB
Duplicate Pring – Buckley	2027	50	Newlands trunk	90	CC
Construct 3rd Galilee mine loop	2028	70	Galilee	105	DD
Duplicate Havilah – Newlands Jct	2028	110	Newlands trunk	105	EE
Construct 6th port loop	2028	50	Newlands trunk	105	FF
Duplicate Durroburra – Pring	2029	40	Newlands trunk	120	GG

Figure 29: Newlands 4 loco 30tal option infrastructure requirements

NEWLANDS SUMMARY RESULTS

COMPARISON OF OPTIONS

Figure 30: Newlands net present cost



GOONYELLA

SCENARIO DEFINITION

This scenario builds on the existing capacity of 140mtpa from the port of Hay Point.

1. An initial 4mtpa from the North Goonyella branch to DBCT in 2020, corresponding to the DBCT zone 4 project.
2. This is followed in 2021 by DBCT 8X with 13mtpa from the Blair Athol and North Goonyella branches.
3. In 2023 and 2024 20mtpa of capacity is provided for HPX4 from the South Goonyella and North Goonyella branches.
4. In 2025 10mtpa of capacity is provided for the Bowen Basin Terminal from the South Goonyella branch.
5. 34mtpa of capacity is provided from the North Goonyella and South Goonyella branches for DBCT 9X, ramping up in 2026 and 2027.

Figure 31: Goonyella growth scenario

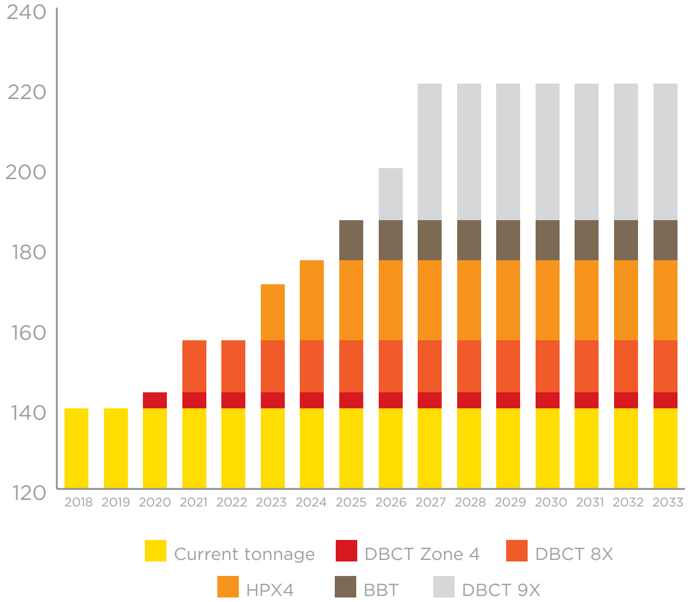


Table 18: Goonyella scenario definition

Stage	Port expansion	Branch	Tonnage	Year
1	DBCT Zone 4	North Goonyella	4	2020
2	DBCT 8X	Blair Athol	10	2021
		North Goonyella	3	2021
3	HPX4	South Goonyella	14	2023
		North Goonyella	6	2024
4	BBT	South Goonyella	10	2025
5	DBCT 9X	South Goonyella	13	2026
		North Goonyella	17	2027
Total			77	

Figure 32: Goonyella source tonnes

3 LOCO – INFRASTRUCTURE-BASED EXPANSION

INTRODUCTION

The operational design applied for each service group is described in Table 19.

This option does not require existing infrastructure to be extended for longer trains and enables a consistent length train to be operated for all hauls – existing and expansion.

Table 19: Goonyella 3 loco operational design

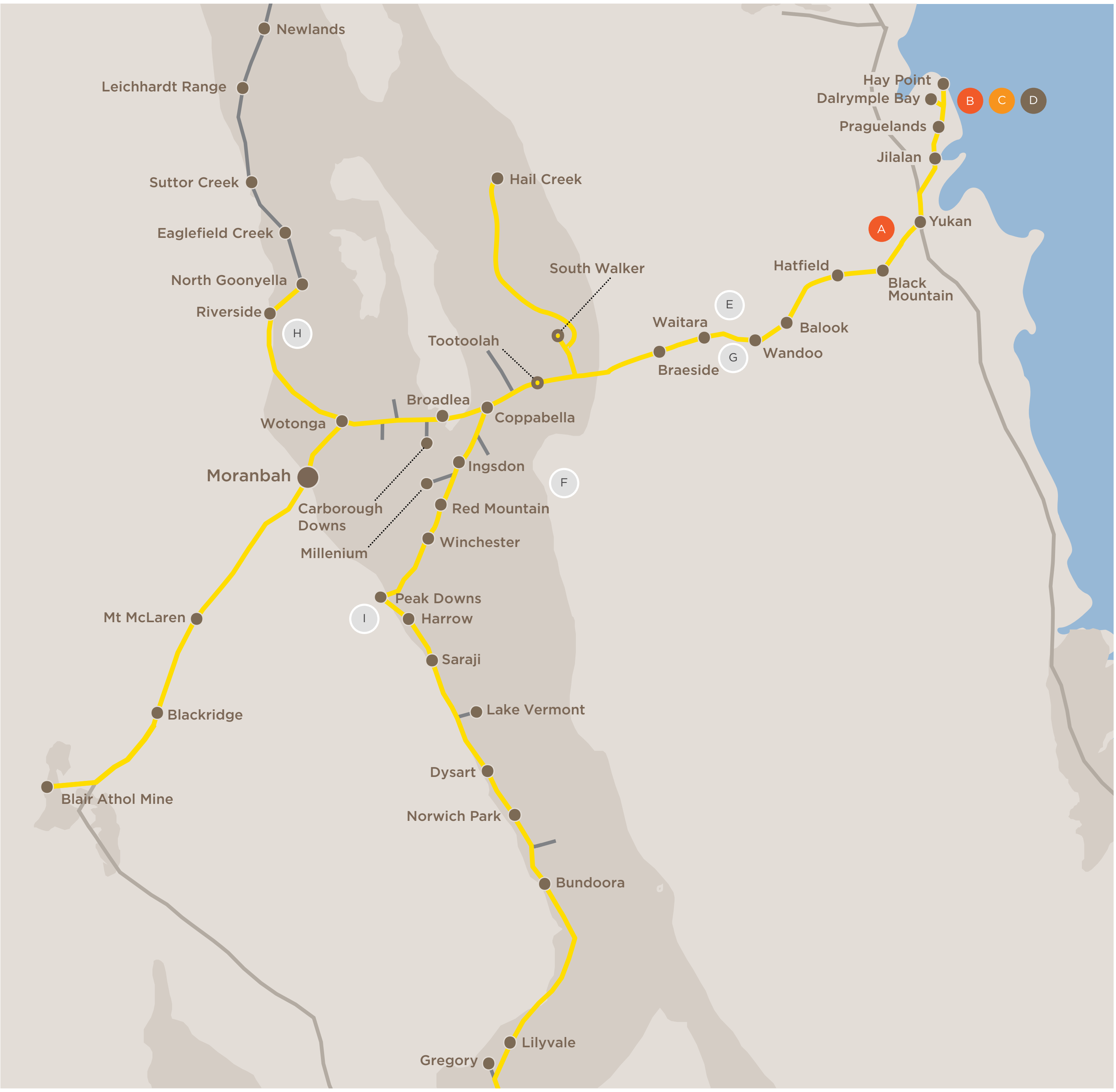
Source tonnage	Rollingstock	Notes
Existing Goonyella	GLT	3 loco, 126 wagon configuration to meet existing electric loco and infrastructure capability.
Expansion Goonyella	3 loco/126 wagon	New electric locos expected to have capability to haul 47 wagons per loco. 3 loco configuration will be overpowered but will fit within existing infrastructure constraints.

INFRASTRUCTURE REQUIREMENTS

Table 20: Goonyella 3 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct 3rd track Hatfield – Yukan	2021	800	Goonyella trunk	14	A
Construct DBCT 4th loop	2021	45	Goonyella trunk	14	B
Construct HPCT 3rd loop	2023	45	Goonyella trunk	31	C
Construct BBT loop	2025	45	Goonyella trunk	47	D
Additional signalling Bolingbroke – Balook	2026	6	Goonyella trunk	60	E
Duplicate Ingsdon – Red Mountain	2026	100	South Goonyella	37	F
Additional signalling Wandoo – Waitara	2027	6	Goonyella trunk	77	G
Duplicate Riverside – Wotonga	2027	170	North Goonyella	30	H
Duplicate Peak Downs – Harrow	2027	100	South Goonyella	37	I

Figure 33: Goonyella 3 loco infrastructure requirements



3 LOCO – IMPROVED HEADWAY

INTRODUCTION

The operational design applied for each service group is described in Table 21.

This option differs from the infrastructure solution by assuming that an operational change and investment is undertaken to resolve headway issues through the Connors Range rather than a third track.

Table 21: Goonyella 3 loco improved Connors Range headway operational design

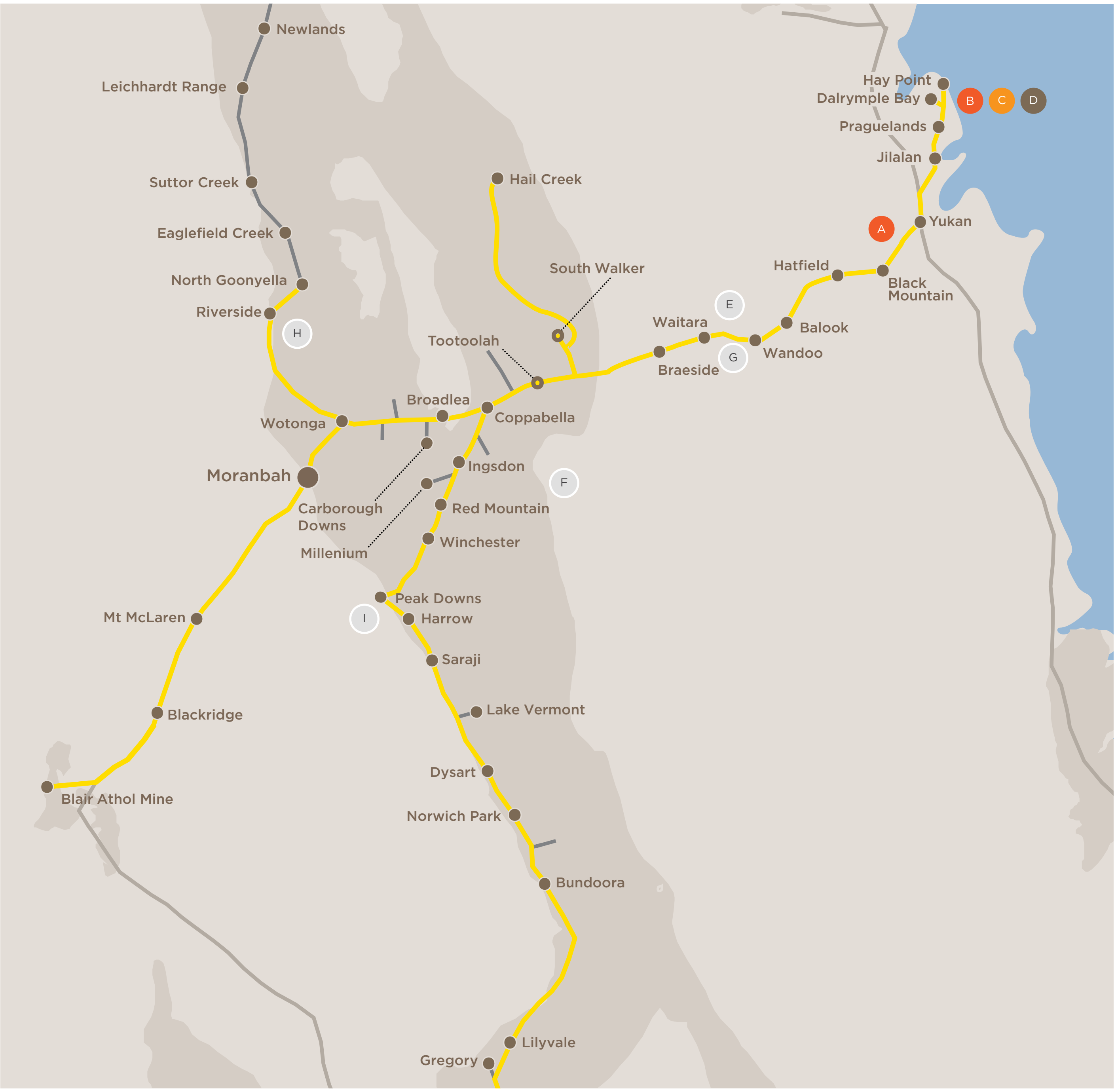
Source tonnage	Rollingstock	Notes
Existing Goonyella	GLT	3 loco, 126 wagon configuration to meet existing electric loco and infrastructure capability.
Expansion Goonyella	3 loco/126 wagon	New electric locos expected to have capability to haul 47 wagons per loco. 3 loco configuration will be overpowered but will fit within existing infrastructure constraints.

INFRASTRUCTURE REQUIREMENTS

Table 22: Goonyella 3 loco improved Connors Range headway infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Decrease headway Hatfield – Yukan	2021	100	Goonyella trunk	14	A
Construct DBCT 4th loop	2021	45	Goonyella trunk	14	B
Construct HPCT 3rd loop	2023	45	Goonyella trunk	31	C
Construct BBT loop	2025	45	Goonyella trunk	47	D
Additional signalling Bolingbroke – Balook	2026	6	Goonyella trunk	60	E
Duplicate Ingsdon – Red Mountain	2026	100	South Goonyella	37	F
Additional signalling Wandoo – Waitara	2027	6	Goonyella trunk	77	G
Duplicate Riverside – Wotonga	2027	170	North Goonyella	30	H
Duplicate Peak Downs – Harrow	2027	100	South Goonyella	37	I

Figure 34: Goonyella 3 loco improved Connors Range headway infrastructure requirements



4 LOCO

INTRODUCTION

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation. Due to an increase in loco capability, trains operating to expansion mines/ports are longer than extended trains to existing mines/ports.

This option assumes that an operational change and investment is undertaken to resolve headway issues through the Connors Range rather than a third track.

Table 23: Goonyella 4 loco operational design

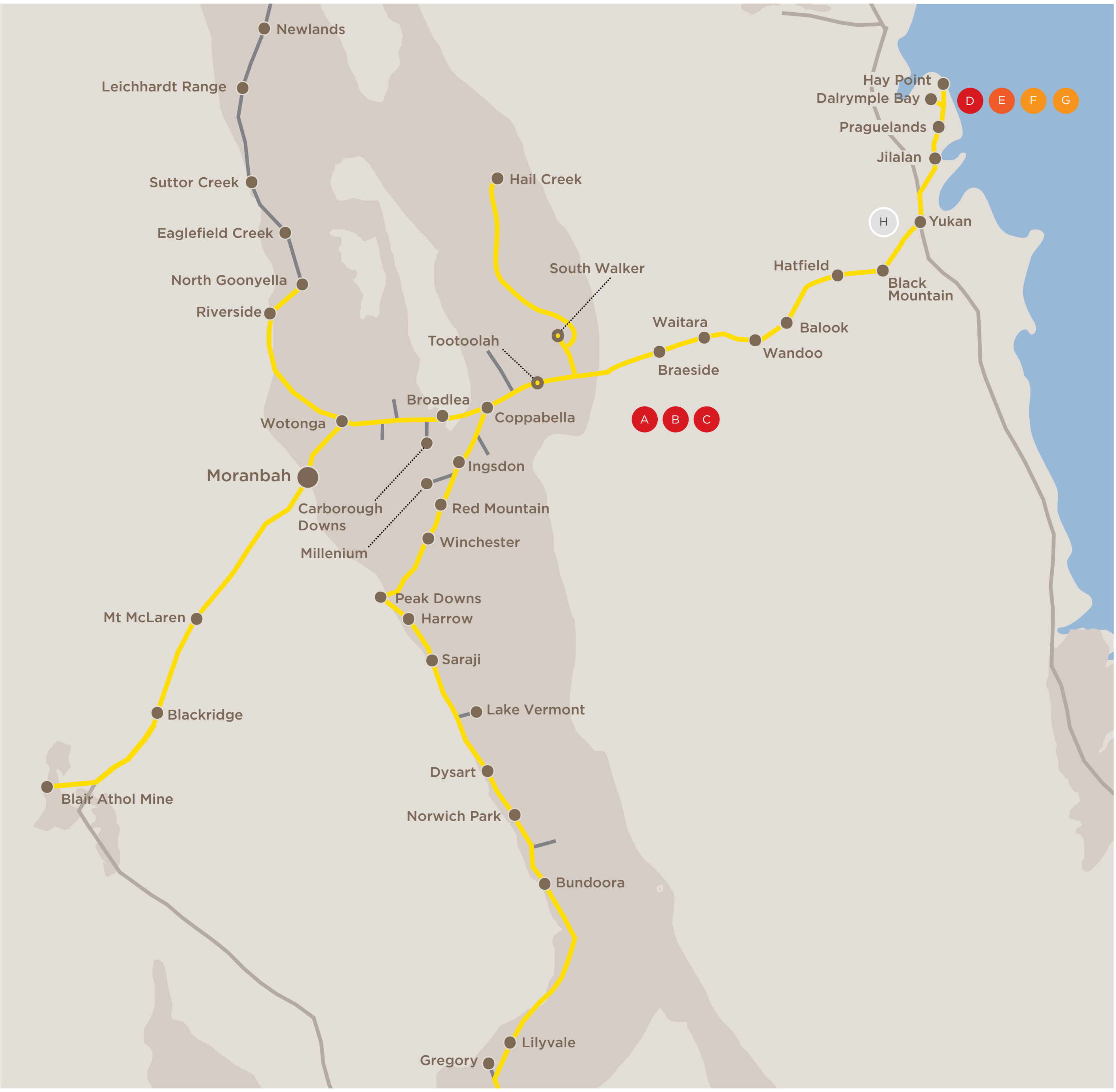
Source tonnage	Rollingstock	Notes
Existing Goonyella	GLT-4	Existing trains reconfigured to a 4 loco, 166 wagon configuration.
Expansion Goonyella	4 loco/188 wagon	New electric locos expected to have capability to haul 47 wagons per loco. 4 loco configuration can haul 188 wagons.

INFRASTRUCTURE REQUIREMENTS

Table 24: Goonyella 4 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Extend mine loops	2020	270	Goonyella trunk	4	A
Extend network infrastructure	2020	250	Goonyella trunk	4	B
Extend passing loops	2020	160	Goonyella trunk	4	C
Extend DBCT & HPCT loops	2020	80	Goonyella trunk	4	D
Construct DBCT 4th loop	2021	70	Goonyella trunk	14	E
Construct HPCT 3rd loop	2023	70	Goonyella trunk	31	F
Construct BBT loop	2023	70	Goonyella trunk	47	G
Decrease headway Hatfield – Yukan	2027	100	Goonyella trunk	77	H

Figure 35: Goonyella 4 loco infrastructure requirements



3 LOCO IMPROVED AVAILABILITY UTILISATION

INTRODUCTION

The operational design applied for each service group is described in Table 25.

This option assumes that an operational change and investment is undertaken to resolve headway issues through the Connors Range rather than a third track.

To evaluate the benefits of increased availability and utilisation, the impact of maintenance has been reduced from 15% to 10% and utilisation from 25% to 20%. This is offset by an increased cost of maintenance by 50% per gtk.

Table 25: Goonyella 3 loco improved availability operational design

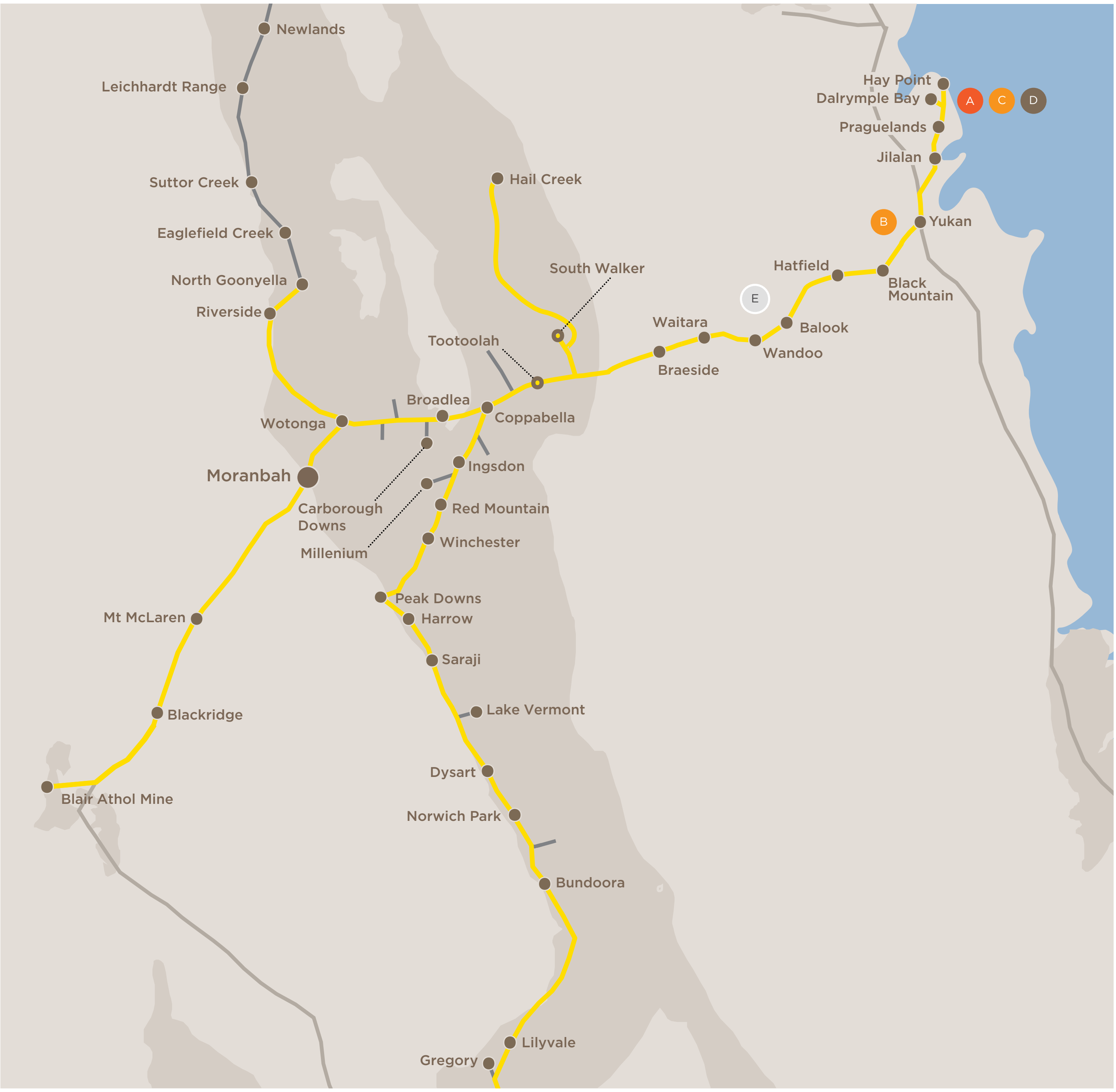
Source tonnage	Rollingstock	Notes
Existing Goonyella	GLT	3 loco, 126 wagon configuration to meet existing electric loco and infrastructure capability.
Expansion Goonyella	3 loco/126 wagon	New electric locos expected to have capability to haul 47 wagons per loco. 3 loco configuration will be overpowered but will fit within existing infrastructure constraints.

INFRASTRUCTURE REQUIREMENTS

Table 24: Goonyella 4 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct DBCT 4th loop	2021	45	Goonyella trunk	14	A
Decrease headway Hatfield – Yukan	2023	100	Goonyella trunk	31	B
Construct HPCT 3rd loop	2023	45	Goonyella trunk	31	C
Construct BBT loop	2025	45	Goonyella trunk	47	D
Additional signalling Bolingbroke – Balook	2027	6	Goonyella trunk	77	E

Figure 36: Goonyella 3 loco improved availability infrastructure requirements



3 LOCO WITH 30TAL

INTRODUCTION

The operational design applied for each service group is described in Table 27.

This option assumes that an operational change and investment is undertaken to resolve headway issues through the Connors Range rather than a third track.

This option introduces 30tal operation for expansion Goonyella hauls to understand what cost savings may be achieved through heavier axle loads.

Table 27: Goonyella 3 loco 30tal operational design

Source tonnage	Rollingstock	Notes
Existing Goonyella	GLT	3 loco, 126 wagon configuration to meet existing electric loco and infrastructure capability.
Expansion Goonyella	3 loco/122 wagon 30tal	New electric locos expected to have capability to haul 41 30tal wagons per loco.

INFRASTRUCTURE REQUIREMENTS

Table 28: Goonyella 3 loco 30tal infrastructure requirements

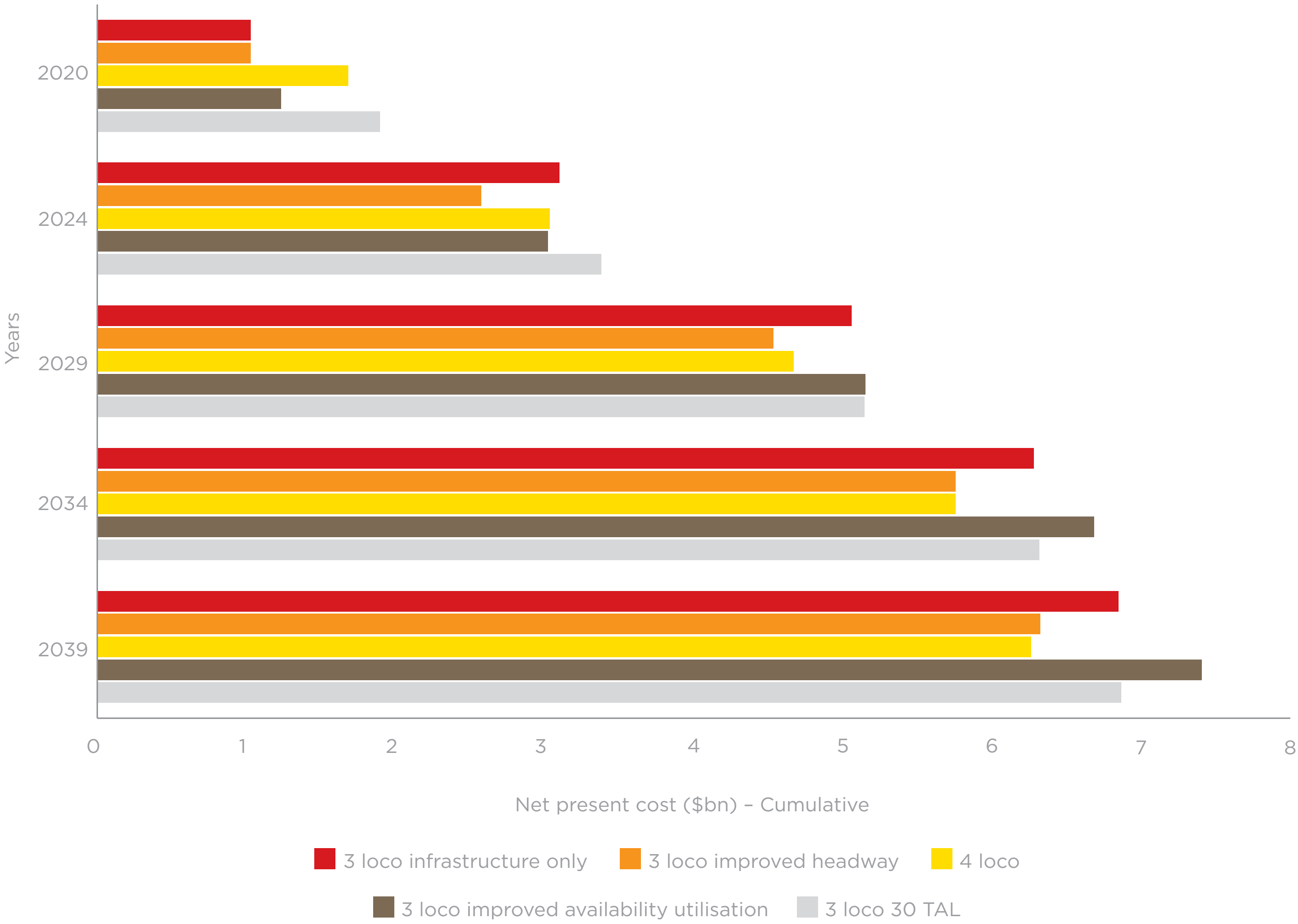
Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Upgrade network for 30tal	2020	1000	Goonyella trunk	4	A
Decrease headway Hatfield – Yukan	2021	100	Goonyella trunk	14	B
Construct DBCT 4th loop	2021	45	Goonyella trunk	17	C
Construct HPCT 3rd loop	2023	45	Goonyella trunk	31	D
Construct BBT loop	2025	45	Goonyella trunk	47	E
Duplicate Ingsdon – Red Mountain	2026	100	South Goonyella	37	F
Additional signalling Bolingbroke – Balook	2027	6	Goonyella trunk	77	G
Duplicate Riverside – Wotonga	2027	170	North Goonyella	30	H

Figure 37: Goonyella 3 loco 30tal infrastructure requirements

GOONYELLA SUMMARY RESULTS

COMPARISON OF OPTIONS

Figure 38: Goonyella net present cost



BLACKWATER/MOURA

SCENARIO DEFINITION

The scenario builds on the existing 120mtpa of capacity through the Blackwater and Moura systems.

1. 30mtpa to a 4th balloon loop at RGT from 2021 to 2022. This includes capacity from South Goonyella, Blackwater trunk, Rolleston and Moura branches.
2. 30mtpa to a second balloon loop at WICET in 2024 and 2025. Capacity is provided from South Goonyella, Rolleston and Blackwater trunk.
3. A third loop at WICET in 2026–2027. This includes 24mtpa from SBR and Moura systems and 6mtpa from Blackwater trunk.
4. A further 30mtpa from SBR to a 4th loop at WICET in 2028 and 2029.

Table 29: Blackwater/Moura scenario definition

Stage	Port expansion	Branch	Tonnage	Year
1	RGT 4	South Goonyella	12	2021
		Blackwater trunk	4	2021
		Rolleston	8	2022
		Moura	6	2022
2	WICET 2	South Goonyella	9	2024
		Blackwater trunk	4	2024
		Rolleston	6	2025
		South Goonyella	11	2025
3	WICET 3	Moura	4	2026
		Blackwater trunk	6	2026
		SBR	20	2026–2027
4	WICET 4	SBR	30	2028–2029
Total			120	

Figure 39: Blackwater/Moura growth scenario

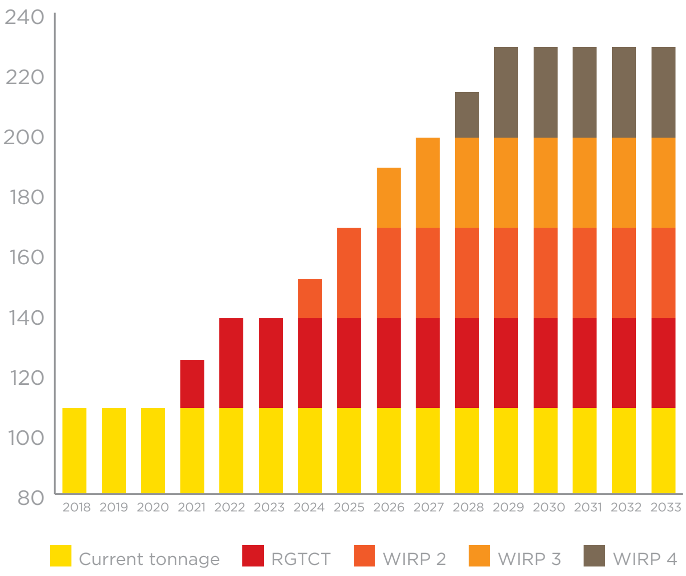
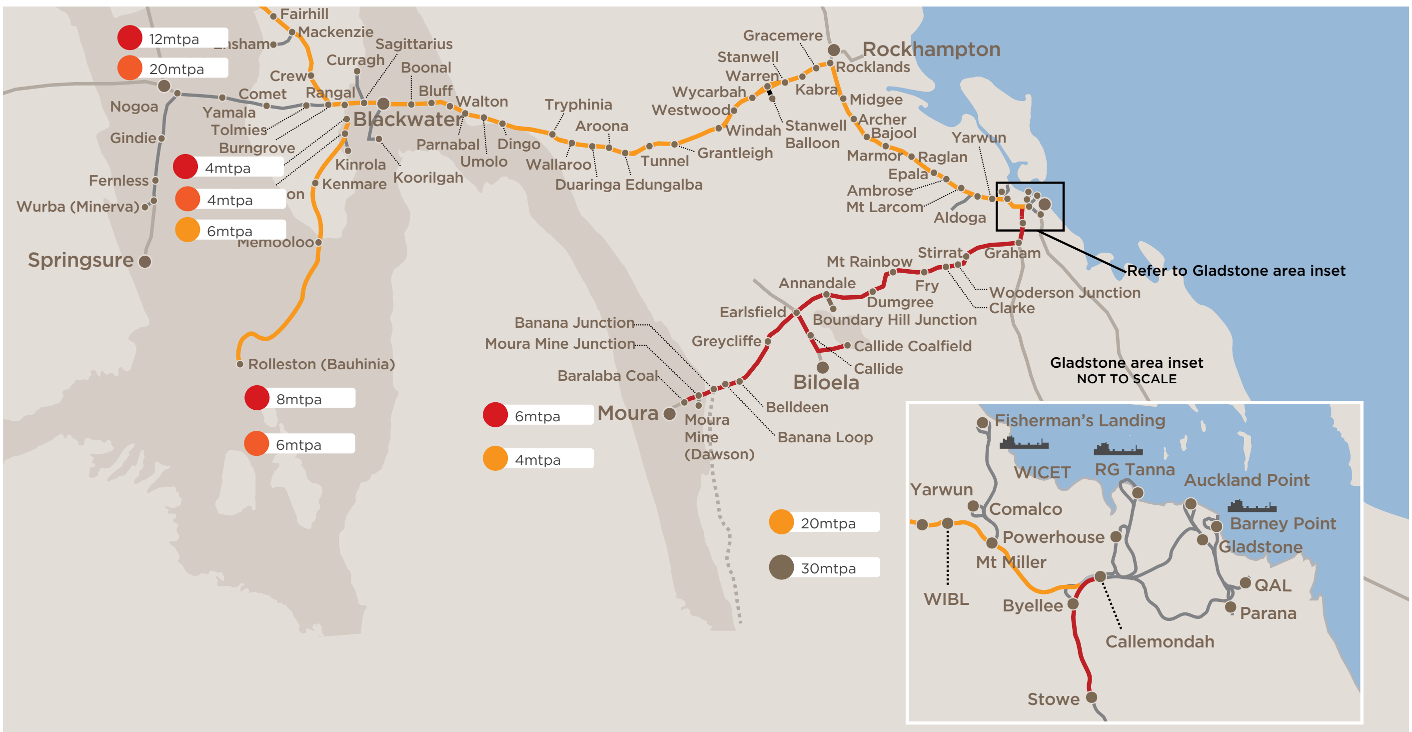


Figure 40: Blackwater/Moura source tonnes



3 LOCO

INTRODUCTION

This option does not require existing infrastructure to be extended for longer trains but requires augmentation (additional loops, duplications, yard expansions) earlier than for the longer train scenarios considered.

Table 30: Blackwater/Moura 3 loco operational design

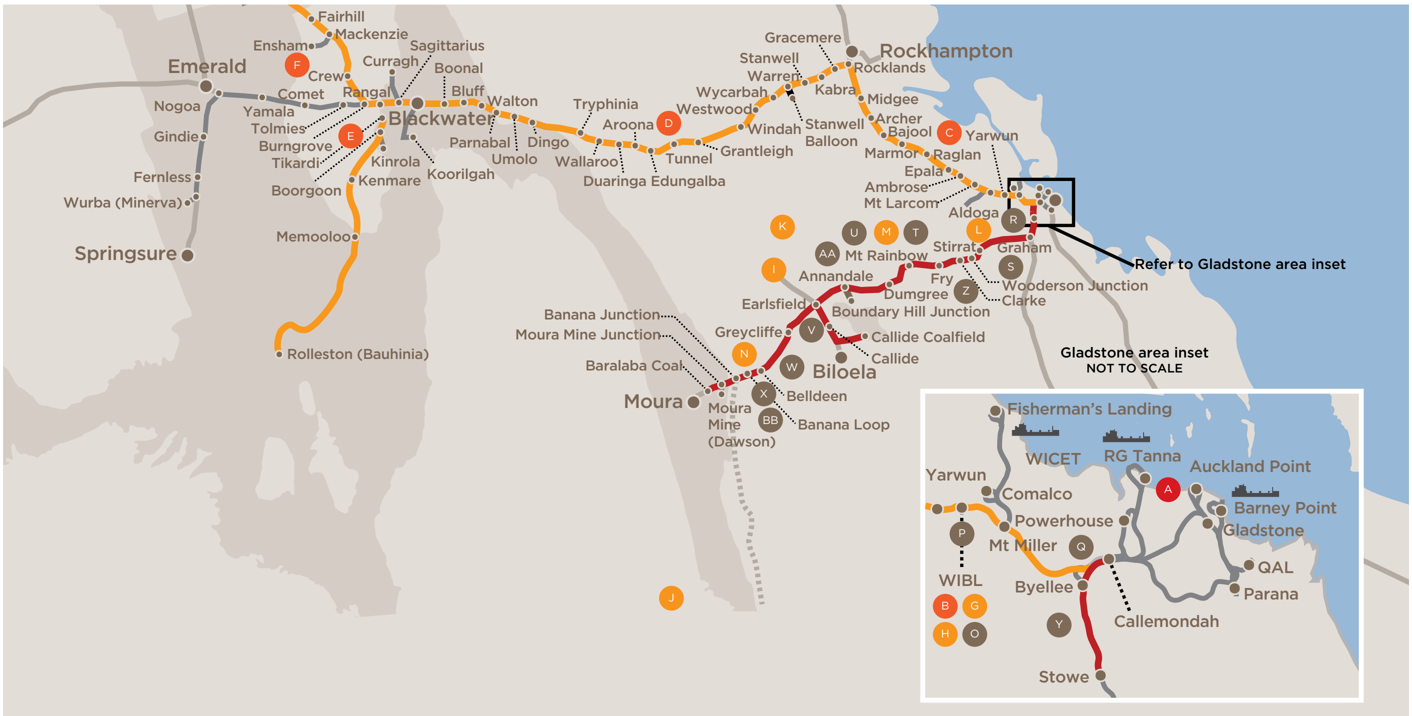
Source tonnage	Rollingstock	Notes
Existing Blackwater	100 wagon train	100 wagon trains operate with AC electric (3 locos).
Existing Moura	100 wagon diesel train	Diesel operation only.
Expansion Blackwater	100 wagon electric train	3 loco AC configuration will be overpowered but will fit within existing infrastructure constraints.
Expansion Moura/SBR	100 wagon diesel train	4 loco configuration will be overpowered but will fit within existing infrastructure constraints.

INFRASTRUCTURE REQUIREMENTS

Table 31: Blackwater/Moura 3 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct RGT 4th loop	2021	40	Blackwater trunk	16	A
Construct WICET 2nd loop	2024	40	Blackwater trunk	43	B
Decrease headway North Coast Line	2025	500	Blackwater trunk	54	C
Construct Tunnel – Edungalba grade easing	2025	100	Blackwater trunk	54	D
Duplicate Tikardi – Kenmare	2025	30	Rolleston	14	E
Construct passing loop Crew – Mackenzie	2025	20	South Goonyella	32	F
Construct WICET 3rd loop	2026	40	Blackwater trunk	80	G
Construct southern connection to WICET	2026	400	Moura trunk	20	H
Construct passing loop Annandale – Greycliffe	2026	20	Moura trunk	45	I
Construct SBR railway incl. 2 passing loops	2026	1,040	SBR	20	J
Moura formation strengthening	2027	100	Moura trunk	30	K
Construct passing loop Stirrat – Wooderson Jct	2027	20	Moura trunk	30	L
Duplicate Mount Rainbow – Dumgree	2027	170	Moura trunk	30	M
Construct passing loop Belldeen – Banana Loop	2027	20	Moura trunk	30	N
Construct WICET 4th loop	2028	40	Blackwater trunk	105	O
Duplicate WICET Jct – WICET	2028	130	Blackwater trunk	105	P
Construct passing loop Callemondah – Byellee	2028	20	Moura trunk	45	Q
Construct passing loop Stowe – Graham	2028	20	Moura trunk	45	R
Duplicate Wooderson Jct – Clarke	2028	170	Moura trunk	45	S
Duplicate Fry – Mount Rainbow	2028	150	Moura trunk	45	T
Construct passing loop Dumgree – Boundary Hill Jct	2028	20	Moura trunk	45	U
Duplicate Annandale – Greycliffe	2028	70	Moura trunk	45	V
Duplicate Greycliffe – Belldeen	2028	240	Moura trunk	45	W
Duplicate Belldeen – Banana Loop	2028	150	Moura trunk	45	X
Duplicate Byellee – Stowe	2029	110	Moura trunk	60	Y
Duplicate Clarke – Fry	2029	100	Moura trunk	60	Z
Duplicate Dumgree – Boundary Hill Jct	2029	110	Moura trunk	60	AA
Additional signalling Belldeen – Banana Loop	2029	0	Moura trunk	60	BB

Figure 41: Blackwater/Moura 3 loco infrastructure requirements



4 LOCO – NEW ONLY

INTRODUCTION

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation. Mines without expansion tonnes continue to operate with current train size eliminating the need for balloon loop extensions.

Table 32: Blackwater/Moura 4 loco new only operational design

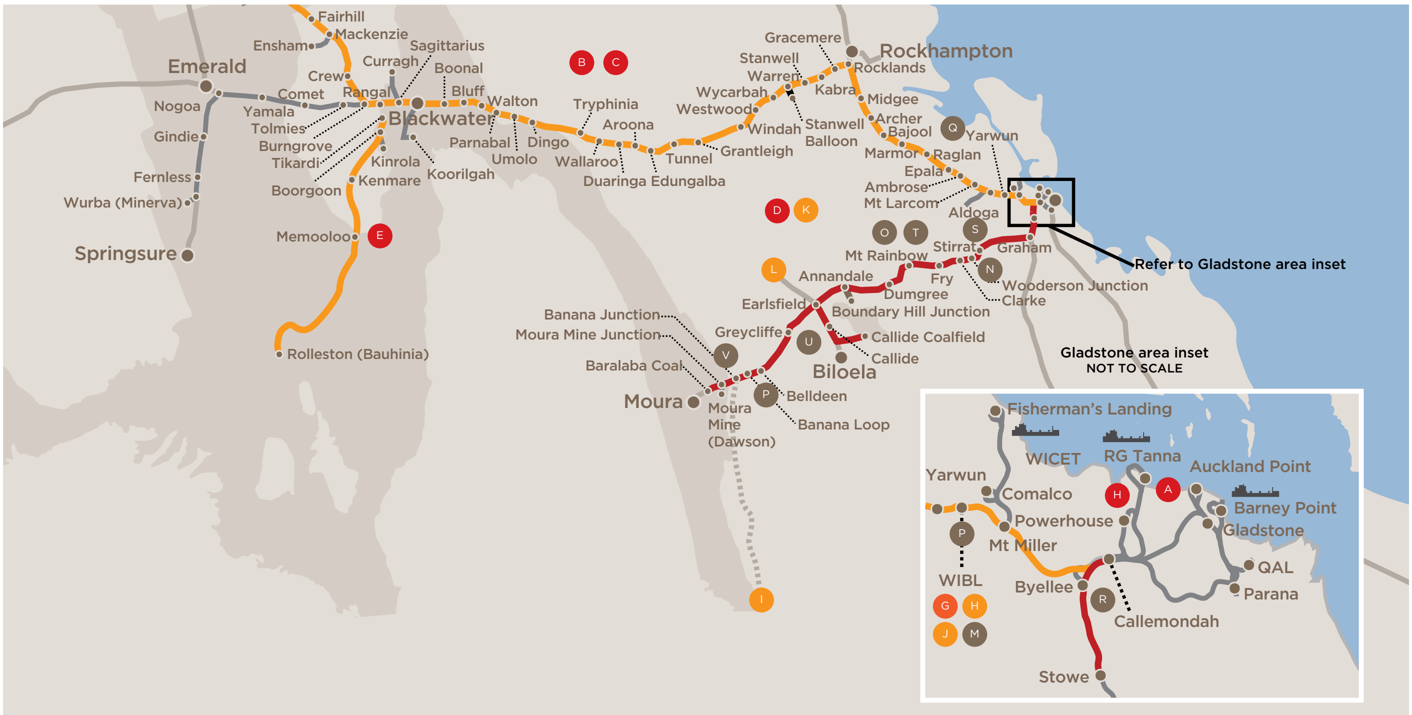
Source tonnage	Rollingstock	Notes
Existing Blackwater	100 wagon train	100 wagon trains operate with AC electric (3 locos).
Existing Moura	100 wagon diesel train	Diesel operation only.
Expansion Blackwater	168 wagon electric train	4 loco AC configuration can haul 168 wagons.
Expansion Moura/SBR	152 wagon diesel train	4 loco Diesel configuration can haul 152 wagons.

INFRASTRUCTURE REQUIREMENTS

Table 33: Blackwater/Moura 4 loco new only infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct RGT 4th loop	2021	60	Blackwater trunk	16	A
Extend network infrastructure	2021	200	Blackwater trunk	16	B
Extend mine balloons	2021	90	Blackwater trunk	16	C
Extend passing loops	2022	70	Moura trunk	6	D
Construct 3 passing loop extensions – Rolleston	2022	30	Rolleston	8	E
Construct WICET 2nd loop	2024	60	Blackwater trunk	43	G
Construct WICET 3rd loop	2026	60	Blackwater trunk	80	H
Construct SBR Railway incl. 3 passing loops	2026	1,060	Moura trunk	20	I
Construct southern connection to WICET	2026	400	Moura trunk	20	J
Moura formation strengthening	2027	100	Moura trunk	30	K
Construct passing loop Annandale – Greycliffe	2027	30	Moura trunk	30	L
Construct WICET 4th loop	2028	60	Blackwater trunk	105	M
Construct passing loop Stirrat – Wooderson Jct	2028	30	Moura trunk	45	N
Duplicate Mount Rainbow – Dumgree	2028	170	Moura trunk	45	O
Construct passing loop Belldeen – Banana Loop	2028	30	Moura trunk	45	P
Decrease headway North Coast Line	2029	500	Blackwater trunk	60	Q
Construct passing loop Callemondah – Byellee	2029	30	Moura trunk	60	R
Duplicate Wooderson Junction – Clarke	2029	170	Moura trunk	60	S
Duplicate Fry – Mount Rainbow	2029	150	Moura trunk	60	T
Duplicate Annandale – Greycliffe	2029	70	Moura trunk	60	U
Duplicate Belldeen – Banana Loop	2029	150	Moura trunk	60	V

Figure 42: Blackwater/Moura 4 loco new only infrastructure requirements



4 LOCO – ALL HAULS

INTRODUCTION

This option, as for all longer train scenarios, requires existing infrastructure to be extended to cater for the longer trains. This delays the need for augmentation (additional loops, duplications, yard expansions) and influences the efficiency of the above rail operation. In this option it is assumed all mine balloons and loadouts are modified for longer trains.

Table 34: Blackwater/Moura 4 loco operational design

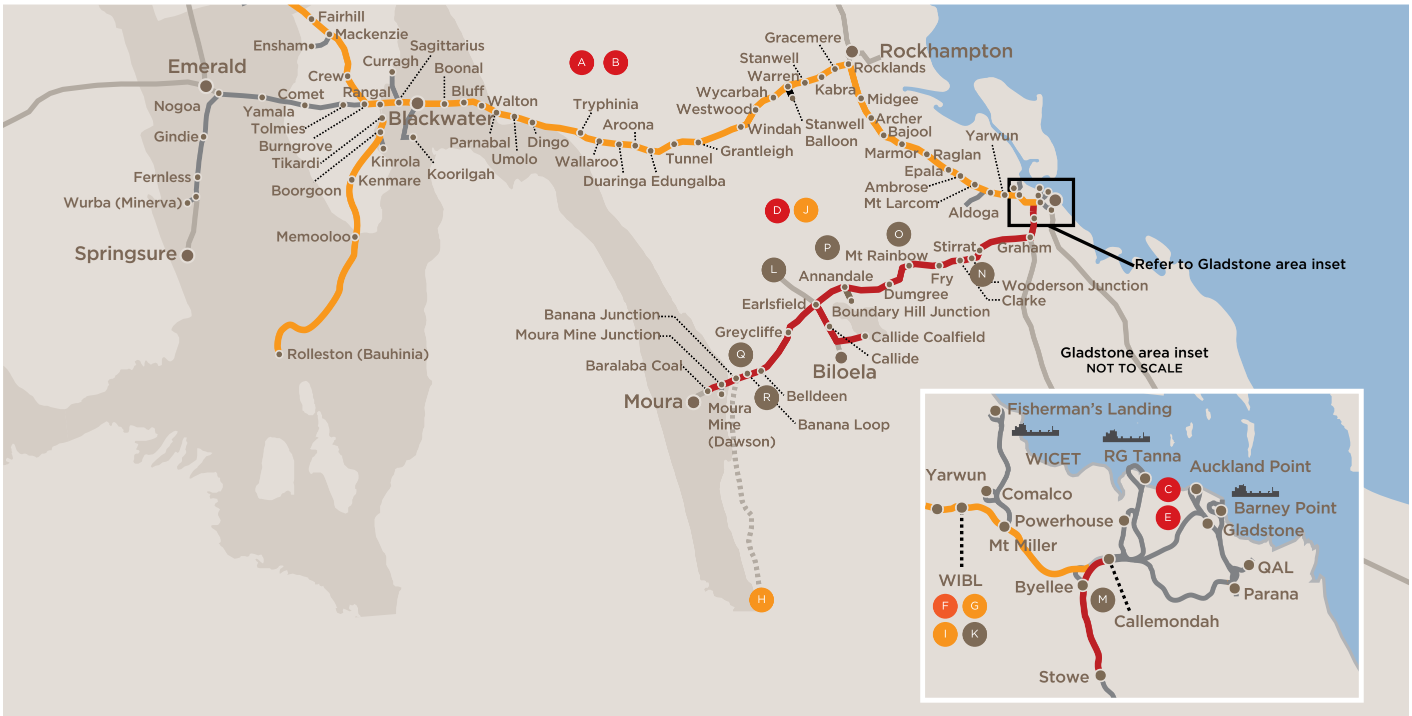
Source tonnage	Rollingstock	Notes
Existing Blackwater	168 wagon train	Reconfigured as a 5 electric loco 168 wagon consist.
Existing Moura	166 wagon diesel train	Reconfigured as a 6 diesel loco, 166 wagon consist.
Expansion Blackwater	168 wagon electric train	4 new generation electric locos can haul 168 wagons.
Expansion Moura/SBR	152 wagon diesel train	4 new generation diesel locos can haul 152 wagons.

INFRASTRUCTURE REQUIREMENTS

Table 35: Blackwater/Moura 4 loco infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Extend network infrastructure	2020	200	Blackwater trunk	0	A
Extend mine loops	2020	200	Blackwater trunk	0	B
Extend RGT loops	2020	70	Blackwater trunk	0	C
Extend passing loops	2020	90	Moura trunk	0	D
Construct RGT 4th loop	2021	60	Blackwater trunk	16	E
Construct WICET 2nd loop	2024	60	Blackwater trunk	43	F
Construct WICET 3rd loop	2026	60	Blackwater trunk	105	G
Construct SBR Railway incl. 3 passing loops	2026	1,060	Moura trunk	20	H
Construct southern connection to WICET	2026	400	Moura trunk	20	I
Moura formation strengthening	2027	100	Moura trunk	30	J
Construct WICET 4th loop	2028	60	Blackwater trunk	105	K
Construct passing loop Annandale – Greycliffe	2028	30	Moura trunk	45	L
Construct passing loop Callemondah – Byellee	2029	30	Moura trunk	60	M
Construct passing loop Stirrat – Wooderson Jct	2029	30	Moura trunk	60	N
Duplicate Fry – Mount Rainbow	2029	150	Moura trunk	60	O
Duplicate Mount Rainbow – Dumgree	2029	170	Moura trunk	60	P
Construct passing loop Belldeen – Banana Loop	2029	30	Moura trunk	60	Q
Duplicate Belldeen – Banana Loop	2029	150	Moura trunk	60	R

Figure 43: Blackwater/Moura 4 loco infrastructure requirements



3 LOCO IMPROVED AVAILABILITY UTILISATION

INTRODUCTION

This does not require existing infrastructure to be extended for longer trains but requires augmentation (additional loops, duplications, yard expansions) earlier than for the longer train scenarios considered.

To evaluate the benefits of increased availability and utilisation, the impact of maintenance has been reduced from 15% to 10% and utilisation increased from 75% to 80%. This is offset by a maintenance cost increase of 50% per gtk.

Table 36: Blackwater/Moura 3 loco improved availability operational design

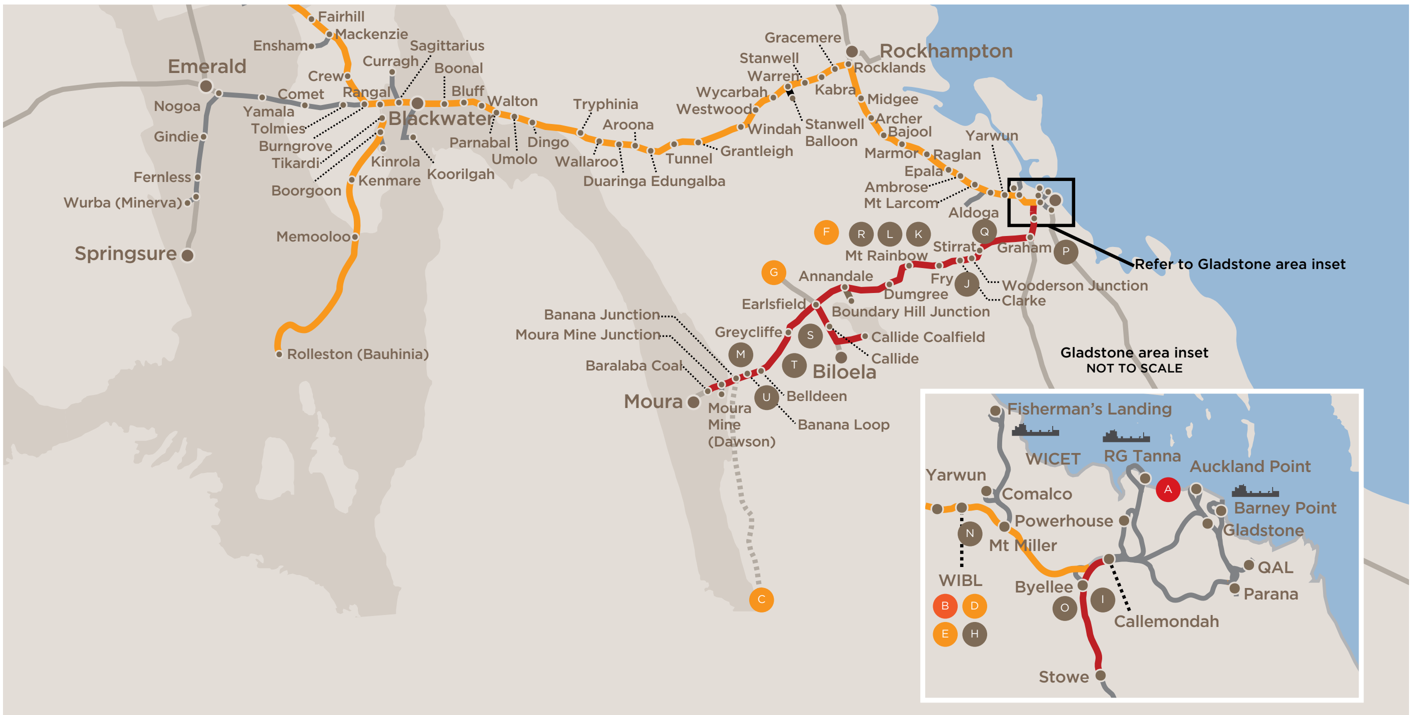
Source tonnage	Rollingstock	Notes
Existing Blackwater	100 wagon train	100 wagon trains operate with AC electric (3 locos).
Existing Moura	100 wagon diesel train	Diesel operation only.
Expansion Blackwater	100 wagon electric train	3 loco AC configuration will be overpowered but will fit within existing infrastructure constraints.
Expansion Moura/SBR	100 wagon diesel train	4 loco configuration will be overpowered but will fit within existing infrastructure constraints.

INFRASTRUCTURE REQUIREMENTS

Table 37: Blackwater/Moura 3 loco improved availability infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct RGT 4th loop	2021	50	Blackwater trunk	16	A
Construct WCET 2nd loop	2024	50	Blackwater trunk	43	B
Construct SBR Railway incl. 2 passing loops	2026	1,040	Moura trunk	20	C
Construct southern connection to WICET	2026	400	Moura trunk	20	D
Construct WICET 3rd loop	2026	50	Blackwater trunk	80	E
Moura formation strengthening	2027	100	Moura trunk	30	F
Construct passing loop Annandale – Greycliffe	2027	20	Moura trunk	30	G
Construct WICET 4th loop	2028	50	Blackwater trunk	105	H
Construct passing loop Callemondah – Byellee	2028	20	Moura trunk	45	I
Construct passing loop Stirrat – Wooderson Jct	2028	20	Moura trunk	45	J
Duplicate Fry – Mount Rainbow	2028	150	Moura trunk	45	K
Duplicate Mount Rainbow – Dumgree	2028	170	Moura trunk	45	L
Construct passing loop Belldeen – Banana Loop	2028	20	Moura trunk	45	M
Duplicate WICET Jct – WICET	2029	130	Moura trunk	60	N
Duplicate Byellee – Stowe	2029	110	Moura trunk	60	O
Construct passing loop Stowe – Graham	2029	20	Moura trunk	60	P
Duplicate Wooderson Jct – Clarke	2029	170	Moura trunk	60	Q
Construct passing loop Dumgree – Boundary Hill Jct	2029	20	Moura trunk	60	R
Duplicate Annandale – Greycliffe	2029	70	Moura trunk	60	S
Duplicate Greycliffe – Belldeen	2029	240	Moura trunk	60	T
Duplicate Belldeen – Banana Loop	2029	150	Moura trunk	60	U

Figure 44: Blackwater/Moura 3 loco improved availability infrastructure requirements



3 LOCO 30TAL SBR

INTRODUCTION

This option introduces 30tal operation from the Surat Basin to understand what cost savings may be achieved through heavier axle loads.

Table 38: Blackwater/Moura 3 loco improved availability operational design

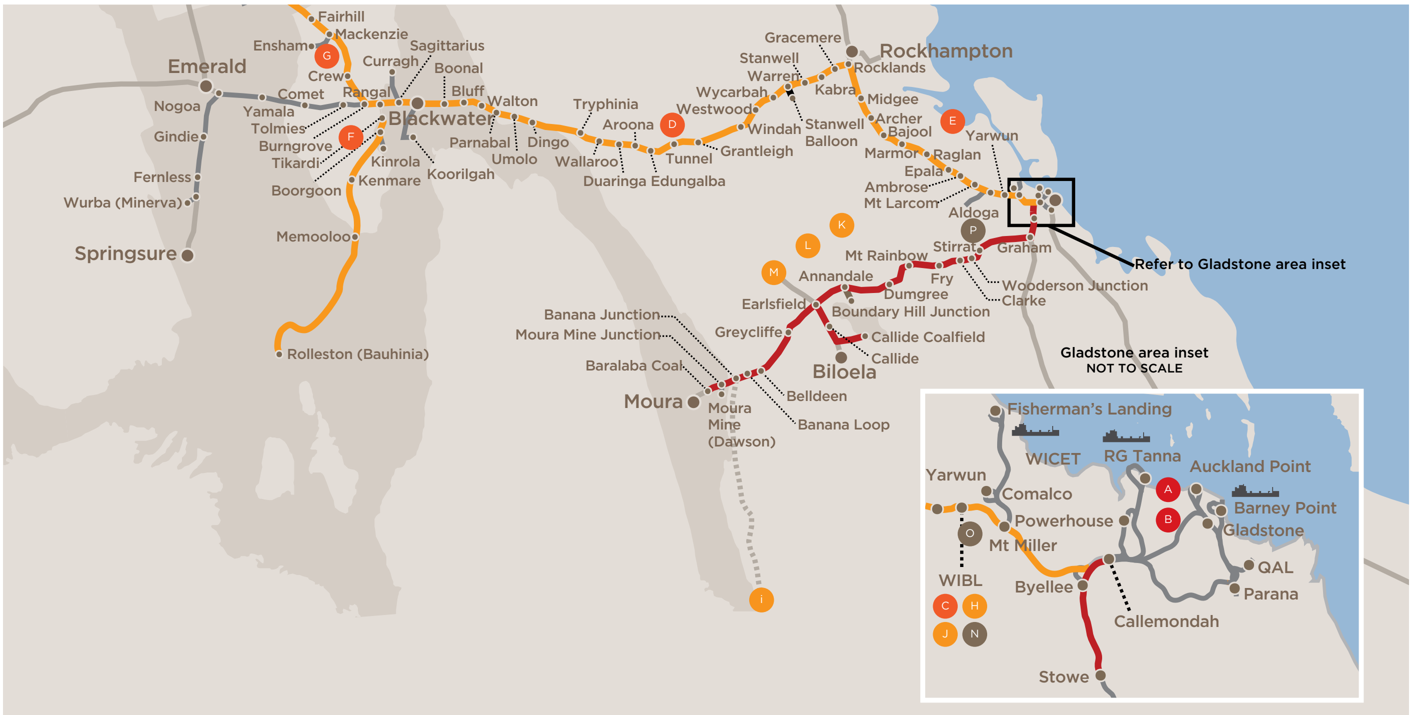
Source tonnage	Rollingstock	Notes
Existing Blackwater	100 wagon train	100 wagon trains operate with AC electric (3 locos).
Existing Moura	100 wagon diesel train	Diesel operation only.
Expansion Blackwater	100 wagon electric train	3 loco AC configuration will be overpowered but will fit within existing infrastructure constraints.
Expansion Moura/SBR	136 130tal wagon diesel train	4 loco configuration can haul 136 wagons.

INFRASTRUCTURE REQUIREMENTS

Table 39: Blackwater/Moura 3 loco 30tal SBR infrastructure requirements

Description	Year	Cost estimate ($m)	Section	Trigger volume	ID
Construct RGT loop extensions	2020	70	Blackwater trunk	0	A
Construct RGT 4th loop	2021	40	Blackwater trunk	16	B
Construct WICET 2nd loop	2024	60	Blackwater trunk	43	C
Construct Tunnel – Edungalba grade easing	2025	100	Blackwater trunk	54	D
Decrease headway North Coast Line	2025	400	Blackwater trunk	54	E
Duplicate Tikardi – Kenmare	2025	30	Rolleston	14	F
Construct passing loop Crew – Mackenzie	2025	20	South Goonyella	32	G
Construct WICET 3rd loop	2026	50	Blackwater trunk	80	H
Construct SBR Railway incl. a passing loop	2026	1,060	Moura trunk	20	I
Construct southern connection to WICET	2026	400	Moura trunk	20	J
Extend passing loops	2026	90	Moura trunk	20	K
Moura formation strengthening	2026	100	Moura trunk	20	L
Construct passing loop Annandale – Greycliffe	2026	20	Moura trunk	20	M
Construct WICET 4th loop	2028	50	Blackwater trunk	105	N
Duplicate WICET Jct – WICET	2029	130	Moura trunk	60	O
Duplicate Wooderson Jct – Clarke	2029	170	Moura trunk	60	P

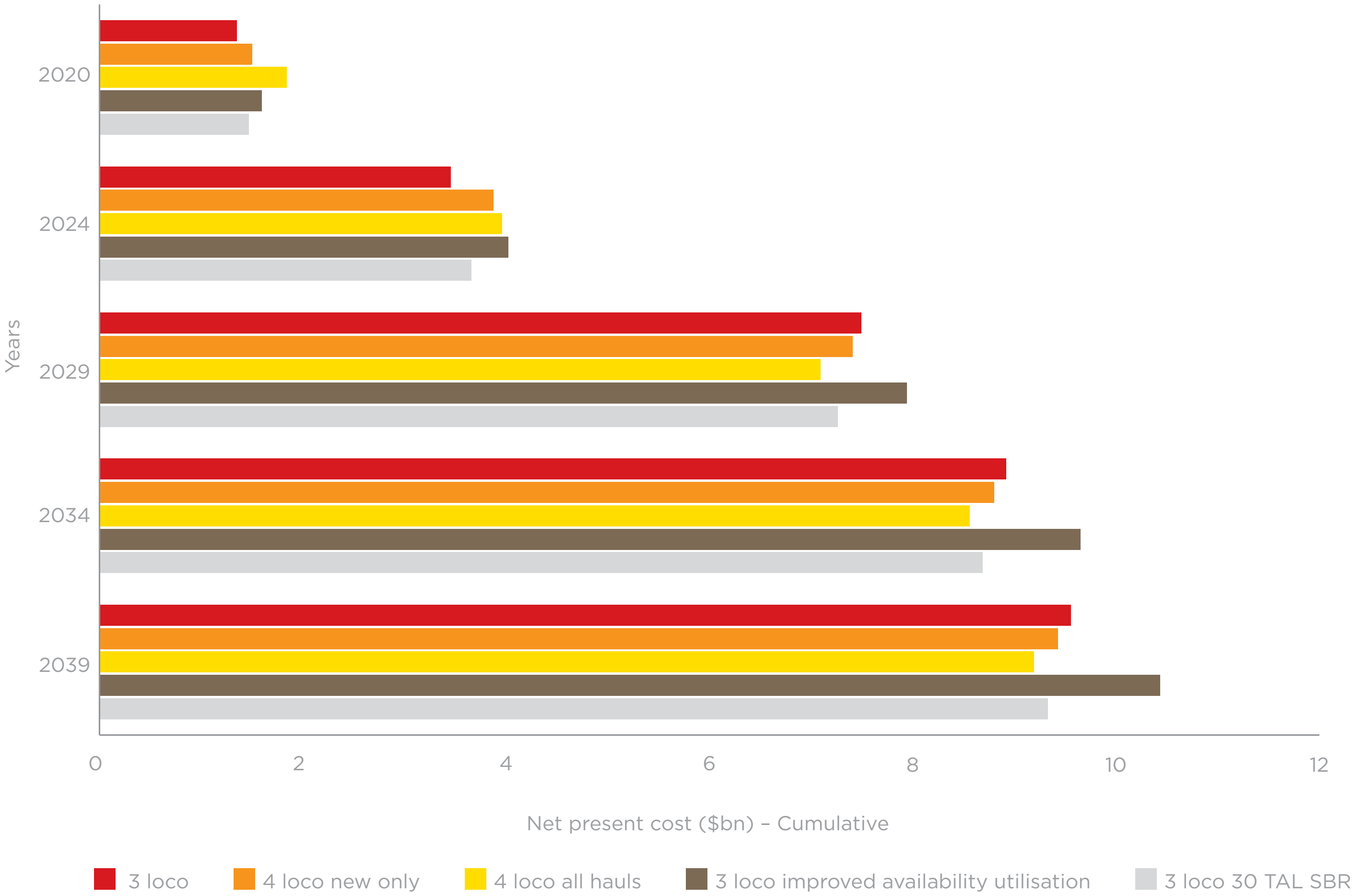
Figure 45: Blackwater/Moura 30 tonne axle load SBR expansion infrastructure requirements



BLACKWATER/MOURA SUMMARY RESULTS

COMPARISON OF OPTIONS

Figure 46: Blackwater/Moura scenario net present cost



05 Further Studies.

The 2014 NDP identified a number of corridor studies and investigations to be undertaken. The progress made on these to date and future plans are provided in the table below.

Area	2016 Progress	2017 planned work
Newlands	The X110 study has continued through 2016 with a focus on developing an integrated solution for the port precinct at Abbot Point.	Finalisation of the study stage with selection of the most cost effective system configuration.
Goonyella	No work undertaken.	No studies planned for 2017.
Blackwater/Moura	Participation in the state government Gladstone Port Master Planning process.	Continued participation in the state government Gladstone Port Master Planning process.
Maintenance and availability	During 2016 we revisited the maintenance and renewal input parameters used in the CQSCM to reflect the impact of investments in APEX, NAMS, PACE and other systems that affect availability. This is documented in the System Operating Parameters.	Data collected and analysed as a result of the implementation of NAMS, APEX and PACE will be used to revisit the static modelling input parameters used in pre-concept and concept analysis.
Utilisation	To enable a robust analysis of practical utilisation levels, Aurizon Network Planning & Development has commenced enhancements to the CQSCM.	The CQSCM will continue to be developed to enable the ability to measure achievable levels of utilisation across the CQCN.
Speed increase	In 2016, work has been undertaken to identify individual sections where speed increases could be implemented.	During 2017 the potential benefit and costs of these speed increases will be evaluated.
Train density	A concept study into increasing train density was completed as part of the Network Technical Strategy.	

A	
Above rail services	Those activities, other than below rail services, required to provide and operate train services, including rollingstock provision, rollingstock maintenance, non-train control related communications, train crewing, terminal provision and services, freight handling and marketing and administration of those services and above rail has a similar meaning.
AAPT	Adani Abbot Point Terminal.
APCT	Abbot Point Coal Terminal.
APEX	Advanced Planning and Execution system.
B	
Below rail services	The activities associated with the provision and management of rail infrastructure, including the construction, maintenance and renewal of rail infrastructure assets, and the network management services required for the safe operation of train services on the rail infrastructure, including train control.
Blackwater System	The rail infrastructure comprising the rail corridor from the Port of Gladstone (including domestic coal terminals in the vicinity of Gladstone) to Gregory, Minerva and Rolleston mines, and all branch lines directly connecting coalmine loading facilities to those corridors with the exception of: › the corridor to Oaky Creek (and beyond) › the corridor to Moura mine (and beyond).
BPCT	Barney Point Coal Terminal.
C	
CAGR	Compound annual growth rate.
COO	Concept of Operations – a document providing detail regarding proposed future operating model of the rail network.
COP	Conceptual Operating Plan – a document submitted by an access seeker as part of an access request defining their proposed operation.
CQCN	Central Queensland Coal Network.
CQSCM	Central Queensland Supply Chain Model – a discrete event model built specifically to assess performance of the CQCN including supply chain interfaces.
Coal Rail Infrastructure Master Plan (CRIMP)	The master plan, produced up until 2010 contains an outline of possible future expansions, identifies projects where investments in rail infrastructure are required, and facilitates the regulatory voting process.
Coal supply chain	The coal supply chain encompasses all activities associated with the flow and transformation of coal from the extraction stage, through to the end user, as well as the associated information flows.
CTM	Cost of Transport Model.
Cycle time	The total time taken by a train, once ready to depart from the depot, to travel to the mine, load, travel to the port, unload and arrive back at the depot. It includes all planned and unplanned dwells and delays.

D	
Daily Train Plan (DTP)	That document detailing the scheduled times for all train services and any planned possessions, urgent possessions and emergency possessions for a particular day on a specified part of the rail infrastructure.
DBCT	Dalrymple Bay Coal Terminal.
DTC	Direct Traffic Control – a system of safe working where train movements are governed by instructions contained in DTC authorities issued by the train controller to a train driver. In DTC territory the track is divided into sections known as DTC blocks, the entry to which is identified by lineside block limit boards. A DTC authority gives a train possession of the block/s up to the nominated block limit board.
G	
GLT	A standard Goonyella length electric train of 124 wagons.
GLT (D)	A diesel hauled train of length suitable for use in the Goonyella system. Nominally 122 wagons and 4 locomotives.
Goonyella Newlands Connection	The rail infrastructure between the North Goonyella mine junction and the Newlands mine junction.
Goonyella System	The rail infrastructure comprising the rail corridor from the ports at Hay Point and Dalrymple Bay to Hail Creek mine, Blair Athol mine, North Goonyella mine and the junction with the Gregory mine branch line and all branch lines directly connecting coalmine loading facilities to those corridors, with the exception of: › the branch line to Gregory mine › the corridor beyond North Goonyella mine to Newlands mine (and beyond).
Gtk	The gross tonne kilometres attributed to the relevant train service, being the total gross weight (in tonnes) of the rollingstock utilised in the relevant train service (including all goods, product, persons or matter carried) multiplied by the distance (in kilometres) travelled by the train service.
H	
Headroom	The amount of unallocated capacity required to cater for variability in the supply chain, caused by: weather conditions, rail infrastructure reliability, port and mine infrastructure reliability, incidents and accidents (e.g. level crossings, trespass) variation in demand.
Headway	The amount of time that elapses between two trains passing the same point travelling in the same direction on a given route.
HPCT	Hay Point Coal Terminal.
H82	A train type compatible with the Newlands and GAPE systems nominally 82 wagons and 3 diesel locomotives.
I	
IDM	Integrated Development Model.
Investment approval process	Aurizon Network's framework, which facilitates sound capital investment decisions within the Aurizon group. Study phases (in order) are: concept, pre-feasibility, feasibility, execution and operation.
ILCO	Integrated Logistics Company.
L	
Load time	The time between a train service arriving at a nominated loading facility, and that same train departing the nominated loading facility. For the purpose of clarity, this time runs from when a train service arrives at the entry signal to the nominated loading facility until it has completed loading, presented at the exit signal, is ready to depart the nominated loading facility and has advised the relevant train controller accordingly.
M	
Maintenance work	Any work involving maintenance or repairs to, or renewal, replacement and associated alterations, or removal of, the whole or any part of the rail infrastructure (other than infrastructure enhancements) and includes any inspections or investigations of the rail infrastructure.
Moura System	The rail infrastructure comprising the rail corridor from the Port of Gladstone (including domestic coal terminals in the vicinity of Gladstone) to Moura mine and the loading facility for Baralaba mine in the vicinity of Moura mine, and all branch lines directly connecting coalmine loading facilities to that corridor but excluding the corridor to Blackwater (and beyond).
MTP	Master Train Plan – document detailing the distribution of train service entitlements as advised by Network from time to time for all train services and any planned possessions on a specified part of the rail infrastructure.
Mtpa	Million Tonne per Annum.

N	
NAMS	Network Asset Management System.
NCL	North Coast Line.
NDP	Network Development Plan.
Newlands System	The rail infrastructure comprising the rail corridor from the Port of Abbot Point to Newlands mine, and all branch lines directly connecting coalmine loading facilities to that corridor, with the exception of the corridor between the Newlands mine and the North Goonyella mine (and beyond).
NSAP	Network Strategic Asset Plan.
P	
PACE	The Possession Assessment and Capacity Evaluator – a tool for the planning of maintenance and renewals works.
Payload	The total net tonnage hauled by a train.
PN	Pacific National.
Practical available capacity	The number of train paths that can be scheduled over a particular line segment for a specified time period (e.g. annually, daily), once contracted train paths, infrastructure maintenance and construction requirements and operational reliability (reduction factor) are considered.
Project Operating Parameters (POP)	Developed by Aurizon Network, a POP describes project specific assumptions on the operation of each element of the coal supply chain, where different to the assumptions provided in System Operating Parameters (SOP). A POP is to be read in conjunction with the referenced SOP.
Project stage gate	The process used in Aurizon's investment approval process to proceed from one phase of a project to the next (e.g. concept phase to pre-feasibility). Management approval is required before proceeding to the next project phase.
Q	
QAL	Queensland Alumina Limited – located at Parsons Point, Gladstone Queensland Australia.
QCL	Queensland Cement and Lime – now operated by Cement Australia.
R	
RAB	Regulatory Asset Base – the asset value for the Central Queensland Coal Region, accepted by the QCA for the purpose of developing reference tariffs for coal carrying train services.
RCS	Remote Controlled Signalling – a system of safe working where train movements are governed by the aspects displayed in colour light signals which are controlled from a remote location (or from designated local control panels), and by the passage of trains.
RGTCT	RG Tanna Coal Terminal.
Rollingstock	Locomotives, carriages, wagons, railcars, railmotors, light rail vehicles, light inspection vehicles, rail/road vehicles, trolleys and any other vehicle that operates on, or uses, the track.
S	
SBR	Surat Basin Railway.
SRT	Section Running Times – the time measured from when a train service passes the signal controlling entry into a section between two locations on the nominated network to the time the train service passes at the signal controlling entry into the next section between two specified locations. Does not include an allowance for planned dwell times.
Stowage	The storage of trains (excluding individual items of rollingstock) on the rail infrastructure at locations specified by Aurizon Network under the following circumstances: › during a possession › during the operation of a train service.
System closure	A time period where no trains (coal, freight or passenger) can travel on the network due to closures from maintenance and/or unplanned events.
System Operating Parameters (SOP)	Aurizon Network's assumptions on the operation of each element of the coal supply chain and the interfaces between those elements including in relation to the supply chain operating mode, seasonal variations and live run losses.
System path	A path that can be taken by a train service from a specific origin to a nominated unloading facility.

T	
Theoretical capacity	The theoretical capacity of the rail system is calculated by dividing the number of minutes in a 24-hour period (1,440 minutes) by the scheduled path separation. This calculates the total number of paths that can be scheduled in a day assuming no reductions/restrictions are applied to the system. The daily theoretical capacity is then multiplied by 365 days to establish the annual theoretical capacity of a system.
TLO	Train load out at mine.
Track	That part of the rail infrastructure comprising the rail, ballast, sleepers and associated fittings.
Train separation	The spacing of trains according to their speed, braking capability track configuration, gradient and signalling to ensure a safe distance between trains.
Train service	The operation of a train on the rail infrastructure between a specified origin and destination.
TrainSim	Aurizon's train performance simulation program.
TSE	Train Service Entitlement. As defined in the Network Access Undertaking.
U	
Unloading time	The time between a train service arriving at a nominated unloading facility and that same train departing the nominated unloading facility, and for the purpose of clarity, this time runs from when a train service arrives at the entry signal to the nominated unloading facility until it has completed unloading, presented at the exit signal, is ready to depart the nominated unloading facility and has advised the relevant train controller accordingly.
W	
WICET	Wiggins Island Coal Export Terminal.
WIRP1	Wiggins Island Rail Project, Stage One.

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