

The Crossrail COVID-19 Recovery Execution Plan

Document Number: CRL1-XRL-Z-STP-CR001-50038

Document History:

Version:	Date:	Prepared by:	Checked by:	Authorised by:	Reason for Revision:
0.10	12-06-20	[REDACTED]	[REDACTED]	[REDACTED]	First draft for CPO
0.18	19-06-20	[REDACTED]	[REDACTED]	[REDACTED]	Working draft incorporated comments for CPO
1.0	22-06-20	[REDACTED]	[REDACTED]	[REDACTED]	Draft to support DCS1.1 Board submission
1.2	23-06-20	[REDACTED]	[REDACTED]	[REDACTED]	Restructured document for ease of reading
1.6	08-08-20	[REDACTED]	[REDACTED]	[REDACTED]	Working Draft review by Jim Crawford
1.20	14-08-20	[REDACTED]	[REDACTED]	[REDACTED]	Working draft to be submitted to Board
2.00	16-09-20	[REDACTED]	[REDACTED]	[REDACTED]	Update to include Module 10

Current Version Authorisation:

The frequency of updates to the document will be based on the ongoing COVID-19 impact on the programme. The accountable Executive Sponsor is the Crossrail Programme Director

Date:	Authorised by:	Title	Signature
	[REDACTED]	[REDACTED]	Authorised by email correspondence – 13 January 2021
	[REDACTED]	[REDACTED]	Authorised by email correspondence – 13 January 2021
	[REDACTED]	[REDACTED]	Authorised by email correspondence – 13 January 2021
	[REDACTED]	[REDACTED]	Authorised by email correspondence – 13 January 2021

This document contains proprietary information. No part of this document may be reproduced without prior written consent from the chief executive of Crossrail Ltd.

Table of Contents

1	Execution Plan Overview	5
1.1.1	Execution Plan Critical Path	6
	Overview of the Modules	8
1.1.2	Module 1: Restart Niche Works and DT	8
1.1.3	Module 2: Blockade	8
1.1.4	Module 3a: TR2 and Integration Testing	9
1.1.5	Module 3b: SIDT and early TR tests	9
1.1.6	Module 4: Assurance of the Works	10
1.1.7	Module 5: Stations – SC1 and Station Close Out Strategy	11
1.1.8	Module 6: Transition to ROGS Environment	11
1.1.9	Module 7a: Trial Running	11
1.1.10	Module 7b: Trial Ops & Beyond high-level plan	12
1.1.11	Module 8: Organisation Design & Transition	13
1.1.12	Module 9: Commercial Strategy	13
1.1.13	Module 10: Systems Integration	14
	Summary of Execution Plan Modules	16
	Resilience and Agility of the Execution Plan	19
	Risk	19
2	Appendix A.....	20
	Introduction	20
2.1.1	Background	20
2.1.2	The Objectives for Crossrail	20
2.1.3	Scope	21
2.1.4	Events that led to the need for a strategy.....	21
3	Appendix B.....	25
	COVID-19 Scenario Framework	25
3.1.1	Background	25
	COVID-19 Scenarios	26
4	Appendix C.....	30
	Tactical Mitigations and Strategic Interventions.....	30
4.1.1	Background	30
4.1.2	Top 15 Tactical Mitigations.....	30
4.1.3	Progress Update on the Tactical Mitigations deployed	31
4.1.4	Strategic Interventions to the programme - “Scenario D”	33
5	Appendix D.....	36
	Assurance	36

5.1.1	Line of Defence (LoD) 1: Internal Programme Assurance Checks	36
5.1.2	Line of Defence (LoD) 2: Targeted Assurance Review	39
5.1.3	Line of Defence (LoD) 3: External Peer Review of the Programme COVID-19 Recovery Plan.....	41
6	Appendix E.....	42
	Execution Plan Critical Path:.....	42
6.1.1	Module 1: Restart Niche Works and DT	43
6.1.2	Module 2: Blockade.....	43
6.1.3	Module 3a: TR2 and Integration Testing	45
6.1.4	Module 3b: SIDT and early TR tests	46
6.1.5	Module 4: Assurance of the works	48
6.1.6	Module 5: Stations – SC1 and station close out strategy.....	51
6.1.7	Module 6: Transition to ROGS environment	55
6.1.8	Module 7a: Trial Running	60
6.1.9	Module 7b: Trial Ops & Beyond high-level plan.....	64
6.1.10	Module 8: Organisation Design & Transition.....	69
6.1.11	Module 9: Commercial Strategy	73
6.1.12	Module 10: Systems Integration.....	79
7	Appendix F.....	89
	Resilience and Agility of the Execution Plan.....	89
7.1.1	Definition of Resilience and Agility for the Crossrail Programme	89
7.1.2	Why we need to address Resilience and Agility.....	89
7.1.3	Deployment of Existing Programme Management Tools	89
7.1.4	Programme Agility	91
7.1.5	Agility in using Programme Information.....	93
7.1.6	Agility in Tactical Mitigations	94
7.1.7	Navigating Transition in an agile way.....	94
7.1.8	Programme Resilience	96
7.1.9	Closeout of System Issues.....	98
7.1.10	Assurance	99
7.1.11	Overall funding context to the programme	100
	Risk.....	100
7.1.12	Background	100
7.1.13	Risk Management in the Recovery Execution Plan	102
7.1.14	Top Programme Risks by Module	104
7.1.15	Stations Risk Approach.....	108
7.1.16	System Integration Risk Approach	108
7.1.17	Routeway Risk Approach	108

7.1.18 August Programme Risk Overview 109

Learning Legacy Document

1 Execution Plan Overview

COVID 19 is an unprecedented event in the history of the world. It has negatively impacted significant aspects of the Crossrail programme due to the lockdown and the social distancing measures in place by Public Health England. An agile Recovery plan has been developed to optimise works and to mitigate the impact. The Safe Stop (instructed 24 March 2020) has affected the construction and testing programme through non-completion of Dynamic Testing (DT), loss of construction shifts, reduced productivity and the restriction of works to Niche and essential activities. This was necessary to comply with COVID-19 Public Health England guidance and TFL requirement to minimise the use of public transport to support the NHS. On the 15 June 2020, the programme moved from the 'Adapt' phase to the 'Advance' phase, with contractors being remobilised back to site in a controlled way. As at 11 September 2020, the programme is on schedule to the revised plan, with the planned 6-week construction blockade almost complete and productivity rates up from 35% to 97%. An overview of the background and objectives of Crossrail and the events that led to the need for this recovery execution strategy can be found in Appendix A.

Currently, there is no known effective COVID 19 vaccine, and it is expected that in the autumn/winter of 2020/21 there could be a second wave of infections that will affect the UK and global population more severely than before. The impact of this second wave is highly uncertain.

Against this backdrop, Crossrail has developed scenarios (Appendix B), tactical and programmatic interventions (Appendix C) and restructured the delivery schedule to compensate (sections 1.2.1 – 1.2.4).

The primary objective of the Recovery Plan is to start Trial Running under ROGS authorisation as early as possible to minimise any delay to Stage 3 opening. To do this the plan aims to complete the Stage 3 Central Operating Section (COS) Construction, testing & commissioning and assurance of the works necessary for Trial Running this calendar year. The construction works include delivery of Shafts and Portals, Routeway Chapters, and stations complete as a minimum to SC1 configuration.

Crossrail, as with other infrastructure programmes is planning to maximise the shift work opportunity during the summer in a controlled blockade style approach. This is now in train and will maximise construction access under COVID-19 restrictions to complete as much work as possible before the autumn/winter and expected second COVID wave.

Agreements with ASLEF have secured the ability to perform Dynamic Testing (and by extension Trial Running) under COVID-19 social distancing restrictions. Further, the Derogation by the ORR to allow up to 8 trains to be run at any one time has been granted. This de-risks TR2 software testing and the planned timetable running from December under System Integration Dynamic Testing (SIDT), and the transition into Trial Running at the end of March 2021.

The Execution plan at a high level has been constructed to:

- complete outstanding Dynamic Testing of the current software configuration PD+11.4;
- maximise construction access during August and September in a blockade to complete as much of the outstanding work as possible in a controlled way and focused on works needed for a timetabled service to start;
- complete TR2 software testing and the remainder of non-signalling integration testing by mid-November;
- transition to timetabled train running from December 2020 under SIDT
- commence Trial Running in a ROGS environment as early as possible to build confidence in the reliability of the system. Software updates that improve reliability (TR2 in August and Y0.610 in March 2021) resolve operational restrictions and system reliability issues, and these are accommodated in the plan;
- deliver a minimum of Station Configuration 2 by Trial Operations per the DCS1.1 P4 base plan for all stations, and maximise the number of stations opened for revenue service.

This Execution plan describes the ten module recovery strategies that underpin and support the Delivery Control Schedule (DCS) (Appendix E). These include strategies to prepare RfL and CRL for the transition from a construction environment to an operational environment under ROGS, to transition to the end state Elizabeth Line organisation and the commercial strategy that will determine the most cost-effective way to close out the contracts in support of the DCS. Each module has an overall accountable owner. The ten modules have been assessed against their maturity and completeness within this plan, and the relevant gaps identified to achieve full maturity.

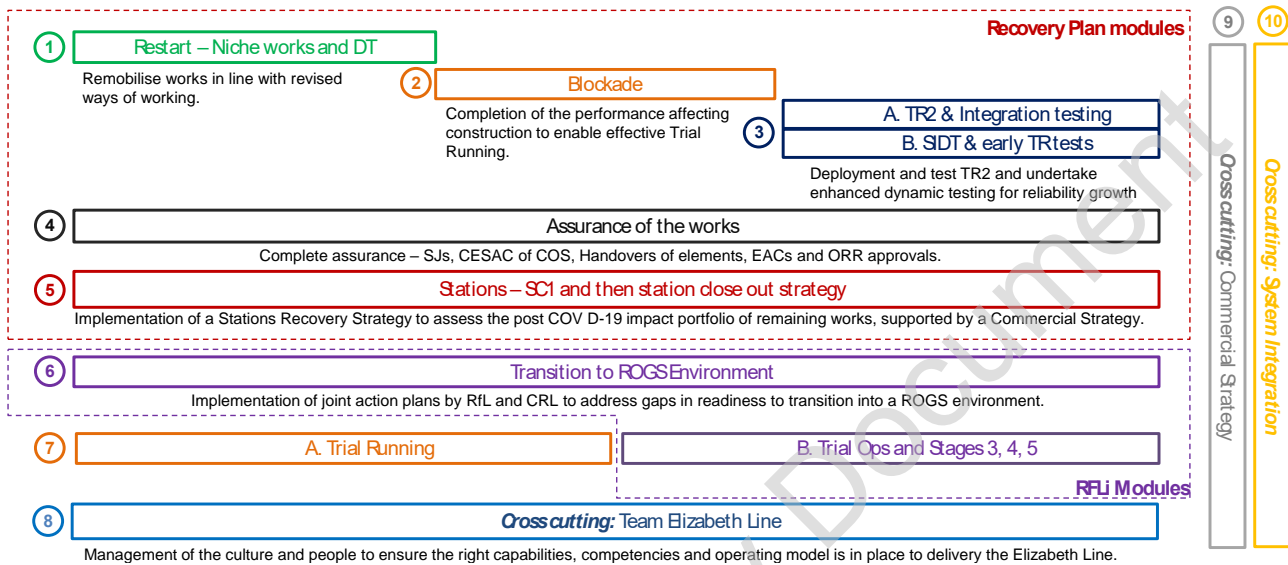


Figure 1: Overview of the ten modules – the foundation of the Recovery Execution Plan

The Delivery Control Schedule (DCS1.1) that this plan supports is being assured (see Appendix D) to confirm the works required are planned and deliverable against this timeframe.

Whilst the opening of Crossrail stage 3 is our primary objective, the key to programme success is the achievement of Stage 4 opening. This is because the revenue generation significantly increases at this point. To achieve this, the Timetable bid at D40 must be accepted by Network Rail. For this to happen, confidence in the system reliability developed through mileage accumulation and software issue resolution must be enough to be able to confirm a robust timetable operation at 24 tph.

There are 4 programme interventions adopted (see Appendix C) to improve the likelihood of entering operational service as soon as possible and transitioning to Stage 4 to protect revenue. These are:

- The deployment of Structured Engineering Judgement in the Assurance phase before ROGS authorisation to minimise the assurance timeline
- Focus on the priority stations required for a credible Stage 3 opening
- Use of the SIDT period to bring forward Trial Running tests and grow reliability early
- The deployment of Stage 4a to de-risk and remove the hard link between Stage 4 and the National timetable change events twice yearly.

As the future impact of COVID-19 on the workforce and contractors becomes clearer, this Execution Plan will be updated to reflect progress and further interventions implemented by the Crossrail Executive to transition to the Elizabeth line as early as possible.

1.1.1 Execution Plan Critical Path

The Critical Path is aligned to DCS1.1 which is supported by the 'Basis of Schedule' document which outlines the DCS1.1 architecture, logic and definition of milestones. The critical path below shows the high-level activities that make up the ten modules. Highlighted is the critical path from now through to Stage 5. See Appendix E for a full-size version.

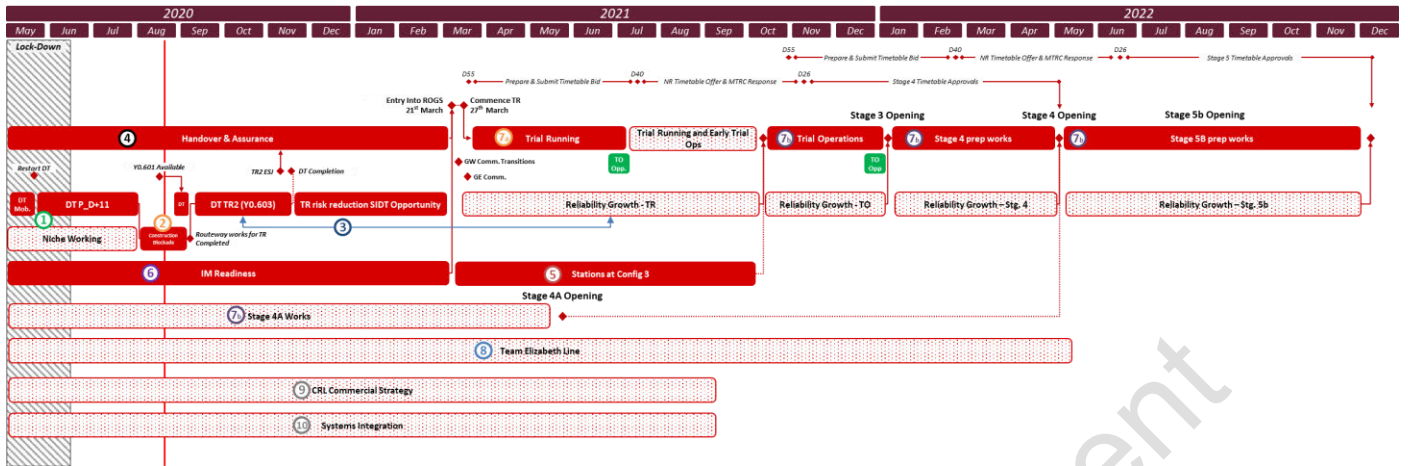


Figure 2: Execution Plan Critical Path

Learning Legacy Document

Overview of the Modules

The following sections provide a description and overview of each of the ten modules.

1.1.2 Module 1: Restart Niche Works and DT

The key success criteria for the Niche Working and Dynamic Testing phase was the safe start of critical works following Public Health Guidelines and the completion of the remaining 22 tests for the P_D+11/Y0.540 software suitable for Trial Running.

Niche works on the Central Operating Section allowed for critical maintenance and focused works to be undertaken that have a beneficial impact on the assurance and handover process.

A Crossrail Guidance document entitled “Route to Finish” has been developed by the Programme Delivery team to detail the migration of Crossrail from Safe Stop and Niche Working to a new way of working. The approach taken is in alignment with the wider Construction Industry, the Construction Leadership Council and Transport for London (TfL) responses to COVID-19. On the 15 June, mobilisation of all the contractors in alignment with this document commenced. This continued until the commencement of the 6-week blockade to complete outstanding scope, documentation, certification and testing necessary to support the submission of the Central Operating Section (COS) Safety Justification to RAB-C and subsequent Crossrail Engineering Safety Acceptance Certificate (CESAC).

Dynamic Testing concerns the completion of the testing of the P_D+11/Y0.540 suite of software systems on a 4 day - 3 day split to accommodate further construction windows. This will ensure that Crossrail has a viable software product available for the commencement of Trial Running.

Niche works commenced on the 20 April 2020 and dynamic testing recommenced 29 May 2020. Both completed on the 31 July before the Blockade commencement. See Appendix E, section 6.1.1.

1.1.3 Module 2: Blockade

A Construction Blockade immediately followed the completion of Dynamic Testing at the beginning of August. The key success criteria for the construction blockade is the completion of the critical construction works to support the Crossrail safety case to deliver a safe and operable railway and the majority of the works required for Trial Running. 3 shift, 7-day working is being deployed to maximise construction productivity. The blockade will provide up to 8 weeks of recovery opportunity against the COVID-19 schedule impact.

The Blockade is concentrating on the following:

1. Delivering the blockade in a safe COVID-19 environment. Currently, safety performance has been exemplary.
2. Prioritised access to complete essential works including Platform Screen Doors
3. Completion of all critical Fire Stopping in the Trace
4. Undertaking of specific stations integrated testing activities where HV isolations are required
5. Completion of outstanding works by the Principal contractors and their suppliers to enable future de-mobilisation of ATC
6. Closeout of as many Element Outstanding Works Lists (EOWs) to complete 30 (19 submitted as of 10th September) Acceptance Certificates of which 17 (7 submitted as of 10th September) are in support of the CESAC, and minimise the works needed during TR and beyond
7. Critical scope of works of:
 - 84 Critical tunnel hop-ups – Complete as of 4th September 2020
 - OHLE bent bolts – Complete as of 4th September 2020
 - Connaught tunnel water leaks – Complete as of 10th September 2020
 - Platform screen doors air gaps – Programmed for end of the blockade

The work to define, detail, plan and execute the blockade is being led by the Silver Routeway Recovery lead. The blockade is 6 weeks in and is achieving 97% cumulative productivity, up from 35%. It is expected to end the blockade on a 96-98% productivity rate. Furthermore, we have complete 9 out of 17 System-Wide Integration Tests and successfully transitioned between dynamic testing and construction as per the blockade management plan. In addition, we have incorporated further scope into the baseline programme during the blockade via the addition of:

- BOS – 173 of 251 trace dependant activities are now complete as of the 10th September
- EOWs – 130 additional EOWs of which 79 complete as of the 10th September

Outstanding works, predominantly at Bond Street, required for the Trial Running Phase are being programmed to complete in a mid-November 2020 mini blockade.

See Appendix E, section 6.1.2 for further details on the Blockade Execution Plan.

1.1.4 Module 3a: TR2 and Integration Testing

Following the Blockade, a key activity is planned whereby the next CBTC Signalling Software upgrade 'TR2' is tested under Dynamic Testing conditions. The key success criteria for this module is to complete the testing of TR2 by the 19 November 2020 to allow for assurance activities to be completed in time for Trial Running commencement in the first quarter of 2021.

The CBTC Signalling software version TR2 release is key to de-risking the programme to Stage 3 opening and is available by mid-August 2020. It is expected that TR2/Y0.603 software will deliver a reduced number of operational restrictions for both drivers and Traffic managers. Further updates bringing the configuration to Y0.610/PR6 in March 2021 will further de-risk passenger service by reducing operational restrictions, introducing auto-Reverse functionality and resolving known reliability issues such as with Platform Screen Doors.

The recent re-start to Dynamic Testing and completion of the subsequent blockade in mid-September provides an opportunity to commence earlier dynamic testing of TR2 software and an extended period of System Integrated Dynamic Testing (SIDT). This earlier testing of TR2 will be necessary to support the associated assurance evidence and submission of TR2 to RAB-C for approval by the ORR for Trial Running. See Appendix E, section 6.1.3.

1.1.5 Module 3b: SIDT and early TR tests

System Integration Dynamic Testing is an opportunity introduced after completion of TR2 Dynamic Testing to take advantage of the lag between the substantial completion of construction activity and the dynamic testing of TR2 and Assurance completion to permit entry into Trial Running. Noting that this is an opportunity activity, a key success criterion for the SIDT period is to undertake routeway integration tests originally planned for the Trial Running phase earlier in SIDT conditions. In some instances, the test results can be banked in SIDT and will not need to be repeated in Trial Running. In the other cases, the tests will need to be repeated but undertaking the tests initially in SIDT may flush out issues sooner, thereby de-risking the later stages of the programme. A second success criterion for SIDT is to accumulate circa 100,000 miles of system dynamic testing under timetabled conditions. Whilst the preference is to achieve the start of Trial Running as early as possible, SIDT is an opportunity to provide an earlier indication of reliability and performance of the various Crossrail systems whilst the assurance for ROGS Authorisation is completed. SIDT provides the following opportunities:

- Running more trains and increasing mileage through the COS (circa 100,000 miles). This will gather a significant volume of reliability data to help support the timetable bidding process for D40;
- Exercising the systems to flush out hidden defects outside of the constraints of the traditional dynamic testing arrangements;
- Stress testing the systems up to 4 months earlier by running for longer periods, increasing mileage and increasing the defect discovery phase;

- Undertaking routeway integration tests previously scheduled for the Trial Running period
- Enabling the cycling of an increased number of train units during this phase to identify any unit-specific defects;
- Enable RfL Ops and maintenance and MTR drivers a significant period of familiarisation of the Crossrail integrated railway systems and operations within a test environment. This should provide a more robust platform for moving into Trial Running.
- SIDT provides an environment where RfL can gain operational experience on the COS prior to going under ROGS by signalling test trains under the ROGS exemption and CCRRB

SIDT continues until the railway is authorised under ROGS regulations. Default timetable operation in the SIDT period operation will be 7 days during traffic hours. SIDT will operate a close headway timetable with a maximum of 8 trains operating. Each night there will be non-traffic hours where the railway infrastructure may be made available for other activities including maintenance and construction.

The Dynamic Testing, SIDT and Trial Running phases will be brought together under one controlling mind, the Trials, Testing & Commissioning team. This will be directed by the Head of Test, Trial & Commissioning (TT&C). The Head of TT&C will continue to deploy the strategy to bring together and integrate the DT, SIDT and TR phases so that mutual opportunities to de-risk the programme can be implemented effectively. See Appendix E, section 6.1.4.

1.1.6 Module 4: Assurance of the Works

This module covers the assurance of the construction works to achieve authorisation of the railway under ROGS. There is no float within the Assurance Fragnet and as such, all the activities are on the critical path.

The key success criteria for the assurance of the works is achieving ROGS authorisation by the ORR first quarter of 2021 (deterministic) followed by the start of Trial Running. To deliver this, Structured Engineering Judgement (STEJ) is being deployed to mitigate any slippage in the schedule and potentially improve on the ROGS Authorisation date. A series of Joint Hazard Review workshops by CRL (Technical and Delivery Directorates) and RFL, successfully used on past major projects in TfL, will be used for the final delivery stages of Trial Running and Trial Operations prior to Revenue Service.

CESAC submission takes place in February 2021 following the RAB-C approval of COS SJ, the integrated assurance approval and the Siemens signalling ESJ submission (TR2). RAB-C approval is planned two weeks later.

Routeway Assurance process overview

- CSM-REA requires a Safety Justification document to present the structured argument for safety.
- This needs a clear System Definition with boundaries drawn around the System or Sub-system for which safety is being justified.
- The contractor provides an Engineering Safety Justification at an asset level.
- CRL generates a Safety Justification at the integrated Railway Sub-system level (e.g. Track, Energy, Signalling).
- CRL generates the Central Operating Section (COS) SJ at the Railway level.
- RFLI generates the RFLI SJ to cover the organisational change to become the COS Infrastructure Manager.

Appendix E, section 6.1.5 shows the current assurance fragnet included within DCS1.1. This workstream is directed through the Crossrail Technical Director, supported by the Crossrail Chief Engineer and the RfL Head of Engineering and Crossrail Infrastructure. See Appendix E, section 6.1.5.

1.1.7 Module 5: Stations – SC1 and Station Close Out Strategy

The key success criteria for the Station Recovery is achieving all LU and RFL stations handed over into ROGS (SC3) by Trial Operations except for Bond Street which will be at SC2.

To achieve this, the priority order for Stations has been agreed and the stations split into 2 swim lanes: RFL and LU, with none of the early stations overlapping the previous station handover process beyond T-4. In this way, the first 3 stations – Farringdon, Paddington and Tottenham Court Road have been scheduled to minimise the peak load on critical engineering assurance staff.

The station recovery plan will align and support the planned routeway blockade (weeks 18-23 – see module 2) to ensure that the Station Tier 1s take advantage of the opportunities afforded by the working window made available to complete all trace dependent works.

Defined physical scope to go is key to delivering the station recovery (EOWLS, COWLS, NCRs etc.) and requires all parties to agree to EOWL triage: (a) Works required for trial running; b) Works required for revenue service, and c) Works that can be delivered post revenue service.

Consideration is given to changing the current cost-reimbursable nature of contracts to either introduce a vertical incentive for early handover or conversion to lump-sum cost arrangement.

Appendix E, section 6.1.6 shows the current station recovery schedule of dates (including assurance and handover of stations).

1.1.8 Module 6: Transition to ROGS Environment

The change from full completion to a staged completion approach for delivery of the project inevitably introduces risk in managing the change through multiple stages. The primary objective of this module is to ensure that Crossrail and the Infrastructure Manager (RFLI) can stand up and operate safely under a ROGS environment through the transition from construction into and through Trial Running.

An IM readiness capability review commissioned by the CRL Executive and jointly sponsored by the Chief Operating Officer and Chief Programme Director was conducted in early April 2020, identifying several issues in plans to transfer safety responsibilities under ROGS, impacting mobilisation planning for Trial Running. A programme of work – supported by improved governance arrangements – was subsequently established to mitigate these issues with a focus on targeted intervention planning such that activity could be monitored with confidence into Trial Running with oversight from an appropriate RFLI or Crossrail Executive. The nominated initiatives were supported by working groups until they were under control and transitioned to business as usual.

A key challenge in mobilising sufficiently to transition into ROGS is the need to mobilise RFLI with the ability to accept the railway in a staged way, as well as operate the railway. Where RFLI have not been sized to cope with this, Crossrail is working with RFLI to identify how support can be provided through personnel, support contracts and engineering expertise.

Appendix E sections 6.1.7 provides an overview of the different issues described above and their current status.

1.1.9 Module 7a: Trial Running

The purpose of Trial Running (TR) is to demonstrate that the railway is capable of reliably meeting the capacity and other requirements of the Crossrail Programme Functional Requirements and the Sponsors' Requirements. TR will involve appropriate integrated testing with multiple trains to demonstrate that the Central Operating Section (COS) Railway system can achieve these requirements.

The key success criteria for this module is to provide evidence that the system is reliable enough for the stage 3 timetable to recover from any Service Affecting Failures. Whilst the 15 Trial Running

tests are expected to be completed in the SIDT phase, it will be necessary to successfully demonstrate full operation at up to 24tph. Any outstanding works that are critical to operational service will also need to be completed and any associated assurance completed during TR.

There is a detailed set of Trial Running Exit criteria, which needs to be demonstrably met in order to confirm that the railway can meet the operational and reliability requirements after being authorised into service under ROGS. These include consistent headway, the overall performance (PPM) and transition elements, both in terms of the number of successful passes and in overall performance terms.

A detailed day by day model has been developed to fully detail the required activities to be conducted. This model has now been baselined following reviews with all relevant stakeholders. This plan integrates the key activities for the following 3 categories: Traffic Day (MTR Timetable operations and CRL Integrations Testing), Possessions & Signalling Protected Zone (SPZ) opportunities (to conduct Train and Signalling Updates) and non-traffic Hours (stations commissioning and maintenance cycles). The Trial Running period will commence after the Elizabeth Line is authorised into service under ROGS. This is currently planned for Q1 2021.

The general principles for Trial Running are set out in Appendix E, section 6.1.8. The strategic oversight and controlling mind for the Trial Running Phase will be held by the Head of Test, Trial and Commissioning, reporting into The Engineering Director. This will be integrated with the DT and SIDT strategy and philosophy (See module 2 and 3) to maintain a consistent and programme level approach to testing and commissioning across these three phases.

1.1.10 Module 7b: Trial Ops & Beyond high-level plan

This module covers the transition of the Elizabeth Line from testing and commissioning the railway systems to the operation of the railway under ROGS Authorisation in full passenger revenue service.

The Key Success Criteria for Module 7b is the successful entry into service of Stage 3 followed by the successful entry into Stages 4 & 5 at the appropriate timetable changes to maintain revenue growth. It also includes the launch of stage 4a. This will be achieved through demonstration exercises during Trial Operations that the operations of the railway and stations are robust enough to deliver a reliable service of 12TPH under any COVID-related Public Health England Guidelines in place at the time for stage 3. There is then a minimum gap of 12 weeks (and a planning assumption of one national TT phase) to increase reliability ready for stage 4 and 24tph in the COS.

Commissioning Stage 4a will be a key de-risk activity for Stage 4.

Successful bidding of timetables for Stages 4 and 5 and implementation of these will be critical to capacity and revenue growth.

The Delivery of this module is directed through the Chief Operating Officer working with MTR and Network Rail.

Trial Operations is a 13 week period of time supported by a detailed plan of 54 published tests and exercises and 20 unpublished exercises. These exercises include passenger evacuation exercises, infrastructure and rolling stock failures and are staggered across the 13 weeks. At the point of entering TO, CRL will commit to a specific date for first passenger service. Some exercises require the approval (and witnessing) of key external parties such as ORR and London Fire Brigade where applicable (e.g. evacuation exercises).

Stage 4a is planned to take place on a National timetable change day prior to the commencement of Stage 3 passenger operations. It provides two primary benefits to the CRL programme:

It re-aligns the FLU fleet strategy giving a homogeneous fleet in terms of length and software. The longer platforms at Liverpool will mean a full FLU service can operate on the east for the first time.

It should also mean Stage 4 can take place outside of a national timetable change (subject to wider industry agreement).

The Stage 4a timetable includes paths to run in and out of the COS to the GE off-peak to facilitate this growth in reliability and for driver training/familiarisation.

Stage 4 will provide a peak service of 24tph in the COS. Heathrow and Reading services will continue to serve Paddington Main line station. A key assumption is that Stage 4 needs to be a minimum of 12 weeks after stage 3, due to the need to prove reliability in the COS and for staff/passenger familiarity as well as continuing to run trains across the GE transition (empty and off-peak) to grow that reliability further, ready to support routine use at 12tph.

The On Network works consist of two main elements: Accessibility (induction loops, DDA toilets and lighting levels) and step-free access schemes (lifts and footbridges) during Station Refurbishment. Auto-reverse functionality is also an essential requirement for stage 4 to allow 24tph to turn at Paddington.

Stage 5b must be implemented on a national timetable change due to the scale of change across the western rail network. For this reason, it is also considered that stages 4 and 5b cannot be combined into one large change. Bidding for stage 5 will start just over one year in advance with the main bid 40 weeks before. See Appendix E, section 6.1.9 for more detail.

1.1.11 Module 8: Organisation Design & Transition

This module concerns the definition of the organisation required between now and through to the end state and sets out how the transition will be delivered at each stage through a consistent approach. This is to underpin the successful delivery of the Recovery Plan with a right-sized and capable organisation developed for each discrete state.

The Key Success Criteria for this module is the successful implementation of the CRL Organisation transition from the Crossrail programme to the Elizabeth line organisation.

This module will be delivered by the Chief People Officer through four key workstreams: People & Organisation, Governance, Obligations and Assets

The organisational transition plan will be underpinned and supported by key operating model considerations and includes a review of the governance required to ensure the delivery of the programme. A consistent methodology will apply to the design and implementation process and will define clear design principles to guide and shape the operating model and transition approach throughout the process. The design will be delivered through the following key activities: scenario testing, change impact assessment, communication and engagement, and implementation.

Sponsor and Stakeholder engagement will be a key element of this module. This is to involve key stakeholders at every stage so that receiving organisations are set up for the successful transition of people (where appropriate), governance, obligations and assets. See Appendix E section 6.1.10 for more detail.

1.1.12 Module 9: Commercial Strategy

Prior to the onset of COVID-19, the key commercial issues were at Bond Street and Whitechapel, with low productivity and commercial behaviour driving continued programme delays and cost increases. The introduction of the Safe Stop of all construction activities across the programme to assess the implications of the COVID-19 PHE guidelines and adapt our approach to complying has introduced further commercial considerations. A revised commercial strategy to mitigate the cost and revenue impacts of COVID-19 is therefore required.

The key success criteria for the Commercial Strategy will be the delivery of the Elizabeth line within the P50 funding envelope. Allied to this is the development and implementation of a mutually agreeable contractor demobilisation plan by the end of summer 2020.

The Commercial Strategy is directed by the Chief Finance Officer supported by the Deputy Commercial Director.

CRL undertook a risk assessment to determine the COVID-19 impact on supply chain liquidity that concluded that Crossrail was largely protected from Tier 1 business interruption. However, there were major concerns with the Tier 2/3 supply base and their potential liquidity. As such, 13 critical Tier 2/3 suppliers have been identified. A Supply Chain approach to incorporate these considerations has been developed and shared with both DfT and TfL with general agreement that CRL has adopted a pragmatic approach.

The commercial strategy is to remain vigilant, flexible and able to deal with the uncertainty that COVID 19 brings. To understand the impact on financial forecasts against the funding envelope, CRL has undertaken a modelling exercise to estimate the impact of the various scenarios developed on schedule and programme costs.

To support financial forecasting, CRL has identified key commercial risks and the key commercial interventions to mitigate these risks. These are grouped as follows:

- Resolution of Pre COVID-19 Issues including Bond Street Station, Paddington dispute, and concerns through the Tier 1 Stations supply chain regarding a dilution of fees
- Interventions to support the COVID 19 B1 and B2 scenarios
- Additional commercial interventions that could be deployed to reduce costs
- Impact on revenue of delays, and the opportunity to mitigate this through business case justified interventions
- Abnormal, degraded and emergency scenarios. These formed the basis for:
 - a gap analysis to determine if the currently planned integration testing (set out above) will provide sufficient assurance that the Crossrail System will operate as expected at the Railway Level;
 - a set of requirements for such tests; and
 - Providing traceability between the CPFR and the Contractors' Works Information.

Functional Descriptions have been produced for several high-risk focus areas: Platform Train Interface, Train Interfaces, RCC & Tunnel Vent System, NR Interfaces (GW, GE) and Yellow Plant.

The subsequent Gap Analysis will be concluded by the end of August following supplier review and the provision of evidence to close the gaps. Early indications are that there are no critical test gaps that are required to inform the COS SJ or Trial Running CESAC. However, there may be a small number of tests that need to be performed in Dynamic Testing to flush out any potential software issues. Where necessary these will be planned via the Dynamic Testing planning process. The remaining gaps will be resolved through integration testing in SIDT and/or Trial Running and will be planned in via Test and Trials team.

Further detail on the commercial strategy can be found in Appendix E, section 6.1.11.

1.1.13 Module 10: Systems Integration

The objective of Systems Integration (SI) is to ensure that the Elizabeth Line is commissioned in a structured and staged way, with appropriate controls to manage any deviations. This objective is accomplished through the creation of a Migration Plan with identified key integrating milestones. These milestones are further defined as configuration states of the railway that ensure the related functional and non-functional requirements (safety, reliability, operability, etc.) are present to achieve the purpose of the state and are clearly understood by the other module owners and delivery teams. This is to ensure there is a balance between delivered functionality and operability (considering operational restrictions associated with functionality gaps or bugs) for each agreed configuration state. The SI module is a cross-cutting module and ensures integration across the programme, technical and organisation.

The Key Success Criteria are to develop and migrate system elements and software in accordance with the programme and successfully integrate across signalling, trains, stations, control centre, customer information, depots/yellow plant and other railway systems to achieve sufficient reliability

to enter passenger service. The successful outcome is a safe, resilient, operable and maintainable railway.

System Integration is directed by the Head of Systems Integration. This is accomplished using 3 main integration streams: Overall Railway level, Trains and Signalling, and Stations Commissioning. Siemens (CBTC Crossrail, Application Design, Interlocking, CBTC Integration (CIF)) and Bombardier Technology (BT) (Train Build, Train Systems Integration, Train Assurance) are the main contractors developing systems and software requirements for the programme. This is managed through a joint collaborative team, 'Plateau 1' headed by Hugh Bridge. Similarly, the Stations Integration and commissioning is managed collaboratively through 'Plateau 2' headed by Lee-John Allen.

Under Plateau 1, the software configuration fully assured by CRL upon entry into ROGS will be Y0.603. Following entry to ROGS Y0.610 will be released to enable the entry into Trial Running. This will be the first software released configuration assured under RFLi. A detailed software release plan has been developed which shows the 'last call for change', 'supplier approved' and 'fully assured' milestones for each release (Appendix E, section 6.1.12).

Crossrail is responsible for Systems Integration, Software Strategy and Testing Verification & Validation Strategy at a programme level. The overall railway level integration is managed through the System integration team lead by Malcolm Thomas, this team also acts to define and manage the configurations of the railway and well as defining system-level integration test activities.

Plateau 2 combines the Communications and Controls elements with the Stations delivery and the RCC (further detail of the scope and objective of Plateau is described in the Execution plan Appendix E section 6.1.12 extracted from the Plateau 2 Terms of Reference). A key principle of the commissioning strategy is to apply learnings from the first wave of stations that are commissioned which are Custom House (RFL station) and Farringdon (LU station).






These components are described in further detail, see Appendix E section 6.1.12.





Summary of Execution Plan Modules




The Crossrail Programme Director is the sponsor to the Execution plan, with dedicated owners for each module. The modules are underpinned by the DCS 1.1 baseline schedule for the works to complete.

As strategic interventions aligned to each module are agreed, they will be incorporated into the DCS1.1 and will be tracked periodically. Tactical mitigations and strategic interventions will be continually developed to de-risk the programme to Stage 3 opening and Stage 4 Revenue Service. As these are adopted, the Execution Plan will be updated. It is therefore recognised that the modules are not yet fully mature.

The table below sets out the summary of their current status, identifies the gaps and assesses the respective maturity.

Modules of the Execution Plan	Owner	Status	Gaps	Maturity	DCS 1.1 Incorporated?
1. Restart – Niche Works & DT	Mark Cooper	Niche works and DT have commenced and are underway since 20 th April. DT plan to deliver P_D_+11 in place	No Gaps		Yes
2. Blockade	Mark Somers & Rob Lines	Blockade scope currently in week 7 of 8. Current productivity rates are 95% and we expect this to be the end productivity rate of the blockade. Substantial additional scope has been added during the blockade from BOS and additional EOWs form the technical directorate.	As of the 10 th September: 1286 activities, currently 1132 complete (baseline) Delivered an additional 79 EOWs and delivered an additional trace dependant scope of works at BOS		Yes
3.A. TR2 and Integration Testing	Jason Lacey & Catherine Latham	TR2 test plan issued. TR2 loaded on the COS and testing commencing in September 2020. Routeway integration tests detailed planning complete	No gaps		Yes
3.B. SIDT and early TR tests	Colin Brown & Catherine Latham	SIDT developed as a programme mitigation to run a timetable pre Trial Running	Mileage running curves, further analysis on the beneficial impact of future software releases on PPM. Define how we are going to track train reliability of train signalling, train M&E, PSD, TVS, Power and points performance Undertake DITLO and Peer Review		Yes
4. Assurance of the works	Colin Brown & Steve Turner	A review of the use of Structured Engineering Judgements has been undertaken by the CRRP (Crossrail Risk Review Panel) and processes/tools are already in place to allow its use – it is being used on c660 and CAW assurance and will be used more widely in the programme after the construction blockade is complete and the final (TR) state is known.	Identical the critical resources where there are bottlenecks Prioritise the order of the Assurance documentation Map that on a programme to provide MI on what we are going to get when		Yes – key assurance dates built into DCS1.1 and tracked to cardinal key events

<p>5. Stations – SC1 & station close out strategy</p>	<p>Neil Thompson</p>	<p>Targeted objectives have been developed for the station recovery plan. Consideration is given to changing the current cost-reimbursable nature of contracts. Immediate actions include Mobilisation instruction for Stations to be sent to Tier 1s, the establishment of a new SC2 milestone definition for Bond Street and a review of critical resource dependencies.</p>	<p>There is a need to resolve the concurrency of station handover with the handover of other critical elements (e.g. Routeway chapters) to mitigate the critical resourcing issues</p> <p>Station work scope with Routeway blockade to ensure we can deliver the critical station works during the 5 weeks blockade</p>		<p>Yes</p>
<p>6. Transition to ROGS environment</p>	<p>Howard Smith & Neal Lawson</p>	<p>An IM Readiness plan has been developed encompassing areas critical to ensuring safe transfer of responsibilities under ROGS ahead of Trial Running. The plan is split into two distinct components:</p> <ol style="list-style-type: none"> 1. IM Readiness; and 2. Crossrail readiness. <p>The plan is monitored the Trial Running Mobilisation Board (TRMB), with escalations raised as needed to the RFLI and Crossrail Executive group.</p>	<p>Initiatives mobilised in April 2020 were designed as short-term recovery plans, many of which have now been transitioned to business as usual. However, to complete planning and assurance for the stand up for ROGS and the entry to Trial operations, both Trial Running and Trial Operations functional configurations must be locked down with Crossrail and then configuration managed. Work is underway to lock down this configuration and assess the ability to safely operate and maintain the Elizabeth Line in light of the total number of required mitigations created due to a staged configuration approach.</p>		<p>Yes – key milestones</p>
<p>7. A. Trial Running plan</p>	<p>Colin Brown & Catherine Latham</p>	<p>Detailed Trial Running plan being updated to reflect COVID-19 Recovery Plan, and integrated with SIDT opportunity pre-ROGS.</p> <p>The Trial Running plan will also be updated to include the Trial Operations opportunity (2 weeks).</p>	<p>Integrate SIDT component to show opportunity for building reliability.</p> <p>Validate software plan and build into the</p> <p>Integrate station commissioning assumptions (2 by 2)</p> <p>Challenge the underpinning assumptions to develop a robust scheduled to ensure D40 timetable bid confidence.</p> <p>Agreement of the TR exit configuration (Y0.610 operational) for Trial Operations</p> <p>Integrate TO opportunities</p>		<p>Yes – key milestones</p>
<p>7. B. Trial Ops, Stage 3,4,5</p>	<p>Howard Smith & Richard Schofield</p>	<p>The DCS is now in compliance with the B1 Recovery Plan. This included the critical timetable bidding dates.</p> <p>3 of the 20 elements that make up the DCS form the Trial Ops & Beyond Plan:</p> <ul style="list-style-type: none"> • DCS HIT: Integration and Assurance • DCS SFC: Surface Handover • DCS OPS: Operations-RFLI/LU/MTR Readiness <p>Detailed schedules sit outside the DCS with the various owners, such as NR and MTR.</p> <p>A detailed day by day plan has been developed highlighting RFL's Trial Operations exercises.</p>	<p>Dedicated Stage 4a programme manager is required to help coordinate and lead efforts to reach 16th May 2021 opening of Stage 4a.</p> <p>Stage 4 programme of works and key milestones to be incorporated to the DCS</p> <p>Integrate TO opportunities into TR plan</p> <p>An agreement that Stage 4 ad 5b cannot be implemented on the same national timetable change date</p>		<p>Yes</p>

<p>8. Cross-Cutting: Transition plan organisational design</p>	<p>Angela Williams</p>	<p>An Organisational Design and Transition Plan is in development which aims to define the organisation design and transition required at key phases of the programme, between now and through to the end state.</p>	<p>Work has been completed to develop the end state and pre-Trial Running OD. Further work is required to develop the Trial Running and Trial Ops OD in conjunction with RfLi and TfL to ensure alignment with the programme and the receiving organisations.</p>		<p>Yes – but needs further iteration</p>
<p>9. Commercial Strategy</p>	<p>Rachel McLean, Rod Nathan & David Stacey</p>	<p>A risk assessment to determine the impact on supply chain liquidity has been undertaken identifying major concerns with the Tier 2/3 supply base and their potential liquidity. To evaluate the financial forecasts a modelling exercise on schedule and programme costs was completed and key commercial risks and interventions to mitigate have been identified.</p>	<p>Develop a strategy for cash flow basis (taking in to account costs and revenue instead of a funding envelope)</p>		<p>No</p>
<p>10. System Integration</p>	<p>Colin Brown & Pradeep Vasudev</p>	<p>Definition of configuration states by phases defined and managed through Plateau 1, 2 and SI teams, underpinned by a Migration plan which is aligned to the DCS 1.1</p>	<p>Formally stand up Plateau 2 to support the station systems integration Map the CRL asset break structure to the accountability of Plateau 1, 2 and SI team.</p>		<p>Yes</p>

Learning Legacy Document

Resilience and Agility of the Execution Plan

With the backdrop of COVID-19 and the uncertainty it brings paired with the current phase of the Crossrail programme, there is a need to identify and improve the robustness, resilience and agility of the programme. Known and unknown risks will arise in the programme and using the resilience and agility methods and tools identified, the programme can continue to deliver to the agreed baseline.

Key areas in which tools and strategies are deployed to address resilience and agility are:

- Programme management
- The timely provision of accurate Programme Management Information
- Tactical interventions and mitigations
- Transition planning for each configuration state
- Closeout of system issues
- Assurance.

To achieve the baseline schedule, CRL and RfL will adopt tools and techniques to maintain the resilience and agility of the programme as described in Appendix F.

Risk

The mitigation of programme risks forms a key component in the development of the COVID-19 Recovery Execution Plan. This has allowed for the identification of further programme interventions over and above those interventions already identified ('Scenario D') to improve the programme resilience.

There are three levels of risk management considered in developing the DCS 1.1: enterprise risk, programme risk and project risk. In addition, within the Programme Risk layer, CRL has developed the Elizabeth Line Risk Landscape which describes the key risks associated with transition into operation which are held by each of the interested parties (see figure 2a below).

The Risk Landscape outlines the key areas of interest – or objectives – of each of the parties and the key risks to achieving those objectives. Each section of the Risk Landscape is owned and managed by leads from each of the organisations, and the process is overseen by ELRG and CRL Board. Further detail on the risk management and cost management of the Execution Plan is described in Appendix F.

ENTERPRISE RISK

Combination of:

- Externally driven, relating to funding, market and economic factors, industry and stakeholder relations
- Summary of key areas of risk within the programme for reporting to the CRL Board and Sponsors

PROGRAMME RISKS

- Risks to Crossrail's functional requirements
- Risks associated with coordination, interfacing and integration of projects
- Significant risks which cannot be resolved within projects

PROJECT RISKS

- Risks associated with delivery of Project scope

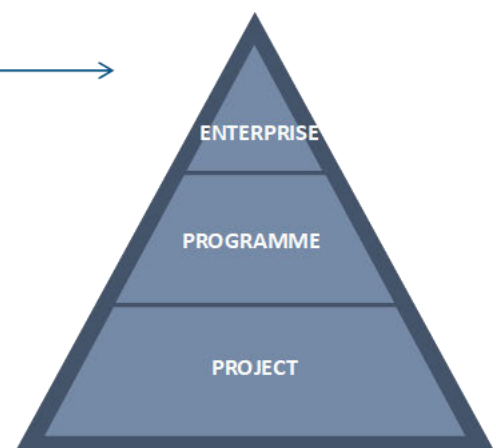


Figure 2a: Risk hierarchy

2 Appendix A

Introduction

2.1.1 Background

The Project Development Agreement (PDA) between Crossrail Limited (CRL) and its Sponsors (the Secretary of State and Transport for London) appoints CRL as the legal entity accountable for the management and implementation of the Crossrail Project (Crossrail).

This Execution Plan sets out how CRL will deliver the works to complete and open the Elizabeth Line taking into account the impacts of COVID 19. It sets out Crossrail's remaining scope, its overall objectives, what has to be achieved by when, and the main risks to those objectives. It demonstrates that CRL has in place the organisation, strategies, controls and resources to manage Crossrail as a whole to successfully achieve Substantial Completion, Final Completion and Handover to the Operators. It is underpinned by the Crossrail Management System (CMS).

It was intended that the 2016 version of the Delivery Strategy would be the final version in advance of Stage 3 opening in December 2018. However, following the announcement of the delays in 2018, the Earliest Opening Programme (EOP) was introduced. This initiative examined a revised opening strategy to allow the opening of the Central Operating Section (COS) of the Elizabeth Line (i.e. Stage 3 opening) at the earliest date possible, and support the subsequent staged opening of the end-to-end railway (through Stage 4 and 5) for Sponsors as soon as possible thereafter, now considering the COVID 19 impacts.

The EOP Strategy took the form of a strategic business case for the development of a new set of detailed Crossrail plans and strategies to support a new direction in the programme. It outlined the key principles and interventions to optimise the programme in its new state. This directed the update of cornerstone documents within the CMS which have since been disseminated to within the programme, including an updated Handover Strategy.

With the impact of COVID 19 on the Crossrail programme, it has been necessary to develop a strategy to recover the time lost following the Safe Stop and controlled return to work under the Governments Social Distancing guidelines.

This document sets out the execution plan for the recovery in terms of nine modular strategies and supports the revised Delivery Control Schedule (DCS) 1.1 that will determine the Earliest Opening Programme.

2.1.2 The Objectives for Crossrail

The Sponsors Requirements sets out the following high-level objectives for the Crossrail Project:

1. The planning, construction, commissioning and implementation of service shall be consistent with the Government's overall approach to the provision of major transport infrastructure, and the Mayor's plans for the development of the capital's infrastructure;
2. The Project shall support the Secretary of State's plans for public transport provision, in particular concerning how it interfaces with other existing and future transport schemes and shall be integrated with the Mayor's transport and sustainability strategies;
3. Value for money shall be provided at every stage of the Project;
4. Robust cost control mechanisms shall be in place throughout the lifetime of the Project;
5. Subject to other requirements in these Sponsors Requirements, CRL shall ensure that the design and delivery of the Project shall be such as to achieve a service capacity of 24 TPH utilising 200m Trains in the Normal State of Operation in the Central Section at the Final Delivery Date;
6. The Project shall be developed, designed and constructed in a way that optimises whole life cost based on an appraisal period of 50 years from the Target Final Delivery Date and using TfL Business Case Development Manual assumptions as to methodology and discount rates,

- except that such analysis in respect of On-Network Works shall be undertaken with reference to Network Rail's equivalent procedures and parameters;
7. Quality assurance, environmental assurance, safety and security regimes shall be established to be implemented during the phases of design, construction, commissioning and service operation;
 8. In all circumstances, the design of the Crossrail Project shall comply with all Applicable Laws and Applicable Standards including, but not limited to, those pertaining to safety, security, interoperability, the environment and provision for those with a disability;
 9. World-class levels of performance and reliability shall be delivered;
CRL shall co-ordinate the activities of parties to the Crossrail Project to deliver pro-active and consistent communications and relations with stakeholders, the media and local communities; and
 10. All outputs shall be achieved for a minimum of 50 years from the Target Final Delivery Date, allowing for increased use of the system and the requirements for maintenance and renewal of Crossrail Assets over this time period.
 11. Where deemed appropriate all lessons learnt, good practice and innovation developed will be shared on the Crossrail Learning Legacy.

2.1.3 Scope

The purpose of this document is to outline Crossrail's COVID-19 (COVID-19) recovery strategy and present it to the Sponsors to capture the CRL response to the pandemic and associated strategic decisions. The contents will cover the COVID-19 scenario-building framework and how to interpret the modelled scenarios. An in-depth analysis which compares the scenarios and how they impact the progress of the programme is explored. An overview is provided of the recovery plan from the perspectives of the 9 main modules of the Execution plan and how they knit together.

This Execution Plan will describe the key mitigations that have already been realised and the mitigations that are recommended to be deployed. Analysis of the cost and schedule impact of the mitigations is considered.

Also considered is the commercial and financial impact on Crossrail's supply chain, the funding response to the amended programme and next steps. The communication and stakeholder engagement plans are aligned with the COVID 19 Recovery Execution Plan to ensure all parties are informed. Finally, a summary of the recommendations will be made responding to the impact that COVID19 has on the construction and handover of the Elizabeth Line.

2.1.4 Events that led to the need for a strategy

In response to the COVID-19 global pandemic, Crossrail has reacted and remobilised to protect its' people and strategize how it will move the programme forward.

On 24 March 2020, Crossrail's Gold Response Team (GRT) decided to enact 'Safe Stop' of works. The 'Safe Stop' was introduced to actively respond to the Public Health England guidelines of maintaining a safe 2m between others, and to support TFL's initiatives to reduce the volume and frequency of journeys, prioritising key workers.

'Safe Stop' was in two phases: Phase 1 being the immediate cessation of all activities except those deemed essential to maintain the security and safety of the sites, and Phase 2 being the more complicated protection of the temporary and permanent systems. Phase 1 was achieved on 25 March 2020, the day after the GRT's decision, and Phase 2 was achieved on 07 April 2020. The full enactment of 'Safe Stop' occurred over 14 days. The GRT also established four Silver response teams to support the organisation and manage the implementation and the new work stream demands of the 'Safe Stop' programme (H&S and People, Recovery, Response and Professional & Financial Support).

Concurrently to undertaking the 'Safe Stop', Crossrail coordinated with Transport for London's Major Projects Directorate (MPD) to determine what works could be safely executed under Public Health England guidelines alongside the enabling processes, with these works being called 'Niche Works'.

On 07 April 2020, Crossrail secured approval for its Niche Working proposal. The start of Niche Working was on 20 April 2020. This resulted in the total period of 27 days from the decision by the GRT to enact 'Safe Stop', during which no works to progress the programme was being undertaken.

The Niche Working environment has seen an incremental increase of resources from 27 on 'day one' (20 April 2020) to over 1900 personnel mobilised as at 18/6/20. Niche Working has been commissioned in compliance with the policy on social distancing and to minimise the use of public transport in the rush hour peak.

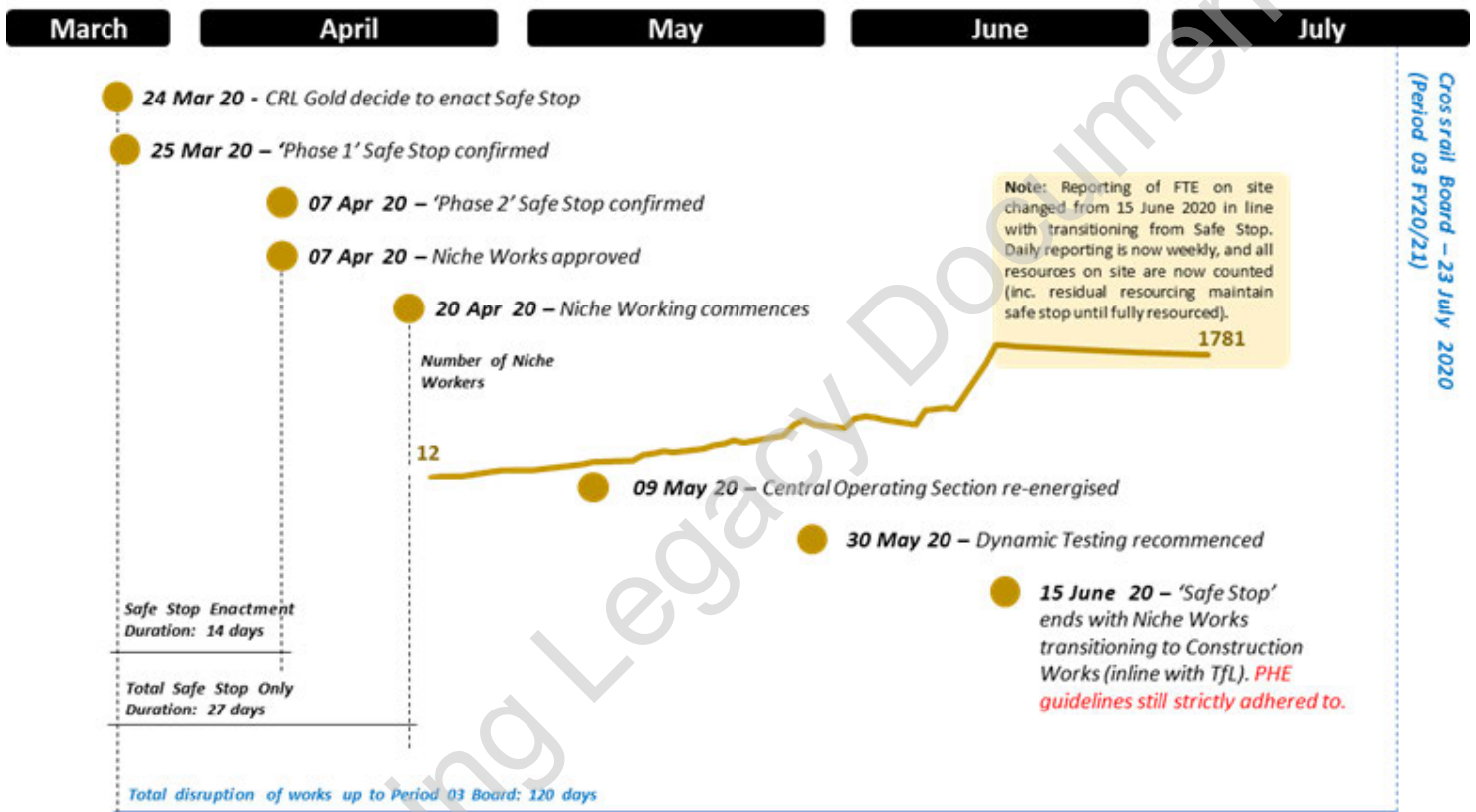


Figure 3: High-level timeline of Crossrail's programme COVID-19 response

On the weekend of 09 May 2020, Crossrail re-energised the Central Operating Section in anticipation of restarting dynamic testing. Dynamic Testing recommenced at the end of May following the successful conclusion of negotiations with ASLEF Train Drivers on the return to work COVID 19 working conditions. Significant Dynamic tests are being completed to programme.

Up to the date of the Period 1 Crossrail Board, the total disruptive period to programme works has been 65 days from the GRT's decision to effect a 'Safe Stop'. The following timeline captures important milestones and actions taken during the pandemic and provides an overview of how the current state was reached.

High Level CRL COVID-19 Events Timeline

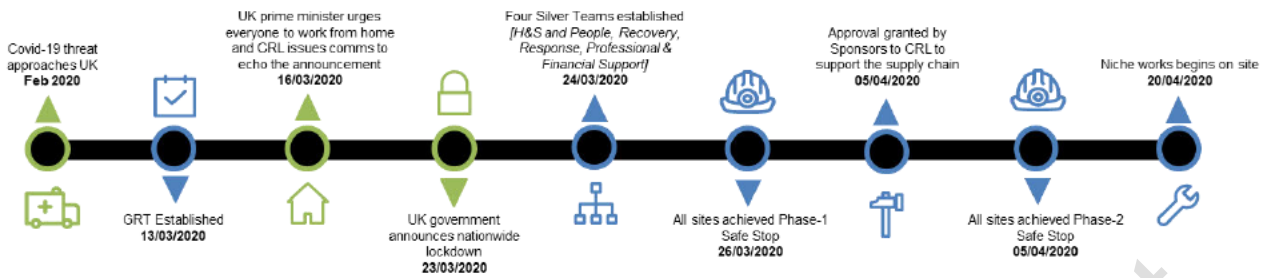


Figure 4: CRL COVID-19 Events Timeline

There are a number of strategic papers being presented to the Board and Executive Group. Together, they will address the challenge from the board to demonstrate how the programme is managing the recovery from COVID-19 and the execution plan.

The Crossrail COVID-19 Recovery Execution Plan and DCS 1.1 are keys to putting in place the enablers to restart the programme and fix the new programme baseline with our teams and sponsors as they set the backdrop and agree the assumptions to move forward. The Draft Elizabeth Line Transition Plan, IM Readiness (Transition to ROGS) and Closeout Strategy are all linked and are dealing with the same strategic issues but for different parts of the organisation at different times in the programme lifecycle.

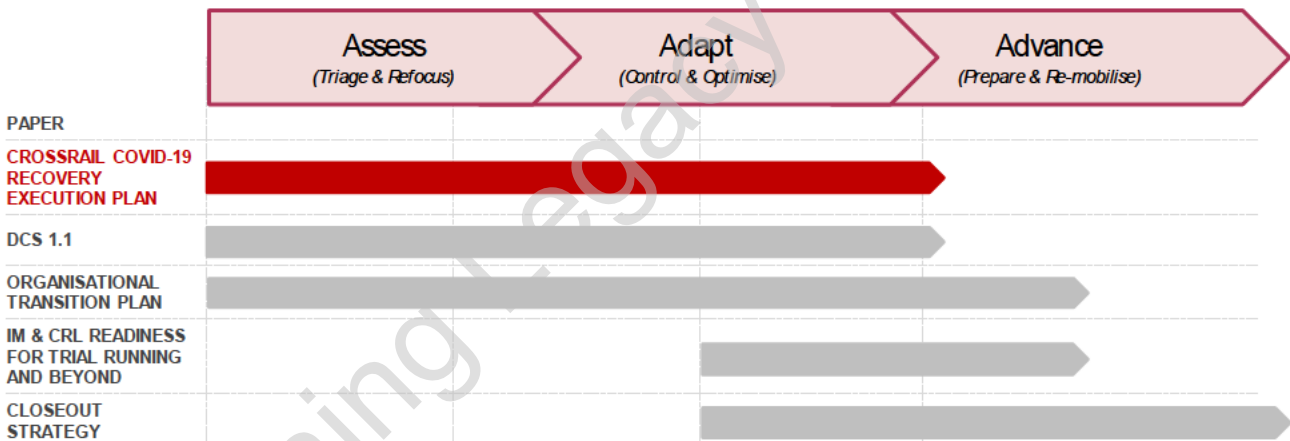


Figure 5: Interlinked papers to address the recovery and execution of the Crossrail Programme.

2.1.4.1 Silver H&S and People Team

The Silver H&S and People Team were mobilised to manage and support the well-being and focus on the longer-term, strategic impact and assessments of the programme. Following the safe stop of the delivery programme, the H&S and People team developed the Resourcing Hub to provide visibility into remote work capabilities and re-deploy capable resources to critical works. The H&S and People Team continue to monitor the capacity and well-being of the workforce and reports directly to the GRT.

2.1.4.2 Silver Response Team

The Silver Response Team was mobilised to manage Phase 1 and 2 Safe Stop and the subsequent Niche works to restart the programme. The Safe Stop of all works, including dynamic testing, was authorised to commence following the national lockdown instructions from the UK government. Approval to support the supply chain during this time was endorsed by the Sponsors to ensure Tier 2 and Tier 3 suppliers will be operational post-COVID-19. Workforce availability from the safe stop

activities was funnelled into the resource hub to re-deploy available people, while approval for niche works was given by the Deputy Mayor of London to continue select activities safely.

2.1.4.3 Silver Recovery Team

The Silver Recovery Team evolved from the Programme Recovery Scenario workstream that the Executive team initiated to investigate the potential impacts to Trial Running due to COVID-19 circumstances. The Silver Recovery Team has subsequently been broken into two – a Routeway Recovery workstream and a Stations Strategy workstream. Revised logic and resequencing was developed into a recovery schedule to Trial Running. This was used to form the basis for the Recovery Scenario modelling. The revised schedule logic and sequencing incorporating a blockade was endorsed at the May Board and the recovery execution strategy planning commenced. Currently, the Delivery Control Schedule DCS 1.1 is being developed utilising SMEs from CRL/RfL to inform programmatic impacts with updated timeframes.

2.1.4.4 Silver Professional and Financial Support

The Silver Professional and Financial Support Team integrates and coordinates functional decisions taken by CRL executives in relation to the COVID-19 response. Decisions include matters such as Legal, Agreements, Commercial, Land & Property, Finance, HSQE, IT and Procurement. This team meets on an as-needed basis and reports to the GRT.

Learning Legacy Document

3 Appendix B

COVID-19 Scenario Framework

3.1.1 Background

This section articulates the work carried out to develop the COVID-19 Scenario Framework against which the Recovery Execution plan and Delivery Control Schedule is being developed.

The Delivery Control Schedule (DCS) 1.1 is being developed following Board endorsement of the revised programme logic and sequencing in May. It will bring together the Routeway Recovery Strategy and the newly formed Silver Stations Recovery Strategy for consideration at June Board, followed by the sign off at July board. This will be integrated with the Trial Operations and Beyond Recovery Plan to create an end to end schedule.

Crossrail’s Programme Recovery Framework comprises nine modules that support the CRL Recovery Plan, all of which are linked to the overarching commercial strategy.

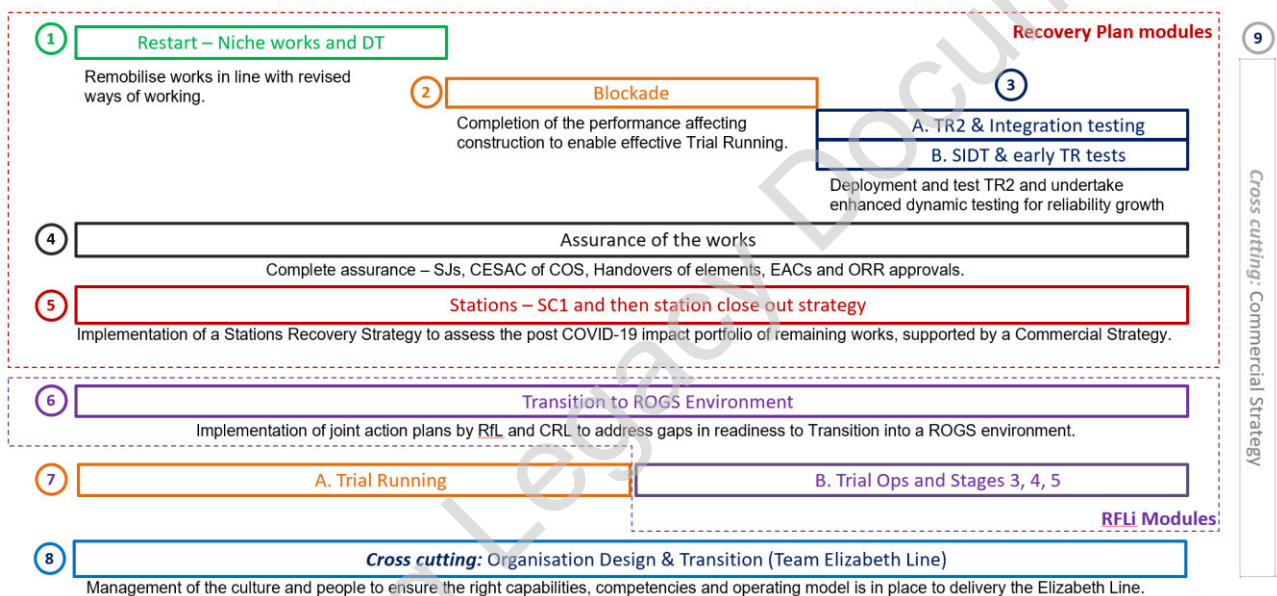


Figure 6: Overview of the nine modules – the foundation of the Recovery Execution Plan

Modules 1-5 are grouped in Recovery Plan Modules. The Recovery Plan (which is based on COVID-19 Scenario B1) covers the start, blockade, TR2 and reliability growth, Assurance and Stations.

Modules 6 (Transition to ROGS Environment) and 7b (Trial Operations and Stages 3, 4, and 5) are RFLi owned modules.

Module 7a is a CRL owned module and will provide the transition from a Construction environment to an operational one as the Railway and Other Guided Systems (ROGS) authorisation is granted.

Each of these modules is being developed and linked to the emerging commercial strategy so that as the recovery plan is developed, our response to contractors and partners is aligned.

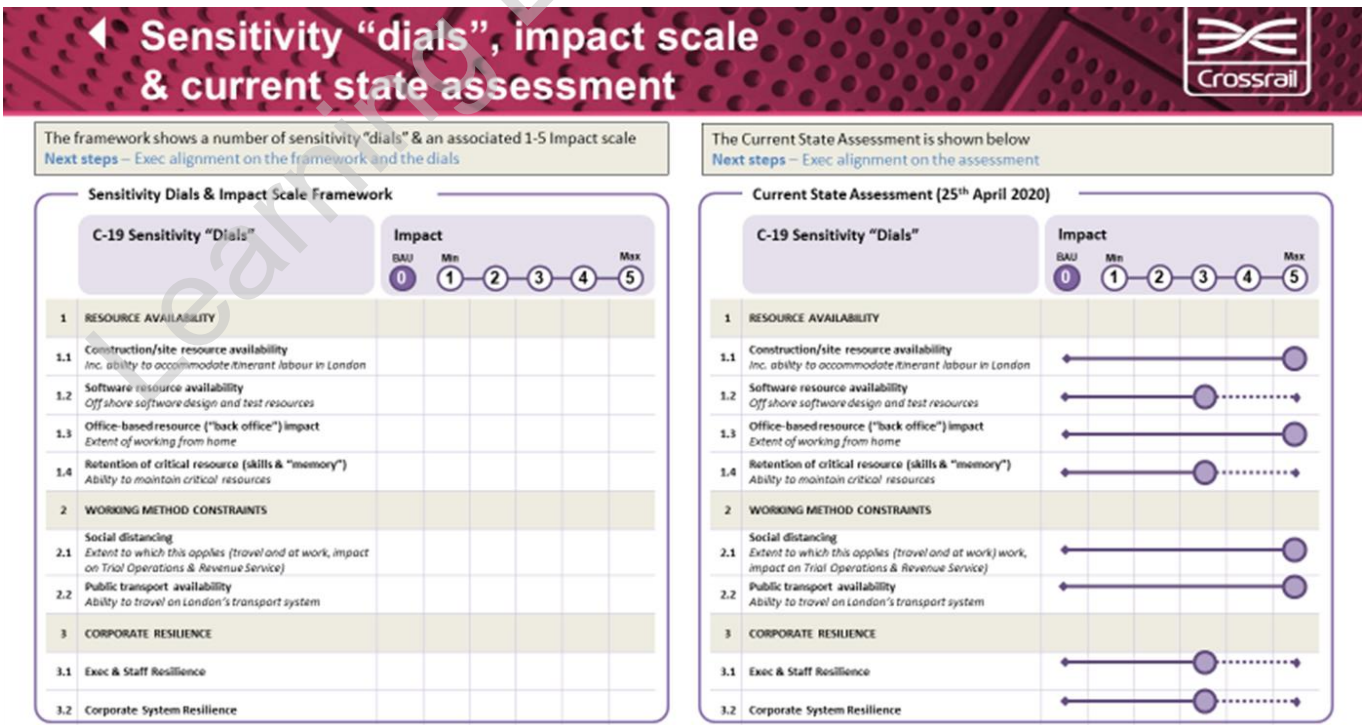
COVID-19 Scenarios

Crossrail has developed a framework for assessing the potential impacts of COVID-19 beyond June 2020. The framework assessed each COVID-19 scenario against an impact of score “0-5” (where “0” is Business As Usual (BAU) and “5” is full lockdown and maximum programme impact). The scenarios are described below:

A1 – Board reference case (P10) used for cost only	P10 forecast introduced delivery windows and associated funding that gained Board alignment
A2 - Reference Case “Do Nothing” scenario following single lockdown - Analyse for comparison	The current lockdown eases and London and the UK return to normal ways of working, travelling and living by mid-June. Office and construction workers are back on-site with no impact to efficiencies, supply of materials or resources. The public-use normal means of transport. In developing this scenario CRL has applied a schedule risk to the original P13 forecast to account for the lockdown between March and June. This reference case is the “Do nothing” option whereby 3 days of Dynamic Testing and 4 days construction is undertaken. In this scenario, there is no blockade and the software configuration for Trial running remains at P_D+11.
B1– Optimistic Constrained work from May/June “BAU” from start TR	Lock Down measures are, on the whole, in place. Office and construction workers are able to return to work provided there is specific measures put in place. This results in a constrained working environment whereby work on-site if less efficient, travelling to work can be challenging, resulting in supply chain and resource constraints through to the end of 2020. This is resolved by the time CRL reaches Trial Running. This plan is based on the Recovery Plan (shown overleaf), which forecasts entry into ROGS as January 2021.
B2 – Most Likely No 2 nd Lockdown But Social Distancing to Summer 2021	From summer 2020 through to summer 2021, social distancing measures are in place across the UK. Office and construction works return to work with specific mitigations in place. There are resourcing and supply chain constraints as a result throughout this period. This impacts the entry into ROGS, TR period and TO period resulting in a delay to Stage 3 Passenger Service.
C – Worse Case 2 nd Lockdown and Social Distancing to Summer 2021	The UK comes out of full lockdown May/June 2020, with social distancing mitigations in place in the workplace. However, at the start of Trial Running a second peak of COVID-19 cases across London or the UK resulting in a second lockdown. Public transport, non-essential travel and construction are again brought to a safe stop/minimum for 8-12 weeks. After which social distancing is in place until summer 2021.

Using the descriptions of the COVID-19 Scenarios and the as-is assessment against the sensitivity dials CRL developed a score for the impact that COVID-19 presents to key phases of the programme.

Figure 7: Sensitivity dial assessment framework



The average scores (0-5) for each phase of the programme have then been used to develop indicative timelines for the pre Trial Running, Trial Running, Trial Operations periods and opening dates for Stages 4 & 5b. These have been developed and refined following Executive review.

These Scenarios were taken to the May CRL Board and it was agreed that at Programme level the recovery plan and the nine modules should be based on scenario B1, however, CRL will report to the Board against B2 performance, recognising that further mitigations should be sought to mitigate the programme.

Determining the Pre-Trial Running period for Scenarios B1, B2 and C

Scenario B1 uses the Recovery Plan summarised in the previous section.

Scenario B2 takes the deterministic routeway recovery plan and applies a high-level COVID-19 QSRA. This adds a further two months to the pre-Trial Running period.

Scenario C adds a further three months to the Scenario B2 (most likely) schedule to account for the impact of a second wave of COVID-19 infections. This is to account for the impact on the workforce and critical Tier 2 and Tier 3 suppliers. This is supported by experience from the Hong Kong Flu epidemic where a second wave had a far greater impact on the population than the first wave.

Determining the Trial Running period for Scenarios B1, B2 and C

The Trial Running periods used for each Scenario are based on the agreed periods from the 26 November 2019 Board workshop. These were assessed as:

- Deterministic (base case) – 4 months based upon P_D+11 software
- Most likely – 5 months
- Conservative – 9 months

In the scenarios, we have applied:

- Scenario B1 – 4 months
- Scenario B2 – 5 months
- Scenario C – 6 months.

We have reduced Scenario C to 6 months from the Conservative 9 months as B1, B2 & C all have TR2 software. This resolves several operational bugs and improves reliability.

Determining the Trial Operations period for Scenarios B1, B2 and C

In the scenarios, we have applied:

- Scenario B1 – 13 weeks as per P13 Mitigated forecast (no COVID-19 impact)
- Scenario B2 – 4 months (additional one month COVID-19 schedule risk)
- Scenario C – 4 months (additional one-month COVID-19 schedule risk)

The additional one month COVID-19 schedule risk accounts for social distancing impact on the ability to perform the Trial Operations exercises with volunteers.

Stage 4 and 5b

Stages 4 and 5b are modelled to the next applicable timetable change.

As part of the DCS1.1 development, a QSRA will be conducted on the preferred scenario. The resultant Schedule durations for each scenario are depicted in the diagram below:

In developing Scenario B2, Module 7(b) Trial Operations and beyond plan has been developed to reflect the revised Stage 3, Stage 4a, Stage 4 and Stage 5b dates. This is shown overleaf.

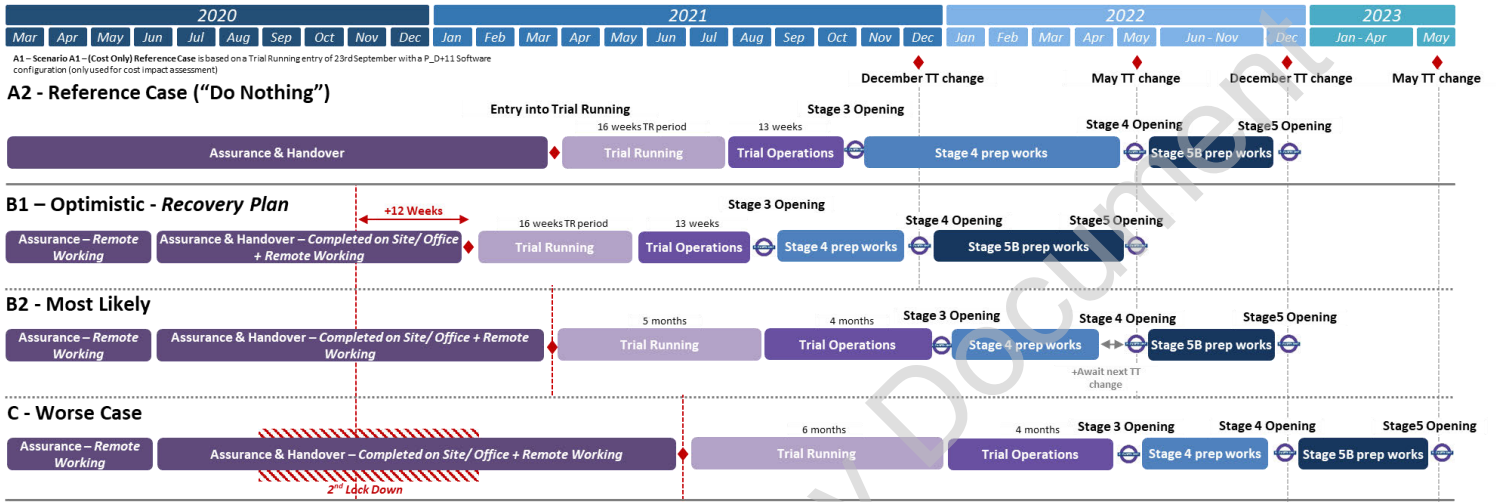


Figure 8: COVID-19 Scenario plans

Crossrail COVID-19 Recovery Execution Plan
 CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

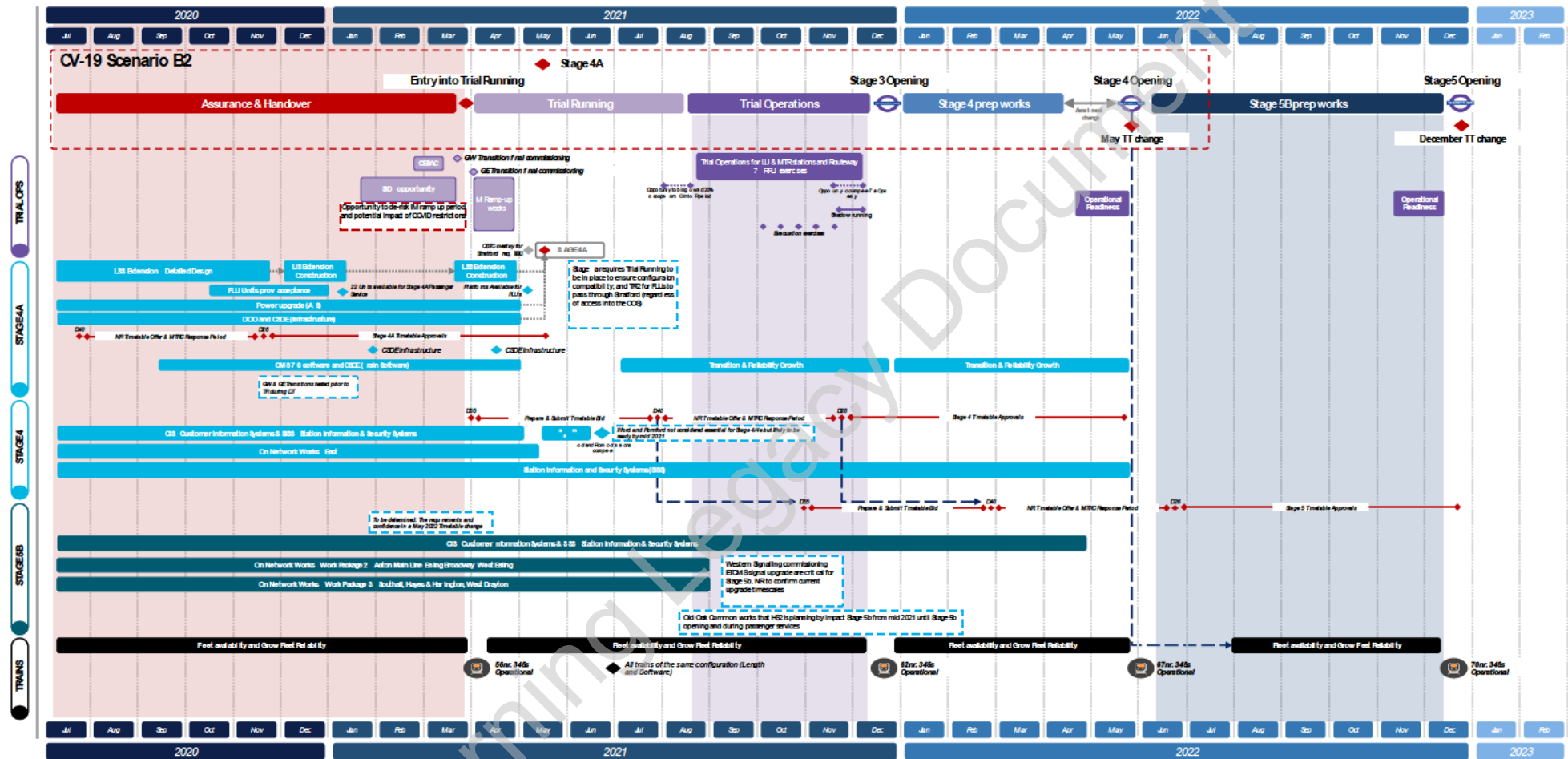


Figure 9: Trial Ops and beyond Scenario B2

4 Appendix C

Tactical Mitigations and Strategic Interventions

4.1.1 Background

This section describes the tactical mitigations already in train to mitigate the impact of COVID-19 and describes the programme interventions required to further mitigate the schedule.

4.1.2 Top 15 Tactical Mitigations

The top 15 mitigations identified have been selected based on their ability to beneficially impact four main areas.

Mitigations to improve contracts access to the site:

1. Classifying site-based staff as Key workers/critical staff
2. The creation and stand-up of a TfL Transport logistics team in order to implement plans to transport those staff not accommodated in hotels from hub car parks to the sites.
3. Underwrite the contractor procurement of thermal cameras (£15k each), toilet facilities, mobile food outlets
4. Underwrite procurement of 20,000 face masks per month from TfL central store of 3million/month at Acton

Mitigations to improve Office based staff productivity:

5. Endorse the principle that all office-based staff remain at home unless assessed via a risk-based assessment process and signed off as critical to office-based/site-based activities by their line manager
6. Request permission for Crossrail to make available up to £500 per office-based staff member prevented from accessing an office to procure equipment so that home working is more DSE compliant
7. Upgrade Office 365 to full functionality (to be defined what the difference is)
8. Remove security restrictions on Zoom calls from CRL/TfL laptops when off-site/working from home

Mitigations to improve System integration and sign-off productivity:

9. Improve the efficiency of Dynamic Testing through changes to the Rulebook and task mitigations. There has historically been low efficiency of DT driven by the rulebooks.
10. Utilise the existing suppliers' rigs differently (e.g. use existing rig interfaces to link in BT/Siemens kit) to cover more on-site testing and reduce the demand on COS. We have started to challenge our suppliers on this area but need to push harder at Director level to secure and prioritise CRL over other programmes
11. Part validate the Crossrail Integration Facility (CIF) based in Chippenham. This has two testbeds, is a great system test facility but is not validated. Investment to validate this rig could allow some supplier tests to be moved on to the rigs as well as some of CRLs System Integration testing. We are assessing the timescale/benefits for CIF validation
12. Engage with the ORR to move from a sequential safety validation, review and sign off approach to a more integrated and in some cases parallel approach to shorten regulatory timescales. This will need governmental/DfT support and influence

Mitigations to improve Trial Operations and Revenue Service:

13. Operations develop a detailed COVID-19 recovery plan covering Trial Ops, Stage 3, 4a, 4 and 5b and incorporate in DCS 2.0. DCS2.0 will reflect this mitigation by the end of June.
14. Develop and agree on timetable options and trigger points/milestones with NR and TOCs taking into consideration the revised programme forecast generated by DCS2.0
15. Restrict numbers of stations open at Stage 3.

4.1.3 Progress Update on the Tactical Mitigations deployed

Mitigations that improve contractors' access to site progress update:

- Given the relaxing of restrictions by the Government on construction worker access to public transport, Mitigation 1 will not now be deployed. Should a second wave of infections materialise, this will need to be enacted.
- The CFO has authorised the purchase of 50,000 face masks from TfL stock.
- Estimates are being sought for the costs to procure thermal cameras, toilet facilities and mobile food outlets. The site teams are using a much cheaper alternative to thermal cameras – ear temperature probes – that are being used by the security staff to check personnel entering the worksites. Welfare arrangements have been reviewed and restrictions implemented, however, mitigations are in some cases difficult to deploy e.g. at Bond Steet Station where lack of space is preventing enhanced welfare arrangements to be put in place.
- The Programme Delivery Directorate is working with TfL (& MPD) Demand Planning and Logistics Team on Transport logistics
- The Programme Delivery Directorate is working with H&S on creating a CRL 'eco-system' with accommodation/transport/site facilities, and concise guidelines for contractors on how to remobilise the teams. This is building on the mitigations already in place to allow Niche working to be carried out. Since the Safe stop, 2 tranches of Niche works have been restarted following strict control and sign off by CRL on a priority basis. To date, approximately 40% (1900) of the onsite workforce has been mobilised safely since the 28 April. As of 4/6/20 over 2145 Niche working packages have been authorised, 609 packages mobilised and 344 packages completed.
- Where the 2m social distancing rule is preventing critical works being completed, or through welfare restrictions reducing the number of staff that can be mobilised on each shift, a risk-based assessment is being carried out to determine whether the distance can be safely reduced from 2m
- In reviewing the CRL programme response compared with other programmes, CRL has elected to consider bespoke testing facilities at key locations for the Blockade.
- Sellafield Nuclear Power Station Projects have procured a test facility to be available just off-site for personnel to request COVID 19 virus tests with a 90-minute turnaround. This is to provide reassurance to staff who feel they have come into contact with an infected person and prevent loss of wholesale shifts through the requirement to self-isolate. This will be in place for the blockade.

Office-Based staff productivity progress update:

- A risk-based assessment process has been developed by the HR Director and HSQE Director and implemented. This has been briefed out to the Senior Leadership Team and is available. Westferry Circus will be the only office open to staff until the Government Guidelines are relaxed to normal. Staff will continue to work from home unless there is a health and wellbeing requirement or a business-critical need for staff to return.
- To facilitate working from home, a DSE assessment is being made available for staff to assess their homeworking arrangements and for suitable adjustments to be made.
- Review of requirements and budget to procure equipment to support home working and making it more DSE compliant will be undertaken once requirements are known.
- The CFO has assessed the removal of security restrictions on Zoom calls - it was decided that this will not proceed. Instead, CRL will deploy MS Teams as a means to communicate and share content remotely. The licensing and rollout is underway.
- An assessment of office space against social distancing has been undertaken: 20% of West Ferry Circus (WFC) office can be utilised and up to 40% of Endeavour Square (ES). Current uptake has been minimal, except for a handful of Siemens employees. ATC has said they will not need their floor at WFC.
- There is an opportunity to consider centralising office space at ES and vacating WFC on lease expiry.

Improve system integration and sign-off productivity progress update:

- The plan to improve Dynamic Testing (Incl. Rule Books) is in full flight and being managed by Camilla Barrow and Danny O'Connell. This plan was started on Feb 20 by Neal Lawson and Danny O'Connell with ATC.
- Initial informal discussions commenced with BT and Siemens w/c 11 May, formal discussions between the CEO of Bombardier and the President of Siemens scheduled for 16/6/20 to discuss the integration of CIF, Melton, and COS testing to maximise productivity given COVID restrictions. CIF Fidelity (validation) workstream in train.
- A Kick-off meeting occurred on Tuesday 12/5 on CIF validation with Siemens and requests have been sent to the T&C team, BT and System Integration team to collate test cases that have the biggest benefit to transfer to the rigs. Follow up meetings in hand.

Trial Ops & Revenue Service progress update:

- Workshop completed on 07 May 2020 to review Trial Operations, Stage 4a, 3, 4, and 5b.
- No significant issues raised on delivering staged opening, however, works needed for stage 4a are not insignificant and are at risk (NR power supply and infrastructure/train software to support CSDE possibly the most).
- Key mitigations being considered are:
 - Trial Ops: opportunity to de-risk Trial Ops scope by bringing forward 20% scope into Trial Running
 - RCC: Implement control processes for social distancing for the RCC
 - Acton Western Curve electrification project could be a mitigation - MTR are evaluating this option with NR
 - Trains: contingency plans being developed (Phil Clarke). Including options, if COS/software is late, seeking views of ORR and operators on not starting 4a with CSDE and fast-tracking with NR/BT
 - IM readiness: RFL focusing COVID-19 response on planning mitigations to Training and getting people in and out of the RCC
 - Reliability Growth: TR2 for Trial Running good for reliability growth & early Trial Ops. Reliability plans require further development

- Stage 4 & 5b: merging the stages not feasible. Soft launch of parts of Stage 5 earlier/with Stage 4 opening or having a ‘mid-way’ opening could be an option
- Assign clear ownership to each Trial Ops & Beyond phase/stage
- Stage 4A: is still on track for May 2021 with a high element of risk. Key critical path items being; platform extensions at Liverpool Street Station, Power upgrade, DOO, and CSDE (infrastructure and train software).
- A new recovery plan developed and is currently under review. The next step is to get any changes/alterations.
- A Stage 4a significantly de-risks stage 4a and could allow a revised timetable for stage 3, consideration will be given to reviewing the timetable to maximise revenue.

4.1.4 Strategic Interventions to the programme - “Scenario D”

Scenario D of the Crossrail COVID-19 Programme Recovery Plan has been developed to provide strategic intervention options to mitigate schedule delays and cost escalation within the scenario B2 (most likely). In delivering Scenario D interventions, Crossrail commences Trial Running at end of January 2021, secure a Trial Running duration of 16 weeks and a Trial Operations duration of 13 weeks. This would enable a late summer 2021 start of passenger services. Stage 4a is presented as a further opportunity for revenue generation protection/mitigation, through de-risking Stage 4 opening. This is through delinking it from the conventional network timetable change milestone in December 2021.

Scenario D intervention options are presented here for consideration. Selected options will be included in the DCS and monitored.

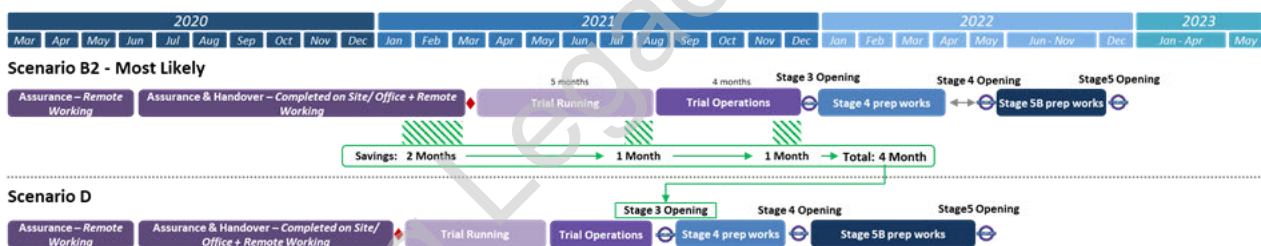


Figure 10: Strategic Interventions to the programme - “Scenario D” plan

Programme mitigation 1: Use of Structured Engineering Judgement in the Assurance process

A review of the use of Structured Engineering Judgements (StEJ) has been undertaken and processes/tools are already in place to allow its use. It is being used on c660 and CAW assurance and will be used more widely in the programme after the construction blockade is complete and the final (TR) state is known. Its use will be to mitigate where information, evidence, or works are incomplete but not essential – to hold the B1 Trial Running date. Delivering the D scenario assurance intervention should provide us with a credible Trial Running Date

- Trial Running reliability is dependent on Y0.610 (including TR2) and getting sufficient mileage on the 345s as well as delivering System Integration Dynamic Testing (SIDT)
- Trial Operations exercises can be delivered in 13 weeks resulting in a 1 month saving for scenario B2, through COVID-19 mitigations planning, and implementing these mitigations. There is also an opportunity to complete Trial Operations in 11 weeks.

Optimising Assurance Closeout

To achieve a start of Trial Running by the end of the first quarter of 2021 (deterministic) the following needs to be in place:

- Use of StEJ in individual handovers and post blockade when collating evidence by risk assessing any missing, incomplete or unavailable information using appropriate expertise from across the programme and with partner organisations.
- A plan to use the time between completion of testing and commissioning and the start of TR for SIDT to grow the reliability of the system to help build the assurance case for the end of TR.
- ORR, AsBo, operators, etc. brought into the process as early as possible to work different processes in parallel or to combine as many as possible.

The CRRP (Crossrail Risk Review Panel), chaired by Colin Brown has been challenged to review how all of the final assurance strands could be pulled together, and any shortfalls addressed by using a pre-planned structured engineering judgement approach (or equivalent). These would need to be pre-agreed with ASBO, RAB-C and ORR.

The status of the above activities is still ongoing. The ability to hold the assurance schedule and meet or improve the transition into ROGS date will be confirmed in July 2020.

Programme Mitigation 2: reduce the Stations commissioned into use for Stage 3 to the minimum 5 or 6 required for a credible service through the core

Given the volume of assurance work and the lack of critical resources in key disciplines, there is a risk that the assurance submission will be rejected by the independent Safety Assessors and RAB-C as incomplete or having too many dependencies. To mitigate this risk, consideration is being given to restricting the number of stations commissioned into operational use at Stage 3 to 5 or 6. The minimum stations deemed acceptable for a credible service through the core are:

- Paddington
- Tottenham Court Road
- Liverpool St
- Canary Wharf
- Abbey Wood.

There will still be a requirement for Bond St to achieve SC2 by Trial Operations so that trains can be evacuated at Bond St in agreement with the London Fire Brigade. The temporary radio system and temporary fire system have already been signed off as acceptable by the London Fire Brigade.

Two other stations are nearing completion and should be considered for inclusion in the minimum list if the demands on the critical resource are sufficiently containable. These are Farringdon and Custom House.

Of the other stations, Bond St works to complete require significant duration, and the COVID restrictions on welfare have reduced the maximum number of personnel at any one time to 60, 30 in each ticket hall, on a 3 shift basis.

Whitechapel Station is needed for Stage 4 and not Stage 3. However, all works to complete will be finished by the end of the blockade so Whitechapel could be available for handover and use for stage 3.

Custom House has already been handed over to RfL, and the remaining LU and RfL stations are on target for handover to RfL during Trial Running in 2021.

Programme Mitigation 3: Deployment of System Integration Dynamic Testing

The System Integration Dynamic Testing SIDT Period is a key opportunity to de-risk the Trial Running and by extension Trial Operations periods. All the Trial Running tests (15 in total) can be completed in the SIDT period with only one requiring rerunning in the Trial Running period. During the SIDT period, there will be 3 point-software updates to the TR2 software baseline that will improve reliability.

Following the approval by the ORR in June 2020 for a derogation to 8 trains in operation, SIDT will be able to operate at 6tph for 16 hours a day, significantly improving the opportunity to test the integration of the systems in a timetabled environment. It is expected that over 100,000 miles of running could be achieved during this period using TR2 software to identify latent defects, software issues, and problems requiring further mitigations. This de-risking will secure the Trial Running Period of 16 weeks and potentially allow the bringing forward of Trial Operations Scenario tests to de-risk the TO period.

To further secure a Trial Running duration of 16 weeks (reduction of 1 month from the B2 scenario) and secure a Trial Operations duration of 13 weeks (a reduction of 1 Month from the B2 scenario) the following needs to be in place:

- Built into the Baseline (B2) recovery plan is the proposal to have Y0.610 software, which includes Siemens TR2 and version 7.6 of the Bombardier TCMS. This is planned to be installed on the 10 March 2021.
- TR2 enables us to start TR with a significantly reduced number of Operational restrictions when compared to PD+11.4 which will enable us to ramp up the testing in line with the agreed TR test scripts. Similarly, TCMC 7.6 is also significantly better from a driver-facing point of view. Starting TR with TR2 software removes the risk of having to do a major software change within the TR period which imports its own risks.
- Successful negotiations have been concluded with ASLEF to agree on acceptable COVID19 Social Distancing rules and these have been successfully implemented during Dynamic Testing. It is expected that these will continue to be refined during DT for use in SIDT and TR/TO.

Programme Mitigation 4: the deployment of stage 4a

The key infrastructure and software upgrades that are brought into use in May 2021 in stage 4a significantly de-risk stage 4, as the infrastructure is available without the need for a further scheduled timetable change in December 2021. This provides options that Crossrail will have at its disposal to further mitigate the impacts of the delay:

1. Stage 4 can be brought in either side of December 2021 with the agreement of the Rail industry, mitigating the 12-month impact of missing the timetable change date mid-December 2021 on revenues
2. The timetable for stage 3 can be reviewed to optimise the train service at the opening for maximum revenue rather than operating a shuttle in the core. More work is required to understand the feasibility and benefits/dis-benefits of this approach.

Risks associated with the Scenario D Programme interventions

There are a number of risks that come with pursuing Scenario D initiatives. These are set out below and need to be carefully managed and monitored on an ongoing basis:

- Continued Pressure on people and workload
- The potential to be a distraction and take longer to embed the changes
- Third-party stakeholders have to agree and participate
- Benefits already assumed in the base plans
- Capability in the organisation, both competence and resource numbers.

The following next steps have been developed and agreed with CRL Executive:

- CRL Risk Review Panel to report back on feasibility, benefits or risks and clear time-bound next steps for the Structured Engineering Judgment approach
- A decision needed on de-risking actions to reduce stations scope
- RfL and MTR to review readiness plans in light of SIDT

5 Appendix D

Assurance

In developing the COVID-19 Recovery Execution Plan and Delivery Control Schedule, there are several key considerations when assuring the plan. The objective of the advisory panel is to assure the Crossrail Executive and Board through targeted independent reviews to verify that the Crossrail Programme execution is robust and deliverable and that future milestones can be achieved on time, considering the COVID-19 impacts and uncertainties. The assurance review will be completed in 3 levels and will follow six key areas of enquiry.

The six key areas of enquiry for Assurance are:

1. Verification of the **scope** to go, ensuring the scope is integrated into the Central Operating Section Access Plan with a clear outline of the point in time within the Programme (i.e. pre blockade, during the blockade, after the blockade up to Trial Running, and after the start of Trial Running);
2. Identification of the critical **resource** constraints and integration of those to the DCS assumptions, and challenge of those assumptions;
3. Confirmation of the adequate **duration** of activities supported by credible productivity assumptions, particularly for critical resources (noting any COVID-19 Social Distancing restrictions);
4. Stress-testing the 'Blockade' success **criteria** to ensure it is achievable;
5. Verify a sufficient **access** plan to resolve issues and allow enough time to achieve the **reliability** growth from the start of System Integration Dynamic Testing, through Trial Running and Trial Operations necessary to support 12 trains per hour at the start of Stage 3 Revenue Service, and then 24 trains per hour at Stage 4, no more than 6 months after;
6. Ensure sufficient **IM resource** profile with the right capability at each handover point to receive the staged railway with a clear transition plan for the organisation and supporting operating model for the Elizabeth Line

Further, the Sponsors are interested in understanding how the Recovery plan will address pre-COVID performance issues, and what assurance addressing those issues have been properly and thoroughly considered. An Assurance Framework has been developed using the Lines of Defence Model (LoD) where 3 levels of Assurance are being deployed:

- Line of Defence (LOD) 1: Internal Programme assurance checks, coupled with correlation to other programmes to adopt best practice and lessons learned
- Line of Defence (LOD) 2: The engagement of the Crossrail Assurance Framework to critically assess the robustness of the plans
- Line of Defence (LOD) 3: External Peer Review of the Programme COVID-19 Recovery plan

5.1.1 Line of Defence (LoD) 1: Internal Programme Assurance Checks

The high-level recovery schedule to Trial Running is structured into:

- Construction completion for Routeway and Stations
- Signaling/train software testing
- Non-signalling integration testing
- Assurance

The Delivery Control Schedule (DCS) is being developed to integrate the Recovery Plan with the remaining activities to full revenue service. As DCS 1.1 is developed, the delivery and planning teams are providing information to confirm:

- The **scope of construction works** to complete pre Trial Running and when is it planned;
- What **assurance products** are required pre Trial Running, what are the critical resources required to deliver them and what are the productivity **assumptions**;
- COVID 19 **impacts on productivity** and establishment of credible rates;
- Resource loaded plans for Delivery, Technical and Operation;
- Concurrency of key element handovers and the impact on critical resources identified above

In order to assure the schedule, evidence to support the robustness of the schedule to Trial Running is being gathered. This is broken down into Construction works, Signalling/Train Software Testing, Non-Signalling Integration Testing and Assurance. These are described below.

Construction Works

The following **data** will be checked to confirm the Construction Works scope to complete and schedule for delivery as each element of the DCS and recovery plan is developed:

- The agreed scope (EOWLs, HAZID closeout and Safety Justification Dependencies) to complete for Trial Running for Signalling & Power, Routeway and stations SC1;
- Supply Chain confirmation of the scope, and confirmation when it can be delivered during the schedule to Trial Running;
- Identification of any remaining scope to complete and confirmation that it is in the post-ROGS access plan;
- Confirmation that sufficient access is available through blockade working, SPZ booking or maintenance/engineering hours;
- Confirmation of the date by which the supply chain will be contractually signed up to works committed to the blockade;
- Confirmation of the arrangements in place to enable good productivity levels to be achieved during the blockade;
- Evidence to support the productivity assumptions and how the COVID restrictions have been incorporated or mitigated;
- Confirmation of any temporary works are required due to deferral of any works into TR/TO;
- Confirmation that the scope of works can be accommodated in the blockade schedule with a p90 confidence or extension of the blockade to the p90 QSRA mitigated scheduled duration;
- Confirmation of durations for sweep trains, removal of temp services and COS clean-up
- Confirmation of the access for VAP activities, firebreaks and access required;
- Confirmation of any maintenance access or testing of maintenance kits such as yellow plant – and agreement with the maintainer and operator;
- Confirmation that any scope to complete work that is deferred to Trial Running can be completed in the predetermined access windows, or overnight engineering hours during Trial Running;
- Confirmation of opportunity in the Integrated Access Planning change process to apply for further access in the post-ROGS operating environment should works not completed by the end of the Blockade.

Signalling / Train software testing

The following assurance checks will be carried out on the Signalling/Train Software testing schedule:

- Confirmation that the PD+11.4 software tests (22 outstanding) can be completed in Dynamic Testing prior to the blockade;
- Confirmation that the TR2 offsite test plan is on track, and deliverable;
- Confirmation that the required COS tests are planned in and being adequately monitored through the Dynamic Testing Steering Group;
- Confirmation of the adequacy of the access plans during testing;
- Confirmation of the NR dependencies, and how these are monitored to closeout;
- Confirmation that the tests meet the assurance plan;
- Confirmation that the tests are all instructed to the supply chain and adequately resourced;
- Confirmation of any specific work required at the RCC or Didcott control centre;
- Confirmation of any work reliant on third parties to undertake and how this is monitored.

Non-Signalling Integration testing

The following assurance checks will be carried out on the non-signalling integration testing:

- Confirmation and evidencing of the completion status, number of tests to go (61% complete, 222 tests to go, including 18 CRL);
- Confirmation of the test completion burn down rate against the original plan, plan to go and forecast;
- Confirmation of an integrated test plan that integrates Station scenario testing, Routeway and train dynamic testing;
- Confirmation of these in the Dynamic Testing plan, resourcing and supply chain instruction.

Assurance

The following assurance check and evidence gathering will be performed on the Assurance Programme:

- For each element, confirmation of the production assumptions for redline drawings, O&M, H&S files, asset data, ACs (note re O&M- 80 PTI, 43 Tunnel System& Safety and 51 Plumstead maintenance facility);
- Resource smoothed plans for critical resources, e.g. fire and MEP against routeway chapter, shafts and portals and stations readiness;
- Confirmation of the deployment of the beneficial use concept (Staged Completion for Familiarisation SCF) and T+8 defect resolution process for routeway, stations etc. ;
- Confirmation of document review time assumptions and closeout rates for redline drawings, As-Built Drawings, H&S files and O&M manuals;
- Confirmation of date for closeout of FDO design;
- Plan to close out remaining 408 HAZIDs;
- Confirmation of the Safety Justification completion resourcing plan, resource smoothed or additional resources identified from TfL;
- Confirmation of the RAB-C submission plan;
- Confirmation of any NR SRP approvals, identification and tracking in the DCS.

Other items

The Assurance Review will establish any outstanding key technical risks needed to be resolved to support TR, along with their associated solution to support the plan and accountable owner

The Assurance Review will assess the overall access plan to establish whether the activities identified above can be accommodated, with clearly identified firebreaks to recover slippage.

LoD1 Advisory Panel Review

The remit for the LoD1 Advisory Panel review is held at annex. Reviews were carried out and further work is being undertaken so that the Advisory panel can act as a 'critical friend' during the development of the recovery plan. In doing this, representatives from other programmes and organisations that are developing COVID 19 recovery plans can compare their experiences and share best practice and lessons learned.

To date, as well as the peer reviews described in the remit, 2 of these strategic 'critical Friend' reviews have been held to review the development of the scenario framework, the recovery plan modules, the tactical mitigations and strategic program interventions being deployed.

The external programmes represented on the Assurance Panel are Hinckley Point C Power Station, Sellafield Nuclear Power Station, Mace Group, Network Rail and High Speed 1.

Key recommendations to date are:

- The inclusion of the assumption into the worst-case scenario that there will be no vaccine available
- The implementation of a test facility at the main site entrance to mitigate against the loss of shifts should a staff member become ill requiring shift teams to self-isolate for 14 days

- The implementation of wrist band technology for 'track and trace' where mobile phones cannot be deployed
- The constructive challenge of the 2m social distancing rule on an age-related risk basis to reduce this for activities where significant benefit can be achieved, either through critical works completion or productivity improvements
- The deployment of digital and remote technology for onsite testing
- Maximising working shifts during the summer months to complete as much work as possible before the expected second wave of COVID disruption

5.1.2 Line of Defence (LoD) 2: Targeted Assurance Review

The objective of the Target Assurance Review (TAR) is to assure the Sponsors and key Stakeholders that the Recovery Strategy and Plan encompassed in the DCS 1.1 and supporting suite of documentation have addressed the pre-COVID-19 performance issues, as well as the challenges of working during the pandemic and provided a robust considered approach to achieve the desired outcomes. The TAR will seek assurance of the six key areas of enquiry (as stated in section 1.5).

In the approach to this TAR, it recognises findings of previous TAR Schedule Reviews (#1 and #8) which, while identifying gaps in comprehensiveness, coverage and detail of schedule content, recognised that the technical process for composition and updates of the DCS was valid and demonstrated integrity.

Therefore this TAR will focus upon completeness and coherence of input definition data, relationships and interfaces both within the DCS and external to the DCS and the alignment of key assumptions, critical to its accuracy, including but not limited to; the logical flow of activity, duration and prerequisites to activity, resources required and consideration of risk.

To this end, the approach to undertaking this TAR recognises the proposed modular construction of the DCS and will therefore execute the lines of inquiry at both an 'integrated-whole' level as well as at a module-by-module level.

LoD2 Assurance Framework Remit

The context and priority of the development of the Recovery Strategy, Execution Plan and re-baselining of the Delivery Control Schedule (DCS) requires programme assurance to be done in parallel with the development of the products, such that their ultimate consideration and approval may be undertaken on a timely basis, and that submissions are accompanied by a supporting independent assessment by the LoD2 Programme Assurance function. Assurance advice will be submitted as Project and Programme Assurance (PPA) Targeted Assurance Review (TAR) Report, Ref. TAR#021.

In undertaking in-parallel assurance the programme assurance team will (and have already started) be engaging closely with the development teams, providing in-flight participation in development reviews and providing real-time advice and feedback.

Maintaining Independence:

A key factor of particular emphasis in executing this phase of assurance will be to preserve full and proper independence throughout and to make sure that any advice, feedback or guidance does in no-way prohibit an objective assessment of the products at the point of their submission. This will be achieved by preserving separation and independence between PPA Team members during the development phase activities and the final review, findings and recommendations phase of the assurance process.

Areas of Focus:

It should be noted that in the light of previous PPA assurance reports TARs #001, #002, #008 and #009, the assurance effort will focus less upon the systematic process for construction of the schedule and associated plans as these have been subject of significant previous review and have

found to be satisfactory tools for the compilation, control and coordination of planning documents. Therefore this review will focus upon provenance and completeness of the constituent elements and their adequacy to permit the community of Crossrail and Elizabeth Line stakeholders to work together to realise the envisaged outcome.

The following topics reflect the principal areas of focus. The detailed review plan, lines of enquiry and interview/meetings engagement plan are set out in the TAR#021 Terms of Reference document.

1. Objectives, Success Factors and Key Issues

Identify the particular objectives and criteria for success for this phase of the project, both in terms of what outcomes (interim and ultimate) are being sought (lag indicators) and how will we know that we're doing the right things (lead indicators) like (e.g. freezing scope, signing off design changes for manufacture and installation, achieving lead productivity metrics.) Other success factors will be around levels of supply chain engagement, end-user/operator involvement, critical resources and how we will achieve value for money. Confirm the extent to which objectives are defined and aligned across all parties, organisations and stakeholders and are reflected in their respective plans.

2. Delivery Approach

Setting out the CRL philosophy beyond the schedule narrative, e.g. 'strategy is to reduce TR readiness risk by proving a minimum acceptable level of software/systems functionality and then adopt a blockade-based works completion strategy to closeout and assure all essential scope items. A key factor is the adoption of a risk-based assurance process bought into by all client-stakeholder parties that will be agreed by a particular deadline.'

3. Organisation and Leadership

Who specifically will be responsible for achieving the principal objectives and what will their organisations look like. What are the key organisational interfaces and points of contact? Clear link with the organisation design and transition plan

4. Performance Shift

What will be done differently to achieve the required shift in performance? Acknowledgement that historic performance of planned vs actual wasn't sufficient and that CRL is committed to realising a step change; and that it is to be achieved through several key interventions (e.g. adoption of T+8 process, Blockade-oriented delivery, supporting tactical initiatives including additional TfL support to RFL through Technical discipline leads and Assurance expertise, F-Team and others, plus more detail)

5. Risk Management

The degree to which the collective products explain how risk is to be managed, actively, through the next phase of the project; reference to supporting plans; an acknowledgement that there will be an active regime and cycle of; risk reviews, mitigations planning, risk action execution, risk re-review, and so on.

6. Railway, Operational and Technical Assurance

The plan products should confirm how the key objectives of the recovery activities are going to be assured by the LoD1. The Plan and the suite of supporting documentation should be listed, with clear auditable trails of the governance and decision making that is under-pinning the "confirmations" that activities meet the requirements i.e. what is the assurance that we have indeed got the absolute minimum work-scope required for Trial Running (and is supported by all appropriate stakeholders), how have lessons from past productivity issues been captured and appropriately taken forward in the recovery planning (and are all supply-chain stakeholders committed to achieving productivity requirements?).

7. Miscellaneous

- The recovery plan is not going to recover all the time lost, only mitigate the impacts of COVID-19. Before COVID-19 the project was considerably behind the baselined dates and we are not going to recover this lost time.
- The word “critical” is used widely in the text, where the word “essential” may be more appropriate in places.
- The word “works” is used widely in the text, where the word “activities” may be more appropriate in places (more encompassing to include non-physical works).
- The executive summary highlights the likelihood of a second wave in winter 20/21 but the Plan appears silent on its impact or proposed mitigations
- The robustness of each of the 10 modules
- The completeness of the scope to go and the productivity assumptions

The risk assessment and comparisons with other ‘Programmes in class’ using benchmark norms to verify timescales

5.1.3 Line of Defence (LOD) 3: External Peer Review of the Programme COVID-19 Recovery Plan

Two further reviews were held, a T-4 Blockade Review and a Recovery Execution Plan & DCS Peer Review on the 12 August 2020. A Recommendation report was submitted to the August Board and subsequent recommendations and action tracker is in place to manage these to close out.

The Advisory Panel review team commented on the robustness and the agility of the Recovery Plan, CRL organisation and decision making, to deal with the uncertainty that COVID-19 brings and any issues or unknowns that are uncovered in the remaining scope delivery, testing and commissioning programme.

It should be recognised that this is “progressive assurance” i.e. a focus on process and approach, not the end product (as time is not available). As such the Recovery teams will provide access to key meetings, products, and CRL’s own LOD1 approaches and material.

LoD2 assurance is already in train with the attendance of the PAR staff at critical programme and DCS meetings/reviews. It is expected that the DCS1.1 fully assured sign off will be achieved at the October Board.

6 Appendix E

Execution Plan Critical Path:

The critical path below shows the high-level activities that make up the nine modules. Highlighted is the critical path from now through to Stage 5.

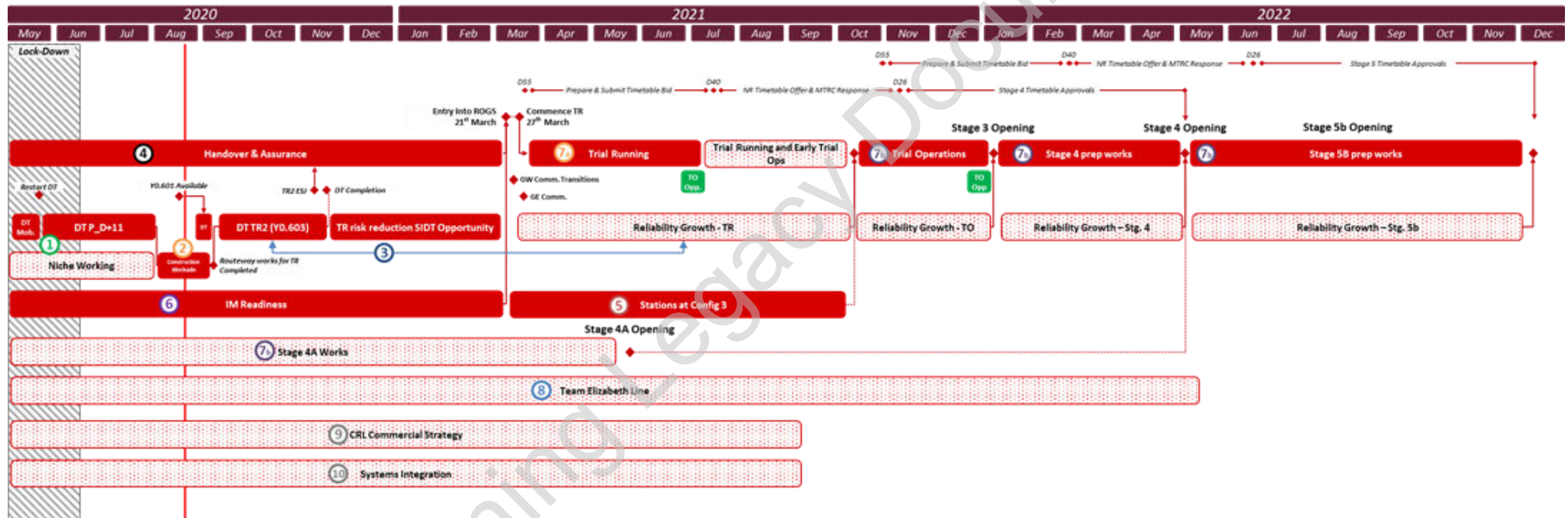


Figure 11: Execution Plan Critical Path

6.1.1 Module 1: Restart Niche Works and DT

The first phase of Safe Stop of all sites (phase 1) was achieved 26 March 2020 followed by phase 2, which was achieved 05 April 2020. Niche works, following Health England guidelines, began on-site 21 April 2020, in two tranches. Construction restart was successfully achieved on 15th June 2020.

A Crossrail Guidance document entitled “Route to Finish” has been developed by the Programme Delivery team to detail the migration of Crossrail from Safe Stop and Niche Working to a new way of working, the ‘new normal’. The approach taken is in alignment with the wider Construction Industry, the Construction Leadership Council and Transport for London (TfL) responses to COVID-19.

Niche works on the COS allows for critical maintenance and focused works to be undertaken, having a beneficial impact on the assurance and handover process. The Niche works will continue until the commencement of the 5-week blockade to complete outstanding documentation, certification and testing necessary to support the submission of the COS SJ to RABc and subsequent CESAC. To date, approximately 1900 or 40% of the onsite workforce has been mobilised safely since the 28 April. As of 4 June, 2145 Niche work packages had been approved, 609 mobilised and 344 completed.

Dynamic Testing (P_D+11): Completion of Dynamic Testing of P_D+11/Y0.540 suite of software systems, reverting to a 4 day - 3 day split to accommodate further construction windows. This will ensure that Crossrail has a viable software product available for the commencement of Trial Running. Dynamic testing recommenced 29th May 2020.

Niche Working & DT Module – contained within the Recovery Plan B1

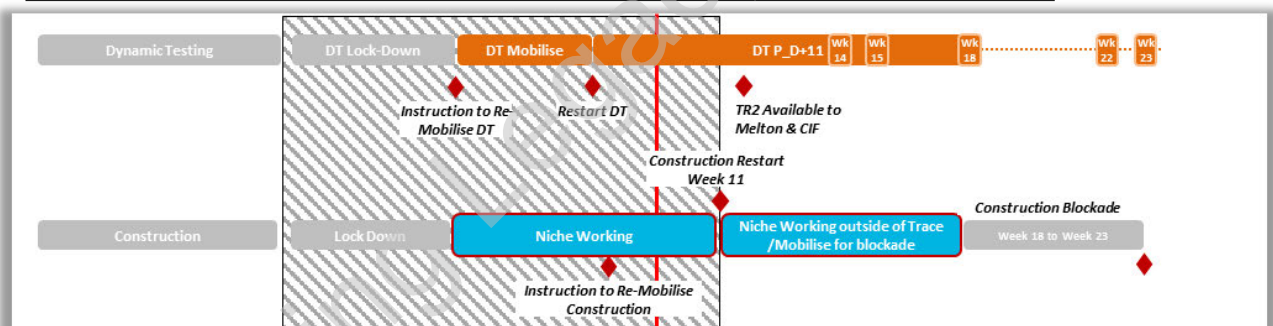


Figure 12: Niche Working and Dynamic Testing module

6.1.2 Module 2: Blockade

A Construction Blockade immediately followed the completion of dynamic testing at the beginning of August. All critical construction works to support the Crossrail safety case to deliver a safe and operable railway will be completed during Niche works and a 6-week summer blockade from week 18 to week 23. The deployment of 3 shift, 7-day working can be deployed to maximise construction productivity. Current productivity is limited to 2 shifts per day per 4 day construction period each week. The blockade will provide up to 8 weeks of recovery opportunity against the COVID-19 schedule impact;

The Blockade will concentrate on the following:

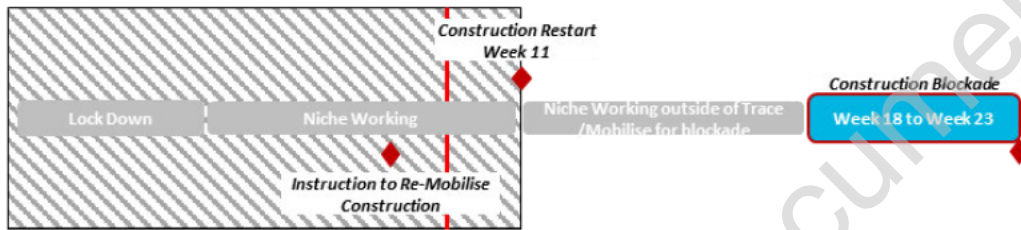
1. Prioritise access to complete essential works including Platform Screen Doors
2. Completion of all critical Fire Stopping in the Trace
3. Undertake specific stations integrated testing activities where HV isolations are required
4. Complete outstanding works by the Principal contractor and their suppliers to enable future de-mobilisation of ATC

5. Closeout as many EOWs to minimise the works needed during TR and beyond

The following key items have been excluded from the blockade and will be completed under RfL control at a later date:

1. Connaught Tunnel Leaks are to be fixed at a point to be determined with temporary solutions found in the interim to allow TR & TO and stage 3
2. Non-Priority Tunnel Hop-ups are to be completed post the August Blockade
3. Elements of Outstanding Works that cannot be accommodated in the blockade and are not required for the Safety and Assurance Case
4. Bond Street Station Platform End Walls for Platform Screen Doors.

Construction Blockade – contained within the Recovery Plan B1



Week 18							Week 19							Week 20											
18 Aug 20	19 Aug 20	20 Aug 20	21 Aug 20	22 Aug 20	23 Aug 20	24 Aug 20	25 Aug 20	26 Aug 20	27 Aug 20	28 Aug 20	29 Aug 20	30 Aug 20	31 Aug 20	1 Sep 20	2 Sep 20	3 Sep 20	4 Sep 20	5 Sep 20	6 Sep 20	7 Sep 20	8 Sep 20	9 Sep 20	10 Sep 20	11 Sep 20	
14:00 to 14:45	14:45 to 15:30	15:30 to 16:15	16:15 to 17:00	17:00 to 17:45	17:45 to 18:30	18:30 to 19:15	19:15 to 20:00	20:00 to 20:45	20:45 to 21:30	21:30 to 22:15	22:15 to 23:00	23:00 to 23:45	23:45 to 00:30	00:30 to 01:15	01:15 to 02:00	02:00 to 02:45	02:45 to 03:30	03:30 to 04:15	04:15 to 05:00	05:00 to 05:45	05:45 to 06:30	06:30 to 07:15	07:15 to 08:00	08:00 to 08:45	08:45 to 09:30
14:00 to 14:45	14:45 to 15:30	15:30 to 16:15	16:15 to 17:00	17:00 to 17:45	17:45 to 18:30	18:30 to 19:15	19:15 to 20:00	20:00 to 20:45	20:45 to 21:30	21:30 to 22:15	22:15 to 23:00	23:00 to 23:45	23:45 to 00:30	00:30 to 01:15	01:15 to 02:00	02:00 to 02:45	02:45 to 03:30	03:30 to 04:15	04:15 to 05:00	05:00 to 05:45	05:45 to 06:30	06:30 to 07:15	07:15 to 08:00	08:00 to 08:45	08:45 to 09:30
14:00 to 14:45	14:45 to 15:30	15:30 to 16:15	16:15 to 17:00	17:00 to 17:45	17:45 to 18:30	18:30 to 19:15	19:15 to 20:00	20:00 to 20:45	20:45 to 21:30	21:30 to 22:15	22:15 to 23:00	23:00 to 23:45	23:45 to 00:30	00:30 to 01:15	01:15 to 02:00	02:00 to 02:45	02:45 to 03:30	03:30 to 04:15	04:15 to 05:00	05:00 to 05:45	05:45 to 06:30	06:30 to 07:15	07:15 to 08:00	08:00 to 08:45	08:45 to 09:30
14:00 to 14:45	14:45 to 15:30	15:30 to 16:15	16:15 to 17:00	17:00 to 17:45	17:45 to 18:30	18:30 to 19:15	19:15 to 20:00	20:00 to 20:45	20:45 to 21:30	21:30 to 22:15	22:15 to 23:00	23:00 to 23:45	23:45 to 00:30	00:30 to 01:15	01:15 to 02:00	02:00 to 02:45	02:45 to 03:30	03:30 to 04:15	04:15 to 05:00	05:00 to 05:45	05:45 to 06:30	06:30 to 07:15	07:15 to 08:00	08:00 to 08:45	08:45 to 09:30
14:00 to 14:45	14:45 to 15:30	15:30 to 16:15	16:15 to 17:00	17:00 to 17:45	17:45 to 18:30	18:30 to 19:15	19:15 to 20:00	20:00 to 20:45	20:45 to 21:30	21:30 to 22:15	22:15 to 23:00	23:00 to 23:45	23:45 to 00:30	00:30 to 01:15	01:15 to 02:00	02:00 to 02:45	02:45 to 03:30	03:30 to 04:15	04:15 to 05:00	05:00 to 05:45	05:45 to 06:30	06:30 to 07:15	07:15 to 08:00	08:00 to 08:45	08:45 to 09:30
14:00 to 14:45	14:45 to 15:30	15:30 to 16:15	16:15 to 17:00	17:00 to 17:45	17:45 to 18:30	18:30 to 19:15	19:15 to 20:00	20:00 to 20:45	20:45 to 21:30	21:30 to 22:15	22:15 to 23:00	23:00 to 23:45	23:45 to 00:30	00:30 to 01:15	01:15 to 02:00	02:00 to 02:45	02:45 to 03:30	03:30 to 04:15	04:15 to 05:00	05:00 to 05:45	05:45 to 06:30	06:30 to 07:15	07:15 to 08:00	08:00 to 08:45	08:45 to 09:30

Figure 13: Construction Blockade module and Blockade Box Plan (see POAP documents for larger version)

A two-step change control process is now in place for works to be delivered during the Blockade, involving the Technical Director and Routeway Silver Team lead. This is being tracked daily



Figure 13a: Blockade change control process

November Construction Blockade:

Following the completion of the August blockade, whereby 96% productivity was achieved, the need for a further Blockade has arisen to ensure all Trace dependant works are completed ahead of entry into SIDT and ultimately Trial Running. This blockade will fit between the completion of TR2 Dynamic Testing and the beginning of System Integration Dynamic Testing (SIDT), and will run from Monday 23rd November and finishing on Tuesday 2nd December. A 3 shift, 7-day working will be deployed to maximise construction productivity.

In order to ensure the best productivity can be achieved during the November blockade, a series of lessons learnt workshops have taken place, the output of which will be a Lessons Learnt Report, aimed at resolving issues and further improving construction productivity. As previously stated in the August blockade, the key success criteria for the construction blockade is the completion of the critical construction works to support the Crossrail safety case to deliver a safe and operable railway and the majority of the works required for Trial Running.

A series of meetings will start from Thursday 1st October to start the construction blockade planning process, with a fully developed plan will be finalised by T-4 weeks.

The current high level scope of the November blockade includes the following:

- BOS End wall works
- Custom House platform extension
- Power Factor Correction at LIS, TCR, FAR, WOO, CUH
- Completion of the remaining routeway hop-ups
- Prioritisation of any other trace dependant works both in Stations and Routeway
- Closeout of as many Element Outstanding Works Lists (EOWLs) to complete 17 Acceptance Certificates in support of the CESAC, and minimise the works needed during TR and beyond

6.1.3 Module 3a: TR2 and Integration Testing

Software update TR2 will be available for testing prior to the Trial Running period. Updating the system to TR2 after commencing Trial Running would lengthen the time taken to get to a Revenue service.

Although P_D+11 is future-proofed to allow entry into TR, the TR2 release is key to the success of the execution plan and is available to load in the COS by mid-August 2020. It is understood that TR2/Y0.604 software will deliver a reduced number of operational restrictions for both drivers and Traffic managers, however, the full extent of the changes from P_D+11 are not yet clearly defined.

The release will introduce improved reliability and software fixes, although until these systems are fully tested under dynamic testing, it will not be possible to confirm that this will deliver the levels of performance required to exit Trial Running.

The release of TR2 also enables routeway integration testing, BT TCMS 7.6.x and OST testing to take place.

The earlier start to DT and the subsequent blockade provides an opportunity to commence earlier dynamic testing of software and an extended period of System Integrated Dynamic Testing (SIDT). This will be necessary to support the associated assurance evidence and submission to RAB-C for approval by the ORR for Trial Running.

The current Programme Delivery Schedule planned dates identify the commencement of Trial Running at the end of March 2021 with the TR2/Y0.610 software. This will be upgraded through the software point release 6 (CBCT TR2 PR6) software that resolves issues including defects in the PSD sub-system impacting reliability. It is envisaged that a future software update of both train and signalling control systems (TR3) is likely to occur during the Trial Running period to enable Trial Operations.

6.1.4 Module 3b: SIDT and early TR tests

System Integration Dynamic Testing is an opportunity introduced after completion of TR2 Dynamic Testing to take advantage of the lag between DT complete and Assurance complete. Whilst the preference is to achieve an earlier date for Trial Running, SIDT is an opportunity to provide an earlier indication of reliability and performance of the various Crossrail systems whilst the assurance is completed. SIDT provides the following opportunities:

- Running more trains and increasing mileage through the COS to gather significant reliability data to help support the timetable bidding process at the end of 2020 for D40;
- Exercise the systems to flush out hidden defects outside of the constraints of typical dynamic testing guidelines;
- Stress test the systems 2 months earlier by running for longer periods, increasing mileage and increasing the defect discovery phase outside the constraints of the DT guidelines;
- The opportunity to complete all Trial Running Routeway integration tests earlier
- Enable cycling of more train units during this phase to identify any unit-specific defects;
- Enable RfL Ops and maintenance and MTR drivers a significant period of familiarisation of the Crossrail integrated railway systems and operations within a test environment. This should provide a more robust platform for moving into Trial Running.
- SIDT provides an environment where RfL can gain operational experience on the COS prior to going under ROGS by signalling test trains under the ROGS exemption and CCRRB

SIDT, therefore, is a key mitigation to the risk of delay in meeting the exit criteria for Trial Running with the subsequent delay to later phases of the programme. The SIDT and Trial Running schedules are currently being integrated into a single plan.

Summary of SIDT:

- SIDT commences after 'Phase 2' of the COVID-19 Recovery Dynamic Test Plan. Phase 2 is also known as TR2 and Integration testing
- SIDT is planned to commence on 3rd Dec 2020
- Default timetable operation in the SIDT period operation will be 7 days a week during traffic hours.
- SIDT will operate a close headway timetable with a maximum of 8 trains operating.
- Each night there will be non-traffic hours which may be available for other activities such as maintenance and construction.
- Integration tests brought forward from the TR period will be undertaken in the SIDT period
- The following access windows have been identified to accommodate residual project construction and testing activity that cannot coexist with SIDT train running:
 1. 10 days continuous whole line possession to accommodate outstanding routeway construction activity.
Note: this period is directly before SIDT and following the completion of the TR2 and Integration Testing
 2. Non-traffic hours every night
Note: maintenance activities will be prioritised during these windows. Likely productive working time will be approximately 4 hrs per night.
 3. 3 x 72hr whole line SPZs for the testing & commissioning of C620 point releases to TR2.
Note: an opportunity for other parties to undertake works except for when test trains are operating
 4. 4 days whole line possession at Christmas (24th Dec – 27th Dec 2020) due to driver availability and to accommodate outstanding Routeway works and activity at Bond Street

5. 14 days whole line possession in February 2021 acting as the August 2020 blockade ‘fire break’ and to accommodate TVS testing

- C620 is still reviewing access requirements to complete testing prior to TR. For example transition testing on weekends.

It is anticipated that the access windows above will also act as a contingency for as-yet-unknown access requirements.

Future Software releases beyond TR2 and Y0.610

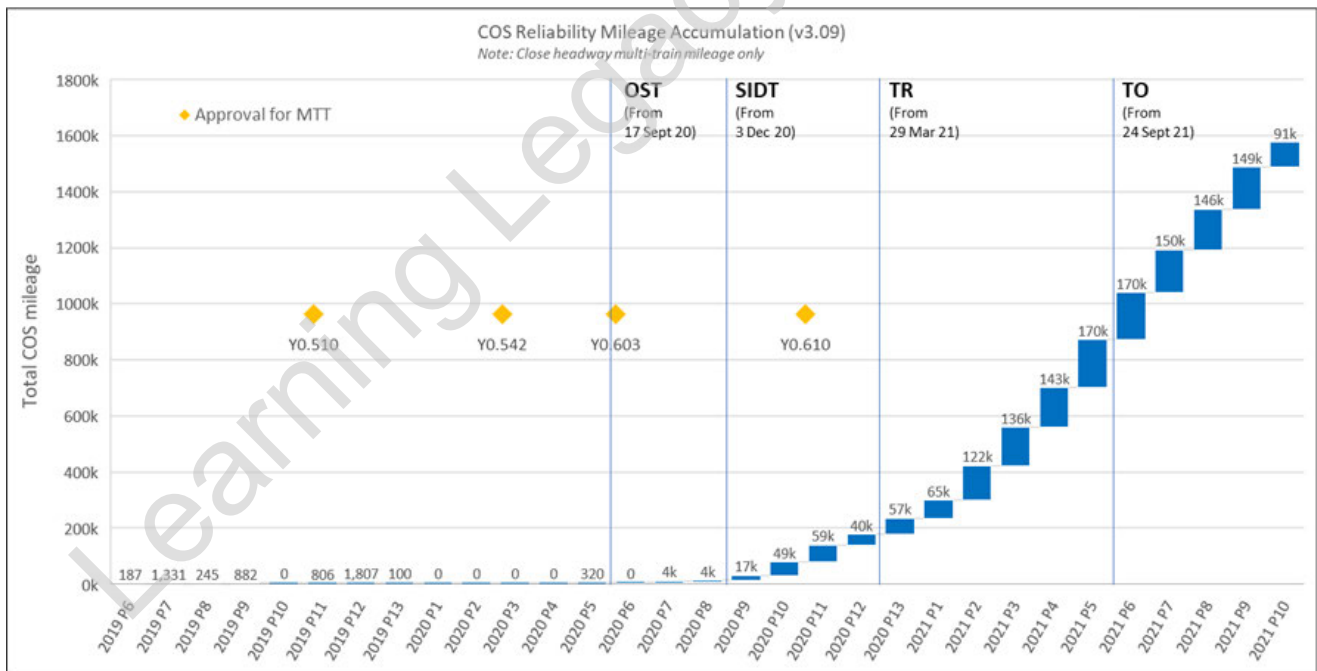
Siemens has confirmed the plan for the next major software upgrade (TR3). Please refer to Module 10 (figure 10b) for the Software release plan.

Reliability growth

A reliability mileage accumulation curve has been developed based on the restart of Dynamic Testing and the start of OST on 24 September 2020 for 9 weeks and the start of SIDT on 3 December running to the end of March 2021.

On this plan, the expected mileage is:

- Circa 5,250 reliability miles to date – Full-Length Units (FLUs) running in COS, close headway, multi-train runs
- Circa 8,352 miles expected from 9 weeks of OST at one day per week. OST is carried out with 4 trains for 16 hours (4 x 4-hour test blocks)
- Circa 215,153 miles expected from SIDT from December through to the end of March. This is based on the B1 scenario schedule.



Graph 1: Cumulative Reliability mileage forecast for DT, OST, SIDT and Trial Running (B1 scenario schedule)

6.1.5 Module 4: Assurance of the works

Structured Engineering Judgement will be deployed to mitigate any slippage in the schedule and potentially improve on the ROGS Authorisation date.

Structured Engineering Judgement is a formal documented risk review demonstrating that risks have been mitigated to ALARP. This will be achieved through a series of Joint Hazard Review workshops by CRL and RFL. The use of HAZID workshops as part of CSM has successfully been used on past major projects in TfL for the final delivery stages of Trial Running and Trial Operation prior to Revenue Service.

The Assurance fragnet within the DCS1.1 lays out the submission of Safety Justifications (SJs) on the 27th August from:

- PT
- Comms & Control
- Energy
- Tunnel Systems
- Civils
- Plumstead sidings
- Plumstead Depot
- Earthing & Bonding
- Romford Control Centre
- Great Western & Great Eastern Fringes and NKL

CESAC submission takes place on 11 February 2021 following the RAB-C approval of COS SJ, the integrated assurance approval and the Siemens signalling ESJ submission (TR2). RAB-C approval is planned two weeks later. Between the end of February and start of Trial running there will be several final mobilisation activities for RFL to operate and manage the Routeway and receive the handover from ATC.

There is no float within the Assurance Fragnet and as such, all the activities are on the critical path. As such it presents the opportunity for SIDT to be delivered between the Blockade (weeks 18-23) and the commencement of Trial Running.

The overall fragnet retains Scenario B1 / Silver Team recovery logic as a basis.

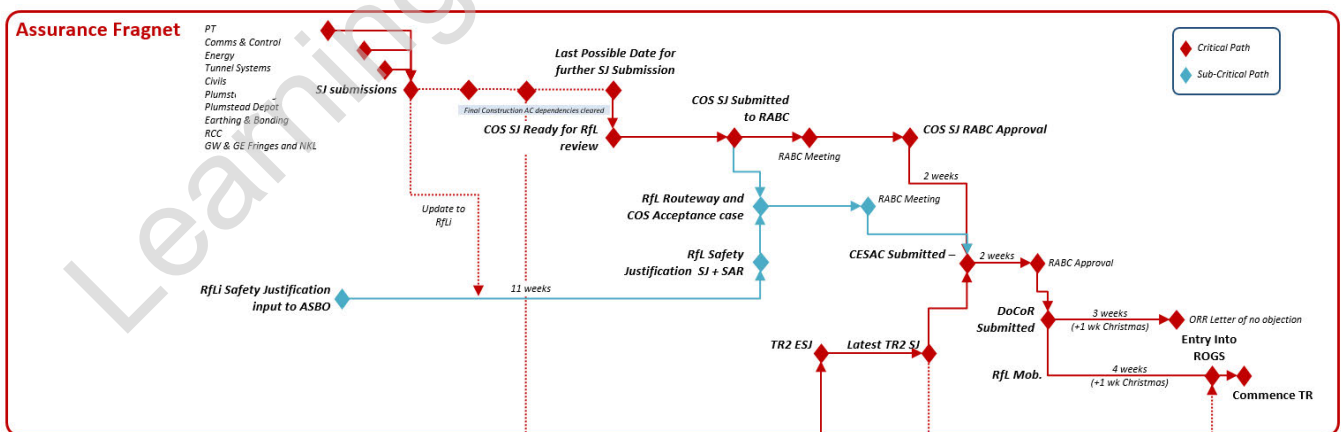


Figure 14a: Assurance fragnet module logic

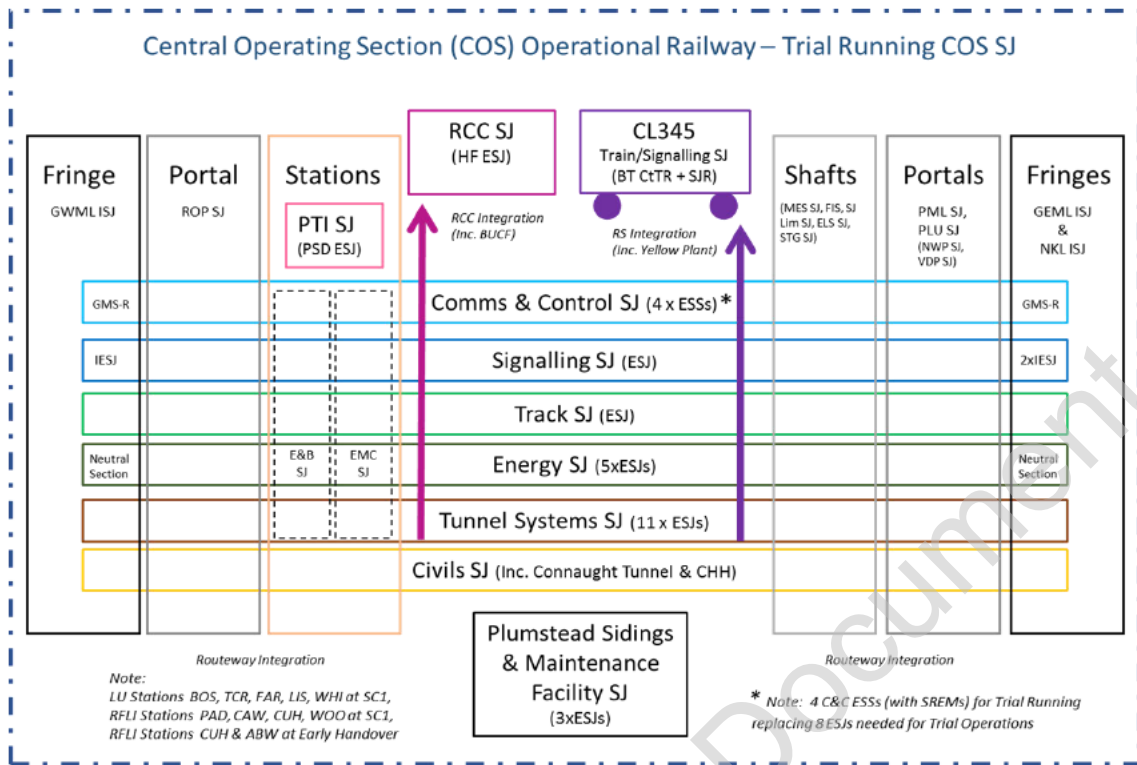


Figure 14b: COS Safety Assurance Integration

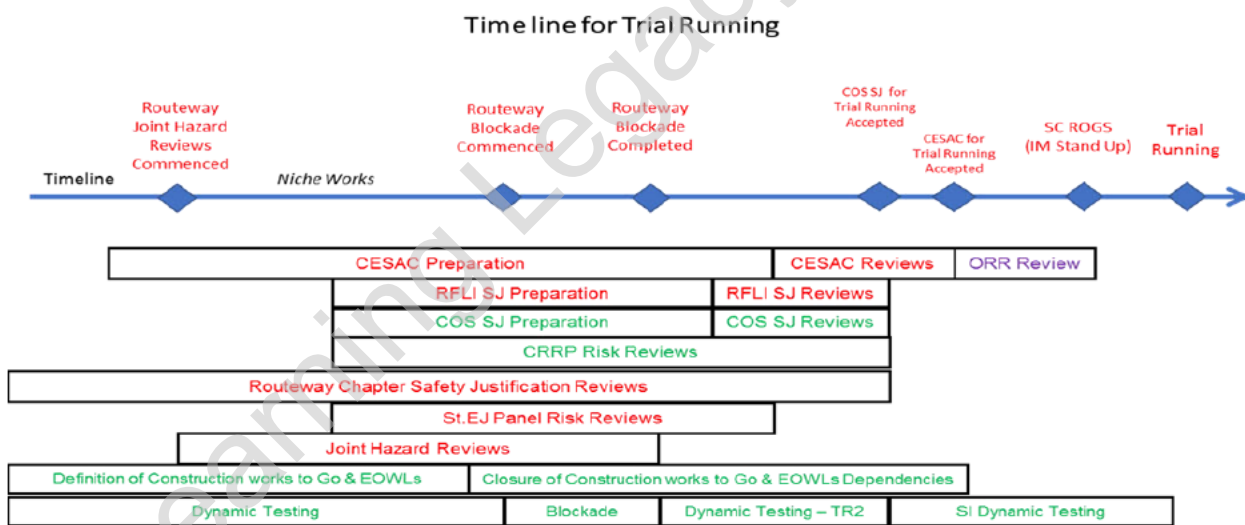


Figure 14c: Routeway Assurance Time-line

A final CRRP risk review for Trial Running will be held at the end to support the RFLI SJ and COS SJ safety justifications and feed into the CESAC readiness arguments. This will have to occur before the COS SJ readiness date.

Schedule Contingency

Based on the level of confidence and uncertainty from DCS1.1 Reviews, a series of targeted schedule amendments were made comprising changes to the base schedule durations and logic, inclusion of “firebreaks”, and edits to risk provision. These include increase of one week for RCAC approval of key routeway chapters, firebreaks built into SC3ROGS dates for stations, overall de-risking of ESM and CEG works. The full description and quantification of the firebreaks and risk

provisions included in the DCS1.1 base case are described in the “Basis of Schedule” document that supports the DCS1.1.

Ref	DCS Component	Schedule Intervention 1 Amend Base Schedule (e.g. Concurrency de-confliction)	Schedule Intervention 2 "Fire break" – I.e. Add Visible Schedule Contingency (e.g. Blockade +1 week for unplanned work)	Specific Associated Model Schedule Risk (as at 08/07/20)	Remarks
1	Restart & PD+11	No	No	No	If incomplete, will be completed in TR2 window in August
2	Blockade	No	1. +1 week allowance (5 to 6 weeks) 2. "Sweep Up Blockade" Mid Jan 21, nominally +2 weeks	No	Sweep-up blockade does not impact critical path but does lose 2 weeks of SIDT
3A	TR2 & Non Signalling Integ Testing	No – Schedule Point Releases catered for in base plan (3x2 day windows in SIDT)	No	Low probability high impact risk for wrong side failure test mode	
3B	SIDT	No	No	SIDT assumed as opportunity works so no risk included here	Some construction access in SIDT Plan (adequacy tbc)
4	Assurance (Routeway)	Resequencing of Routeway chapters (and subsequently RAB-C submissions), with +4 week impact	No	Risk 2,4,6 week duration on final ORR approval	
5	Stations	Intervention to sequence T-12 process for Stations to remove concurrency	No	No	
6	Transition to ROGS	No	No	No	
7	Trial Running	No	No	No	
7B	Trial Ops, Stage 3-4-5	No	No	No risk applied to Trial Ops duration [4 weeks opportunity identified not modelled]	
8	Team Elizabeth Line	No	No	No	
9	Commercial Recovery Strategy	No	No	No	
10 NW1	Whole system integration	No	No	Top integration Risks modelled (Final cross-check to Tech Director required)	

Figure 14d: Basis of Schedule

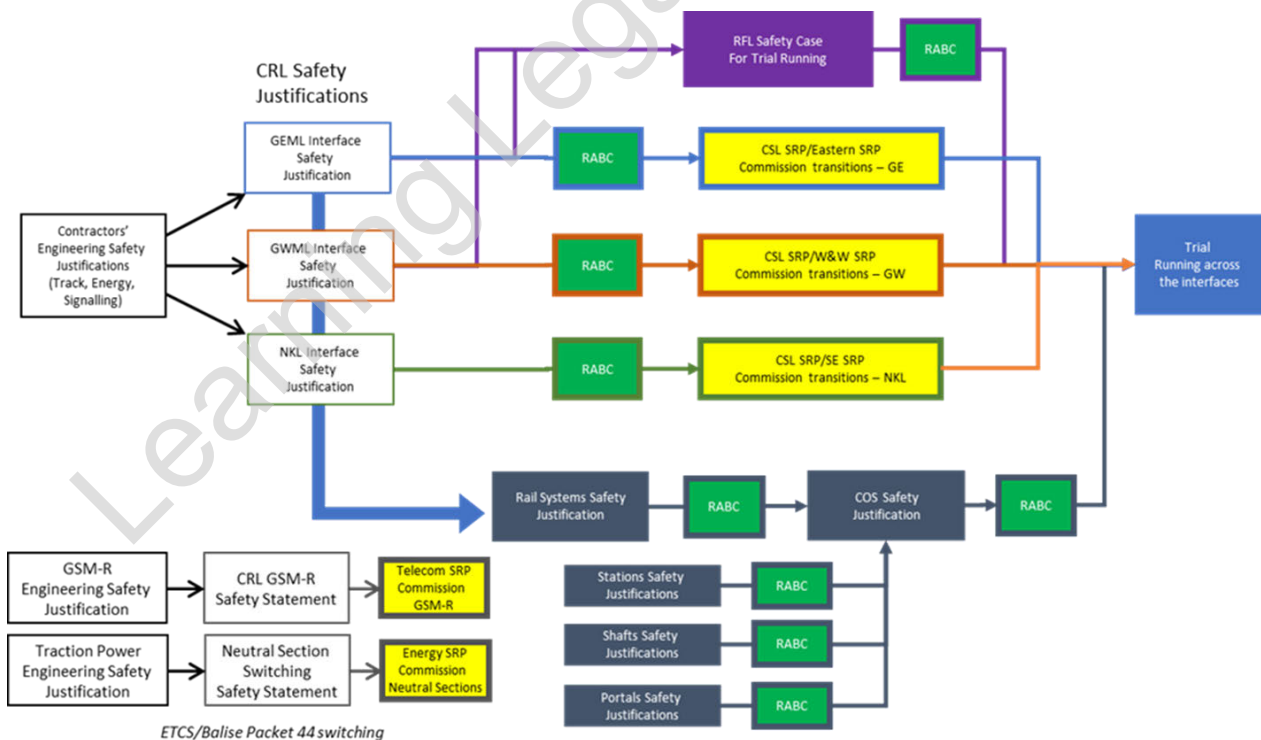


Figure 14e: Routeway Assurance – NR Fringes

6.1.6 Module 5: Stations – SC1 and station close out strategy

The following objectives have been developed for the station recovery plan:

- Agreement of priority order for Stations with RfL aligned to the Early Transfer proposal agreed with LU.
 - 6 Primary Stations for Stage 3 i.e. Farringdon, TCR, Liverpool St, Paddington, Canary Wharf & Abbey Wood.
 - 2 Secondary Stations for Stage 3 i.e. Custom House & Woolwich
 - Whitechapel
 - Bond Street
- The return to work following COVID-19 Safe Stop undertaken in a safe and an efficiently planned and coordinated manner, taking account of potential post-COVID-19 working restrictions and Public Health England Guidelines. Of paramount importance is maintaining resilience against the spread of the virus.
- Alignment with the planned route-way blockade 3rd Aug to 18 September 2020 ensuring that the Station Tier 1s support the route-way works and take advantage of the opportunities afforded by the working window made available to complete all trace dependent works.
- Agreement of the physical scope to go (EOWLS, COWLS, NCRs etc.) by all parties following the 'hard prune' EOWL triage which identifies:
 - (a) Works required for trial running
 - (b) Works required for revenue service
 - (c) Works that can be delivered post revenue service
- Production by the Tier 1s of a resource and cost loaded programme to be agreed prior to re-mobilisation, setting out requirements to deliver outstanding assurance and the physical work content.
- The development of an early handover strategy and/or a progressive assurance process with RfL.

Works required in (c) above to be delivered by an alternative to the current Tier 1. Review of works in (b) to be undertaken to pass as much as practicable to a Tier 1 alternative.

Consideration is given to changing the current cost-reimbursable nature of contracts to either introduce a vertical incentive for early handover or conversion to lump-sum cost arrangement.

Immediate Actions:

- Mobilisation instruction for Stations to be sent to Tier 1s cognisant of:
 - Scope to complete exercise completion enabling omission of works for scope not required for revenue service
 - Blockade opportunity for trace dependent works
 - Ability to control resources returning to the site and mitigate costs
 - Post-COVID working environments
 - Learned outputs from the shafts and portals handover process
 - Agreed ET dates for LU stations and SC3 ROG Assured dates for RfL stations
- Establishment of new SC2 milestone definition for Bond Street to enable completion by 31st December 2020
- Review of critical resource dependencies
- Consistency and clarity in the early transfer requirements in particular what will be transferred from a maintenance perspective and what will be available for beneficial use.

Overleaf shows the revised Station Silver Recovery Summary Programme *rev: 070820-draft* based on Station Configuration 2. The following key assumptions support this plan:

- Central resources to support the programme from the Technical Directorate are available.

- RfL is able, with support from L, to take maintenance of RfL assets 2 months in advance of SCROGs at Farringdon.
- The ESM fragnet and process agreed with C660 for SJ inputs is workable.
- IDT teams and in particular the PDEs will be empowered to verify SC3.
- Moorgate Ticket Hall works that are dependent on the SOR integration planned after SC3ROGS are not required for Trial Operations
- The current strategy under development for the Ticket Hall opening at Whitechapel and the required Secondary Means of Escape can be accommodated within the programme.

In developing the station close out strategy, CRL has assessed the configurations state for stations CRL and developed options for a risk-based schedule for entry into Trial Running, Trial Operations and Passenger services (Stage 3, 4 (incl. 4a and 5b) which are to be taken to the board for review and approval.

Learning Legacy Document

Crossrail COVID-19 Recovery Execution Plan
 CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

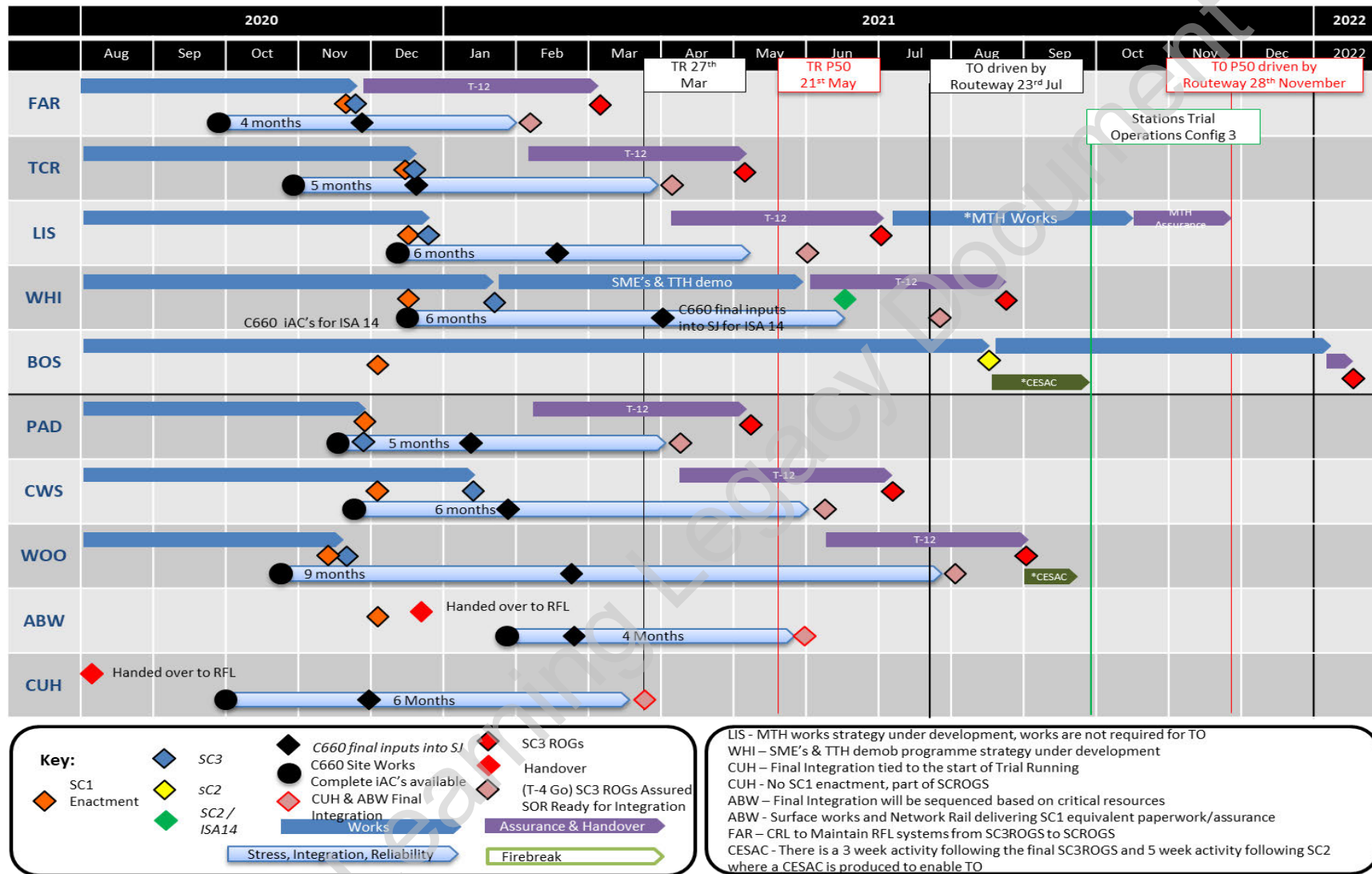


Figure 15a: Station Recovery Plan

Priority	Config 1	Config 2	Config 3	Config 4	Config 5
1. Farringdon					
2. Paddington					
3. TCR					
4. Canary Wharf					
5. Abbey Wood					
6. Liverpool St					SC2
7. Custom House					SC2
8. Woolwich				SC2	SC2
9. Whitechapel			SC2	SC2	SC2
10. Bond Street		SC2	SC2	SC2	SC2

Figure 15b: Proposed Station Configurations for Revenue Service

6.1.7 Module 6: Transition to ROGS environment

IM Readiness issues requiring resolution to support the safe operations, maintenance and delivery of works on the Elizabeth Line under a ROGS environment have been tracked since April 2020, monitored by weekly TRMB meetings and escalation to the RFLI and Crossrail Executive.





These were designed as short-term recovery plans, intended to correct known risk and transition tracking of these elements into business as usual. The issues are split into two elements: 1) IM Readiness; and 2) Crossrail Readiness. Both of which are reported to TRMB by Neal Lawson. Progress shown in the table overleaf is measured using the following scale:

- Red: the issue is unmitigated, and rectification plans did not achieve the desired outcome or end-date originally specified. These activities have not transitioned to BAU.
- Amber: the issue has been partially mitigated within the original end-date specified, and there are plans to continue to track outstanding activity to resolution. These activities have transitioned to BAU but have critical actions remaining to fully mitigate.
- Green: the issue has been mitigated within the original end-date specified and remains 'open' as it continues to be tracked through ongoing governance fora. These activities have transitioned to BAU.
- Blue: the issue has been mitigated within the original end-date specified and is closed.

The issues requiring resolution to support RFLI's capability to operate, maintain and manage the delivery of works by others on the railway under ROGS include: Mobilisation Governance; Asset Data; Handover Strategy; Capability Assessment; Technical Standards; Competent Maintenance Resource; Commercial Accountabilities; Joint Communications Plan; Critical Spares; Joint Hazard Review Workshops; Operations and Maintenance Manual Completion; Enterprise Bentley (eB) Transition to RailLink.

The issues requiring resolution to support Crossrail's capability to deliver works in a ROGS environment include Crossrail organisational design to supplement RFLI; Crossrail Transition to ROGS.

Initiatives to support RFLI’s capability to operate, maintain and manage delivery of works by others on the railway under ROGS.

No.	Issue	Status	Status Update	Transitioned to BAU
0	Mobilisation Governance		<p>A programme of work to improve Infrastructure Manager (IM) readiness and ensure that safety responsibilities are transferred appropriately was established in April 2020, aimed at addressing several capability gaps outlined in this update. Formal governance arrangements and improvements were put in place to support this programme, with a number of outcomes achieved. These include:</p> <p>1) Establishment of weekly 'Transition to ROGS' meetings (aka Ops Level 1.5 Vis), improving the link between RFLI project managers to weekly governance meetings to ensure critical issues are being discussed and resolved in a timely manner. Escalation items to RFL level 1 and TRMB are identified in this meeting</p> <p>2) Development of improved dashboards to streamline reporting requirements from the RFLI project managers, and improve visibility of emerging issues to the leadership team. These dashboards are now used for RFL level 1 Vis, TRMB and the PEF report.</p> <p>3) Adjustments to the RFLI governance cadence to ensure information and escalation items were flowing from project managers up to Ops Level 1 Vis and TRMB.</p> <p>4) A TRMB dashboard for the Elizabeth Line Readiness status has been developed which includes metrics from TfL (trains), MTR, LU and NR.</p> <p>5) Establishment of weekly RFLI Acceptance Activity (RAAM) meetings to drive progress of RFLI 'acceptance' activity such as Operations and Maintenance Manuals (O&Ms); Health & Safety Files; Asset Data; Safety Justifications (SJs); and Element Outstanding Works List (EOWLs). Dashboards have now been developed for each, and have now been introduced to the Ops Level 1 Vis meetings as of 02-Sep-20. Dashboards will continue to be refined over the next four weeks.</p>	✓
1	Asset Data		<p>A working group – involving participants from both CRL and RFLI – was established in May 2020 to manage Asset Data issues emerging as a critical risk for the programme. The asset data handover and acceptance process was reviewed and streamlined, and a programme for forward asset data drops was developed to monitor progress ahead of Trial Running. A number of process improvements have been achieved, and new reporting enhancements have been delivered to improve visibility up to TRMB.</p> <p>However, despite progress, Asset Data continues to pose a major risk to the programme and an independent review was commissioned by the TRMB which made several recommendations now being implemented.</p>	✘
2	Handover Strategy		<p>Handover and mobilization strategies have now been written for both RFLI Operations and Maintenance. The Operations strategy was converted into a plan in June 2020 and is currently being rebase-lined against DCS 1.1.</p> <p>The Maintenance strategy has been endorsed by the RFLI Executive group. It is currently being planned in detail against DCS 1.1. Apart from Track, it has been assumed that there will be no MoBo of Routeway chapters. However, a paper was written for the RFL IM Readiness Exec that set out the decision process RFL will use to determine if other MoBo could happen.</p> <p>In addition, a strategy has been completed for the IM Ramp up in TR and this has been included in the TR Readiness Working Group planning</p>	✓
3	Capability Assessment		<p>A LOD1 RFLI capability maturity assessment was completed in June 2020. The assessment outlines baseline capability maturity ratings across 19 capability areas, utilizing a pre-existing RFLI capability model framework known as the Asset Intensive Business Architecture (AIBA), developed in 2016. Further, four cross-cutting themes were identified as contributing to lower maturity across several capability areas. These themes have been presented to the Crossrail Board.</p> <p>A working group has been established to mitigate high-priority 'strategic' level risks posed to RFLI ahead of Trial Running. Through this working group, RFLI has a greater level of participation at weekly Organisational Transition Programme (OTP) meetings led by Crossrail. Recommendations and actions from the Capability Assessment are now in 'business as usual' state.</p>	✓

Crossrail COVID-19 Recovery Execution Plan
CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

No.	Issue	Status	Status Update	Transitioned to BAU
6	Technical Standards	●	<p>The RFLI Engineering team conducted a bottom up review of over 700 technical standards required across nine assets prior to Trial Running. A completion glide path was developed in June 2020 that depicts the plan to complete all documentation by early October 2020.</p> <p>Delivery of Technical Standards is now in 'business as usual' state and is monitored weekly via Transition to ROGS and Operations Level 1 Vis meetings. These metrics are also reported periodically to PEF.</p>	✓
7	Competent Maintenance Resources	●	<p>The RFLI Business Management and Maintenance teams conducted a bottom-up analysis of the number of required Maintenance Competencies for ROGS. This analysis highlighted a requirement of c. 1,400 competencies by February 2021. A training and competency completion plan has now been developed to monitor whether required run rates are being achieved, and Maintenance Competency is now in 'business as usual' state.</p> <p>The completion plan to achieve required Maintenance competencies remains impacted by two key risks: COVID-19 continues to have an impact on the ability to run in-person training courses. This is being mitigated, but social distancing policies may hinder forward progress.</p> <p>Further delays to Trial Running timeframes may cause competency numbers to decline, either through attrition of suitably skilled resources or through qualifications expiring.</p>	✓
8	Commercial Accountabilities	●	<p>Very much linked to Maintenance Competency and Spares, Procurement is also now in 'business as usual' state. Critical contracts required to bolster resource/ capability shortfalls in the Operations and Maintenance areas have been identified and are being tracked weekly via Transition to ROGS and Operations Level 1 Vis.</p> <p>Run rates to date have been achieved by the RFLI Commercial team, but forward forecasts through the September and October period have slipped marginally. It is expected these timeframes will be mitigated to ensure all contracts are in place by March 2021 in time for Trial Running.</p>	✓
9	Joint Communications Plan	●	<p>The launch of the Elizabeth Line Trial Running 'Hub' in May 2020 gave both CRL and RFLI a platform to communicate successes and ongoing activity via a common platform. The Hub was launched via an all-staff briefing, and success stories are being continuously gathered and uploaded across all Elizabeth Line organisations by the Communications team. As such, Initiative 9 is completed.</p> <p>Work is underway to bring to life transition artefacts that clarify roles and responsibilities of different entities within the Elizabeth Line team and how these evolve. This will require communication across the organisation. A current all staff 'away day' is being planned for October 2020 to communicate some of these themes to ensure all staff are engaged.</p>	✓
10	Critical Spares	●	<p>A Spares Working Group was established as part of this initiative to support the production of an RFLI Spares Procurement Strategy and resolution of the aforementioned issues. The primary issue faced by the RFLI Maintenance team was the lack of an agreed and verified spares list, and subsequent delivery timeframes. RFLI and CRL have worked jointly to resolve this issue, and a consolidated spares list with a number of clarification questions has been issued concurrently to CRL (Rob Carr) and RFLI Maintenance Engineers for validation. Final responses from all CRL and RFLI parties are expected by the end of August to finalise the Spares Procurement Strategy for submission on 4 September to the TFL Commercial Approvals Meeting.</p>	✓
11	Joint Hazards Review Workshops	●	<p>In June 2020, Crossrail developed a Joint Hazard Review (JHR) procedure with input from RFLI to outline and approach for a series of workshops to be conducted from July to September 2020. The outputs of these workshops are required to inform a number of key artefacts to demonstrate readiness to transition to ROGS - in particular the RFLI Safety Justification. A series of five workshops was originally planned, with</p>	✘

Crossrail COVID-19 Recovery Execution Plan

CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

No.	Issue	Status	Status Update	Transitioned to BAU
			<p>all outputs expected to be concluded by 05-Sep-20. The five workshops included: 1) End State Chapters; 2) Tunnel Systems and Safety; 3) Safe Train Movement; 4) Routeway Integration; 5) Route Control Centre. Subsequently, two additional RFLI workshops were included: 1) C345 Rolling Stock operation in ETCS L0, and 2) Yellow Plant transition from NR to COS infrastructure.</p> <p>Six workshops have been concluded, with one outstanding. Final outputs are now expected to be concluded for the CRL workshops by w/e 12-Sep-20, and final HAZID outputs are expected to be finalised by w/e 26-Sep-20.</p> <p>Following or in parallel with this, RFL needs to include the relevant mitigation actions in their Readiness plans. At the conclusion of the JHRs, RFL will also conduct a workshop to assess their ability to maintain and operate the railway safely considering the total number of restrictions/actions that they need to put in place.</p>	
12	Operations and Maintenance Manual (O&Ms) Completion	●	<p>An O&Ms Working Group was established – led by Sharon Duffy – as part of this initiative tasked to review and significantly improve completion run rates. Completion rates, visibility on critical issues, and collaborative working between CRL and RFLI have significantly improved since the inception of the working group. Weekly RAAM meetings continue to track O&M progress with a primary focus on achieving completion of all critical documents for Trial Running. O&Ms are now in 'business as usual' and a similar approach is now being applied to H&S files.</p>	✓
13	Enterprise Bentley (eB) to RailLink Transition	●	<p>The Data Management Strategy for RFL remains underway. A strategy was endorsed by the RFLI Executive in early August 2020, outlining the approach to continue to use the CRL eB system throughout Trial Running ensure that contracts can access up to date processes and procedures in a timely manner. This approach significantly de-risks Trial Running timeframes, however, the long-term configuration issues of RailLink remain.</p> <p>The initiative team continue to investigate options, timeframes and the potential future implication of this risk. A further update on the approach being taken was brought to the RFLI Executive group on 26-Aug. The need to tie this into broader information management and governance is now being addressed by the working group.</p>	✘

Issues requiring resolution to support CRL's capability to delivery works in a ROGS environment

No.	Issue	Status	Status Update	Transitioned to BAU
4	CRL organisational design to supplement RFLI	●	<p>A review of critical CRL resources that may be required by RFLI to support a safe transition to operating under a ROGS environment was conducted in May and June 2020 involving stakeholders from across both organisations. This review – which was endorsed by the RFLI Executive group on 8 July 2020 – concluded that capability and resource are required by RFLI across four areas: 1) Engineering; 2) Health and Safety; 3) Data and Information Technology, and 4) Operations & Maintenance. Reliability Growth Support was also highlighted as a potential fifth area but requires further investigation.</p> <p>Critical CRL resources in the four areas stated above have been provisioned in the latest CRL business plan to ensure resources are not prematurely decommissioned, and Initiative 4 is now in 'business as usual' state.</p> <p>The creation of a 'hybrid' organisation where CRL will be responsible for delivering some of RFLI's accountabilities will need to be reflected in the CMS for TR. A separate exercise is ongoing to identify the relevant procedures required to support this 'hybrid' organisation.</p>	✓

Crossrail COVID-19 Recovery Execution Plan

CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

No.	Issue	Status	Status Update	Transitioned to BAU
5	CRL transition to ROGS	●	<p>CRL has been classified as a 3rd Party Supplier and the arrangements for H&S have been communicated to the programme and supply chain in the H&S arrangements for the transition to operational rules (ROGS) document and associated CEC's. Version 2 is due to be issued by the end of Aug 20.</p> <p>CRL is developing its outstanding works plan for works after the blockade, through SIDT and into TR and TO. This will define the remaining scope, the team structure and sizes to complete the scope and therefore the training requirements. In the interim, a Training Request form has been developed and is available on Crossrail Connect. A dedicated training manager due to start in Oct is being recruited to deliver the CRL training programme and provide support to the supply chain. Suppliers have been briefed on the training requirements as set out in document above and able to start preparing their workforce.</p> <p>IAP is operating in shadow mode preparing to take over from ATC at SCROGS. CRL will present its access plan for the outstanding works mentioned above in September 2020 to ensure the planning timescales are adhered to. A digital Site of Work Request Form is available on the Integrated Access Planning SharePoint as an interim solution before Engineering Possession Planner is available. The Terms of Reference are in the final draft ready for signatures by the end of August.</p> <p>Crossrail, working collaboratively with RFLI, undertook lessons learnt from the Custom House incidents post-handover to RFLI. Subsequently, DTSRP has driven action plans to improve the handover process such as the Key Event Schedule which is a DCS visualization issued weekly by Programme controls and the Asset Transfer Comms process which includes a new Countdown to Change Notice issued by the IDTs detailing what the changes are in site safety responsibility and when they are happening. Updates also are being made to the Handover and Delivery strategy which will be briefed out in November 2020.</p>	✓

Figure 16: IM readiness plan status

6.1.8 Module 7a: Trial Running

Purpose

The Purpose of Trial Running is to demonstrate that the railway is capable of reliably meeting the capacity and other requirements of the Crossrail Programme Functional Requirements and the Sponsors' Requirements which will include any relevant Undertakings and Assurances. Trial Running (TR) will involve appropriate integrated testing with multiple trains to demonstrate that the Central Operating Section Railway system can achieve these requirements.

The objective of the TR plan is for CRL to prove that all programme requirements have been adequately met.

This is demonstrated via the following activities:

- Timetable running, emulating passenger service
- Timetable demonstrations (12 TPH Chadwell Heath, 2.5min close headway)
- Routeway Integration Testing (that cannot be achieved prior to TR)
- Cyclical planned maintenance, fault response and rectification

Trial Running is a provisional 16 weeks period. This is a nominal period (to be verified) which does not take in to account the opportunity for Systems Integration Dynamic Testing (SIDT) to de-risk the achievement of timetable reliability, and therefore reduce the time required during Trial Running.

There is a detailed set of Trial Running Exit criteria, which needs to be demonstrably met in order to confirm that the railway can meet the operational and reliability requirements. These include consistent headway, overall performance (PPM) and transition elements, both in terms of several successful passes and in overall performance terms. The criteria will be used to demonstrate that the railway is ready for Trial Operations and can sustain a reliable operation with passengers for stage 3.

General Principles

The general principles for Trial Running are as follows:

- The integrated testing during Trial Running will be under the direction of CRL and its Contractors, to demonstrate that the railway infrastructure and systems reliably meet the capacity and requirements, leading to Substantial Completion.
- During Trial Running the railway infrastructure will be operated by the Rail Systems Infrastructure Manager (RfL), and the trains will be operated by the Train Operator (MTR-C).
- The Central Section railway will come under ROGS, and the Safety Management Systems of the Rail Systems Infrastructure Manager (RfL) and the Train Operator (MTR-C) will apply.
- A near-normal Stage 3 12 tph timetabled service will be run 7 days a week, with trains entering and exiting the Central Section from/to Old Oak Common Depot at the start and end of the traffic day. The first four weeks of TR is for 'IM Ramp Up' activities only with trains running at 4TPH. Thereafter, timetable alterations facilitate 4TPH, 8TPH and 12TPH throughout the remaining 12 week TR period
- Outside of this underlying framework of timetable operation, there will be specific trials performed that will require special arrangements and timetables, including but not limited to:
 - Sustained 24 tph demonstration in the Central Section,
 - Sustained operation of the transitions onto Network Rail infrastructure at Westbourne Park (Great Western) and Pudding Mill Lane (Great Eastern),
 - Emergency and degraded modes of operation.
- Suitably trained Route Controllers (signalling and electrical) and Train Operators will be provided by the Operators for the trials.
- Maintenance will be under the control of the Infrastructure Managers.
- Access for maintenance and defect rectification will be under the control of the Infrastructure Managers and in accordance with their Safety Management Systems.

- To enable Contractors to fix critical faults and undertake maintenance, the access change control process will be implemented to support the T minus access planning process that facilitates the prioritisation of access and enables working under construction rules. It should be recognised that the utilisation of these possession opportunities should be kept to an absolute minimum to maximise timetable running. It will be possible to revert to timetable running should the opportunity possessions be given up. An agreement has been reached with construction that the access will be limited to 3 x 3-day SPZ opportunities (prioritised for Software point drops if required) and the 8 hour overnight Maintenance window.
- Trial runs across the boundary with the Network Rail infrastructure, other than timetabled depot moves, will be arranged in accordance with Network Rail industry processes.
- The Great Western (GW) Transition must be commissioned after entry into ROGS and before entry into TR. The Great Eastern (GE) must be commissioned after entry into ROGS and before timetable change to 12TPH.

Routeway Integration Testing:

There are 15 Routeway Integration Tests to be run in the Trial Running phase. Eight days have been allocated in the TR plan for the execution of these tests on-site. If the SIDT period is successfully used to complete the 15 tests, only one of the tests will need to be repeated. Where possible, CIF testing will be undertaken to obtain earlier confidence in the TR phase tests. The scripts for the tests are being produced by a resource in the TR team, scheduled completion 5th Sep 2020. This milestone would be accelerated with additional resource and the programme is seeking to further mitigate through opportunities to consolidate tests and accelerate the schedule.

Output criteria

In general terms, the key output criteria are the satisfaction of the Substantial Completion criteria following the PDA, i.e. that the railway is capable of reliably meeting the capacity and other requirements of the CPFR and Sponsors' Requirements.

The demonstration of the Central Section Rail Systems element at an optimal level of performance during Trial Running would also require an advanced level of operational competence and confidence. This can only be practically gained through extended operation as is likely during Trial Operations.

It is proposed that an overall railway output set of criteria is utilised for the Trial Running period as follows:

- All Trials successfully completed i.e. meeting the pass criteria for the trials;
- The agreed target level of mean miles between service affecting failures (MMBSAF) has been achieved, measured through the Rolling Stock;
- The agreed minimum operating requirements have been demonstrated and there are no major operational restrictions; and
- There is an agreed acceptable level of minor snagging along with agreed corrective action plans.

Trial Running POAP

A detailed day by day model has been developed to fully detail the required activities to be conducted during Trial Running. This model has now been baselined following reviews with all relevant stakeholders. This plan integrates the key activities for the following:

Traffic Day:

- MTR Timetable operations and CRL Integration Testing

Possessions & SPZ:

- Opportunities to conduct Train and Signalling Updates
- Opportunities to conduct outstanding works

Non Traffic Hours:

- Stations Commissioning (SC3 ROGS)

- Communications Update
- Maintenance Cycles
- Trial Operations Exercises

Learning Legacy Document

Crossrail COVID-19 Recovery Execution Plan

CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

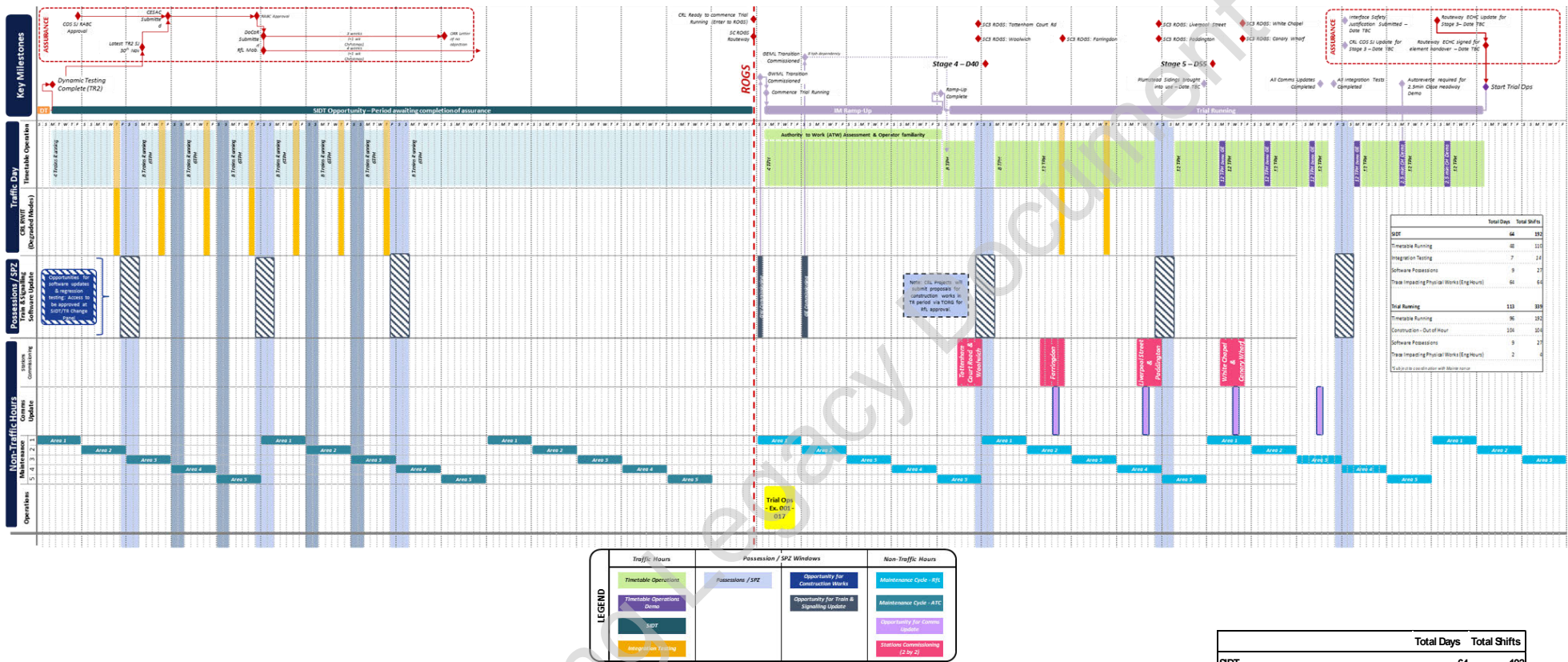


Figure 17: Trial Running (including SIDT plan) v3.09 based on DCS 1.1 P3 deterministic (subject to confirmation)

6.1.9 Module 7b: Trial Ops & Beyond high-level plan

Trial Operations is a 13 week period of time supported by a detailed plan of 54 published tests and exercises and 20 unpublished exercises. These exercises include passenger evacuation exercises, infrastructure failures, the rescue of a failed train, responding to broken PSD's and are staggered across the 13 weeks.

At the point at which CRL can exit TR and enter TO the reliability has to have achieved the requirements of the TR Exit Criteria so there is no undue impact on TO. At the point of entering TO CRL will commit to a specific date for first passenger service so reliability must be passenger-ready.

Some exercises require the approval (and witnessing) of key external parties such as ORR and London Fire Brigade where applicable (e.g. evacuation exercises).

Throughout TO the train service will continue to operate with an interruption for exercises limited as much as possible to allow operational staff to gain as much familiarisation with the railway system, train and operating procedures. Any operational incidents will be dealt with as if the railway were open to passengers. All drivers and operating staff will be cycled through as much as possible and be exposed to as many tests and exercises plus unplanned events as possible. The last two weeks are shadow running when the service will run uninterrupted for normal operating hours and at 12 trains an hour to ensure a smooth transition into passenger service.

There is an opportunity to bring a limited number of planned exercises forward into Trial Running (estimated at around 20%) but this will depend on the overall system performance in Trials.

If Bond Street or other stations are not going to open to passenger service for stage 3 then they will need to be at SC2 (the point by which a station can support a mass evacuation and routeway emergency lighting). A plan is under development to achieve this in time for TR.

Stage 4a

Stage 4a is planned to take place on Sunday 16th May 2021 which is a National timetable change day.

Stage 4a provides two primary benefits to the CRL programme:

1. It re-aligns the FLU fleet strategy which is now out of sequence due to the early implementation of stage 5a on the west and allows shorter RLUs to be lengthened in time for the start of stage 4 – giving a homogeneous fleet in terms of length and software. The longer platforms will mean a full FLU service can operate on the east for the first time.
2. It should also mean Stage 4 can take place outside of a national timetable change (subject to wider industry agreement). The stage 4a timetable will see FLUs operating at 12tph (peak) on the GE and with consistent stops at all stations, and stage 3 will introduce the same in the COS. This alignment will make for an easier transition between the two stages – albeit still needing some changes to the overall timetable.

There are several critical elements to deliver Stage 4a:

- Platform extensions at Liverpool Street which will be brought into use on 11th April 2021 – approximately one month before the timetable change, after the major blockade over Easter. This work is funded by TfL outside of the CRL programme and being delivered by MTR. The platform extensions at Liverpool Street will result in the three RLU platforms being converted to two FLU platforms. This means once completed there would be insufficient

platforms post the work to facilitate the Eastern service using lower capacity RLUs without disruption.

- The COS must be in TR as a minimum to enable the transfer of up to 5 FLUs per night back to OOC for maintenance as there is no fleet maintenance facility for FLUs on the east.
- Homogenous software on all FLUs across the fleet (Y0.610 Software as a minimum for a correct side door operation and CBTC for COS use). Trains running in the COS (TR) and on the GE will be interchanged so must be of the same type.
- GE and GW transitions commissioned and operable.
- Timetable bid submitted in August 2020 and accepted by NR

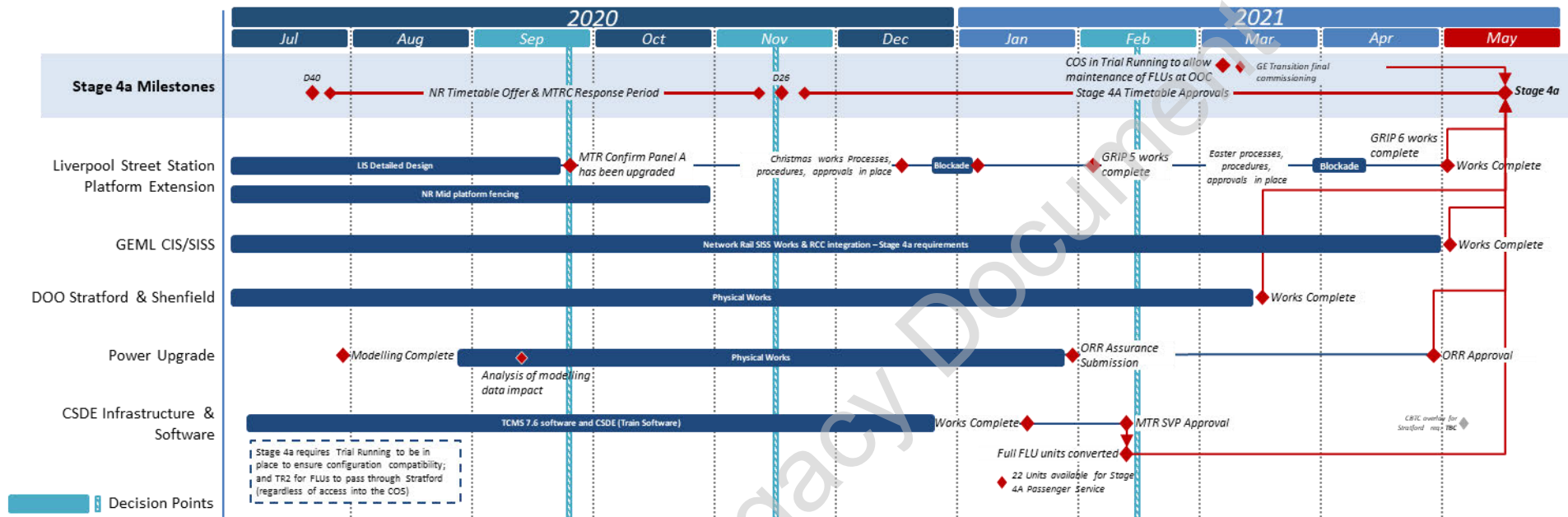
Also, the following elements are essential but could have mitigations in place, although these remain under-developed and without clear ownership at this point.

- DOO upgrade at Stratford and Shenfield (NR led project) – could use manual dispatch subject to development and agreement with the operator.
- NR Power upgrade on the East (NR ATF project) as Greater Anglia would have also increased their service at the same time. It is believed (and NR concur) that there will be sufficient power for stage 4a BUT the upgrade will be essential for the full stage 4 services. They have confirmed that the delivery plan will be in place to support stage 4 at the point of bidding stage 4a.
- CSDE (infrastructure and train software) (RfL led project) – could apply to ORR for a further delay to implementation, subject to that further delay not being too long and agreed by all parties including the operator.
- CIS / SISS in place across stations (NR led project) – mitigations are in place currently and could continue until full stage 4.

As a result of these elements, there are a number of involved parties across CRL, RfL, MTR and NR. A clear lead for the full breadth of stage 4a will be appointed to focus on the integration and delivery of this important mitigator.

Crossrail COVID-19 Recovery Execution Plan

CRL1-XRL-Z-STP-CR001-50038 Rev 2.0



Decision Point 1: Sept 2020

- Power modelling by NR complete to confirm if needed for stage 4a
- Timetable (TT) bid submitted
- Blockade underway/complete for critical Trial Running works
- Confirm any mitigations needed

Decision Point 2: Nov 2020

- Construction blockade complete
- TR2/TCMS testing underway and complete/progressing well
- Panel A Liv St complete
- TR date confirmed and robust
- TT bid confirmed (T-26)
- Confirm mitigations & go/no go on Christmas blockade for Liverpool Street station

Decision Point 3: Feb 2021

- Programme is in TR, or TR start imminent and robust
- Liverpool St station Christmas blockade delivered full works and Easter planned/ready
- Power upgrade complete and submitted to ORR
- CSDE complete on fleet and infrastructure
- FLU fleet available
- Transitions tested and commissioned
- Confirm mitigation and go-no-go Liv St blockade

Stage 4:

The Stage 4 introduction will continue to route trains from Abbey Wood to Paddington at 12 TPH with Shenfield Trains also routed into the COS and to Paddington at a rate 12 TPH. This will give a peak service of 24tph in the COS. Heathrow and Reading services will continue to serve Paddington Main line station.

A key assumption is that Stage 4 needs to be a minimum of 12 weeks after stage 3, due to the need to prove reliability in the COS and for staff/passenger familiarity as well as continuing to run trains across the GE transition (empty and off-peak) to grow that reliability further, ready to support routine use at 12tph. Stage 4 could be planned for the December 2021 timetable change but would need stage 3 to open in early September at the very latest. Therefore if Stage 3 is any later than four weeks post the planned August 2021 date (as per B1) then Stage 4 would have to be delayed to the next timetable change in May 2022 or into a non-standard timetable change in Q1 2022 (facilitated by delivery of Stage 4a and with industry agreement).

The stage 4a timetable includes paths to run in and out of the COS to the GE off-peak to facilitate this growth in reliability and for driver training/familiarisation.

The On network works consist of two main elements:

- Accessibility (induction loops, DDA toilets and lighting levels) and step-free access schemes (lifts and footbridges)
- Station Refurbishment works including canopy, retail facade roundel or Interlith totem, bollards, lighting, cycling hubs, and back of house upgrades to staff areas.

It should also be noted that works mitigated for stage 4a would need to be complete at the point of stage 4 at the very latest – including power upgrades, DOO at Shenfield and Stratford and CIS/SISS.

Auto-reverse functionality is also an essential requirement for stage 4 to allow 24tph to turn at Paddington. Once stage 5 opens this need to more driven by reliability and benefits in perturbation rather than for the service as only 12tph will turn back at Paddington.

Stage 5b:

Stage 5b must be on a national timetable change due to the scale of change across the western rail network. For this reason, it is also considered that stages 4 and 5b cannot be combined into one large change. Bidding for stage 5 will start just over one year in advance with the main bid 40 weeks before. Under the B1 plan, this would be in August 2021, potentially before the opening of stage 3 and therefore would need a careful argument and consideration to gain support.

Crossrail COVID-19 Recovery Execution Plan
 CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

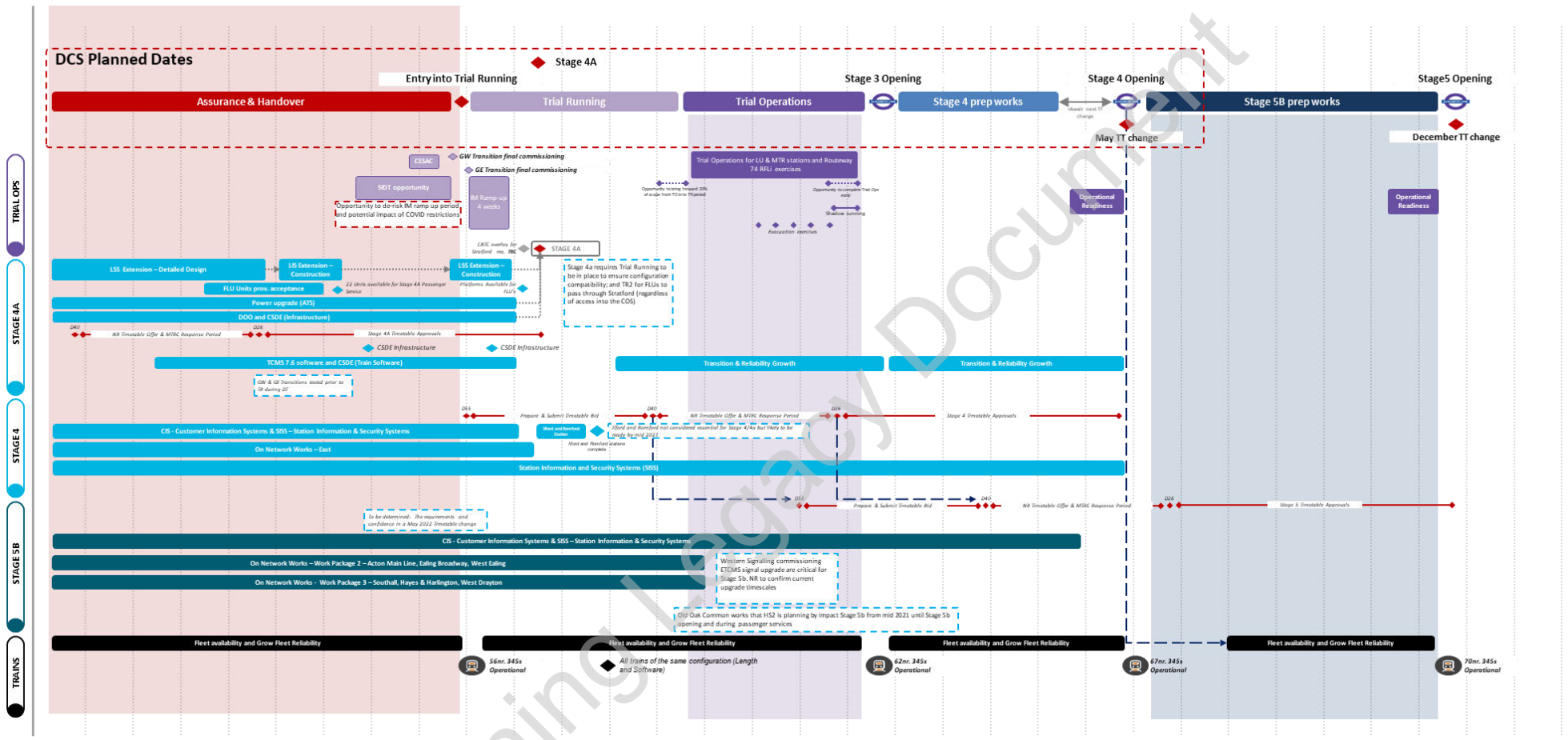


Figure 18: Trial Ops & Beyond high-level plan DCS1.1 Planned Dates

6.1.10 Module 8: Organisation Design & Transition

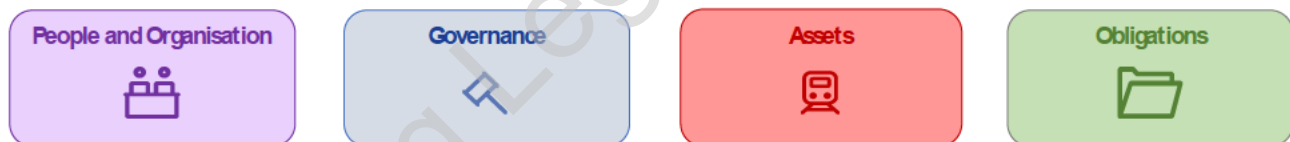
The aim of the organisation transition plan and associated workstreams is to define the organisation and resources required at key stages of the programme from today through to the end state. The organisation transition plan will align to the recommendations set out in the Recovery Strategy and impacts to the E2E plan as a result of COVID-19 to ensure the right organisation is in place to mitigate key risks to delivery. The plan will be underpinned and supported by a number of key operating model considerations outlined in this module.

Principles, scope and ways of working

For reference, the overarching principles of the Elizabeth Line Transition Programme and plan are to:

- Bring the railway into safe and reliable passenger service as soon as practicable,
- Work collaboratively to integrate the plans of the relevant organisations into the ELTP framework.
- Ensure the Sponsors objectives for the Elizabeth line are met.
- Facilitate the planned transition of CRL into the live railway (The Elizabeth Line) without destabilising delivery.
- Utilise existing oversight and governance processes where possible.
- Utilise the most cost-effective resource to deliver transition.
- Ensure learning is captured and embedded to ensure the effective on-going performance of the Elizabeth Line
- Ensure communications are clear and consistent across the organisation.
- Maximise the benefit from retained expertise and capability; ensure CRL fulfils its obligations and enables an effective transition to the Elizabeth Line across all areas of the programme and the transition plan.

In support of the ELTP programme, the Transition Plan scope includes overseeing and monitoring transition-related activities that are split into four workstreams: People and Organisation, Governance, Obligations and Assets, as outlined below.



- **People & Organisation** - Defines and delivers an effective workforce planning approach to ensure that the right resources are retained to transition the programme into operations and beyond where required. A clear culture, including values and behaviours, will be developed and embedded to ensure the successful delivery and future operations of the Elizabeth Line.
- **Governance** – Designs, tests and implements the appropriate corporate and programme/operational governance structures to successfully transition the programme from delivery into the Elizabeth Line.
- **Obligations** – Identifies how CRL assures that obligations and liabilities have been discharged, or if they are not discharged for any reason, how they are transferred to the IM or TfL. The transition programme aligns with the workstream and ties in with the relevant leads.
- **Assets** – Ensures that the transfer of hard and soft assets are aligned to the overarching programme plan and the necessary arrangements are in place to transition from delivery to the Elizabeth Line. This will be fully aligned with all stages of the integrated programme plan.

A detailed overview of the Transition Plan that highlights the interdependencies across all four workstreams is also shown in figure 19a below.

1.) People & Organisation

A single coherent and cohesive approach will be developed and applied to the design at all stages and aligned with the overall programme transition to drive consistency. This approach will include a review of the governance required to ensure the delivery of the programme. Consistent methodology will apply to the design and implementation process and will define clear design principles to guide and shape the operating model and transition approach throughout the process.

At each phase of the programme, we need to consider the following organisational components:

- **Activities** – to define the key activities to be delivered at each stage (stop/start/continue/transfer).
- **RACI** – to define clear accountabilities for the specified activities, remove duplication and clarify interfaces and ways of working across the programme.
- **Capabilities** – to identify the specific capability requirements to deliver key activities.
- **Organisation design** – to define roles & responsibilities which are organised to optimise the allocation of skills, capabilities and talent to enable effective and cost-efficient delivery of the agreed plan.
- **Ways of working & culture** – to define the ways of working, culture, values and behaviours required to underpin the organisation design and deliver the Elizabeth Line.
- **Other operating model layers** e.g. process, data & reporting, systems – to identify where organisational change will impact other layers and vice versa.

The design will be underpinned by these key activities:

- **Scenario testing** – to ensure integration across the operating model components and bring the model to life
- **Change impact assessment** – to identify areas of significant change where mitigations are required to successfully implement and embed the change
- **Communication and engagement strategy** – to engage with stakeholders across CRL, RfL and TfL for developing the narrative for delivery and align the organisation behind it
- **Implementation approach** – to develop an approach to implement the new operating model and embed the change, working closely with Comms and HR to ensure alignment with key processes and the right level of employee engagement is in place to support staff
- **Sponsor and Stakeholder engagement** – to ensure all key stakeholders are engaged at every stage of the transition to ensure receiving organisations are set-up to receive and deliver the operational railway through the successful transition of people (where appropriate), governance, obligations and assets.

Detailed work has been completed to define the workforce planning approach. To ensure the effective delivery of the Programme and transition of Crossrail into the Elizabeth Line, we must understand exactly what critical resources are required throughout the remaining stages of the programme. The approach developed provides a holistic view of resourcing across the life of the programme, including what Crossrail, RfL and TfL require. This will define and identify: (i) critical resources, (ii) top talent (aligned with the TfL approach to Talent Management); (iii) potential workforce constraints which may impact the delivery of the programme plan; (iv) streamline management of resource extensions to align with milestones in the Crossrail Integrated Programme Plan (DCS 1.1.) and (v) will be costed and sit within the agreed funding envelope.

Organisational design for Trial Ops and beyond

To ensure the key objectives and needs of the programme are met after Trial Running, targeted organisational design will be undertaken for Trial Ops and beyond in the next phase. This will consider the key workstreams and maturing transition requirements by re-evaluating all the organisational components to deliver the Elizabeth Line in its' end state, in close collaboration with RfL and TfL.

2.) Transition of Governance

As Crossrail evolves into the Elizabeth Line, there is a need to evolve its governance design to be fit for purpose for an operating railway. Over the past few weeks, the governance workstream, working with the Chair of the Board and nominated NEDs developed a proposed governance design for the Elizabeth Line. A number of options were also developed to depict potential transition governance designs that Crossrail could adopt to arrive at the proposed “end-state”.

TfL have now defined the governance design they wish to implement, and we are working closely with them to enable this transition of governance smoothly and effectively without disruption to the delivery of the DCS1.1 and the overall integrated Crossrail programme.

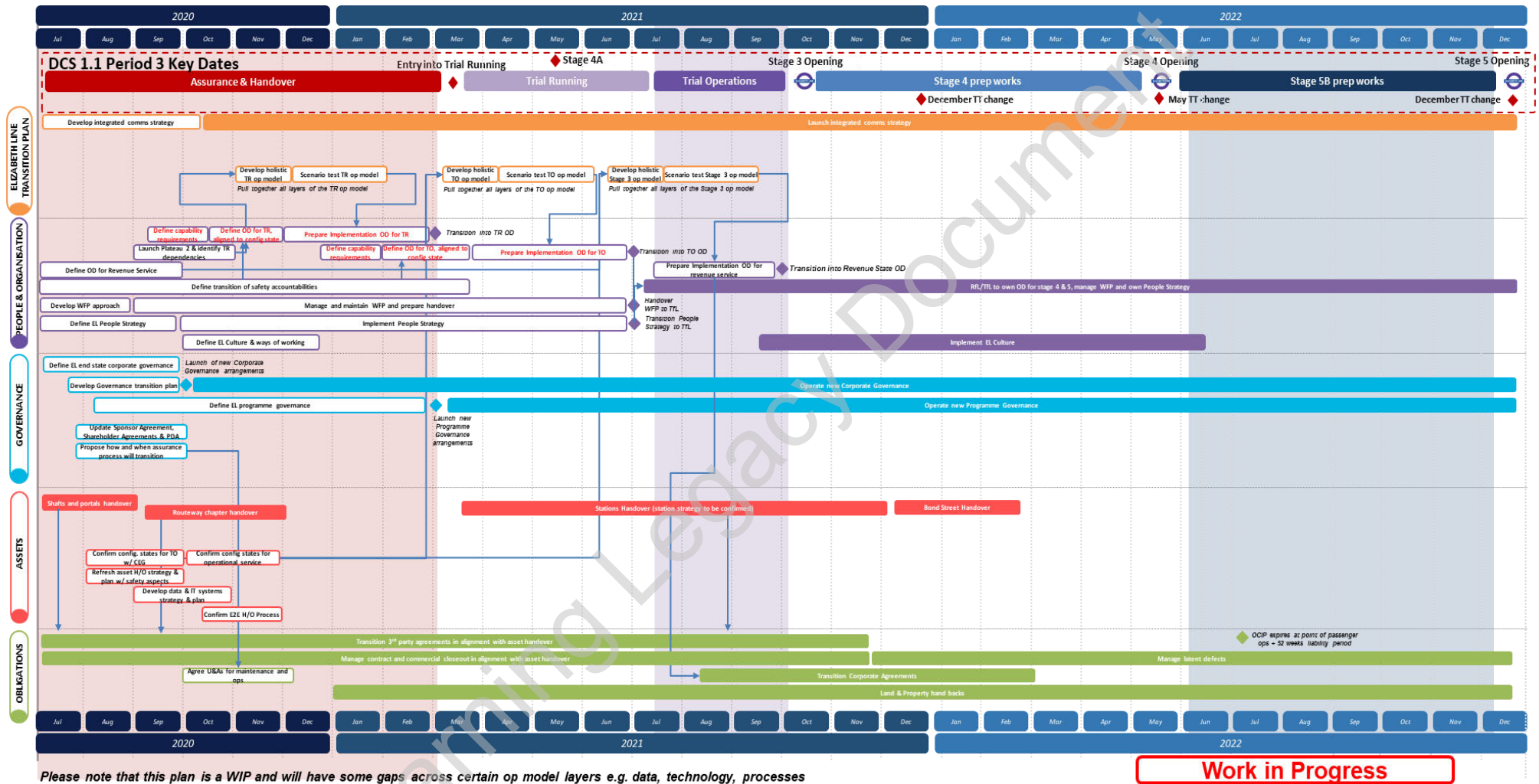
An overview of the change plan that will enable this transition is currently being prepared by working closely with the TfL team. Further updates will be provided in due course.

3 & 4) Transition Plans C and D:

Parts C (Assets) and D (Obligations) of the Transition Plan are detailed below. While requiring oversight and an aligned plan, except for some activities, most of the activities will be carried out as part of the overall integrated Crossrail Programme Plan implementation.

Learning Legacy Document

Crossrail COVID-19 Recovery Execution Plan
 CRL1-XRL-Z-STP-CR001-50038 Rev 2.0



Please note that this plan is a WIP and will have some gaps across certain op model layers e.g. data, technology, processes

Figure 19a: High-level transition milestone plan

6.1.11 Module 9: Commercial Strategy

Pre-COVID 19 position

The CRL funding package set in 2018 was for a total of £14,964m. In November 2019, TfL announced that CRL would exceed that by £400m to £650m (P50 to P80). As at the end of March 2020, ie prior to the impact of COVID-19, the AFCDC was forecast to be £456m to £640m above the funding package. Activities are ongoing with Sponsors to secure funding certainty.

	Funding	P13 AFCDC	Difference	Forecast deficit
Funding package	14,964	15,420	(456)	
Announced P50 deficit	400			456
P50	15,364	15,420	(56)	
Announced P80 deficit	650			640
P80	15,614	15,604	10	

Prior to the onset of COVID-19, the key commercial issues were at Bond Street and Whitechapel, with low productivity and commercial behaviour driving continued programme delays and cost increases. Given the emerging cost nature of the Supplemental Agreements in place, in practice, CRL has been constrained in its ability to effect positive change on these contracts.

At all sites, commercial incentives for contractors to prolong the work can be high, although each contractor has acted differently. The existing commercial approach has therefore been to develop bespoke close-out strategies per contractor.

Impact of COVID-19 – supply chain liquidity

On the 23 March, the government announced a national lockdown. The consequent instruction for the Safe Stop of all construction activities at CRL led initially to the standing down of all on-site staff aside from those essential for safety, security and care and custody duties.

CRL undertook a risk assessment at the outbreak of COVID-19 in the event of a disruption to activities and concluded that Crossrail was largely protected from a Tier 1 business interruption. However, there were major concerns with the Tier 2/3 supply base and their potential liquidity. As such, 13 critical Tier 2/3 suppliers were identified.

The Tier 1 risk was perceived low because:

- CRL reliance upon major JVs with joint and several liabilities in the event of one of the parties being unable to complete their contractual obligations.
- The physical works being largely complete with no major plant installations remaining.
- CRL ability to instigate early handover and/or ADM approach to potential Tier 1 insolvency.
- CRL transparency on cash given project bank accounts and cost journals.

CRL formally instructed Safe Stop to Tier 1s and soon after confirmed payment principles to suppliers as follows:

- Continuation of the contract payment mechanism
- Care & custody on site
- Demonstrable productive remote working – this involved a relaxation on the Schedule of Cost Components to allow work outside the ‘work area’
- Niche working
- Tier 2/3 bench – where the identified 13 strategically critical suppliers are being paid for seconding key staff onto a bench.

- Social distancing & safe travel 'extra over' costs, eg car parking
- Advance on stage payments given clear criteria being met

CRL has not committed to certify during COVID-19:

- Staff/Labour retained by Suppliers at Home but not productively utilised
- CRL will not pay 100% of staff salaries where Contractors have imposed 20% or 30% cuts on staff salaries.
- Items of commercial dispute that materialised prior to Safe Stop.
- Advance payment for work that has not yet been undertaken.
- Any gaps between the furlough relief and the actual cost to the Tier 1
- Acceleration of the contractual payment cycle.

The analysis that compares application to payment with the amount certified shows relatively low levels of commercial difference, aside from the Paddington dispute. Discrepancies largely comprise compensation events yet to be evaluated, differences on cost accruals/forecasts and routine disallowed costs.

Two key Government publications have been issued to support contracting authorities such as CRL in how to provide contractual relief to 'at risk' suppliers (and their supply chain) that have been affected by COVID-19:

- *Procurement Policy Note 02/20: Supplier relief due to COVID-19* which sets out information and guidance for public bodies on payment of their suppliers to ensure service continuity during and after the current coronavirus COVID-19 outbreak.
- *Additional guidance, FAQs and model terms for Construction* which provides specific recommendations and options for public bodies operating within a construction environment.

CRL has shared its approach and policy with both DfT and TfL with general agreement that CRL has adopted a pragmatic approach. There is a weekly alignment meeting with TfL's Commercial Directorate, and whilst there are differences in contract portfolios there is perceived to be a similar approach being taken to the respective supply chains. Given all the above CRL believes it has taken reasonable measures for compliance with the intent and spirit of PPN 02/20.

However, potentially the most testing period regarding supplier solvency will be during remobilisation. Cash commitments for the Tier 2/3s could be most challenging as both Clients and Tier 1s make demands on resource growth to complete works. Furthermore, Government interventions such as the Coronavirus Job Retention Scheme are being modified and may even be removed, exposing some of the supply chain.

The commercial strategy is to remain vigilant, flexible and on the front foot as events unfold.

Impact of COVID-19 – financial forecasts

CRL has undertaken a modelling exercise to estimate the impact on schedule and programme cost of an essentially passive response to COVID-19. This represents a useful pre-intervention benchmark. Compared to B1, this scenario (A2) would see a two-period slip in the programme for the commencement of Trial Running.

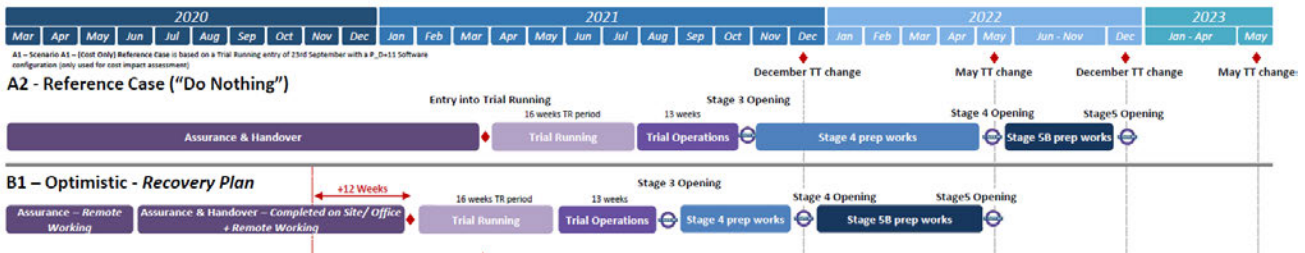


Figure 20a: A2 reference case plan “Do Nothing”

The cost of the A2 ‘do nothing’ scenario, would be expected to be a £240m (Low), £280m (Mid), £320m (High) increase on the pre-COVID-19 position. This cost projection has been estimated using the same financial model and background assumptions as the B1 scenario outlined elsewhere in the paper.

Impact of COVID-19 – Commercial Risks

The key commercial risks are described in the Commercial Interventions section below. However, we are working in unprecedented times where the financial strength of our supply chain is threatened. As noted above, this has been addressed through supply chain management initiatives and support for our contractors working effectively in remote locations. There will likely be claims regarding this period but it has been determined that our early and generous response together with an interventionist strategy with the key players in the Tier 2 and 3 supply chain will have properly defended that threat.

Bond Street is now the only station on the Crossrail programme not to have achieved Staged Completion 1 (SC1) which is the essential milestone necessary for the start of Trial Running. Work to complete the station includes design, construction and installation along with testing and commissioning. The negative impact of social distancing on production rates will inevitably mean that the impact of COVID-19 falls most heavily on this project. As a result, Bond Street represents a very specific commercial risk, and so is being addressed separately.

Commercial Interventions

Resolution of Pre COVID-19 Issues

There are significant issues that were in train prior to the COVID-19 Impact

- a) Progress at Bond Street – addressed separately
- b) A formal £12m dispute at Paddington regarding the liability of cost for Electricians during the first months of 2019. This is subject to a formal adjudication, currently, the Contractor is continuing to deliver the works. A select group of senior and experienced staff will meet prior to the adjudication result to propose a range of responses dependant on the outcome of the adjudication and the potential effects it will have on Contractor behaviours.
- c) Concerns through the Tier 1 Stations supply chain regarding a dilution of the fee. In the supplemental agreements made in December 18/January 19 most of the remaining works were to be undertaken at emerging cost with the fee element for that work based on an anticipated outturn included in the settled sum. As costs have risen that fixed fee element represents an ever-decreasing percentage on turnover. Many of the Contractors have expressed dissatisfaction. There is no appetite to address this directly as moving on one contract would effectively set a precedent even under commercial confidence. It is proposed to address a combination of issues at one time in Completion agreements for these contracts.

Interventions to support the B1 and B2 scenarios

Routeway Contracts

These largely comprise of the Routeway contract itself (C610) together with the Platform Screen Doors (C635) and a suite of largely completed Power contracts. The key expenditure is in the C610 contract and it is divided between construction cost and the cost of running the railway during dynamic testing. All the resources are recompensed as emerging cost with a modest fee. There are two key issues

- Ensuring that construction is complete within the blockade window – we have no commercial levers to use to ensure this happens – however, any works left over will be more expensive for CRL to have installed outside blockade and may threaten programme milestones. The Contractor would then be required to demobilise all construction effort reducing that part of the cost base.
- The provision of safety and other support during Dynamic Testing is scheduled to continue to the start of Trial Running. Theoretically, the contractor would fully demobilise – however a “softer” handover is more likely. That would have little commercial impact on TfL-wide cost as the same number of people would be required from either organisation. However, this element would see the most significant cost growth if the entry to Trial Running was delayed.

Systems Contracts

These are two contracts with Siemens for Signalling (C620) and Communications (C660). These are where the cost growth during Trial Running and Trial operations will be most evident, all other contractors will have demobilised. Any initiative will have to be appropriate for the circumstances pertaining at that point. Currently, the contracts are due to have a presence throughout Stages 4 and 5 – whilst the anticipated cost for this time is low, for matters of supervision it may be more appropriate to reconsider how this service would be provided.

Shafts and Portals

The Portals elements are either already in the process of being handed over or shortly will be therefore no specific commercial intervention is required. The final Shaft is due for completion and handover in September 2020.

Stations

These measures will align with the Stations Recovery Plan. The Stations can be split into distinct groups.

Priority Stations:

- LU managed stations: Tottenham Court Road (TCR), Farringdon, Liverpool Street,
- RfL managed stations: Paddington, Canary Wharf, and Abbey Wood.

Secondary Stations:

- Custom House (Handed over),
- Woolwich

Bespoke plans:

- Bond Street
- Whitechapel

The commercial strategy falls into four phases, Restart, Completion Agreement, Commercial Management, and Commercial Closure.

This does not apply to Custom House and Abbey Wood (completed), Canary Wharf (Delivered directly) and Bond Street and Whitechapel (Bespoke plans)

Restart

The method and commercial framework for restarting is based on the need to control the number of resources coming to the sites. The Stations delivery strategy is explicit on the need to right-size the returning workforce and not go back to pre-COVID-19 levels. The following principles are being adopted for all station restarts.

- 1) No restart until the scope is known –The Stations recovery plan describes how elements of work will be defined and prioritised. The restart instruction will be issued in conjunction with the scope prioritisation
- 2) Access reflecting the blockade strategy will be instructed to allow the Contractors to develop their plans
- 3) When the revised scope is instructed it must be noted that this is a negative CE on Settled Sum
- 4) Stations resource schedule to be agreed before restart – if not it will be instructed – however this only controls number of resources – not quality
- 5) Request completion of staged completion and handover works by stated dates as a programme constraint
- 6) No restart without a safety management plan
- 7) Stations restart on dates shown on Stations Delivery Plan – Instructions can and should be issued as early as possible
- 8) Any revised reporting requirements to be part of the instruction

Completion Agreement

The strategy is developed to provide greatest cost certainty and the ability for Contractors to increase their margin by managing delivery risk to completion – the key blocker previously was the uncertainty regarding the route to completion which has been addressed in the Stations Delivery Plan.

Drivers

- a) Settlement of historic issues.
- b) Contractors' and suppliers' aspiration to address the fee dilution resulting from significant increases of emerging cost.
- c) Lack of effective levers to control delivery on required dates.
- d) Inability to ensure quality (as opposed to quantity) of the resources.
- e) Fixity of Scope and schedule.
- f) Contractor's desire for margin increase; Crossrail requirement to minimise the total cost.

Outcomes

- a) Fixed lump sum amounts to be negotiated for outstanding works required for Completion (where defined), with a suitable payment mechanism to incentivise achievement of significant milestones.
- b) Return control of Supply Chain to Tier 1 contractor (this will limit CRL ability to prioritise T2 resource) – option to retain control but this releases overall cost and schedule responsibility.

- c) Payment of final amount to be dependent on clearing all defects at end of defect period.
- d) Significant reduction of an administrative burden.

Issues

- a) Timing – best initiated before stations return to work but unlikely to have scope and schedule tied down by then.
- b) Contractor's ability to deliver.
- c) Maintaining control should baseline change.
- d) Volume – number of separate agreements required within a comparatively short period.

Commercial Management:

Business as usual, as it was for both the Contractors and CRL prior to safe stop, will not be acceptable to complete the programme within the available funding. Flexible and reactive commercial models will be required which may lead to the reallocation of staff.

The goal is to achieve the operating railway at the lowest possible cost using whatever contractual and delivery model is best placed to achieve that.

The focus must come on those contracts and head office activities with considerable amounts of AFC still to be spent. This will reduce to focus onto a handful of cost centres which will demand bespoke solutions.

The Crossrail management of the activities is described in the "Commercial Team Structure" paper.

Commercial Closure:

Shafts, ROP, VDP, Custom House Station, PML and Ancillary contracts are brought to a commercial close on their full scope with a Settlement Agreement.

Woolwich Station and Associated Portals, Liverpool Street, Farringdon, Tottenham Court Road and Paddington will take a similar approach. These are all currently on Supplementary Agreements with a combination of Settled Sum (largely completed but with some payments scheduled for the latter stages of Completion) and emerging cost. The preference is to reach a Completion Agreement as described above; however, if that is not possible at or near the phased return, as soon as the Station is ready for revenue service (SC3 ROGS assured) it is proposed to demobilise the Contractor and reach a commercial close – The vast majority of the outstanding works are scheduled to be undertaken on an emerging cost basis so that aspect should not present a significant commercial challenge – there will be an aspiration for further fee margin from the Contractor and outstanding issues on Major Change.

Whitechapel and Bond Street have their own plans circulated separately for confidentiality.

Canary Wharf has a different commercial basis and will have a unique closeout plan.

Further interventions that would need to be considered if Scenario C (worst case) was to pass and key suppliers/contractors/staff become severely affected by a second wave:

The practices and lines of communication that have been developed to support the supply chain during the first wave will be maintained, albeit at a lower level, during the recovery phase. This has been undertaken with close consultation with the wider TfL. Personal contacts and procedural safeguards will not be lost and can be deployed during any second wave. However, it must be remembered that Crossrail is budget-constrained and assistance can only be offered when CRL need is paramount.

Additional commercial interventions that could be deployed to reduce costs:

The physical infrastructure is constructed and therefore options for savings in this aspect are minimal. Some works relate to the Undertakings and Assurances that are part and parcel of the Crossrail Act and PDA, these include for example £5-8m for reconfiguring Sainsbury's car park at Whitechapel – the Railway will run without completing all of those but property hand back will fail.

Many of the initiatives included in option D are already reflected in some way in the interventions suggested in the B options. The key saving will be the Routeway contract not having to maintain the trace.

Of the Stations – provided the compromises on assurance are made – Whitechapel and Bond Street are the outliers. Whitechapel can continue in its current configuration and allow the Elizabeth line to operate safely – but with increased levels of operating personnel to ensure safety. Bond Street needs just to ensure SC2 for Trial operations and passenger services. However, the technical challenge costs of eventually bringing the station into use within an operating environment will be considerable.

Impact on revenue of delays

The impact on revenue to TfL of delays is expected to be at least £350m a year.

- Stage 3 expected to be in excess of £50m per year
- Stage 4 expected to be in excess of £100m per year
- Stage 5 expected to be in excess of £200m per year

As set out elsewhere in this document, currently stage 4 and stage 5 opening need to take place sequentially in the timetable windows of May and December. Because the assumption is there would need to be a minimum of 12 weeks between Stage 3 opening and Stage 4, a slippage of just a few weeks in Stage 3 opening could cause a half-year slippage to *both* Stages 4 and 5. This would mean lost revenues of at least £150m.

Such an impact would mean the programme could afford to bear additional costs to expedite the earliest opening to passenger services, for example, the cost of completing one or more stations post Stage 3 opening.

6.1.12 Module 10: Systems Integration

Systems Integration (SI) ensures there is a balance between delivered functionality and operability (considering operational restrictions associated with functionality gaps or bugs) for each agreed configuration state. The SI module is a cross-cutting module and ensures integration across programme, technical and organisation with the main contractors developing systems and software. Siemens is responsible for CBTC Crossrail, Application Design, Interlocking, CBTC Integration (CIF) and Bombardier Technology (BT) for Train Build, Train Systems Integration, and Train Assurance. Crossrail is managing Systems Integration, Software Strategy and Testing Verification & Validation Strategy at a programme level.

Strategy of the SI module

In 2019, CRL stepped up as the systems integrator and Plateau was established to move away from a heavy reliance of contracts to deliver systems integration. The purpose of Plateau was to integrate the train signalling teams and provide resolution of long-standing technical issues and configuration states. Through Plateau, software scope control was implemented, and off-site testing was increased. The software strategy focuses on linking to the systems operability and reliability growth. To date, the Plateau forum has been a successful driver of completing required Dynamic Testing and advancing the programme. The second edition of Plateau, referred to as Plateau 2, has been established to compliment Module 5: Stations Closeout Strategy and is focusing on integrating stations systems. See figure 20e for more detail.

Plateau 2 will also be responsible for Stage 4, 5 and On Networks Works and Stations Integration.

The following factors will contribute to the successful SI of the programme:

- Plateau 1 and Plateau 2
- Control centre integration
- Managing supply chain complexity
- Managing the contracts and deliverables

Plateau 2 will be established under the guidance of Pradeep Vasudev and Lee-John Allen. The objectives are to develop an overall stations systems commissioning strategy. A key principle of the commissioning strategy is to apply learnings from the first wave of stations that are commissioned which are Custom House (RFL station) and Farringdon (LU station). Plateau 2 will act as the guiding mind for Siemens and Bombardier.

Plateau 1 and the Routeway Systems Integration Strategy

Crossrail has entered a phase of dynamic testing, trials and commissioning that will identify issues that prevent the system from achieving the required levels of reliability (95% PPM) at the exit of Trial Running. The Plateau 1 high-level software strategy aims to achieve upgrade software release as close to the change of the programme phases as possible to allow for maximised learnings from the previous phase to be incorporated. The software strategy is outlined in figure 20b.

Combined Software release Y0.603, introduces CBTC TR2, ETCS 2.3 and a minor TCMS change. It is currently under test and will feed into the CRL assurance (COS SJ/CESAC) baseline for entry into Trial Running.

A further release Y0.610 will include upgrades to CBTC TR2 and TCMS which along with an additional non-trainborne CBTC release will resolve known operational restrictions. These will be introduced under the RfL Change Assurance Process and endorsed post-ROGS stand-up and before Trial Running.

Y0.630 introduces CBTC TR3, ETCS and TCMS changes and will be available during Trial Running for entry into Trial Ops. The last call for change for Y0.630 software to fix significant issues identified with TR2 is currently forecast on 11-Dec, during SIDT (DCS1.1 date). With the new TO date, delaying the freeze date for TR3 by up to 3 weeks to capture more learning from the SIDT is being assessed. This becomes a key milestone and decision point for Software Integration and TR planning.

The programme has built-in an additional targeted contingency software point release to CBTC TR3 to address a small number of urgent fixes identified during the 12TPH testing during Trial Running however the last call for change is before the release of Y0.630.

The last call date for the CBTC TR3 point release before Trial Ops is 28 May 2021 (DCS1.1 Deterministic) allowing 2 months of Trial Running to identify any fixes required to achieve 95%PPM.

If Y0.620 and Y0.630 provide sufficient reliability and functionality then the CBTC TR3 point release will not be used. During TR there are currently nine days of possessions allocated which can be applied for to be used as Software update implementation and testing and potentially TVS modification and testing.

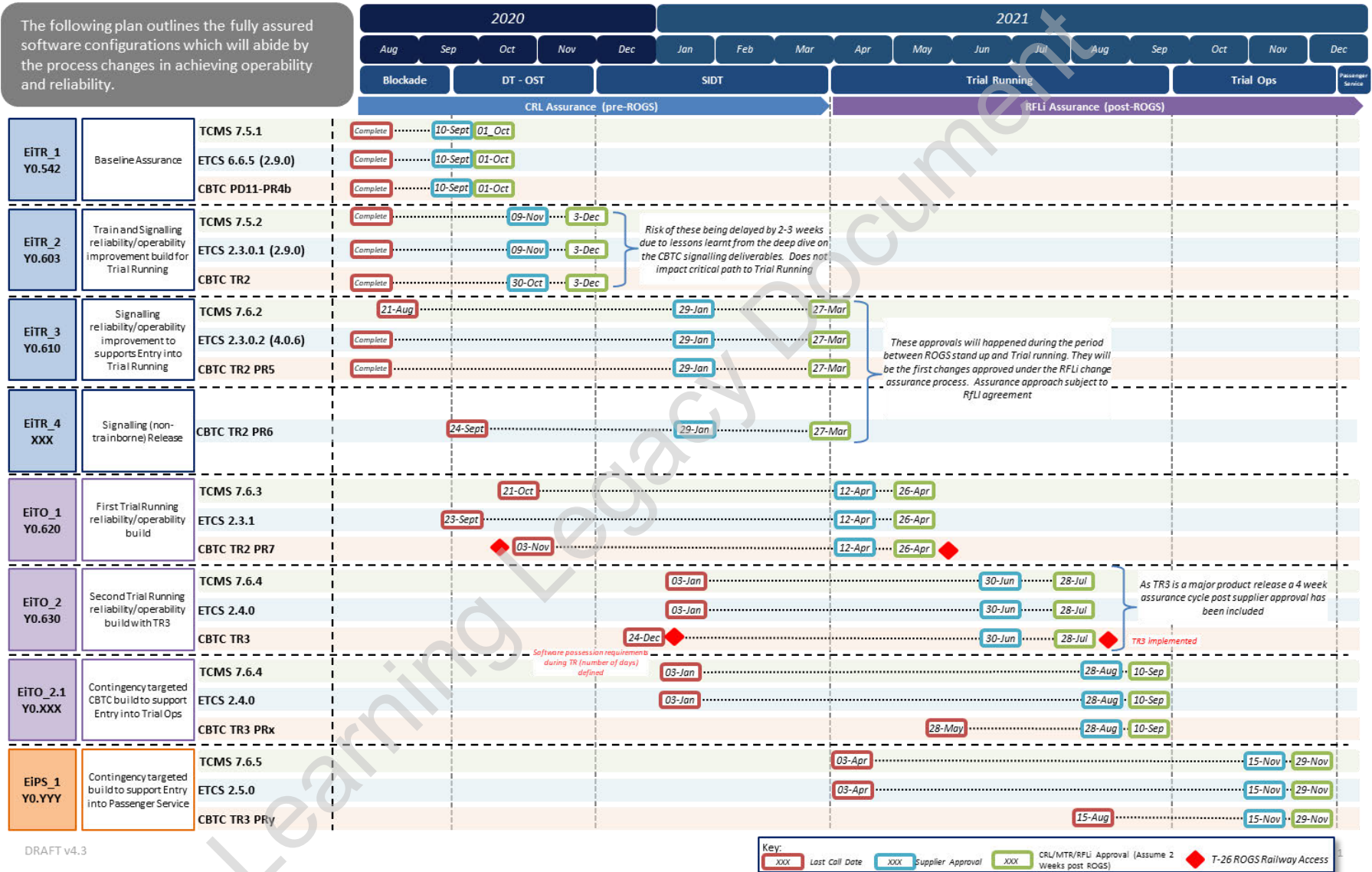
There is a risk that the nine SPZ are insufficient for the point releases and TO configuration testing between 29th March and 24th September. This can be mitigated using non-traffic hours, especially if these can be lengthened when required by cancelling timetable runs at the end (or beginning) of a traffic day.

TR 4 is planned for 2022 and future software releases focusing on maintenance will be carried out periodically and managed through RfL.

Crossrail COVID-19 Recovery Execution Plan

CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

The following plan outlines the fully assured software configurations which will abide by the process changes in achieving operability and reliability.



DRAFT v4.3

Figure 20b: Software 'last call for change' plan

Plateau 2 and Station Systems Integration Strategy

The purpose of the Plateau 2 Team is to ensure Stations including Station Operation Rooms and RCC interfaces are fully integrated, functional and brought into use with contribution from all stakeholders in accordance with the relevant IM's functionality requirements. The team shall identify the key interfaces between systems and stations including system-wide and station system to enable successful integration of stations without compromising the existing operational railway.

The Plateau 2 team principle is to drive greater collaboration to achieve programme and technical integration between Crossrail, Siemens, LU, RfL, and station Tier 1, 2 and 3 contractors in working efficiently together, leveraging existing relationships to clear integration blockers with common tier 3 contractors (Kone, ASL, Verint, Commend).

The scope includes the programme and technical SOR system integration and commissioning through the delivery lifecycle within the wider Crossrail programme. This includes the principal user "head End" of the Station Management System (SMS) and all its relevant interfacing systems, comprising:

- Station Data Network (LAN), Intruder Detection, BMS, PA/VA, CCTV, Telephony, Customer Information System (CIS); Additionally the other main SOR systems "Head Ends" comprising:
- Fire Protection Systems, Fire Alarm Panel, Watermist status Panel, Smoke Ventilation Panel, Lighting Control Operator's station, TVS HMI, AFC, PA/VA paging mic, Telephony handsets, "Back up Panels" – PA/VA zone selection keypad and Microphone (Fireman's Microphone), CCTV selection keyboard, Connect Radio Dispatcher, Help point / Lift comms handset, Remote control for security bollards (where used), PSD indicator; and finally,
- The integration of all systems with the Route Control Centre (RCC) via the system-wide Central Data Network (WAN). Of importance is the need to consider all systems that make up the SOR and not focus solely on the comms systems alone.

All other systems that have no interface to the station control systems (e.g. Train or Signalling systems) are outside the scope of the Plateau Team and their integration remains with the Crossrail System Integration team who also has overall responsibility for the full integration of the Crossrail programme, including its governance.

The Plateau 2 team will:

- a) Continue to use existing delivery teams and establish new effective working structures, processes and practices;
- b) Identify, maintain and manage to resolution a register of programme and technical risks and issues relating to SOR integration to be investigated, monitored and validated. Ensure the successful management to the closure of any interface issues relating to the delivery of Trial Running and Trial Operations. This includes both technical and operational stakeholders. Where necessary direct changes to sub-contractors to implement contractual changes;
- c) Ensure operator and maintainer buy-in for the delivered configurations, closer engagement to undertake operator scenarios testing within the SOR and RCC and clarity in terms of what they want the system to exercise during Trial Running, Trial Operations and beyond;
- d) Establish and deliver a coherent SOR integration strategy for delivering key configuration states through the following five fundamental programme and technical integration workstreams:
 - Systems Integration Strategy
 - Software Strategy and Implementation
 - Testing and Commissioning Strategy
 - Assurance
 - Project Controls

In establishing Plateau 2, under the proposed workstream the following outputs will be produced:

- a) Integrated plan on a page style programme of activities in a common format to DT detailed plan covering both Plateau 2 design and SI tasks along with 'Boots on the Ground' team activities
- b) Baselines to support DCS milestones (Trial Running, Trial Operations and Revenue) including minimum functionality requirements, metrics on software bug fixes, metrics on testing, test blockers and assurance documentation acceptance
- c) Minimum functionality configuration map and system block diagrams per station
- d) Integrated Software Release Strategy and software build state documentation linked to I/O schedules
- e) Single Plateau Issues Tracker (PIT) for Programme and Technical delivery issues and risks
- f) Updates to Crossrail risk register
- g) Assurance submission plans
- h) Operator mitigations and control measures (i.e. tracking Operational Restrictions)

The Sponsor for the Plateau is the key membership organisation executives, namely; Crossrail Technical Director, Crossrail Stations Silver Recovery Director and Siemens Corporate Directorship.

Systems Integration Strategy

The three main areas of consideration in developing the System Integration Strategy are Programme, Technical and Organisation. These are summarised below.

1.) Programme

The creation of a detailed migration plan that enables management and integration with the DCS. The creation of a number of key documents will underpin the Programme (DCS1.1) and ensure that the major stages of the programme consider the needs of the integrated railway.

To do this, there are a number of key documents and management tools:

- Migration Plan (CRL1-XRL-O8-STP-CR001-50165) to reflecting the current state of the project integrated with the DCS1.1
- The definition of the high-level configuration stages throughout the Trial Running phase (CRL1-XRL-O8-STP-CR001-50172) and Trial Ops phase (Doc no. TBC).
- The entry/exit criteria as per the EiTR Config State (CRL1-XRL-O8-RGN-CR001-50403) and EiTO Config State (Doc no. TBC).

2.) Technical

Routeway Integration Testing:

The requirements for routeway and rolling stock integration testing are set out in the document *Technical Requirements: Integration tests for Route-way systems Rolling stock and related installations* (Ref. CRL1-XRL-Z-RGN-CR001-50511). This defines 144 test requirements grouped into 32 scenarios, which have been derived from subject matter experts from Chief Engineers Group and Rolling Stock, Safety and Reliability teams.

These tests are largely discharged through Contractor Testing during Dynamic Testing, and CRL led tests that are executed during SIDT and Trial Running. The output from the Contractor Testing will form the basis for the Contractors' Engineering Safety Justifications and the COS SJ. The output from the CRL led testing will provide input into the COS Safety Justification, the Trial Running CESAC and the Trial Operations CESAC as follows:

- COS SJ – Scenarios 5 (TVS); 7 (safe evacuation); 9 (signalling system re-boot); and 10 (comms system re-boot)
- Trial Running CESAC – Scenarios 6 (noise and vibration), 15 (maintainability); 17 (depot and sidings); and 21 (Railway Performance tests)
- Trial Operations CESAC – remaining scenarios

All scenarios and tests required for the COS SJ and Trial Running CESAC will need to be performed (and passed) during Dynamic Testing to feed the assurance process. The remaining tests will be performed in SIDT and Trial Running.

Functional Descriptions and Integration Test Gap Analysis:

Through a series of multi-stakeholder “Day in the life of” workshops, CRL has produced a series of Functional Description Documents that define end-to-end system and user behaviour across a range of normal, abnormal, degraded and emergency scenarios. These formed the basis for:

- a) A gap analysis to determine if the currently planned integration testing (set out above) will provide sufficient assurance that the Crossrail System will operate as expected at the Railway Level;
- b) A set of requirements for such tests; and
- c) Providing traceability between the CPFR and the Contractors’ Works Information.

Functional Descriptions have been produced for a number of high-risk focus areas: Platform Train Interface, Train Interfaces, RCC & Tunnel Vent System, NR Interfaces (GW, GE) and Yellow Plant.

The subsequent Gap Analysis will be concluded following supplier review and the provision of evidence to close the gaps. Early indications are that there are no critical test gaps that are required to inform the COS SJ or Trial Running CESAC. However, there may be a small number of tests that need to be performed in Dynamic Testing to flush out any potential software issues. Where necessary these will be planned via the Dynamic Testing planning process. The remaining gaps will be resolved through integration testing in SIDT and/or Trial Running and will be planned in via Test and Trials team.

Plateau 1 was established to support the delivery of routeway integration testing.

Station Integration Testing:

All station M&E systems complete, M&E Scenario tests complete, statutory certification complete and AC signed off. SMS software complete and all interfaces tested for the station – LU11 MICA for LU, Siemens for RfL, with complete coverage of scenarios 1, 2 and 3. Comms and network stress testing complete (scenario 14). Integration of all head-end systems within the SOR and reliability growth culminating in extended scenario 11 fault free running test. Final over and gone of SMS and fire systems in LU operational SOR (FAR, TCR & BOS).

Plateau 2 is the guiding mind of delivery for Station integration.

3rd Party Assets:

Plateau 1, Plateau 2 and the Systems Integration team collectively manage the assets as allocated in the diagram below (Figure 20d).

3.) Organisation

Crossrail Operational Restrictions (OR) Review Process: CRL1-XRL-O8-GPS-CR001-50034

This process manages the impact of temporary defects and phased delivery of functionality on the users, operators and maintainers responsible for the operational railway at key programme stages such as Trial Running, Trial Operations and passenger service.

The process allows for the review and agreement with users and stakeholders of temporary restrictions, and acceptance of the restrictions for each user type as part of the railway assurance process. The process is implemented through an Operational Restrictions Master Log, Operational Restrictions Working Groups, an Operational Restrictions Review Panel, acceptance of restrictions by user responsible organisations, and the acceptance of an Operational Restrictions Status Report for major software configurations.

The Crossrail Operational Restrictions Process document is currently undergoing an update to reflect recent adaptations to the working group and acceptance aspects of the process, to be completed for the RAB-C assurance milestone for the integrated train/signalling software configuration Y0.542.

Assurance

The current assurance status as outlined in the table below:

Y0.542 – CRL Led Assurance Baseline	<ul style="list-style-type: none"> • Signalling and GW/GE/RCC Fringe ESJs expected to be submitted to RABC on 10/9 • CTO, T&S Integration SJ and Signalling SJ to be submitted to RfLI on 10/9, RAB-C submission for endorsement on 24/9 and RAB-C review meeting 1/10 • Siemens holding lessons learned workshop on ESJ inconsistencies
Y0.603 – CRL Led Assurance Change for ROGS stand-up	<ul style="list-style-type: none"> • TR2 ESJ could see up to 3-week delay on the current end of October delivery date (based on Siemen's lessons learnt activities) • BT evidence to be delivered on 12th November and incorporates ETCS 6.6.6 • CRL/RfLI parallel reviews mapped in an outline plan to support getting RAB-C approval in early December. This assumes a 4-week review cycle from formal submission of the above supplier evidence to acceptance by RAB-C for Signalling ESJ and SJ. A final agreement with RfLI on accelerated reviews to be sought but not on the critical path • Feeds CRL COS SJ (during its revision in December) to support CESAC submission for new TR date
PR5/Y0.610/PR6 to support new TR date – RFLi Led Assurance Change for Trial Running	<ul style="list-style-type: none"> • PR5/Y0.610/PR6 to be loaded on the railway 3rd December, 29th January and mid-Feb respectively to support SIDT under CRL existing processes. • For TR, these changes to be assured through the RfLI CAP arrangements and accepted under RfLI processes post ROGS and before Trial Running. Will form the first RfLI change under ROGS and opportunity to prove the processes based on the evidence available through November to mid-February. This subject to review and agreement with RfLI

Note: DCS1.1 moving of TR has shifted the need by dates and supports PR5/Y0.610/PR6 being deployed on the railway before TR. All configurations are convergence builds meaning that they will also be deployed on GWML via MTR Engineering Change process.

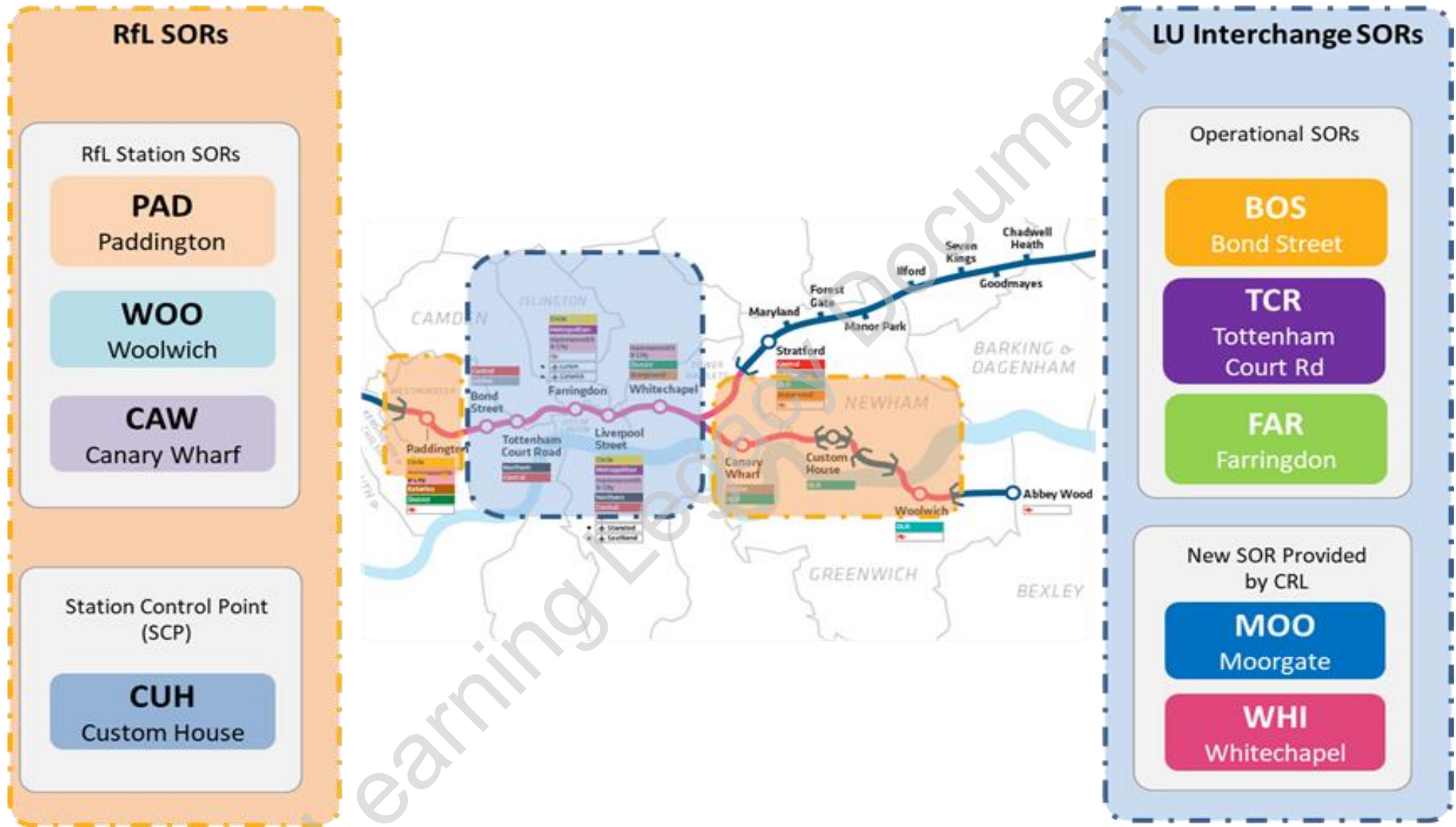


Figure 20c: RfL and LU SORs

Crossrail COVID-19 Recovery Execution Plan
 CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

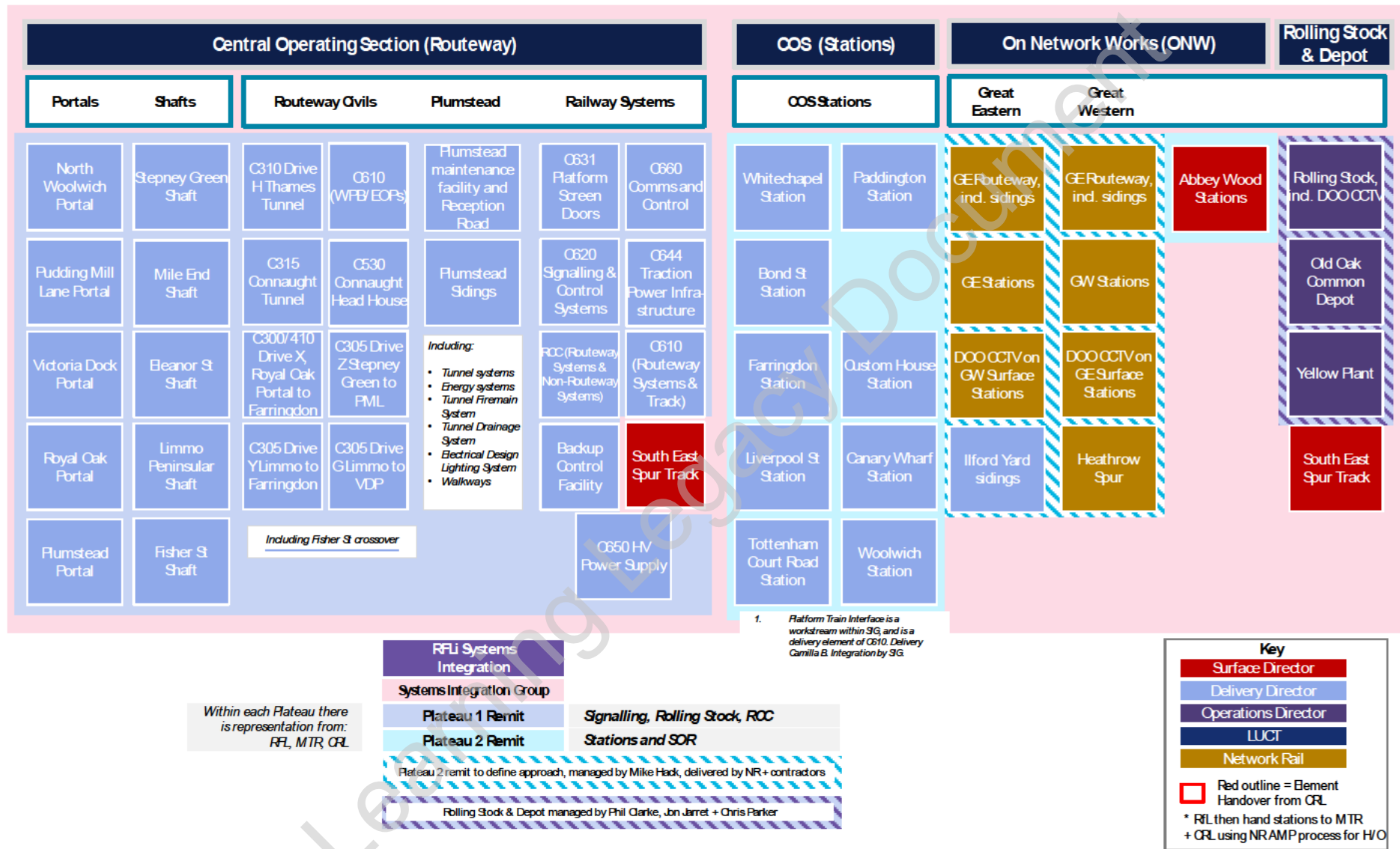
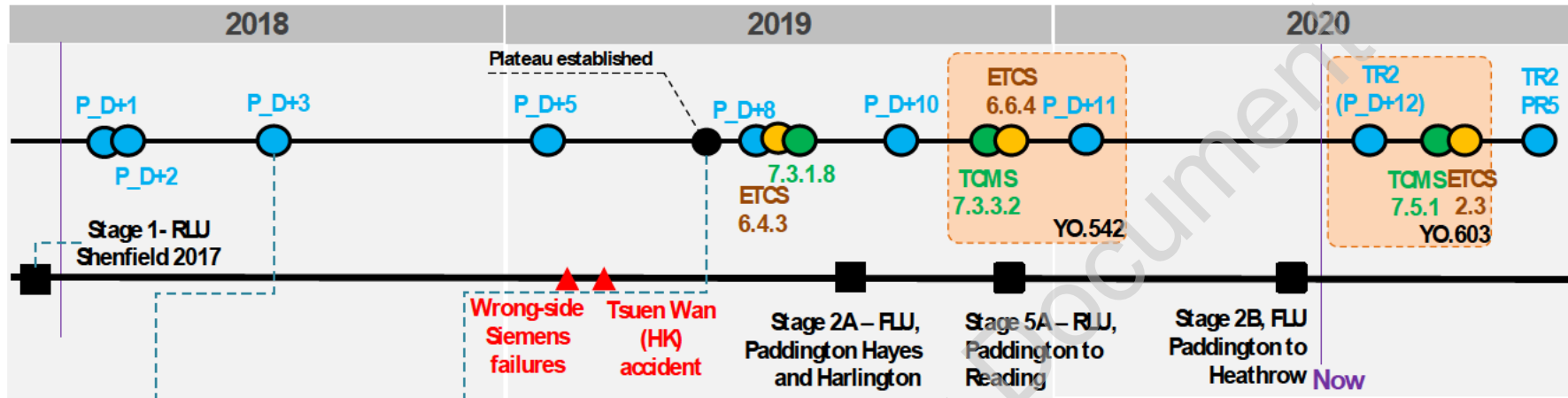


Figure 20d: CRL Handover Scope Map



- Dynamic testing commenced Feb 2018 on P_D+2 software.
- P_D+3 was initially the proposed Siemens build to support revenue service in Dec 2018
- S'w very immature
- Infrastructure not ready for DT
- Heavy reliance on contracts to delivery systems integration

- CRL stepped up as systems integrator
- Integrated Train-signalling team (Plateau) established
- Resolution of long-standing technical issues and config. states
- Implemented s/w scope control and increased off-site testing
- S'w strategy linked to operability and reliability

Key

- TMSBuild (BT)
- CBTCBuild (Siemens)
- ETCSBuild (BT)
- Configuration
- Commissioning event
- ▲ Safety incident

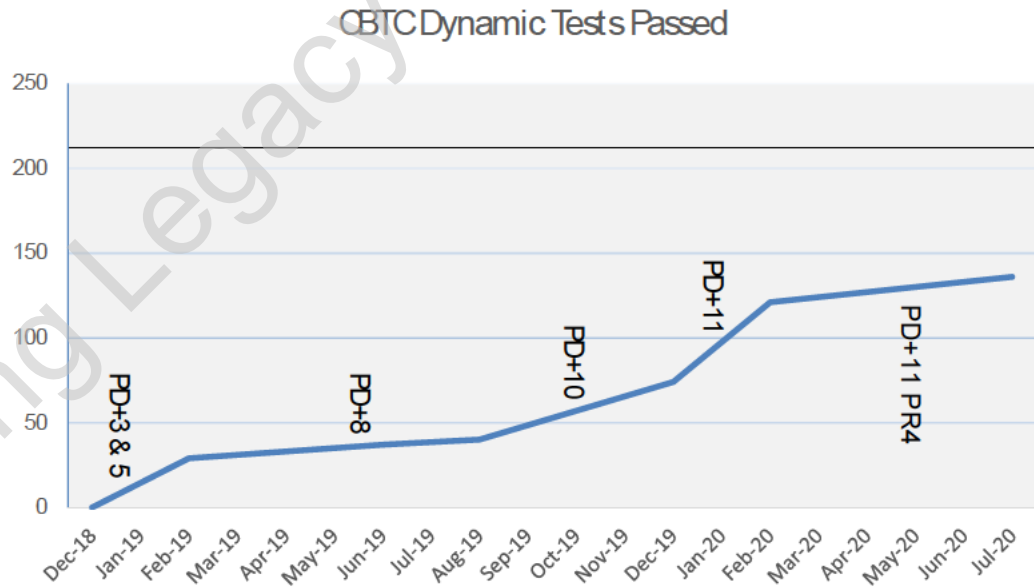


Figure 20e: Software progress to date

7 Appendix F

Resilience and Agility of the Execution Plan

This section defines resilience and agility in the Crossrail environment, describes why the next phase of Crossrail needs enhanced resilience and agility and describes the method and tools for maintaining a robust Execution Plan. This will allow CRL and RfL to evidence the resilience and agility of the Execution Plan to provide further confidence to the Board and CRL Sponsors.

7.1.1 Definition of Resilience and Agility for the Crossrail Programme

Resilience is defined as the programme's ability to recover quickly from difficulties. This can be through the buffers that are built into the programme such as periodic schedule float or contingency allowance. Resilience in the Crossrail programme is:

- A buffer that has been built into the programme, or a lever that we pull to keep moving forward and maintain the schedule and/or quality
- Being prepared upfront for the unexpected and expected risks
- Having effective continuity and resilience plans to avoid adverse events and limit their impact
- Management's approach to contractors and keeping them accountable (e.g. commercial mechanisms)
- The elasticity that the programme has to accommodate unforeseen situations
- The ability to quantify, not just qualitatively, resilience in order to assess, score and improve

The programme's agility is the capacity to pivot quickly given unforeseen risks and external situations (e.g. adapting to a Niche working environment). Agility in the Crossrail programme is:

- Speed of decision making, delegation and escalation from the IDTs to the executive
- The ability to quickly report changes in the programme via the DCS, periodic performance reviews, etc. and modify based on the data
- Management's ability to use the tools of project management to effectively deploy
 - Tactical mitigations
 - Programme interventions (Scenario D plus programme risk interventions)
- Successfully navigating the transition phases of the programme to the baseline schedule

7.1.2 Why we need to address Resilience and Agility

Due to the backdrop of COVID 19 and the uncertainty that brings paired with the current phase of the projects in completing testing and commissioning of the integrated system, there is a need to identify and improve the robustness of the resilience and agility of the programme. Known and unknown risks will arise in the programme and using the resilience and agility methods and tools identified the programme can continue to deliver on the basis of no more time.

In addition to the existing programme management tools that we can deploy to maintain the current resilience and agility, it is necessary to augment these with more agile decision making and closely monitored plans linked to defined phases of the works to go (completion of the works, trial running, and trial operations).

7.1.3 Deployment of Existing Programme Management Tools

The Programme Management tools and methods in Figure 21 are used by Crossrail and RfL to provide resilience and agility to the programme.

How will this make the programme more resilient than it is at the Programme – Using regular risk management, continued scope tracking, continued resource scheduling loading and de-loading the programme will be able to continue to improve its' resilience and agility in response to risks and the ongoing COVID 19 environment.

7.1.4 Programme Agility

The existing decision-making forums at the IDT level and the Programme Level (Infrastructure Readiness/Level 1.5, Integrated Team Meeting (ITM), Trial Running Mobilisation Board (TRMB) and Technical Authority Group and STAR.) Issue escalation from these forums is currently via the Exec member present to the Exec Strategy Group. There is no formal summary of decision made each week and issues required to be escalated that is available for review by the Exec Group across the decision making forums.

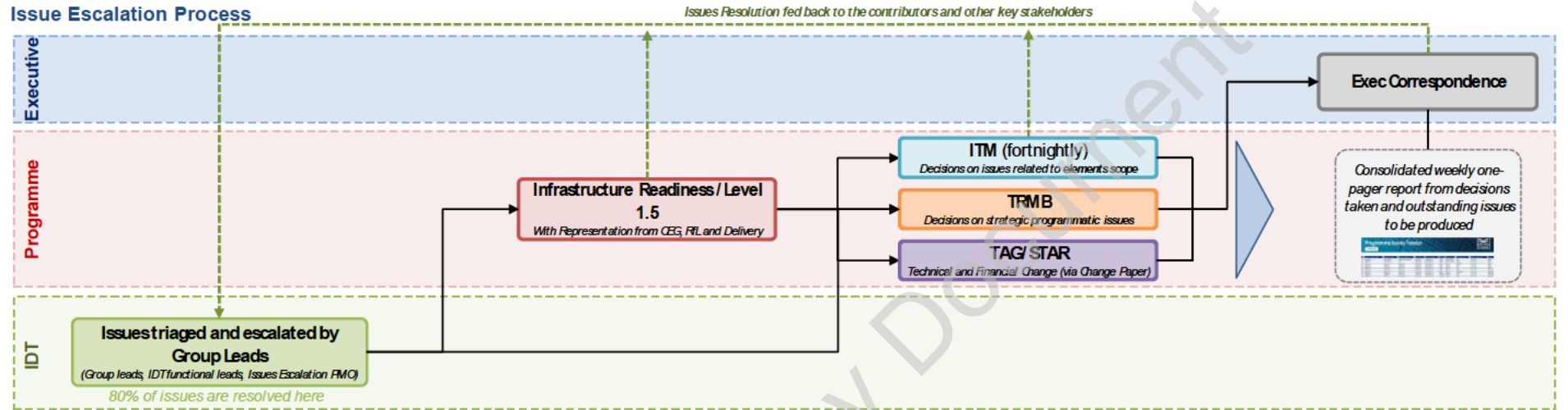
From August, it is proposed to improve the programme agility with the introduction of a weekly issues escalation report. The purpose of this is to expedite the resolution of programmatic issues and monitor the programme closely to enable an agile response to any emerging issues. The weekly issues escalation report is a one-page summary produced by the Chair of each forum covering key decisions made, issues being managed with mitigations, and key issues for escalation to the Executive Group.

Outstanding issues not resolved in the previous forums can be resolved via:

1. Direct correspondence with Execs using the weekly exec blocked time
2. Calling a meeting using Bi-Weekly Exec hold
3. An agenda slot in the fortnightly exec strategy group

Learning Legacy Document

Crossrail COVID-19 Recovery Execution Plan
CRL1-XRL-Z-STP-CR001-50038 Rev 2.0



	Integrated Delivery Teams (IDTs)	Infrastructure Readiness/ 1.5 Monday & Tuesday	Integrated Team Meeting (ITM) Wednesday (fortnightly)	Trial Running Mobilisation Board (TRMB) Wednesday	Exec Correspondence
Purpose	<ul style="list-style-type: none"> Focus on issue resolution on the ground at project level between representatives from across the program (i.e. Operations, Technical, Delivery etc.) 	<ul style="list-style-type: none"> Performance Management forum, focused on project issues to achieve Trial Running Focus is on tracking and assessing performance. 	<ul style="list-style-type: none"> Decision-making forum, acting as the point of escalation for the IDTs focusing on scope issues To resolve issues raised by the IDT's Providing continued support and direction to the IDTs 	<ul style="list-style-type: none"> Decision-Making forum, focused on programmatic issues and to oversee the successful mobilisation and preparations for commencing Trial Running Focus on TR critical issue resolution and strategic interventions 	Outstanding issues not resolved in the previous forums can be resolved via: <ol style="list-style-type: none"> Direct correspondence with exec using the Bi weekly hold in exec diary's Calling a meeting using bi weekly holds A agenda slot in the fortnightly Exec Strategy group (Note: if decisions are made in session, it must be acknowledged in exec group and recorded by secretariat)
Delegated Authority	Empowered to make decisions on the ground e.g. make local technical decisions specific to their element. Authority to make decisions is outlined in the "rules of engagement" document.	<ul style="list-style-type: none"> No Delegated Authority Decisions are sought within the team, facilitated by the meeting chair, keeping escalations to a minimum and feeding back on escalations from IDTs, incl. supporting their own problem solving 	Individual authority attributed to the: <ul style="list-style-type: none"> Technical Director Chief Project Director Chief Operating Officer Chief Engineer 	Individual authority attributed to the: <ul style="list-style-type: none"> Chief Programme Officer Chief Operating Officer 	Individual authority attributed to the programme Chiefs as appropriate
Escalation	<ul style="list-style-type: none"> Vis on site Daily Call 	<ul style="list-style-type: none"> TRMB ITM 	<ul style="list-style-type: none"> Executive Group TAG / STAR 	Executive Group	Executive Group
Sponsors	Sponsor: Jim Crawford Chair: Project Manager	Sponsor: Mark Cooper Chair: Darren Coleman	Sponsor: Colin Brown / Mark Cooper Chair: Colin Brown	Sponsor: Jim Crawford / Howard Smith Chair: Richard Schofield	Sponsors informed as appropriate (i.e. Mark Wild / Jim Crawford / Howard Smith / Rachel McLean / Angela William, Hannah Quince)

Figure 22: Escalation flow of programmatic issues

7.1.5 Agility in using Programme Information

Programme information is treated with a Data-Information-Intelligence approach. Data is collected from the operational environment, which is processed into information and analysed into intelligence. Crossrail's Programme Controls function is the principle function concerned with the data-information-intelligence cycle. If it is imagined Crossrail is split into tiers of Project, Programme, Executive, and Board. Programme Controls takes the intelligence requirements of the Programme, Executive and Board and defines and instructs the process by which this is attained to the Programme and Project level from data collection, information processing and intelligence analysis. Programme Controls also proactively identifies potentially valuable intelligence for the Programme, Executive and Board. Intelligence in this regard includes the Delivery Control Schedule and production/performance metrics.

Requirements of the intelligence are identified through regular weekly and periodic consideration of programme performance, particularly through:

Weekly

- Infrastructure Readiness Level 1.5 (Programme level)
- Trial Running Mobilisation Board - TRMB (Programme/Executive level)
- Programme Performance Check (Executive level)

Periodic

- Schedule Integration Review (Programme/Executive level)
- AFC Review (Programme/Executive level)
- Programme Review (Programme/Executive level)
- Risk/Central Provision (Programme/Executive level)
- CEO Period End Brief (Executive level)
- Week 3 Executive Group Performance Section (Executive level)
- Performance Engagement Forum - PEF (Executive/Board level)
- Board Meeting (Executive/Board level)

These forums link performance conversations to the schedule and delivery plan, and in doing so are aligned to contemporaneous and future intelligence requirements. In addition, various roles in Crossrail have informal and formal meetings with external stakeholders including the Mayor of London's office, the Joint Sponsor Team, and Sponsors. These also act to inform requirements.

Determining the processes by which intelligence is derived and integrated is undertaken either through delegation to individual delivery teams by the appropriate Executive Director for specific performance metrics or by delegation to Programme Controls where these concern the integration of metrics into items such as the schedule (or the cycle that supports determining the schedule position). Programme Controls then triages actions to the various disciplines within it, or to delivery teams.

Intelligence is then validated and authorised for inclusion through either the meeting cadence outlined above or on an exceptional basis. Programme Controls are in the process of determining a Programme Controls Catalogue that will act as a change controlled list of all information and intelligence produced and available to support meetings, and will provide greater visibility and potential utility.

Intelligence is principally (but not exclusively) articulated to internal/external stakeholders through:

Weekly

- Schedule updates
- Crossrail Dashboard (key programme-wide performance metrics – principle regular external performance update)
- Management Information for Programme Performance Check (disaggregated information from that which is summarised in the Dashboard)
- TRMB supporting packs
- Infrastructure Readiness supporting packs

Periodic

- Various packs submitted to support the programme governance
- PEF pack
- Board Report

This structure is a key enabler to agility. It provides a clear and constant process and framework through which certainty is provided in when decisions are made and requirements set, allowing functional teams to have clear boundaries to exercise their expertise to create data-information-intelligence with flexibility and in the appropriate way

7.1.6 Agility in Tactical Mitigations

Crossrail has the ability to deploy programme management tools and strategic interventions to mitigate risks. The Programme was able to be agile in response to the COVID-19 pandemic by setting up Gold and Silver Recovery Teams. The strategic evolution of the silver team leads has been the development of the focus areas of the 9 modules and their workstreams to continue to progress the tactical mitigation requirements of the programme.

7.1.7 Navigating Transition in an agile way

In response to the conditions in the TfL Funding and Financing Agreement and to support the DCS 1.1 and the close-out of the programme, the Transition Plan programme has been commissioned. The Transition Plan objectives are to:

- Bring the railway into safe and reliable passenger service as soon as practicable,
- Work collaboratively to integrate the plans of the relevant organisations into the ELTP framework.
- Ensure the Sponsors objectives for the Elizabeth line are met.
- Facilitate the planned transition of CRL into the live railway (The Elizabeth Line) without destabilising delivery.
- Utilise existing oversight and governance processes where possible.
- Utilise the most cost-effective resource to deliver transition.
- Ensure learning is captured and embedded to ensure the effective on-going performance of the Elizabeth Line
- Ensure communications are clear and consistent across the organisation.
- Maximise the benefit from retained expertise and capability; ensure CRL fulfils its obligations and enables an effective transition to the Elizabeth Line across all areas of the programme and the transition plan.

This workstream builds on the work previously done in 2018 to outline the functional transfers required to transition the Crossrail organisation back to TfL and associated programme risks. The framework used in 2018 has been acknowledged and developed further to provide a more holistic overview of both organisational and people activities required to successfully transition to and launch the Elizabeth Line, as well as linking to the existing programme plan and asset and obligations transfers.

Specific work plans have been developed for each of the four workstreams listed above to understand what activities need to take place, and who the giving and receiving organisations are, in order to successfully complete the transition of the programme to the end state. Governance for this workstream is being finalized with Transport for London, and a 'joint transition working group' has been set up where accountable leads from Crossrail and Transport for London (LU & RfL) review and monitor progress on the transition programme and identify key risks to be escalated upwards to the Elizabeth Line Programme Group and Crossrail and TfL Executives, as appropriate.

Several specific KPIs drive the Transition Plan which is tied primarily to the organisational response and readiness to move the programme into an operational organisation – the Elizabeth Line.



Figure 23: Key Performance Indicators for transition planning

7.1.8 Programme Resilience

For programme resilience and agility, the following needs to be true:

1. We need a framework to transition from a construction environment to an operational service
2. We need to recognise the staged handover of the elements/assets
3. We need to move from a construction 'push' environment to an operator 'pull' environment
4. We need a collaborative governance transition from the TRMB to the proposed Passenger Service Mobilisation Board (PSMB) to collectively deliver the staged transition to operational service

Figure 24 illustrates the programme from the start of Blockade through to Passenger Service identifying the key element/assets to be handed over. During this time the programme culture must transition from a construction delivery (push) environment to an operational readiness (pull) environment. To assist with this a range of tools are and will be developed for use in the current TRMB and the proposed Passenger Service Mobilisation Board (PSMB).

The push-pull model to transition from the CRL led blockade through to the RfL/TfL led Operational Service enhances the resilience and agility framework which underpins the programme. The 'push' and 'pull' tools and methods will need to flex to respond to potential risks, handover of the assets and meet the need of TRMB and PSMB.

Prior to COVID-19 safe stop, a Trial Running Mobilisation Hub was established to run the T-Minus countdown tracker. This will need to be refreshed to align to DCS 1.1. Subsequently, there will be a need to use this to confirm a T-200 day plan (Blockade start to the deterministic Trial Running start). This will detail the actions required to deliver the DCS 1.1. During the execution of the T-200 day plan to Trial Running, it is expected that the frequency of TRMB will increase in order to maintain the required level of decision making agility and to close out the T- minus Readiness Checklist.

There will also be a need to develop a T-200 day plan from Entry into Trial Running to Operational Service.

During the transition, the 'push' of the Trial Running Mobilisation Board (TRMB) is proposed to transition to the 'pull' of the Passenger Service Mobilisation Board (PSMB) in a phased approach. See figure 24 below.

Crossrail COVID-19 Recovery Execution Plan
 CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

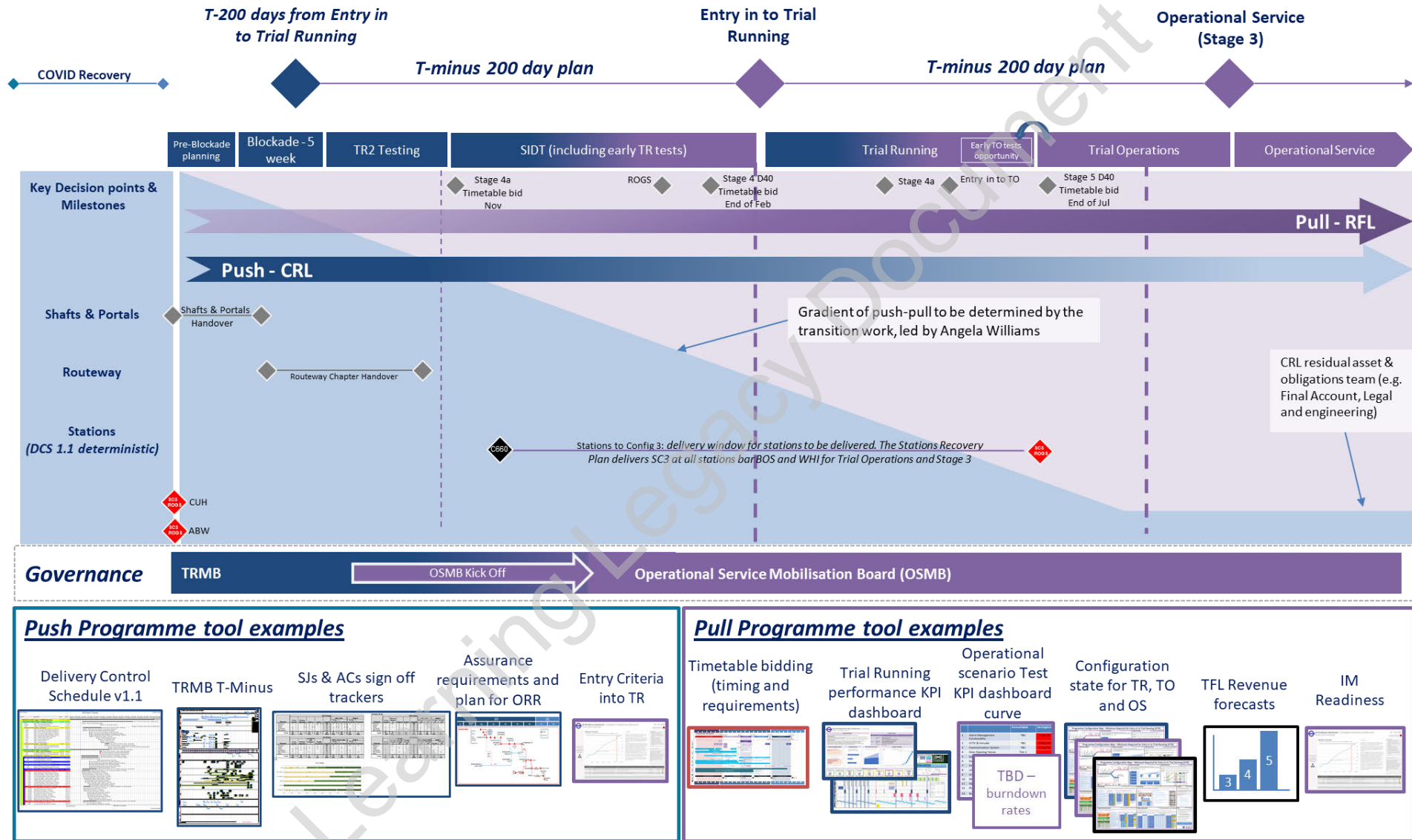


Figure 24: Push-pull model for transition from CRL to TfL to achieve Operational Service.

7.1.9 Closeout of System Issues

There a number of system issues that must be closed out to achieve Entry into TR and Entry into TO and Passenger service. These are defined and documented following the drafting of a consolidated list of 123 technical issues identified between IM and CRL. A workshop held on 9th August 11-5:30 pm to review the potential impact on the DCS and assess risk provision:

The purpose of the workshop was to carry out a line-by-line review of the consolidated Technical Issues & 'Lurker List' (both CRL & IM).

To **identify & validate**:

- DCS Impact and
- Cost & Risk provision
- Operational limitations potential workarounds
- If access provision is required
- Forecast resolution dates

With the outcome of a consolidated view of **Programme Risk – Cost & Time**

- A view of what is already covered/included
- A view of whether extra provision must be made in the base DCS for cost & time
- A view of intermediate solutions & mitigations that can be taken to reduce the immediate impacts

The workshop identified several themes which the 123 issues can be associated with. Although there is a significant number, actions taken from the session fall into the following four areas of concern:

1. Tunnel Vent System

There are several issues within the TVS with good progress regarding scoping the issue, but:

- poor cost allocation
- no DCS impact assumptions
- no defined delivery plans

Key Actions:

- Identify all required activities for the next 18 months (into DCS)
- Appoint Delivery PM (C610) to own the implementation of key mitigations

2. Operability

A number of the issues related to IM concerns regarding the operability of the railway, such as:

- Volume of TM1 & TM2 alarms
- Stage 4A operations

These are risks which have not yet materialised, but currently no ability for proving there isn't reason for concern.

Key Actions:

- Assess the operational concept and size the potential risk these issues pose (to incl. within DCS and risk)
- Identify management forums of these issue going forward

3. Maintainability

There are a number of issues identified associated with the IMs ability to maintain the railway as per intent:

- Possession management
- RAM demonstrations
- Axle counter resetting and grouping

Key Actions:

- Collate all issues relating to maintainability
- Assess current forums and the proactive management of maintenance issues

4. Integration

There are a number of issues which pose integration concerns due to the size and complexity of systems

- SOR Integration
- NR Interfaces

Key Actions:

- Ensure risk coverage for integration activities and assumptions for re-work factored in

7.1.10 Assurance

The stations commissioning strategy has had a favourable impact on the demand on CEG AC reviewers. The following graph provides an example. This can also be found in the LOD1 resource pack.

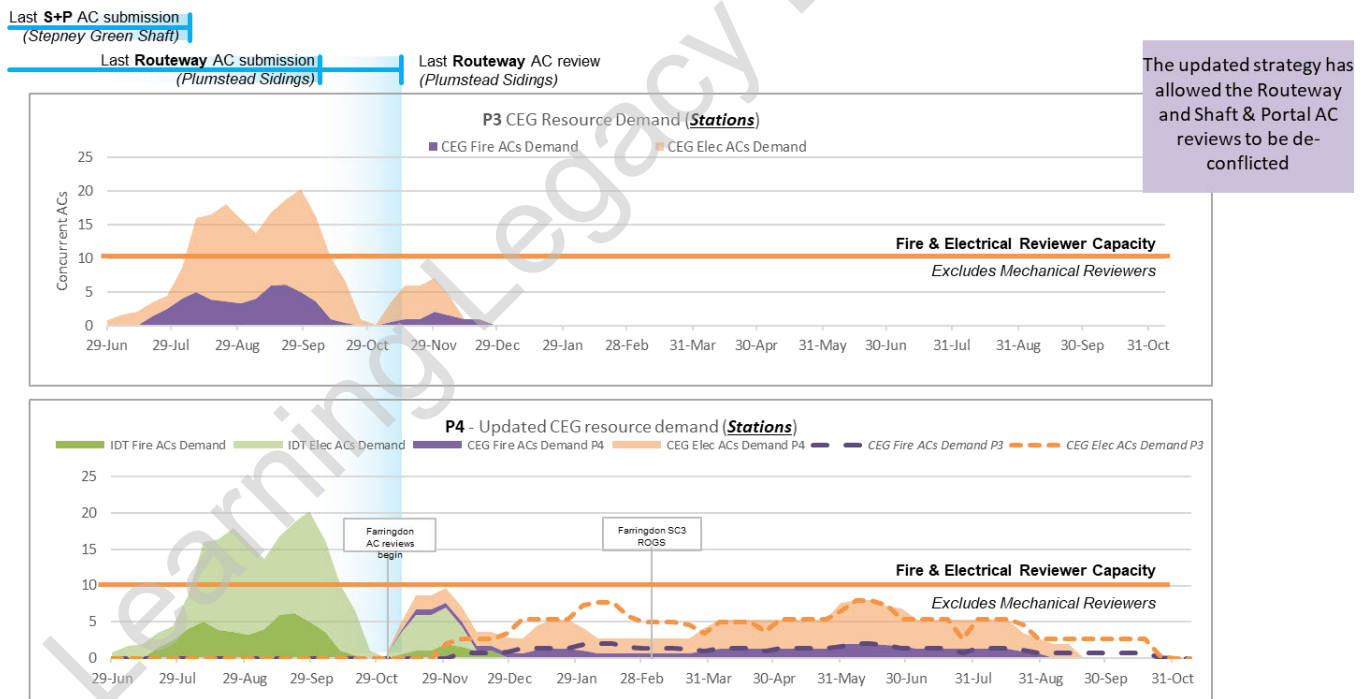


Figure 22: CEG Resource Demand

Through the development of the DCS1.1, the critical resource constraints across the programme been identified and addressed, with proposals to resolve concurrency initially focusing on the programme priority of securing Routeway, Shafts and Portals and Stations SC1 to deliver Trial Running.

One of the key elements impacting productivity has been resource constraint exacerbated by concurrent work, predominantly associated with commissioning and assurance. The following constraints have been identified across the Programme.

Area	Tier 2	Tier 1	CEG	ESM	Rfl	LU	RABC
Routeway			• AC reviewers – MEP & Fire Engineers				
Shafts & Portals				• ESJ reviewers and SJ producers	• O&M reviewers • H&S File Reviewers • Asset data reviewers & uploaders		• SC1 enactments, ESJ, SJ, EAC, RCAC, COS SJs, SAR, CESAC Meetings and reviews
Stations	• Commissioning local systems – Commissioning Engineers	• C660 interfacing works with Stations • Producing ACs – Tier 1 Designers	• AC reviewers – MEP & Fire Engineers			• 1 Early transfer per month	

7.1.11 Overall funding context to the programme

The programme has confirmed funding of £14,964m. COWD at the end of Period 4 is £14,517m.

Announcements were made in November 2019 (but have never been formalised) of an expected increase in costs in the range of £400m to £650m. When added to the confirmed funding of £14,964m, this generates a range of AFCDC outcomes from £15,364m to £15,614m.

Externally this range has been presented as being the outcome of a range of scenarios – internally this position has always been discussed with Sponsors as reflecting a P50 to P80 range.

Pre-COVID, the programme was already forecasted to exceed the bottom of this range – the Period 13 AFCDC forecast of £15,420m was £56m over the lower boundary of £15,364m.

Pre-COVID cost pressure was broadly increasing due to milestone slippage and specific issues notably at Whitechapel and Bond Street, and with continuing high levels of indirect costs.

Post-COVID, the recovery plan has set a new delivery logic to overcome the throughput challenges post-COVID and drive to handover and trial running/trial operations. New cost pressures are arising from the new logic (such as 24/7 working) and the direct costs of managing social distancing (such as welfare and parking facilities, and resilience measures such as a second “war room” for the blockade).

Risk

7.1.12 Background

The mitigation of programme risks forms a key component in the development of the COVID-19 Recovery Execution Plan. This has allowed for the identification of further programme interventions over and above those interventions already identified Scenario D to improve the programme resilience.

There are three levels of risk management considered in developing the DCS 1.1:

In addition, within the Programme Risk layer, CRL has developed the Elizabeth Line Risk Landscape which describes the key risks associated with transition into operation which are held by each of the interested parties (see figure 23a below).

The Risk Landscape outlines:

- The key areas of interest – or objectives – of each of the parties;
- The key risks to achieving those objectives

Each section of the Risk Landscape is owned and managed by leads from each of the organisations, and the process is overseen by ELRG and CRL Board (noting that this is likely to change with the programme's transition into TfL).

ENTERPRISE RISK

Combination of:

- Externally driven, relating to funding, market and economic factors, industry and stakeholder relations
- Summary of key areas of risk within the programme for reporting to the CRL Board and Sponsors

PROGRAMME RISKS

- Risks to Crossrail's functional requirements
- Risks associated with coordination, interfacing and integration of projects
- Significant risks which cannot be resolved within projects

PROJECT RISKS

- Risks associated with delivery of Project scope

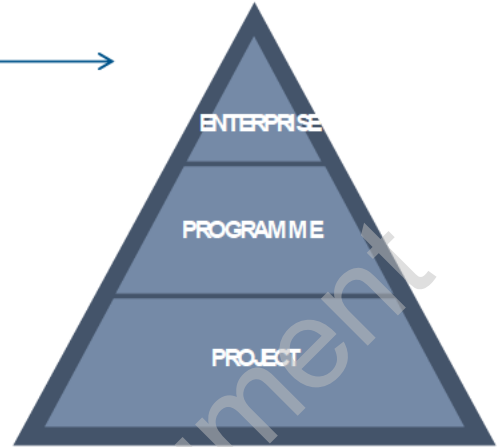


Figure 23a: Hierarchy of risk

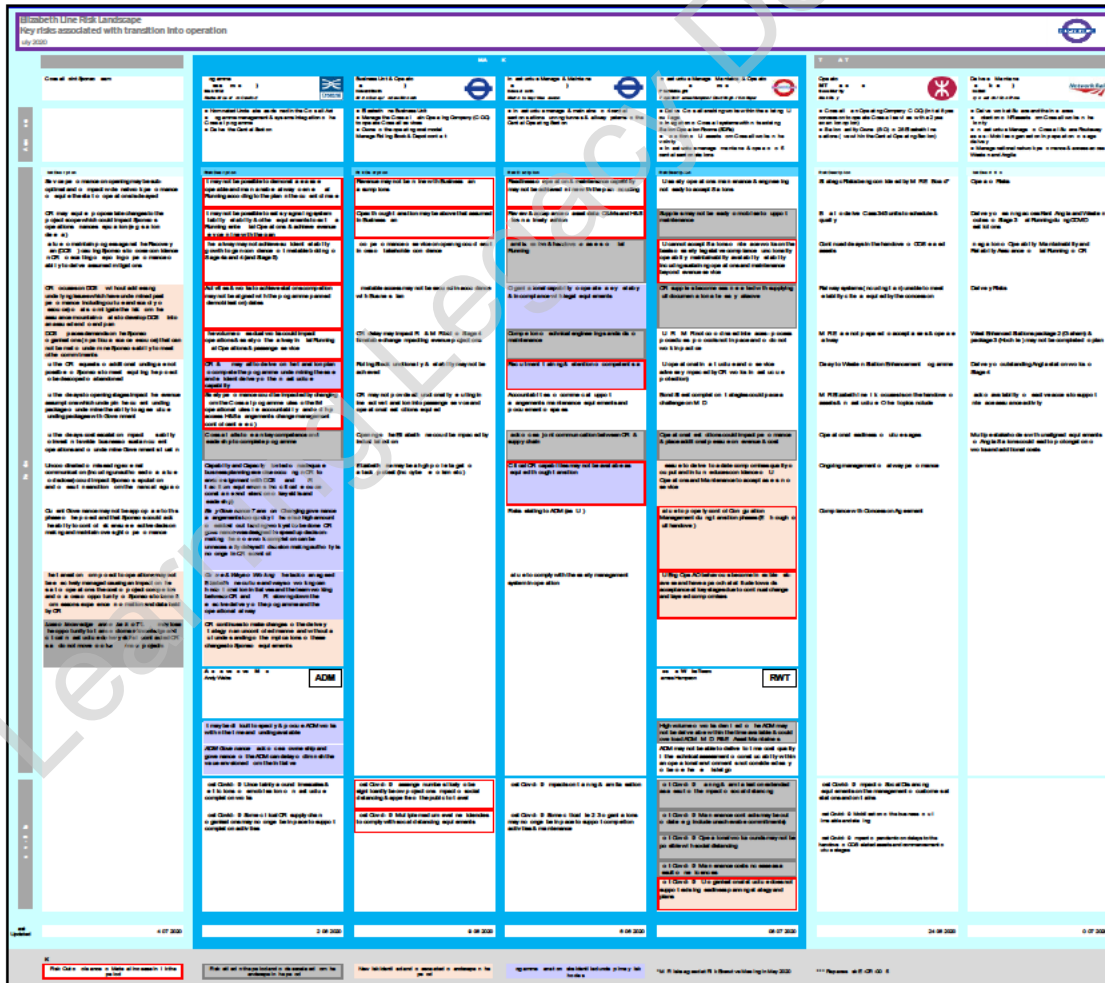


Figure 23b: Elizabeth Line Risk Landscape snapshot (for full risk output please refer to the internal Crossrail SharePoint site [here](#))

7.1.13 Risk Management in the Recovery Execution Plan

The Establishment of a Baseline in DCS 1.1 provides an opportunity to step up the active management of Programme Risk. At this stage in the project life cycle, the bulk of the cost and schedule exposure exists around programme level activities and mitigation actions in these areas would have the biggest impacts in protecting the Recovery Plan objectives.

Programme risks will be managed against the 10 modules in the Recovery Execution Plan and an improved risk cadence will be established to provide a forum for the Programme leadership to review the key risks and risk management performance.

The key actions are listed below.

Project Risk Actions

- Identify opportunities to optimise the identification, assessment and management of Project Risk as part of the revised operating model;
- Where appropriate, integrate the assessment of schedule and cost risk, recognising that schedule prolongation is a key driver of cost escalation at this point in the programme's life;
- Set guidelines for the orderly closeout of Project risk positions as part of the staged completion process, contract closeout and the Employers Completion Process
- Reconsider the use of QCRA instead/in addition/alongside to Project Contingency in the build-up of Project cost forecasts

Programme Risk Actions

- Improve the focus on Programme Risk, structuring a dynamic and robust process around the main headings of the Recovery Execution Plan;
- Continue existing engagement with teams within the programme organisation including:
 - Delivery
 - Technical including Assurance, CEG, Plateau, Systems Integration teams;
 - Trials, Testing & Commissioning;
 - Operations;
 - Commercial;
 - Communications, People and Transition team (special focus on Organisational Transition)
- Establish regular reviews of risks including assessment and mitigation actions in the following areas:
 - Stations Recovery Strategy
 - Whole Systems Integration
- Establish a new cadence of risk specific meetings
- Programme Panel will provide a forum for Programme Leadership to review:
 - New and emerging risks;
 - Progress on key mitigation actions;
 - Overall risk management performance;
- Periodic Risk Review (week 2) will provide a forum for Programme leadership to review:
 - The quantitative assessment of QSRA and QCRA and its inclusion in schedule and costs reporting
- Regularly update the Programme Risk Map (see below) which provides a summary of the key risks in each of the Recovery Plan Modules

Enterprise Risk Actions

- Post finalisation of the DCS1.1 (and migration into the Crossrail Integrated Programme), the Exec will conduct a fundamental review of Enterprise Risks to include e.g.:
 - Delivery of revenue service for Stage 3;
 - Reliability growth to enable timetable bidding for Stage 4 & 5
 - Ability to secure Sponsors funding;

- Future impacts of the pandemic;
- Inability to meet undertakings & assurances agreed as part of the Crossrail Bill;
- Political risk
- Joint Exec Group review/ validation to ensure adequate management
- Engage the CRL Board and Non-Exec Directors (or potential future Elizabeth Line Programme Board) to provide visibility and assurance of risk management performance

Programme Risk Map

The Programme Risk Map provides a summary of the key risks in each of the Recovery Plan Modules and indicates the treatment of each of the key risks in cost and schedule.

1. Project - Risk register and DT	2. R. R&E Interoperability testing & SIBT & early SIB tests	3. R. R&E Interoperability testing & SIBT & early SIB tests	4. Assurance of the works	5. Stationer - SIBT and other work strategy	6. Transition to R&E Environment	7. Final Reviewing	8. From Elizabeth Line NOT MODELLED	
<p>1.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	<p>2.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	<p>3.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	<p>4.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	<p>5.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	<p>6.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	<p>7.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	<p>8.1. Risk Register</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p> <p>There is a risk that the project will not be completed on time due to delays in the delivery of the works.</p>	
<p>10. Overall System Integration</p> <p>Colin Brown</p>								
						<p>INT-004 Tunnel Vent System (coat impact only) - separate risk for time impact in INT-001-006</p> <p>PROG-006 Station Commissioning (NEW RISK) - for resolution in station planning (i.e. installed) then re-assess residual risk not covered by prolongation</p> <p>PROG-009 We may not be able to demonstrate that our systems achieve EMC with each other. (Eleanor Street & Stepping Green)</p> <p>INT-005 Tunnel Vent System - Door pressures caused by the TVS system too high preventing opening and causing stalling</p> <p>PROG-008 We may not be able to demonstrate that our systems achieve Earthing & Bonding with related railway systems</p> <p>PROG-023 Systems integration - SOR to RCC may be delayed due to access constraints on site</p> <p>INT-003 D25 - Noise Tests are not successfully completed and do not meet the minimum design requirements and are not accepted by the Local Authority.</p> <p>INT-006 Tunnel Vent System - Signalling system allows for two trains to enter the same vent section which in an incident cause safety concerns (requiring mode changes).</p> <p>INT-001 Tunnel Vent System - Fire strategy for the COS requires update to deal with lack of functionality in incident mode</p>		

Figure 24: Risk map

Outline of the Risk Cadence

Improvements are proposed to the cadence of Risk Management meetings. New meetings and reporting points are shown in red on figure 25 below.

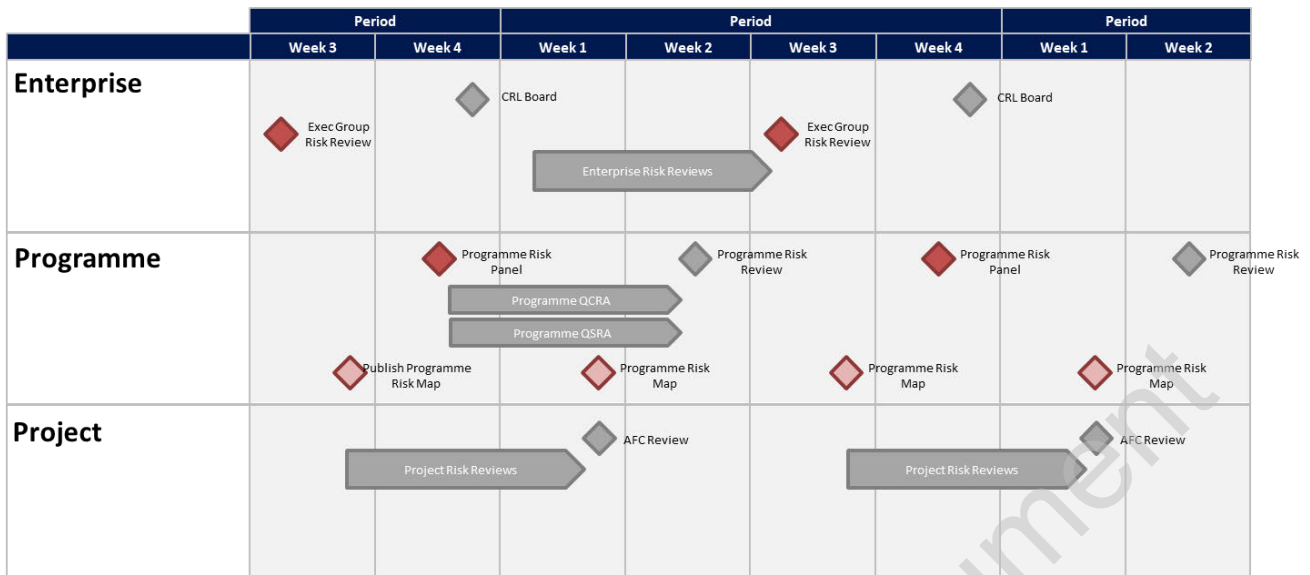


Figure 25: Key risk meetings

Programme Risk Panel Outline Terms of Reference

- Meets every 4 weeks – week 4 proposed
- Chaired by Crossrail Programme Director or delegate
- Representation from
 - Programme Delivery;
 - Routeway;
 - Stations;
 - Technical;
 - Operations;
 - Controls & Finance;
- Objectives to provide:
 - Monitoring of performance in managing risk;
 - Information sharing;
 - Escalation Route;
 - ‘Clearing House’ to focus on critical risks.

7.1.14 Top Programme Risks by Module

Based on the Crossrail Programme Risk Map as of July 2020, the top risks have been selected by module. In instances where there are more than two top risks with a critical (red) status, they are included in the table below. A critical risk is currently mapped against a cost, duration and likelihood impact scoring systems using a relative RAG within in each module by the risk team.

Top Risks for PEP based on programme risk map

Risk ID	Description	Risk owner	Summary mitigation plan
PROG-C19-101	Additional costs may be incurred if a resurgence in COVID-19 impacts the planned works	Mark Cooper	Ensure mitigation measures put in place to maintain productivity during the first safe stop are maintained, and can be implemented in a structured way for any future lockdown.
PROG-B212	There may be unforeseen commercial implications arising from an instruction to the supply chain to work to the blockade	Sam Costello	Coordinated senior and tactical -level engagement with key elements of the supply chain. Potential issues identified during that engagement to be captured and managed through the programme Commercial team.
PROG-078	Delay to signalling development could result in reduced functionality being provided in planned drops and point	Pradeep Vasudev	All documentation to support the safety case will be done by early August (including EMC and HF). Plateau team to coordinate signalling development programmes
OPS-MAIN-005	System integration functionality issues	Jon Jarrett	SIT to be completed prior to the start of Trial Running
PROG-201	Assurance concurrency	Stephen Turner	Analysis of potential key resource concurrency has been undertaken in support of DCS 1.1. Continue to monitor potential concurrency as part of periodic planning process.
PROG-086	Railway parties (ORR, NRL), etc. fail to provide required approvals on time	Stephen Turner	Continue tactical engagement with external approving bodies, such as ORR, Network Rail, etc. Ensure that an escalation route exists, so that potential issues identified by that ongoing engagement can form part of senior engagement with those bodies.
T&C.R21	Stations not at required level of readiness by planned Trial Operations date (SC3 ROGS).	Neil Thompson	Stations recovery plan created to increase chances of successful delivery. Element-specific stakeholder engagement has been implemented, allowing any inconsistencies in view to be identified early and thus mitigated. Produce a plan which shows completion of all outstanding EOWLS post SC ROGS
T&C.R20	Stations, Shafts & Portals unable to support requirements for Trial Running	Darren Coleman	On-going monitoring of SSP progress for ETR and TR
OPS-MAIN-002	RfI acceptance of handover documentation	Jon Jarrett	Ensure RfI working closely and collaboratively with CEG and CRL teams to build trust between the parties. Make sure issues raised and resolved in an effective and timely manner.
T&C.R09	Operational limitations on CCI systems prevents operators from accepting systems for Trial Running	Andrew Clark	Agree first baseline of ORs with the operator, and proactively respond to operational need. Plan an integrated implementation and monitor outcomes
T&C.R22	Railway reliability is insufficient for the start of Trial Operations.	Trevor Birch	Maximise physical opportunities to improve railway reliability (i.e. number of trains). Improve data capture and analysis of reliability, to minimise turnaround on implementing fixes / improvements.
T&C.R25	Time required for works not completed pre-ROGS 1. EOWLS 2. Completion of assurance and approvals 3. Resolution of HF issues and ORs at the control centre	Catherine Latham	With a central team managing Trial Running focussed on an agreed strategy, deliver a rigorous yet agile governance and management process for Trial Running which minimises the turnaround time from an issue's identification to resolution. Identify single point of contact management of Trial Running
OPS-ST45b-001	Reliability proven integrated system for Stages 4 and 5b	Trevor Birch	Maximise physical opportunities to improve railway reliability (i.e. number of trains). Improve data capture and analysis of reliability, to minimise turnaround on implementing fixes / improvements.
OPS-ST45b-002	Transitions functionality issues - West (timetable stages 4 and 5b)	Neal Lawson	Deliver more trains for Trial Running in order to establish more passes of reliability growth in Stage 3
PROG-211	Commercial claims	Sam Costello	Programme Commercial team to continue to monitor potential claims across all projects, and to apply appropriate interventions to control claims as best as possible. Develop Commercial Close Out plan to address all outstanding commercial issues and close out all Tier 1 contracts
PROG-045a	Tier 1 contractor insolvency results in inability to complete their contracted accountabilities.	Sam Costello	Ensure that detailed fallback plans for contractor insolvency are in place, in line with programme wide strategic goals. Monitor supply chain health
PROG-208	Station commissioning and integration risks	Neil Thompson	Establish Plateau 2 team to coordinate integration, testing and commissioning of stations including Stations Operation Room and data links to ROC.
INT-004	Resolution of issues with the Tunnel Ventilation System (TVS) could result in delays and could require additional works to the ventilation system and at SSP sites.	Phil Gayton	Co-ordination via technical team and project engineers. End-to-end plan for design, testing and commissioning of TVCS subsystems. Cost provision provided for any additional works to ensure TVS meets requirements.

DCS Module	Risk Description	Expected cost (EMV) - £k	Expected schedule impact (weeks)
Blockade	There may be unforeseen commercial implications arising from an instruction to the supply chain to work to the blockade	£2,949k	
TR2 & Integration Testing / SIDT & Early TR Tests	Delay to signalling development could result in reduced functionality being provided in planned drops and point releases		13
	System integration functionality issues		6
Assurance of the works	Assurance concurrency		4
	Railway parties (ORR, NRL), etc. fail to provide required approvals on time	£1,500k	2
Stations – SC1 and then station close out strategy	Stations not at required level of readiness by planned Trial Operations date (SC3 ROGS).		5
	Stations, Shafts & Portals unable to support requirements for Trial Running		3
	Additional costs may be incurred if a resurgence in COVID-19 impacts the planned works	£11,115k	2
Transition to ROGS Environment	RfLi acceptance of handover documentation		18
	Operational limitations on CCI systems prevents operators from accepting systems for Trial Running		2
Trial Running	Railway reliability is insufficient for the start of Trial Operations.		8
	Time required for works not completed pre-ROGS:		8
	1. EOWLS 2. Completion of assurance and approvals 3. Resolution of HF issues and ORs at the control centre		
Trial Ops and Stages 3, 4, 5	Reliability proven integrated system for Stages 4 and 5b		18
	Transitions functionality issues - West (timetable stages 4 and 5b)		5
Commercial Recovery Strategy	Commercial claims	£10,000k	
	Tier 1 contractor insolvency results in inability to complete their contracted accountabilities.	£1,875k	2
Overall System Integration	Station Commissioning (NEW RISK) - for resolution in station planning (T1s instructed) then re-assess residual risk not covered by prolongation		6
	Tunnel Vent System (cost impact only - separate risk for time impact in INT-001-006)	£14,491k	

Figure 26: Key Programme risks by module

Crossrail COVID-19 Recovery Execution Plan

CRL1-XRL-Z-STP-CR001-50038 Rev 2.0

Schedule Item	Programme Controls Provision		
	Amendment to base schedule	Contingency applied	Risk provision
Integration of Silver Recovery Strategies	Station SC3ROGS handover dates have been aligned with Config 2 strategy. Planned stations handover dates are not deterministic – they consider P50 position of SC3, concurrency and complexity	No fire breaks injected, however there is float between stations SC3 milestones and T-12 in all stations bar FAR and PAD.	Schedule uncertainty included on works to SC3 and risks modelled against key activities
Blockade	N/A	Added provision for additional construction blockades in late November (10 days), New Year (4 days) & early February 21 (14 days)	Risk included that blockade may take longer than expected.
Scope	None	As above.	Risk that we may carry work into TR period included.
Concurrency Analysis and critical resources	Amendments made to Routeway Chapter SJ dates and Routeway chapter T-0 (Ready for handovers) to reflect CRL TD and RfL requirements respectively	CRL Ready for Handover dates set around T-12 process. RfL RCAC dates include additional RABC Meeting, additional third week for 'big' Chapter cases and spread of chapter across individual RABC meeting. Schedule driven by the RCAC dates	Risk included to reflect assurance concurrency could still affect the COS SJ. Logic in summary schedule prevents overlap of T-12
C660 deep dive	N/A	To be confirmed	No specific risk for C600 resources included. Risk included for additional software cycles and rework for C660 scope.
TVS	Added cost provision for ATC support for TVS testing up to Trial Operations	Number of key TVS issues already included in DCS. External summary programmes are also being constructed to assess extent and possible effect on programme of main issues. Further work needed to integrate into DCS as necessary	Risks included for resolution of TVS issue including door forces and works to D25 noise compliance.
SOR integration	Based upon two teams. One for RfL Station the other for LUL. Sequential working in line with SC3ROGS priorities	Allowance of 12 weeks made in programme. 8 for integration, 4 for reliability growth. Switch to next site occurs after first 8 weeks. Detailed work still work	Risk allowance included for significant issues integrating SoR. Duration uncertainty included for testing activities.
Non-signalling integration testing	Tests now included within base schedule	None	Risk included for unknown integration tests
Handover documentation	Routeway documentation based upon actual figures from EB and forecasts from Handover leads. SS&P documentation built around T-12 process	None	Risks are included for the production and approval of documentation for routeways, S&P and stations.
Productivity assumptions	Project schedules updated to reflect confirmed assumptions e.g. TD document review times and number of cycles Also a link to Concurrency intervention i.e. review times hand in hand with volume of concurrent work	None	Model uses the DCS maturity matrix to assign duration uncertainty to tasks as a percentage spread on planned duration. FAR, PAD and BOS station summary schedules include uncertainties provided by project teams.
Reliability growth	Trace effecting access required by Stations still to be confirmed in terms of EOWL's.	Additional construction blockades built into pre & inter SIDT schedule to accommodate	Risk included that we fail to achieve reliability growth as expect in Trial Running
IM Readiness			Risk included that operations may not be ready to commence Trial Running as planned

Figure 27: Interventions to improve schedule resilience through risk mitigation

7.1.15 Stations Risk Approach

Developing DCS 1.1

In developing the stations recovery programme, risk workshops were held with the silver recovery team and project teams from FAR (first LU station), PAD (first RfL station) and BOS to identify key activities, uncertainties and risks to achieving key milestones in the recovery plan. The output was a list of high-level activities to be included in the DCS summary schedule, key risks and uncertainties and links to dependencies; C660 works and system integration. This information was combined with existing project risk information to enable the QSRA to be completed.

The QSRA analysis was then used to inform the top-down review of the station recovery programme, sequencing of T-12 handovers to LU and RfL, and potential configurations that could be delivered to secure a Trial Operations date.

The approach to managing risk to the T-12 handover period for the stations is to have dedicated teams to support the LU and RfL swim lanes. Only one station in each swim lane will commence its T-12 with the subsequent T-12 handover starting once the preceding station reaches T-4 (except WOO which overlap at T-6 on the assumption the process will improve over time and this is the last T-12 on the critical path). This mitigates concurrency in key resources from CRL and LU/RfL.

Ongoing Stations Risk Approach

Periodic risk reviews are held with the project teams to review and identify risks impacting both the cost and delivery of the schedule. The cost risks feed into the AFC review process in week 1 each period and the schedule impacts are reviewed and incorporated within the QSRA (week 2 to 3). At these risk reviews, mitigation actions are updated, and their status recorded in the project risk register held in ARM by the Risk Manager. Attendees at the risk reviews include the project team and are recommended to include representation from the supply chain.

7.1.16 System Integration Risk Approach

Current Actions

There have been sessions held with Duncan Jackman to identify High-Level programme risks around stations integration. The outputs (critical path, uncertainties and risks) were fed into the DCS 1.1 summary schedule to enable the QSRA to be undertaken and programme risks captured in ARM. The complexity of the system integration and the number of dependencies has required the establishment of a Plateau 2 team to coordinate and manage the system integration.

Next Steps

Once the Plateau 2 team is set up, the risk register will be established in ARM and a periodic review shall be set up to support the management of System Integration risk. A risk manager will be assigned to support the Plateau 2 team.

Where actions are needed by projects or other disciplines (including Operations) these shall be linked in the ARM risk register providing the Plateau 2 team visibility of how dependencies are being managed.

This approach shall mirror that applied to the existing Plateau 1 team.

7.1.17 Routeway Risk Approach

The routeway risk management approach is identical to that of the stations risk approach where a periodic risk review is held to review and identify risks that impact either cost or schedule. Updates to the Routeway DCS are incorporated into the DCS1.1 summary schedule including updates to activity progress.

7.1.18 August Programme Risk Overview

As reported in the August DCS1.1 CRL Board, the table below shows the risks most likely to influence the start of Trial Operations:

Risk	Function	Mitigation Strategy
Issues testing and commissioning the Station Operations Rooms (SOR)	Delivery	Deployment of Plateau 2 team to coordinate station integration and commissioning. Provision of dedicated SOR T&C resources for LU and RfL stations
Train / Signalling integration issues may not be resolved before the start of Trial Running	Technical	Software strategy developed to allow for point releases to resolve issues. Implementation of operational restrictions to be resolved in software during Trial Running
Delays to the production of assurance documentation may occur	Delivery	Concurrency exercise was undertaken to reduce conflict in resources for key safety documentation and for approvals
Time may be required during Trial running for works not completed pre-ROGS	Delivery	Provision of additional access windows before the start of Trial Running. Change control and monitoring of EOWLS
Failure to achieve reliability growth as expected during Trial Running	Delivery	SIDT period to build mileage and identify issues early. Software strategy allows for issues to be resolved during the Trial Running period
Failure to retain and evolve the profile of the resource and capability required to deliver the programme (cost, skill-set and experience) as well as ensuring the availability of critical resources and talent for each phase of the programme.	People	Development and implementation of the Workforce Plan that identifies critical roles, talent, demand and supply of resource required to deliver in line with the DCS1.1, including action plans to address gaps and utilising TfL/CRL resources wherever possible
Operator readiness	Operations	CRL support to RfLi identified for transition through Trial Running. Increased focus on readiness and familiarisation activities to build capability