

RNGIM CUR

Delivery Program Report

28 July 2022

Executive Summary

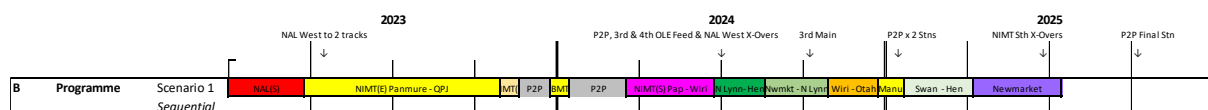
Future growth and benefits realization of committed investment in the Auckland Metro Rail Network is at risk due to the condition of the permanent way infrastructure. The RNGIM CUR SSBC and corresponding project will improve the condition of the permanent way infrastructure through large scale renewal of drainage, formation, railway ballast, rail sleepers and rail.

Renewal of the permanent way infrastructure requires train services to be suspended for the duration of the works. Several models and methodologies have been considered to achieve the outcome aligned with the strategic objective of completing the works prior to current key capacity enhancing projects and minimizing the impact on AMRN users.

The recommended methodology is a series of partial network closures to Auckland Metro passenger services commencing Dec -22 and continuing to Jul-25. Suitable sections of the network will have Auckland Metro passenger and local freight services suspended for periods of up to 8 months. Alternative transport options will include bus replacement services, road bridging, additional rail services and utilization of existing public bus network.

The recommended program broadly meets the strategic objective of completion prior to key milestone projects and provides overall improved outcomes for AMRN users, minimizes risk and offers the best value when compared to the other proposals.

Recommended Program



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1. Background

The Auckland Metro Rail Network comprises 186km of dual use narrow gauge railway between Pukekohe, Britomart and Swanson. The AMRN has experienced significant growth especially in public transport passenger users and is now integral to the Auckland Public Transport network. The future growth of the network is at risk due to the degradation of the aged permanent way infrastructure. The Rail Network Growth Impact Management (RNGIM) Single Stage Business Case (SSBC) is the response to the risk.

AMRN User	No of Services	%tage
AT Metro Passenger	4646	89.6
KR Freight	509	9.8
Other	30	0.6
Total	5185	

The RNGIM SSBC 2020 defines, in problem statement one the issue associated with providing a reliable and performing Auckland Metro Rail Network (AMRN):

‘Investment in the underlying rail network has failed to keep pace with growth, risking the success of planned and major projects and asset failure’

The business case evidences the problem statement using 2 key parameters: train performance and asset age/condition. Train performance deterioration arising from the permanent way infrastructure generally manifest themselves as Temporary Speed Restrictions (TSRs). The number and impact of TSRs applied to the AMRN shows an increasing trend (Fig 1).

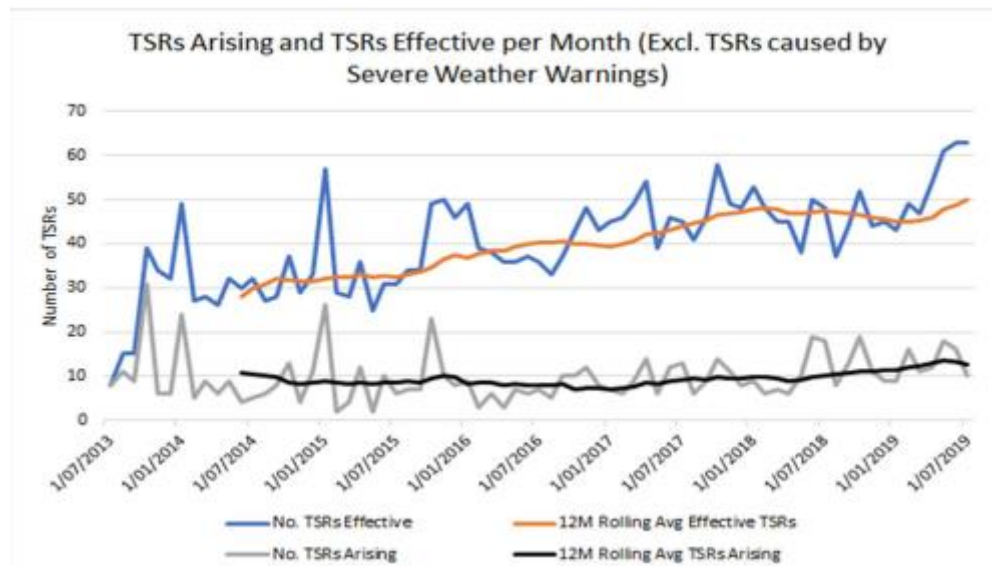


Figure 1 Increasing trend of TSRs

Historic under investment in the permanent way asset driven by a strategy of ‘keep things running rather than investing to achieve improved and sustainable outcomes for longer term’ has resulted in an aged asset (Fig 2).

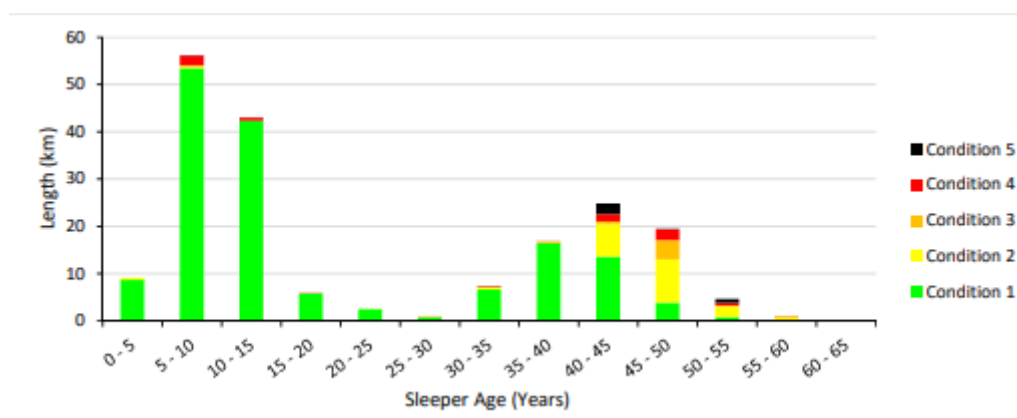


Figure 2 AMRN asset age and condition

Committed investment seeks to increase the usage of the rail network resulting in 'assets having to work harder'. The combination of aging asset and increased usage will accelerate and exacerbate the impact on train performance and put future growth at risk (Fig 3). Reduction in asset age and corresponding improvement in performance is achieved through asset renewal.

Relationship between Performance and Average Asset Age

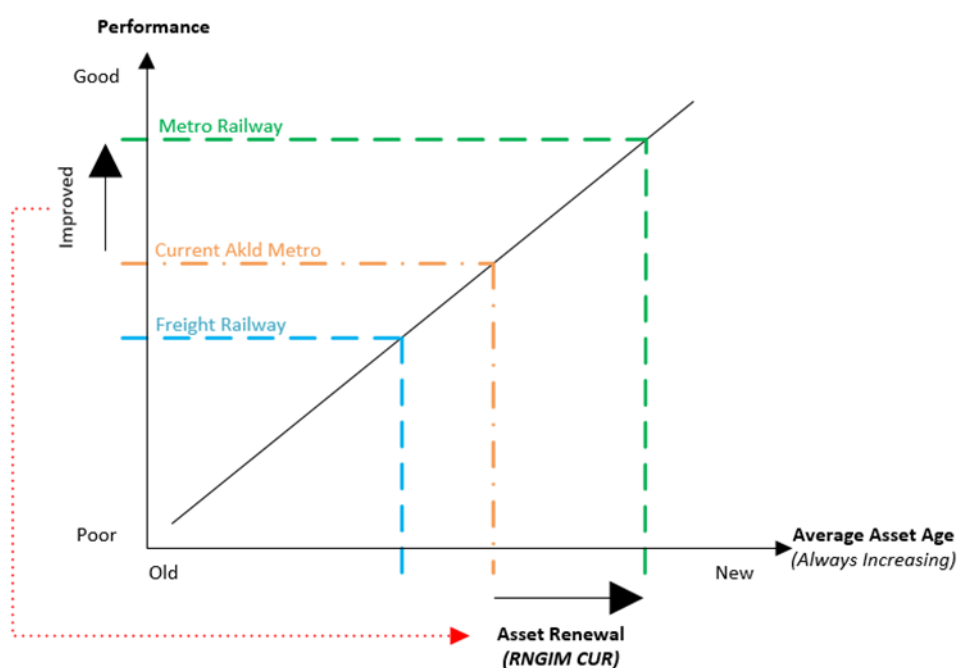


Figure 3 Relationship between asset performance and age

The RNGIM SSBC proposed 6 investment options to mitigate the risk ranging from 'Do Nothing' to 'Whole Network Enhanced Delivery Approaches'. The business case used standard Multi Criteria Analysis' (MCA) and evaluation criteria to recommend Option 4 (Fig 4).

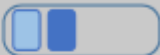
Track renewals		Replacement of all rail pre-1975 (91lb and lower) and 50kg rail with rating of >C4 Replacement of all TPR sleepers, and Concrete sleepers pre-1986. Removal of all 91lb turnouts and 50kg turnouts older than 25yrs. Includes Destress sites where records are older than 8yrs.	\$57.7M	
Track bed renewals		Allows for replacement of top and bottom ballast. Assumes that 60% of track not being resleepered, or formation upgraded will require ballast. Detailed investigation is required. Required for all resleepering works due to increased sleeper depth + allowance of 25% of remaining track for mudspot remediation. Detailed investigation is required.	\$68.0	

Figure 4 RNGIM SSBC option 4 CUR extract

The resulting scope from development of Option 4 is defined as RNGIM CUR Scope (Fig 5) and is equivalent to renewing 20% of the AMRN (building 30km of new permanent way).

Item	Quantity
Rail	18,516m
Sleepers	50,023m
Ballast	59,616m
Formation	26,047m
Drainage	48,425m
Turnouts	38

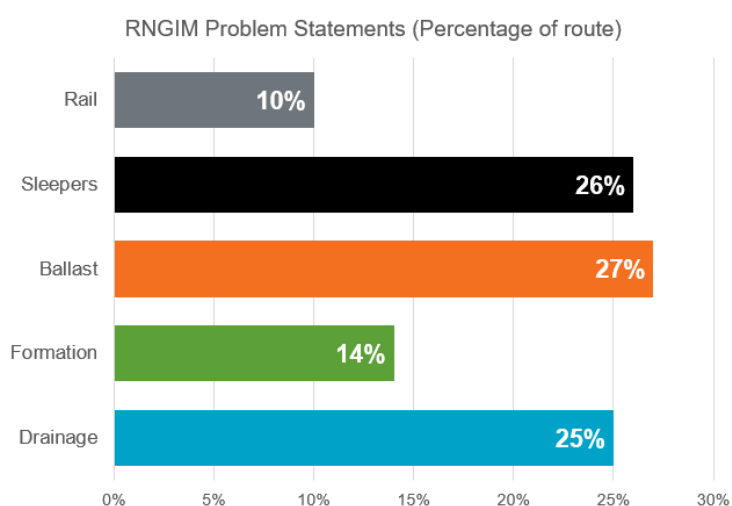


Figure 5 RNGIM CUR scope

2. Value and Benefits

Delivery of the RNGIM CUR scope supports multiple national, regional and local strategic objectives including:

- GPS on Land Transport – ‘improving urban rail services for passengers accessing housing, major employment and metropolitan areas’
- NZTA Statement of Intent – ‘providing a primary contribution to liveable communities’
- RLTP 2018 – 2028 – ‘Auckland’s rail network forms a key part of the city’s strategic public transport and freight network’
- The Auckland Plan – ‘better use of existing transport networks including rail’

The completion of key milestone projects within the AMRN unlocks additional capacity and the opportunity to build on recent growth to achieve the strategic objectives. These projects include:

- City Rail Link (CRL)
- Pukekohe to Papakura (P2P) Electrification
- Wiri to Quay Park 3rd Main (W2QP)
- Rail Level and Pedestrian Crossing Improvements

The existing AMRN must be able to support this increase in growth to enable the benefits of these projects to be realized. Delivery of the RNGIM CUR reduces the average asset age on the AMRN and thereby improves the overall performance of the network. Delivery of the RNGIM CUR scope supports the benefits realization of these key milestone projects and should occur prior to completion of these projects.

3. Delivery Options Assessment

The majority of the AMRN was constructed during a similar period and the under-investment in asset renewal is distributed through out the network. The RNGIM CUR scope affects all routes within the AMRN (Fig 6).

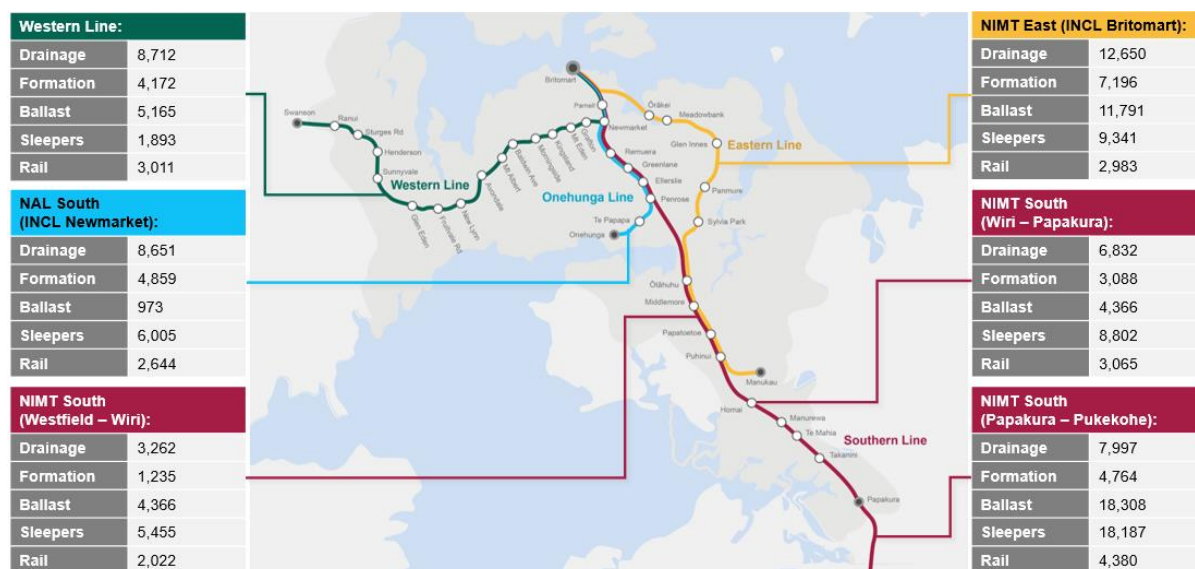


Figure 6 Distribution of RNGIM CUR scope across AMRN

The RNGIM CUR team strategy aligns the work programme on a route basis to permit incremental benefits realization during the project. These routes are:

- Britomart Stn
- NIMT East (Westfield to Quay Park)
- NAL Sth (Westfield to Newmarket)
- NAL West (Newmarket to Swanson)
- NIMT Sth (Westfield to Wiri)
- NIMT Sth (Wiri to Papakura)
- NIMT Sth (P2P)
- Newmarket Line
- Branch Lines (Manukau and Onehunga)

The RNGIM team analyzed these routes against the key AMRN projects and assigned a priority ranking that supported the introduction of these projects (Appendix A).

All RNGIM CUR scope is related to the permanent way asset (Fig 7) and therefore any upgrade or renewal work requires trains to be removed from the asset that is being upgraded. The type of work necessitates a minimum continuous window of opportunity duration of 48hrs. The recognized method for achieving this window is via a 'track occupation' known as a Block of Line (BoL). A BoL suspends train services for a period of time to permit construction activity.

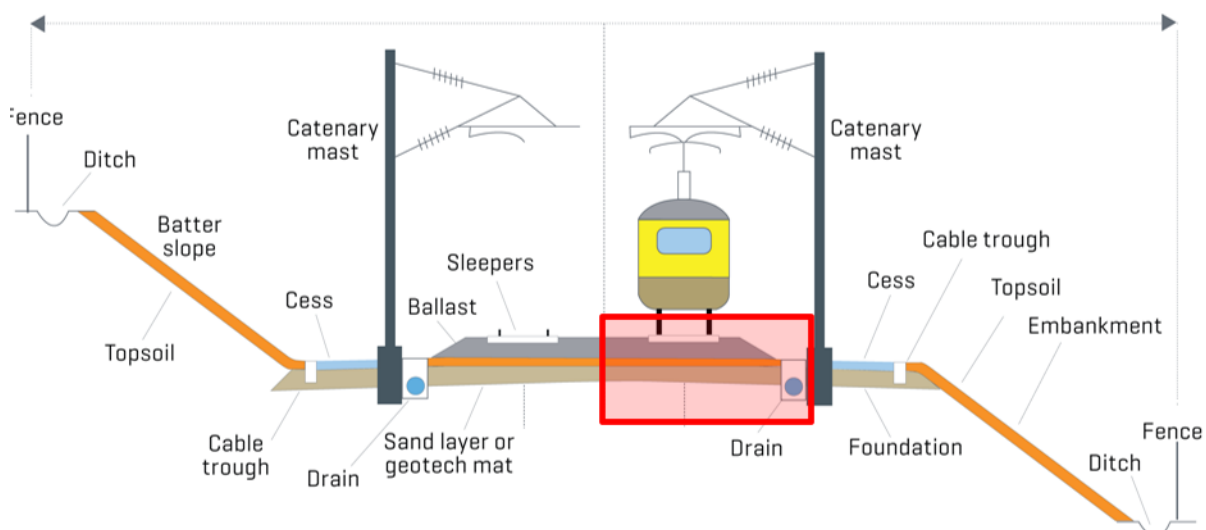


Figure 7 RNGIM CUR scope location

4. Longlist Options

The following delivery options were considered and outline programmes devised (Fig 8):

- Established – utilize existing BoL access (off peak)
- Targetted – enhanced existing off peak BoL access
- Continuous – enhanced continuous access

Programme	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	Benefit Realisation Date
Established																						2041 Finish
Targetted																						2032 Finish
Continuous																						2026 Finish

Figure 8 Outline programme summary

The continuous access option was the only option that offered an opportunity to meet the strategic objective of completing the RNGIM CUR scope in line with the other key AMRN projects. Alternative proposals that met the theme of continuous access were explored with key stakeholders. These included rotating a '2 week' continuous access window around the AMRN routes. The alternative proposals were discounted as being too complex as well as extending the delivery timeframe past key milestones.

The continuous access option taken forward for further development was 'continuous access to segments of single route' (Fig 9). Each of the key routes was divided into shorter sections according to infrastructure constraints to provide the minimum length of network subject to BoL (suspension of train services).

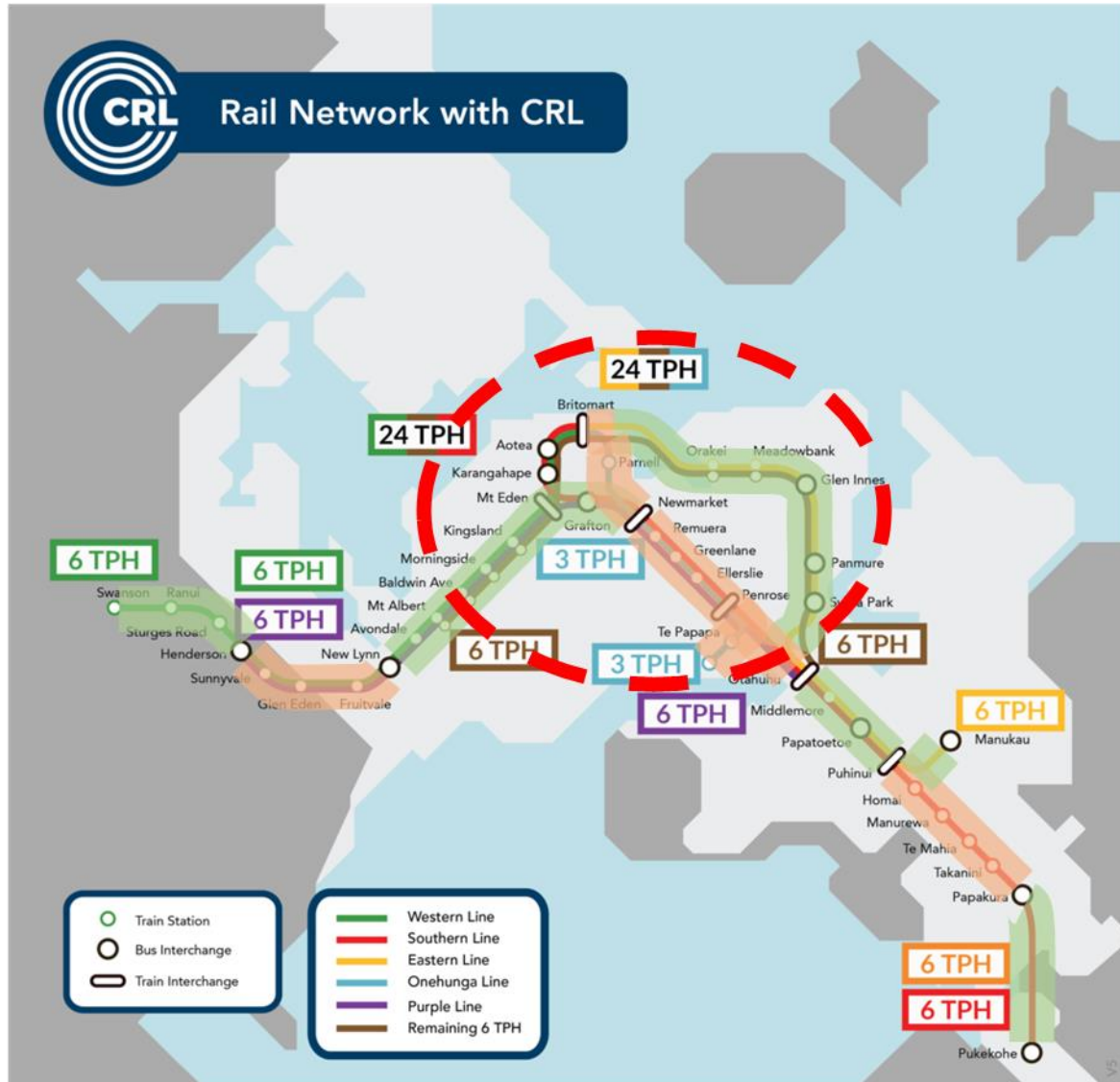


Figure 9 Route segments

5. Programme Assumptions

The RNGIM CUR programme development includes these base assumptions:

- Improving Production Rates
- Resourcing Levels
- Limitations

Production rates are baselined on established norms and ratcheted over time through introduction of enhanced techniques employed on the project such as Overhead Line Equipment (OLE) slewing, panel lifters, GPS control and ground stabilization (Fig 10).



Figure 10 Assumed productivity improvements

Resourcing levels increase to optimal based on the limitations of working on the rail corridor (c20m wide), the urban environment (limited access points) and the sequencing of specialized works (i.e. foundation before surfacing) (Fig 11).

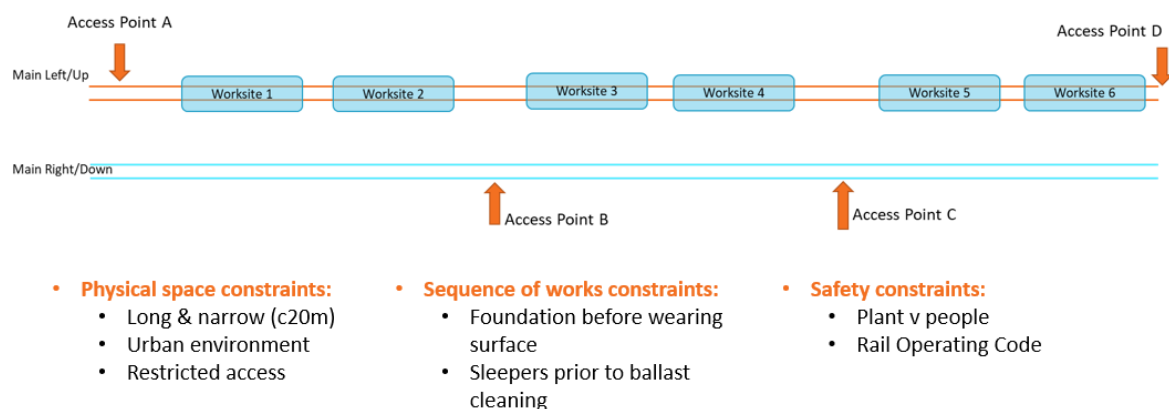


Figure 11 Typical constraints associated with rail corridor work

6. Shortlist Option Development

A technical working group developed the continuous access option under 3 plausible site access scenarios. A 4th scenario of the established access regime was included for benchmarking (Fig 12). The technical working group comprised subject matter experts from the key stakeholders: KiwiRail Operations; KiwiRail Project; Auckland Transport and Transdev (passenger train operator).

RNGIM CUR - Access Optioneering Scenarios

Scenario	Title	Description
1	Continuous BoL	Both mains line impassable to passenger services for duration of works KR passenger services amended KR freight services amended
2	SLW Peak Only	One main impassable to passenger services for duration of works One main available for passenger services during peak hours only Both mains line impassable to passenger services during off-peak KR passenger services amended KR freight services amended
3	SLW Peak to Peak	One main impassable to passenger services for duration of works One main available for passenger services during am peak through to pm peak Both mains line impassable to passenger services pm peak through to am peak KR passenger services amended KR freight services amended
4	Off Peak (W/E's & SH)	Both mains line impassable to passenger services for w/ends only KR passenger services amended KR freight services amended

Figure 12 Access scenarios

An initial multi-criteria analysis was undertaken on the key routes of NAL (Sth) and NIMT East. The stakeholders agreed the evaluation criteria of; benefits realization, customer impact and project impact measured via programme duration, passenger revenue loss and project cost. The output is shown in Fig 13.

The MCA ranked scenario 1 the best with a significant improvement over the baseline scenario 4 and a moderate improvement over the next best scenario. Scenario's 2 & 3 ranked closely and provided a moderate improvement over the base line.

Route	Route Section	Measure	Detail	UoM	Scenario			
					1	2	3	4
					Continuous BoL	SLW Peak Only	SLW Peak to Pea	Off Peak
NIMT East	Quay Park Jcn to Panmure	Benefits Realisatio	Programme Duration	Wks	16.9	24.5	36.8	59.0
NIMT East	Quay Park Jcn to Panmure	Customer Impact	Passenger Revenue Loss	\$	20% - commercial activity			
NIMT East	Quay Park Jcn to Panmure	Project Impact	Project Cost	\$	20% - commercial activity			
NIMT East	Panmure to Westfield Jcn	Benefits Realisatio	Programme Duration	Wks	18.1	26.4	39.6	63.5
NIMT East	Panmure to Westfield Jcn	Customer Impact	Passenger Revenue Loss	\$	20% - commercial activity			
NIMT East	Panmure to Westfield Jcn	Project Impact	Project Cost	\$	20% - commercial activity			
NAL Sth	Penrose to Westfield Jcn	Benefits Realisatio	Programme Duration	Wks	3.3	4.8	7.2	11.5
NAL Sth	Penrose to Westfield Jcn	Customer Impact	Passenger Revenue Loss	\$	20% - commercial activity			
NAL Sth	Penrose to Westfield Jcn	Project Impact	Project Cost	\$	20% - commercial activity			
NAL Sth	Newmarket to Penrose (inc)	Benefits Realisatio	Programme Duration	Wks	11.3	16.4	24.6	39.5
NAL Sth	Newmarket to Penrose (inc)	Customer Impact	Passenger Revenue Loss	\$	20% - commercial activity			
NAL Sth	Newmarket to Penrose (inc)	Project Impact	Project Cost	\$	20% - commercial activity			

Figure 13 MCA summary for NIMT East and NAL Sth routes

Examination of the individual criteria indicates that benefit realization and project cost of Scenario 1 provided a min. 20% improvement on the next best scenario and a 50+% improvement against the baseline. Scenario 4 (baseline) provided the best outcome for the customer impact criteria (50% betterment), however the relative outcomes for the remainder of the scenarios was modest (<5%). Based on the MCA Scenario 1 and 2 were progressed for further development and expanded to the full project scope.

A further 6 options were developed based on the output of the initial MCA focusing on adoption of Scenario 1 and Scenario 2 (Appendix B). The strategic objective of completing the RNGIM CUR scope

prior to the commissioning of the key AMRN milestone projects was determined the most important consideration followed by minimizing the impact to the customer. The programme options are:

- Option A – apply scenario 1 to all routes and overlap BoL segments
- Option B – apply scenario 1 to all routes sequentially
- Option C – apply scenario 2 to all routes and overlap BoL segments
- Option D – apply scenario 2 to all routes sequentially
- Option E – hybrid sequential
- Option F – hybrid overlapping BoL segments

The assessment of the 6 options using the MCA is summarized in Fig 14. Programme option D & E are discounted as significantly exceeding the key strategic objective of delivery by AMRN key project milestones. Programme C & F are discounted due to poor performance against the key strategic consideration of minimizing the impact on the customer. Programme A requires doubling of the resource levels from a construction and provision of alternative transport perspective.

Option	Completion Date	Customer Impact (m)	BC Project Cost (\$m)
A	Jan-25	23.9	91.59
B	Jul-25	22.4	85.47
C	Dec-24	29.5	115.55
D	Sep-26	23.1	103.24
E	Nov-25	20.6	97.42
F	Feb-25	26.8	107.88

Figure 14 Shortlist MCA summary

7. Risk Assessment

An assessment of the risk of implementation of Scenario 1 and 2 against the categories of construction workforce, scheduled AT rail service incident, rail operations complexity, transition between operations/construction and public interface was completed (Appendix C). The categories included these key items:

- Construction Workforce
 - Struck by scheduled AT rail service
 - Contact with live OLE
 - Access/Egress to worksite
- Scheduled AT rail Service Incident
 - Collision with construction activity
 - Infrastructure fault on operational line
- Rail Operations Complexity
 - Unusual routes
 - Customer handling
 - Timetable resilience
- Transition between Operations/Construction
 - Handback to rail operations
 - Handover to construction team
- Public Interface
 - Unfamiliar rail service operation

- Trespass and vandalism

The summary of the output is shown in Fig 15. Application of Scenario 1 provides significant reduction in the risk profile over Scenario 2 for the programme. (S4 included as baseline).

Scenario	Risk Category					Total Risk
	Construction Workforce	Scheduled AT Rail Service Incident	Rail Operations Complexity	Transition to/from construction/rail operations	Public Interface	
1	0	12	42	12	6	72
2	66	72	72	72	12	294
4	0	24	14	30	3	71

Figure 15 Risk assessment summary

8. Other Considerations

Disruption to rail passengers will be significant and the provision of alternative public transport when train services are suspended during a BoL is a significant challenge. The majority of the rail network does not have diversion routes that can be used to support closures. A combination of dedicated rail replacement bus services, re-direction of customers to existing bus services and additional rail capacity (where available) will be required. Clear and timely communication will be critical.

The AMRN is used to support transport to/from key public events (special events) such as National Level Rugby games, music concerts etc. Typically, these events are confirmed with 12 month lead times. The ability to provide support to some of these events will be compromised during the programme.

The AMRN is a dual use network and the rail freight network is considered critical to the national freight task (NZ Inc.). The RNGIM programme assumes that national freight will continue to operate with amended timetables and restricted access to the AMRN. Localized freight movements will be suspended for the BoL and an alternative road-bridging solution implemented.

Several of the key AMRN projects provide additional capacity and flexibility to the network. Specifically,

- 3rd Main
- 3rd and 4th OLE power feed
- Resilience x-overs

These projects could mitigate the impact on customers and the RNGIM CUR programme has been aligned to capitalize on these. There is a risk that these projects are not fully realized to meet the needs of the RNGIM CUR programme due to factors outside the control of RNGIM CUR team.

9. Peer Review

The proposed RNGIM CUR scope and programme were subject to a high level peer review by an independent party via AoR. The review concluded that the works are necessary to improve the reliability, availability, maintainability and safety of the AMRN. The review confirmed the adopted approach of continuous access is the most appropriate method to deliver the programme and acknowledged the constraints of the programme. The review recommended a process of continuous monitoring and improvement to mitigate the impact of the works on the AMRN users.

10. Recommendation

Assessment against the key criteria of benefits realization, customer impact, risk and cost indicates that Programme Option B provides the most appropriate methodology (Fig 16).

Option	Completion Date	Customer Impact (m)	Aggregate Risk (Score)	BC Project Cost (\$m)
A	Jan-25	23.9	8496	91.59
B	Jul-25	22.4	8496	85.47
C	Dec-24	29.5	53590	115.55
D	Sep-26	23.1	53590	103.24
E	Nov-25	20.6	33014	97.42
F	Feb-25	26.8	39086	107.88

Figure 16 Consolidated summary

It is recommended that Programme Option B is adopted and implemented for the delivery of the RNGIM CUR project (Fig 17).

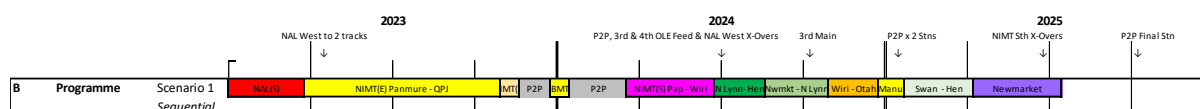
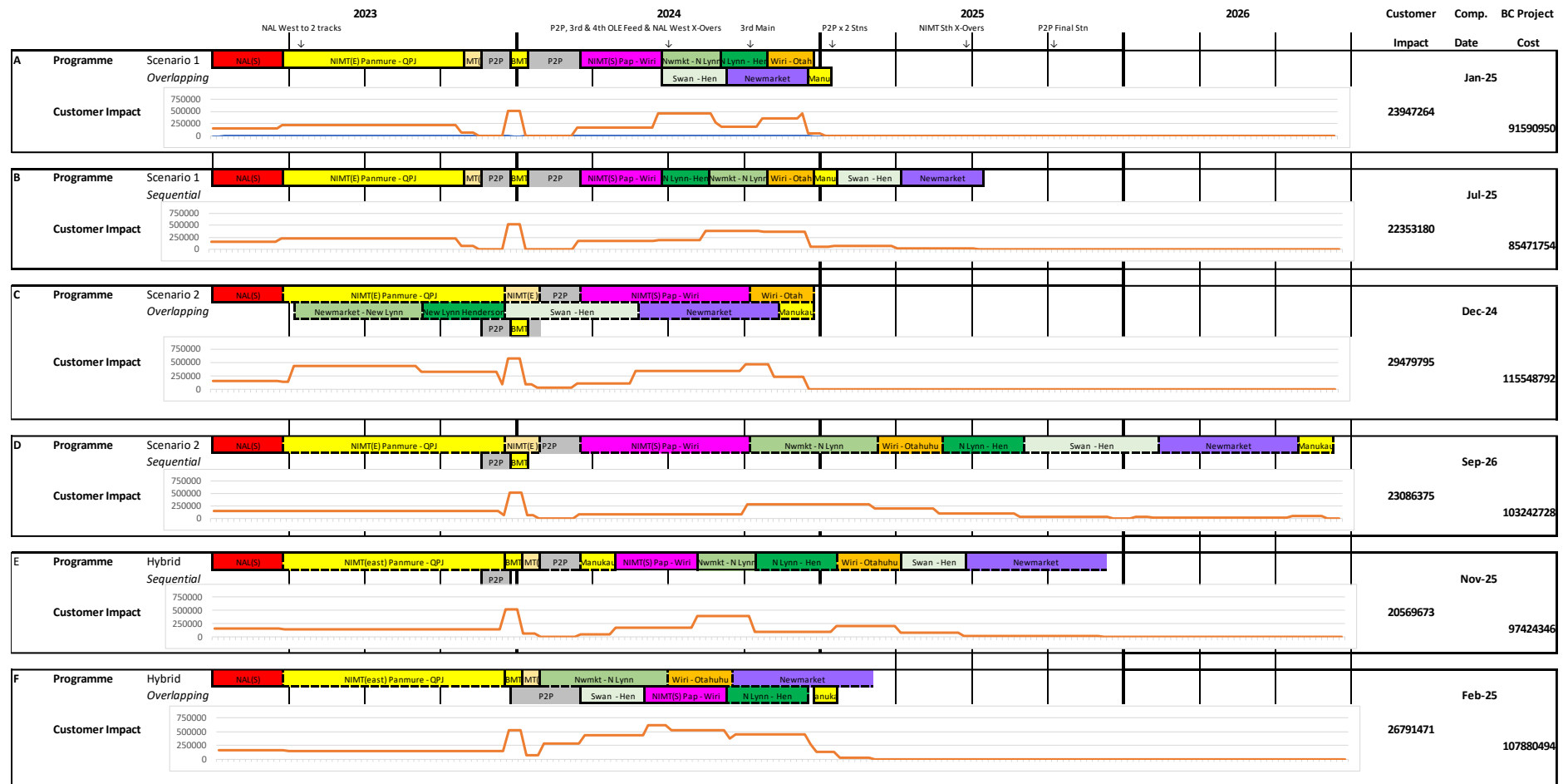


Figure 17 Recommended RNGIM CUR programme

11. Appendix A – Segment Prioritisation

Priority	Route	Section Description	KM - Start	KM - End
1	Britomart	Quay Park - Britomart (Britomart Line)	681.001	681.838
2.1	NIMT East	Westfield Junction (on NIMT East)	666.001	666.403
2.2	NIMT East	Westfield Junction - Panmure	666.404	670.000
2.3	NIMT East	Panmure - Quay Park	670.001	679.256
2.4	Britomart	Quay Park - Britomart (Eastern Line)	679.256	681.000
3.1	NAL Sth	Penrose - Newmarket	3.142	7.897
3.2	NAL Sth	Newmarket Station (on NAL South)	7.897	8.500
4.1	NAL West	Morningside Station	11.342	13.565
4.2	NAL West	Morningside - Mt Albert	13.565	15.300
5.1	NIMT Sth	Wiri Station (including Puhinui Junction)	655.997	659.490
5.2	NIMT Sth	Wiri - Middlemore	659.490	662.353
5.3	NIMT Sth	Middlemore - Railway Lane overbridge	662.353	664.447
5.4	NIMT Sth	Railway Lane overbridge - Westfield Junction	664.447	665.459
5.5	NIMT Sth	Westfield Junction (on NIMT South)	665.459	666.000
6.1	NIMT Sth	Pukekohe - Paerata Junction	628.180	631.638
6.2	NIMT Sth	Paerata Junction	631.638	632.965
6.3	NIMT Sth	Paerata Junction - Papakura Station	632.965	645.375
6.4	NIMT Sth	Papakura Station (P2P)	645.375	647.000
6.5	NIMT Sth	Papakura Station (W2QP)	647.000	648.607
6.6	NIMT Sth	Papakura - Homai	648.607	655.000
6.7	NIMT Sth	Homai - Wiri	655.000	655.997
7.1	NAL Sth	Westfield Junction (on NAL-South)	0.000	0.694
7.2	NAL Sth	Westfield Junction - Penrose	0.694	2.045
7.3	NAL Sth	Penrose Station	2.045	3.142
8.1	NAL West	Newmarket Station (on NAL West)	8.500	9.172
8.2	NAL West	Newmarket - Morningside (incl CRL Junction)	9.172	11.342
9.1	NAL West	Mt Albert - New Lynn	15.300	19.000
9.2	NAL West	New Lynn - Glen Eden	19.000	22.152
9.3	NAL West	Glen Eden - Henderson	22.152	26.012
9.4	NAL West	Henderson Station	26.012	27.145
10	NAL West	Henderson - Swanson	27.145	32.633
11.1	Newmarket	Newmarket Station (on NWMKT)	0.000	0.420
11.2	Newmarket	Newmarket - Quay Park	0.420	3.295
12 (3a)	Branch	Wiri - Manukau	0.000	1.727
13 (4a)	Branch	Penrose - Onehunga	0.000	3.596

12. Appendix B – Shortlist Option Programmes



13. Appendix C – Risk Assessment

RISK: RNGIM CUR High Level Programme Options Assessment										KiwiRail					
KiwiRail Group or Business:		Network Services		Risk Assessment Context:											
Group or Business Unit:		Operations		This risk assessment compares the identified hazards and associated risks associated with the proposed access scenarios for the RNGIM CUR project.											
Assessment Owner:		RNGIM CUR Project Delivery Manager													
Developed By:		N Finch													
Date:		{ddmm/yyyy}													
1. IDENTIFY AND DESCRIBE				2. ASSESS AND EVALUATE						3. CONTROL AND MONITOR					
Risk Category	Risk	Risk Weighting	Risk Details	Current Controls	Scenario	Details	Risk Matrix			Risk Score	Weighted Risk Score	Proposed Controls	Justifications	Accountable Officer	Due Date
							C	L	Ranking						
Construction Workface	Struck by scheduled AT service	3	RISK: The risk of construction equipment/personnel being struck by scheduled AT service Due to encroachment of the operational railway line Resulting in serious harm or death Known Root Causes: - Inexperience - Changing protection arrangements - Poor communication - Inadequate protection system	KiwiRail Induction Pre-start briefings Planned and reviewed protection system	1	No scheduled AT services	Major	Minor	IN/A	0	0		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	Protection system changes 4 times daily	Major	Minor	HIGH	12	36		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	Scheduled AT services for 6/24hr period	Major	Minor	HIGH	12	36		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	Protection system changes 2 times daily	Major	Minor	HIGH	12	36		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Construction Workface	Contact with live OLE	2	RISK: The risk of construction equipment/personnel being electrocuted Due to coming into contact with live 25kV OLE Resulting in serious harm or death Known Root Causes: - Inexperience - Changing OLE isolation arrangements - Poor communication - Inadequate control of plant	KiwiRail Induction and AC Awareness Training Pre-start briefings Planned and reviewed OLE isolations OLE observers	1	OLE isolated and earthed	Major	Minor	IN/A	0	0		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	OLE isolation changes 4 times daily	Major	Minor	HIGH	12	24		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	OLE isolation changes 2 times daily	Major	Minor	HIGH	12	24		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	OLE isolated and earthed	Major	Minor	IN/A	0	0		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Construction Workface	Access/Egress from workface	1	RISK: The risk of construction equipment/personnel unable to access suitable amenities and/or emergency assistance Due to safe working area being cut off from access point as adjacent railway line operational Resulting in minor illness or delayed treatment Known Root Causes: - No safe access/egress to/from workface	First Aid station within workface Site specific emergency plan	1	Unimpeded access to workface	Major	Minor	IN/A	0	0		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	Unimpeded access for 180mins	Major	Minor	MEDIUM	6	6		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	Unimpeded access for 110mins	Major	Minor	MEDIUM	8	8		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	Unimpeded access to workface	Major	Minor	IN/A	0	0		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Scheduled AT Rail Service Incident	Collision with construction activity	3	RISK: The risk of a scheduled AT service colliding with construction equipment Due to construction equipment encroaching the operational railway line Resulting in damage to AT service and/or harm to AT personnel and/or customers Known Root Causes: - Running AT scheduled services - Construction activity during scheduled service operation - Inadequate protection systems	KiwiRail Induction Pre-start briefings Planned and reviewed protection system	1	No scheduled AT services	Major	Minor	IN/A	0	0		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	Scheduled AT services for 6/24hr period	Major	Minor	MEDIUM	8	24		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	Scheduled AT services for 13/24hr period	Major	Minor	HIGH	12	36		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	No scheduled AT services	Major	Minor	IN/A	0	0		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Scheduled AT Rail Service Incident	Infrastructure fault on operational line	3	RISK: The risk of a scheduled AT service incident from infrastructure fault due to infrastructure not meeting rail operating code requirements Resulting in damage to AT service and/or harm to AT personnel and/or customers Known Root Causes: - Inadequate QA processes - Time pressure - Inexperience	OJT for critical tasks Detailed construction programme monitoring	1	No scheduled AT services during works	Major	Minor	MEDIUM	4	12		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	1 inspection upon completion	Major	Minor	VERY HIGH	16	48		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	Scheduled services 2 times daily	Major	Minor	HIGH	12	36		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	Scheduled services 1 times daily	Major	Minor	HIGH	12	36		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Rail Operations Complexity	Unusual routes	2	RISK: The risk of timetable delay Due to changing and/or unfamiliar routes Resulting in reduced performance Known Root Causes: - Inexperience - Unfamiliarity - Rail system shortfalls	Timetable planning and distribution Briefing of staff	1	Normal running on open segments	Major	Minor	LOW	2	4		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	Turnback at recognised nodes	Major	Minor	MEDIUM	9	18		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	Single line working in peak direction	Major	Minor	MEDIUM	9	18		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	Single line working in 'peak' direction	Major	Minor	MEDIUM	9	18		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Rail Operations Complexity	Customer handling	2	RISK: The risk of customers being unable to complete journey Due to changing modes and/or capacity of nodes Resulting in customer dissatisfaction Known Root Causes: - Capacity of interchange nodes - Poor communication - Connections with other PT modes	Timely commits plan Additional staff to assist customers	1	Segments closed for duration	Major	Minor	HIGH	10	20		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	Consistent change for duration of works	Major	Minor	VERY HIGH	15	30		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	Single line working in peak direction	Major	Minor	VERY HIGH	15	30		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	Single line working in 'peak' direction	Major	Minor	VERY HIGH	15	30		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Rail Operations Complexity	Timetable Resilience	2	RISK: The risk of timetable 'falling over' Due to number of changes and/or lack of 'space' Resulting in reduced performance Known Root Causes: - Capacity of network - Timetables for implementation	Timetable planning and distribution Performance monitoring and adjustment	1	1 timetable change per segment	Major	Minor	MEDIUM	9	18		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	Simplified timetabling	Major	Minor	HIGH	12	24		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	2 timetable changes per segment	Major	Minor	HIGH	12	24		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	Complex timetabling	Major	Minor	HIGH	12	24		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Transition to rail operations	Handback to Rail Operations	3	RISK: The risk of delay in handback of to rail operations Due to works running behind programme/issue identified during safety inspection Resulting in AT service cancellations/compounding delays Known Root Causes: - Programme control - Unplanned incident - Resource availability	Construction programme monitoring Resource planning	1	1 x handback	Major	Minor	LOW	3	9		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	2 x daily handback	Major	Minor	HIGH	12	36		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	1 x daily handback	Major	Minor	MEDIUM	9	27		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	1 x handback over multiple occasions	Major	Minor	MEDIUM	6	18		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Transition to rail operations	Handover to construction team	3	RISK: The risk of delay in handover to construction team Due to late running services/ incident on network Resulting in delays to programme and extension of time Known Root Causes: - Unplanned incident - Resource availability - Timetable resilience	Planned timetable Update of construction programme	1	1 x handover	Major	Minor	LOW	1	3		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	2 x daily handover	Major	Minor	HIGH	12	36		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	1 x daily handover	Major	Minor	MEDIUM	9	27		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	1 x handover on multiple occasions	Major	Minor	LOW	4	12		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Public Interface	Unfamiliar rail service operation	1	RISK: The risk of members of public being struck at crossing points Due to unfamiliar rail service operation and/or engineering closures Resulting in injury to member of public from rail service strike Known Root Causes: - Familiarity at crossing points - Lack of awareness - Unfamiliar crossing protection equipments	Gated crossing points Comms plan Rail operating code	1	No scheduled AT services	Major	Minor	IN/A	0	0		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	Unfamiliar AT service direction and timing	Major	Minor	MEDIUM	9	9		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	Unfamiliar AT service direction	Major	Minor	MEDIUM	6	6		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	No scheduled AT services	Major	Minor	IN/A	0	0		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
Public Interface	Trespass & Vandalism	1	RISK: The risk of infrastructure vandalism Due to rail service suspension Resulting in unscheduled repairs Known Root Causes: - Direct access to network	Secured access points Inspection regime	1	No scheduled AT services for duration	Major	Minor	MEDIUM	6	6		Elimination - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					2	AT scheduled services 6/24hr period	Major	Minor	LOW	3	3		Substitution - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					3	AT scheduled services for 13/24hr period	Major	Minor	LOW	3	3		Engineering - Applied / Not applied	Manager: (name)	{ddmm/yyyy}
					4	No scheduled AT services for short durations	Major	Minor	LOW	3	3		Admin - Applied / Not applied	Manager: (name)	{ddmm/yyyy}