

Project Representative Report

**Item: Project Status Report 157 and Crossrail
Response Period 8 FY2021-22**

Date: Period 8 (16 October 2021 – 12 November 2021)

1 Overview

- 1.1 The P-Rep is in place to provide the Sponsors, TfL and the Department for Transport, with oversight of project delivery, advise and raise points of challenge to the Sponsors and scrutinise progress.
- 1.2 The P-Rep observations are shared with Crossrail and are discussed in detail by Crossrail, P-Rep and the Commissioner. Crossrail then produces a written response to the P-Rep report.
- 1.3 In line with the commitments made by the Mayor for greater transparency of the Crossrail project, please find below the latest P-Rep Sponsor Summary and Crossrail's Management Response.
- 1.4 It has been necessary to make some redactions to the reports prior to publication to protect commercially sensitive material. We have sought to keep such redactions to a minimum

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[REDACTED]
Project Representative
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6 January 2022

Dear Stephen,

Re: Crossrail PRep Project Status Report 157 – Period 8

I am writing in response to the PRep Sponsor Summary cover letter for Period 8.

As noted in your letter, commencing Trial Operations on 20 November 2021 was a pivotal milestone in the Programme. This was achieved within the P50 time allowance and is testament to significant collaborative efforts across the Programme.

You are right to point out that this does not constitute the entirety of Trial Operations, however, as mentioned in my previous correspondence, this staged approach allows us to start Trial Operations exercises and activities whilst simultaneously completing critical programme activities that will support the second phase of Trial Operations. This approach has been vindicated by the completion of over 50 Trial Operations exercises (approximately a third of the total) by Christmas 2021. I would acknowledge however that the underlying demonstrated reliability performance of the railway system has somewhat reduced the opportunity to increase this total.

In preparation for entry into Trial Operations Phase 2, a considerable amount of work was completed over the Christmas and New Year break. We commissioned the Siemens ELR110 signalling software, commenced the rollout of Alstom 5.4 software across the fleet, commissioned the latest version of SCADA communications system (v28) and successfully completed essential mode changes to the Tunnel Vent System. I hope you would agree this is a notable tranche of work that was completed, and the upgrades bring the system very close to the intended configuration for Revenue Service.

On 4 January 2022, we commenced a week of timetabled reliability proving to demonstrate the projected uplift in reliability performance in practice. The results of this reliability proving week is very influential in relation to when the railway will open. During the Christmas period, we also replaced all 36 of the faulty Voltage Transformers, removing another risk for opening.

As you note Canary Wharf station did not achieve its transfer to RFLI prior to Christmas. The key issues have been the quality of the electrical installation [REDACTED] and the extensive safety critical upgrade work that has been required. Following extensive work over the Christmas period, we plan to complete the transfer

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of Canary Wharf station in January 2022. Whilst the delay has been disappointing, I am sure you will agree that assuring the safety of the station is the priority.

I hope this response provides a useful summary of the measures in place to address the specific issues you have highlighted. A more comprehensive response focussed on the content of the Sponsor Summary report will be issued as an Appendix to this letter.

Kind regards,



Mark Wild
CEO, Crossrail

Appendix – CRL Response to Period 8 PRep Report

Programme Response Category	PRep Period 8 Sponsor Summary Content	CRL Period 8 Response
<p>Headlines: Progress and Look Ahead</p>	<p>Entry into Trial Operations Phase 1 was achieved on 20 November 2021, as part of a phased approach to Trial Operations; while a notable milestone, it does not constitute ‘full’ Trial Operations. This is because railway infrastructure and associated safety assurance delivery has not yet been completed, requiring the deferral of mass evacuation exercises to Trial Operations Phase 2 in January 2022. Nevertheless, the phased approach to Trial Operations is pragmatic, allowing delivery momentum to be maintained, staff exercises to take place, and reliability to be built, pending completion of works.</p> <p>Planning continues for the major works to be carried out prior to entry into Trial Operations Phase 2, currently scheduled for January 2022. These include: Tunnel Ventilation System (TVS) works, Platform Screen Door (PSD) modifications, Voltage Transformer (VT) replacement and rolling stock and signalling software upgrades. Works access at the interfaces with NR is challenging and has the potential to impact the schedule. PSD modifications have become more protracted than CRL first anticipated, with safety being of prime concern. Three tests remain to confirm Auto-Reverse functionality, and these are scheduled for early January 2022. With sign-off of safety assurance for the use of Auto-Reverse functionality in passenger service proving challenging, alternative arrangements are being</p>	<p>Agree.</p> <p>Commissioning Blockades for the Tunnel Vent System (TVS) took place for a duration of five days from 16 December to 20 December 2021 with all 128 scheduled TVS related activities successfully completed. Over the Christmas period, the ELR110 Software commissioning was successfully executed with all works delivered. Between the 31 December and the 3 January 2022, all the Voltage Transformers (VTs) were replaced and tested, including three NR VTs, rectifying a key defect for entry into Trial Operations Phase 2. At the same time, the Communications and Control software update, CMS28.0, was also commissioned, and the automatic Great Eastern Transition at Stratford was brought into use. High level support has been received from Network Rail, MTR and RFLI for the works over</p>

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	<p>investigated including possible timetable changes and additional drivers.</p> <p>Much of the success in CRL achieving Trial Operations Phase 1 was down to the safety assurance effort, particularly in the two weeks approaching the start date. The adoption of the two-phase approach to Trial Operations meant that the assurance requirements for entry were able to be reduced from those that would otherwise have applied. While this relieved the immediate workload and helped secure the 20 November 2021 milestone, it also had the effect of deferring the most problematic elements of submission delivery and review into the period ahead of the start of Phase 2 on █ January 2022. As a consequence, much pressure remains on the completion of safety assurance in the available timescales, which includes the closure of approximately 500 EOWLs before entry into Passenger Service₁; CRL is seeking to clarify the actual number. The safety assurance process is expected to undergo further review in Period 9, with CRL and RfLI looking to identify ways of ensuring that target dates can be met using the available resources. However, it is difficult to see where the necessary gains might be made, given the limited periods between completion of works, Trial Operations Phase 2, and Passenger Service, and deterministic dates are under threat.</p>	<p>the Christmas period. The remaining Auto-Reverse trials are targeted for the second half of January 2022.</p> <p>The second phase of Trial Operations is now scheduled to commence █ January 2022. This will enable a critical period of reliability running in January to see the actual results of the extensive upgrade works scheduled over the Christmas period. It will also allow time for the safety assurance work to be completed. This change will ensure a more reliable and stable configuration is in place as we enter Trial Operations Phase 2 and entry to Revenue Service in March 2022.</p> <p>CRL and RFLI are close to agreeing the configuration states for the second phase of Trial Operations and Revenue Service using an agreed 'delta' document in conjunction with agreed Safety Justification (SJ) Dependencies and critical EOWLs that RFLI need to be closed out by the respective phases. This significantly reduces the EOWLs to be completed by the second phase of Trial Operations and Revenue Service. It also provides justification for the mitigation of a significant number of SJ Dependencies that are outstanding.</p>
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	<p>Completion of Canary Wharf Station requires the delivery of LV electrical ACs and fire systems certification; inspections by the Fire Brigade are then necessary before an Authority to Use (ATU) can be issued. While CRL works closely with RfLI to achieve BIU, additional scope continues to emerge which increases the demands on the combined resources that remain and add to the existing pressure on the target date of [REDACTED] December 2021². Works completion, principally related to fire systems, cannot slip beyond the T-4 gate review scheduled for mid-December 2021 without likely impact upon entry into Trial Operations Phase 2. Further work is also expected after BIU to fully comply with RfLI requirements, and this has yet to be fully quantified. The station might not be completed in time for earliest Stage 3 Passenger Service, and the consequences of a partial opening are unclear. These uncertainties are applying further cost pressure.</p> <p>The final configuration plan for Bond Street Station, its delivery, and the timing of BIU, was expected to be reviewed at a Go/No Go meeting on 2 December 2021, but the outcome is not yet known. CRL will consider the [REDACTED]</p>	<p>CRL agrees with the Project Representative's comments, however, transfer of Canary Wharf station will take place prior to commencement of the second phase of Trial Operations and subsequently Revenue Service.</p> <p>A readiness review on 15 December 2021 concluded that SC2 at Bond Street station is on target for January 2022. However, with the re-forecast of Trial Operations Phase 2 set for the [REDACTED] January 2022, the decision was taken to re-forecast Bond Street enactment to [REDACTED] January 2022 to reduce costs and maximise unrestricted access at the station for work activities. With that said, enactment 'ready' has been accomplished, therefore, SC2 status to be achieved at any conducive window in the Programme.</p>
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	<p>[REDACTED]</p> <p>The railway has generally performed well since the October 2021 Blockade. However, while the ELR100 and TVS commissioning have largely delivered the anticipated benefits, the railway is not performing at the levels expected for Trial Operations. There remains a range of legacy and unexpected emerging issues, which are conspiring to add to operator workload. Emerging issues, such as Timetable Processor and Wayside Cabinet Units, are causing the overall performance of the railway to be compromised; these are expected to be resolved with the implementation of ELR110.</p> <p>RfLI is implementing the train software H5.3 on services to Heathrow Airport, to prove deployment and achieve a progressive roll-out onto the Elizabeth Line ahead of mid-December 2021; initial indications are that deployment has gone well. In combination with signalling software ELR110, H5.3 is planned to deliver significant reliability improvement. However, given past performance further reliability growth delay is possible, which may yet have implications for entry to Stages 3 and 5B.</p> <p>The deterministic date for the start of Stage 3 Passenger Service on [REDACTED] March 2022 is predicated on the completion of all remaining</p>	<p>Agree and noted.</p> <p>Agree. Improvement in surface FLU reliability performance is not expected until the fixes are delivered in the reliability boost software H5.3/4 on 17 December 2021 (for fleet rollout from 20 December 2021 to 12 January 2022). Pre fleet load confidence running with H5.3 (as non-passenger version H5.4) on one unit started on 24 November 2021 on the Heathrow and Reading routes and increased to two units on 2 December 2021 with 2,400 miles completed to date with no re-occurrence of the Automatic Warning System/Train Protection and Warning System (AWS/TPWS) defect.</p> <p>The determinist date for Passenger Service is now [REDACTED] March 2022 based on a [REDACTED] re-forecast to Trial Operations Phase 2. This change</p>
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	<p>works, delivery of associated safety assurance and attainment of required levels of railway reliability; achievement of these will be challenging. As a result of starting Trial Operations Phase 1, CRL’s P50 date for the start of Passenger Service improved slightly to [REDACTED] May 2022^s, and the P80 date remains within the declared opening window of the first half of 2022. The success of the works up to early January 2022 will indicate whether Passenger Service is more likely to start on the P50 date. No change is indicated for the P50 date for Stage 5B opening of [REDACTED]; however, the P50 Stage 5C opening date has deteriorated by 6 days to [REDACTED], due to increasing reliability risk and the potential for additional software updates. There is a growing risk that the [REDACTED] date for Stage 5B opening will not be achieved, given the pressures on Stage 3 opening.</p> <p>Sponsors’ particular attention is drawn to the following:</p> <ul style="list-style-type: none"> • The Elizabeth Line is not in a safety-assured position for full Trial Operations, and there is limited time during Trial Operations Phase 2 for securing authority for entry into Passenger Service. • Railway reliability growth relies heavily upon the success of critical rail system software upgrades, and scope for operational or schedule mitigation to meet target dates is limited. 	<p>will ensure a more reliable and stable configuration is in place as we enter Trial Operations Phase 2 and entry to Revenue Service.</p> <p>Trial Operations Phase 2 re-forecast is due to a combination of low railway reliability, ability to recover from incidents and lack of completion of Trial Operations scenarios and assurance activities. However, as mentioned previously, re-forecast will enable a critical period of reliability running in January to realise the results of the extensive upgrade works that took place over the Christmas period and allow a longer time span to process safety assurance work.</p> <p>In response to the four issues for attention, CRL responds as follows:</p> <p>Agree.</p> <p>.</p> <p>.</p> <p>Agree and noted.</p>
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	<ul style="list-style-type: none"> • Finalisation of Canary Wharf Station completion scope remains challenging, and full station availability to support earliest Stage 3 Passenger Service opening is uncertain. • The start dates for Passenger Service and Stages 5B and 5C are critically linked by reliability growth, and several technical issues remain beyond Stage 3 for resolution. 	<p>The capability of Canary Wharf station to support Stage 3 Passenger Service is not uncertain. A plan has been devised and a path forward working with RFLI to achieve transfer prior to the commencement of Trial Operations Phase 2.</p> <p>Agree. Both reliability and any emerging technical issues are presented weekly at the relevant forum (PSSG, ELRB) and any mitigations and/or actions are agreed with the Elizabeth line leadership team.</p>
<p>Health & Safety</p>	<p>One High Potential Near Miss was reported by CRL in Period 8, as a result of a lifting incident at Bond Street Station. Overall safety indicators remain within those set by the Programme. There have been several incidents of operational procedure non-compliance, and System Testing with a Train (STT) has been paused until a review has been completed and a plan to move forward is prepared.</p>	<p>Agree and noted.</p>
<p>Programme Overview:</p> <p>Schedule</p>	<p>Entry into Trial Operations Phase 1 was achieved on 20 November 2021. In practical terms, this allows CRL to continue and close-out workstreams previously allocated to the Trial Running period, and to start lower risk Trial Operations exercises and activities. There is no change to the Cardinal Milestone dates reported in Period 7.</p>	<p>Agree and noted. Period 9 shows a [REDACTED] delay to Trial Operations Phase 2 and Revenue Service cardinal milestones.</p>

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	<p>The recent resequencing of activities to align with the two-phase approach shifts management focus and schedule pressure towards the start of Trial Operations Phase 2, and the start of the higher risk mass evacuation exercises, planned from the ■ January 2022. The schedule logic shows the completion of the supporting safety assurance pre-requisites, delivery of ELR110 software and upgrades to the TVS during the two December 2021 Blockades, as the main activities leading up to the start of Phase 2.</p> <p>The main challenges to meeting the target start date of ■ March 2022 for Stage 3 Passenger Service are the completion of necessary works, delivery of safety assurance and the achievement of acceptable levels of railway reliability.</p> <p>Canary Wharf Station delivery has slipped significantly against the schedule during the period. CRL has mitigated this by making this activity a predecessor to the start of Trial Operations Phase 2 rather than to Phase 1. The current forecast date for Canary Wharf Station BIU is ■ December 2021⁶. The Bond Street Station SC3 ROGS forecast date was to be agreed at a hold point meeting on 2 December 2021.</p>	<p>Agree. As previously mentioned, the current period position shows a re-forecast of ■ to Trial Operations Phase 2 and subsequently Revenue Service.</p> <p>Agree.</p> <p>Following extensive work over the Christmas period, target for Canary Wharf’s transfer to RFLI is set for January 2022. However, BIU forecast is subject to ITAP approved SJ submittal and agreement with RFLI.</p>
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<p>Commercial and Risk</p>	<p>CRL’s Period 8 AFCDC is provisionally reported as stable at £15,939m. This is the seventh consecutive period that CRL has reported its forecast around £15,939m and £15,940m, suggesting ongoing stability and containment of emerging pressures. However, pressures continue to emerge, albeit from limited and identified cost centres, which we believe will be covered by risk and provision allowances; at Period 8, CRL reports these allowances to be [REDACTED]</p> <p>The change to a two-phase approach to Trial Operations to accommodate delayed construction and assurance activities is affecting CRL’s opportunity to avoid spending its prolongation risk. Although the COWD achieved in Period 8 was [REDACTED], CTG only reduced by [REDACTED]; the remaining [REDACTED] has been transferred from Risk and Provision allowances to offset emerging cost pressures. Milestone achievement is moving towards P50 dates and P50 risk provisions are likely to be drawn down.</p> <p>The Period 8 provisional AFCDC of £15,939m is £150m above the current funding threshold, and £125m under the £1,071bn funding request limit of £16,064m. The cumulative sum of Project, Programme and Prolongation Risk at Period 8 was reduced by [REDACTED] to [REDACTED]. This reduction did not include retirement or elimination of risk</p>	<p>Agree.</p> <p>CRL agrees with the Project Representative’s comments and note that a move toward the P50 dates would erode our ability to stay within the £825m funding threshold.</p> <p>The Programme team continue to closely manage the schedule and coordinate activities to optimise delivery while keeping risk and opportunities under review.</p> <p>The Programme maintains that the single biggest opportunity to staying within the £825m is to meet the deterministic schedule. Central provisions are being managed to enable the offset of any emerging cost pressures.</p>
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	<p>but was mainly used to offset emerging cost pressures.</p> <p>While demobilisation of the station Tier 1 contractors is maintaining schedule, the demobilisation of the routeway contractors will be affected by [REDACTED] and the delivery of safety assurance associated with the TVS, VTs, PSDs and OHLE maintenance. In Period 8, this has resulted in new prolongation costs and may also create potential new risks.</p>	<p>[REDACTED]</p> <p>Communications and Control (C660) and our signalling (C620) contractors will be held to the [REDACTED] demobilisation date and [REDACTED] contract closeout date respectively. There remains a pipeline of C660 scope that will be processed through governance/PCP approval before instruction to the most appropriate delivery vehicle. These scope items will be delivered post Revenue Service and are covered in allocated Scope Book budget.</p> <p>The current plan for demobilisation and contract close-out is a Stage 3 progressive demobilisation from [REDACTED] through to [REDACTED] plus a three-month contract close out period. C620 instructed/known scope has been assigned to a planned software release and resources have been allocated. Any further changes in the pipeline required post ELR100 Trial Running, Trial Operations and Revenue Service will also be assessed and processed through governance/PCP approval. The current plan for demobilisation and contract close-out is to deliver the last major configuration release ELR300 in [REDACTED] with a reduced C620 team from Stage 3 Revenue Service.</p>
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<p>Organisation</p>	<p>CRL continues to monitor its resource levels. CRL’s full time equivalent resource in Period 8 is forecast at 978, against a Period 7 total of 956⁹. CRL continues to forecast that demobilisation will continue into Period 10, aligned to a reduced organisation structure in early 2022. A more significant drop-off in its resources is forecast in Periods 12 and 13 which is aligned with the deterministic date for the start of Passenger Service, and with the new operating structure for the Elizabeth Line, in which CRL only provides programme close-out support.</p> <p>Demobilisation of the station Tier 1 contractors continues according to the schedule, with four stations now fully demobilised, and with Paddington Station partially demobilised. The balance of the Tier 1 contractors have agreed plans for demobilisation by the end of 2021. Significant resource levels remain at Bond Street, Canary Wharf and Whitechapel Stations, and with Routeway and C660.</p> <p>As CRL transfers responsibility for ownership and operation of the railway to RfLI, CRL will progressively reduce its own meeting workload and reporting requirements. This is to be</p>	<p>It is anticipated that RFLI will set up contracts with Siemens to continue any support or enhancement works beyond the aforementioned dates.</p> <p>Agree and noted.</p> <p>Agree. However, a plan is currently being devised.</p> <p>Agree.</p>
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<p>Stage 3 Trial Running, Trial Operations and Passenger Service</p>	<p>expected as the Programme approaches Passenger Service.</p> <p>The commissioning of ELR100 during the October 2021 Blockade has delivered substantial improvements in mileage achieved and reliability during subsequent Trial Running. This is encouraging for Trial Operations, with the Route Control Centre (RCC) now able to manage and recover faster from incidents. However, new issues continue to emerge, such as signalling interlocking at wayside locations, that might have previously been masked during Timetable Trials; this has resulted in two major suspensions of the railway. This issue is being urgently addressed between CRL and C620.</p> <p>Operational scenario testing has been carried out to simulate a 24 TPH service and has included the first 2½ minute headway exercise. While the initial results seem encouraging, the tests have been limited to 8 trains in service, and the true demonstration of 24 TPH running will be undertaken in early January 2022.</p> <p>CRL has commitment from its suppliers to have delivered all replacement VTs in December 2021, ahead of planned installation in the January 2022 Blockade. However, we understand that product testing continues for the tunnel versions, access arrangements need to be confirmed with NR for 3 VTs, and assurance</p>	<p>Agree. The WCU failure fix is part of the ELR110 Software upload during the Christmas period, and has been tested in the Over and Back testing that took place during the weekend of 10 December 2021, with no issues. Improvements have been made to the management of timetable implementation to avoid interface issues with the Network Rail timetables supplied from Milton Keynes. Issues with the redundant backup units for the Timetable Processor have also been addressed.</p> <p>Demonstration of 24TPH running service has been re-forecast to commence [REDACTED] later as a consequence of starting Trial Operations Phase 2 [REDACTED].</p> <p>The VT units have been successfully delivered to the various locations around the network. Between 31 December and 3 January 2022, all the VTs were replaced and tested, including three NR VTs, rectifying a key defect for entry into Trial Operations Phase 2.</p>
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	<p>evidence will need to be processed efficiently to meet the installation schedule.</p> <p>An updated access plan is required to address [REDACTED] that are becoming apparent, such as for VT installation in the Central Section. Access will also be required to address a recent concern with stalling TVS fans in congestion mode at certain locations. This will require [REDACTED], although it is not clear at present where [REDACTED] access can be made available, and other planned activities may be comprised. An update to the access plan is also expected to capture the works that are required between now and the start of Stages 5B and 5C.</p> <p>CRL has secured supplier commitment to install modifications that will rectify the PSD reliability issues that emerged during Trial Running, but resolution of the “close and lock” function still requires definition and agreement between stakeholders. The scope of this work has grown since it was first identified, and now not only requires physical modifications, but also software upgrades. Given that safety is paramount, resolution of this issue may not prove as straightforward as initially expected. However, it is acknowledged that this is not a critical delivery issue for Passenger Service, and final resolution can be deferred until after Stage 3 has opened.</p>	<p>The Intervention Access Plan workstream is an ongoing activity. Further TVS upgrades to resolve the fan stalling issue are provisionally booked to coincide with the ELR200 commissioning at Easter 2022. Recently inspected HV +ve cables at Stepney Green has confirmed the installations are in good order, such that a risk review has concluded the corresponding -ve cable tests do not need to be carried out, reducing the access burden by three days. Any short notice access requests are monitored along with productivity. Any deviations from the plan are discussed and mitigated as required and the overall status is presented at weekly PSSG forums.</p> <p>The revised design proposal for the PSD ‘closed and locked’ function has been agreed by the Occupational Health and Safety Administrator and TAG approved. CRL is currently working with the contractor on the delivery plan. In the interim, Software version 11 is being rolled out across the 16 platforms and is expected to complete in time for Trial Operations Phase 2. This includes the WNC+ link upgrade.</p>
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<p>Stations Commissioning and Handover</p>	<p>crank assemblies for Pudding Mill Lane Auto-Transformer Station (ATS) is planned in time for installation and ATS re-commissioning in early February 2022. Other issues, such as communications and control performance resilience and HV cable immersion tests vary in complexity and carry with them different risks to the achievement of both Trial Operations and Passenger Service, and all are being tracked to completion centrally by CRL.</p> <p>The Farringdon Station delivery team successfully achieved full completion of the Employers Completion Process (ECP), and contract completion was formally signed-off. CRL continues to manage the remaining stations to a similar close-out position within 90 days of BIU.</p> <p>Canary Wharf Station BIU will require the completion of cable replacement works, activities relating to certification for fire, lighting and mechanical elements, outstanding O&M Manuals, and LV distribution boards; closure of a significant number of Dependencies will also be necessary. Slippage of works beyond this date may threaten the start of Trial Operations Phase 2 in [REDACTED] January 2022.</p> <p>The Bond Street Station delivery team continues to drive the opening of the [REDACTED] by the end of [REDACTED] with supplier commitment to works completion by Christmas 2021.</p>	<p>Agree.</p> <p>All the actions and outstanding works which the Project Representative refers to at Canary Wharf station have been completed.</p> <p>[REDACTED]</p>
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<p>Assurance</p>	<p>Confirmation of the [redacted] opening date was expected at a Go/No Go meeting on 2 December 2021¹⁰. Concerns with additional testing and commissioning resources, and with statutory requirements, will need to be addressed to meet this date. [redacted] opening will be considered at the T-8 review.</p> <p>CRL and RfLI secured ITAP acceptance of the necessary safety submissions to achieve the start of Phase1 of Trial Operations on 20 November 2021. While the number of documents processed in a relatively short period was significant, RfLI determined that the assurance workload could be scaled-down to reflect the marginal change in safety risk associated with Phase 1, rather than the step-change in safety risk which will take place at the start of Phase 2. This had the effect of reducing overall workload (RfLI's in particular) to allow the Phase 1 target date to be met, but only by deferring scope into the already saturated critical period ahead of Trial Operations Phase 2.</p> <p>CRL remains focussed on the completion of VT, PSD and TVS works because these are critical safety systems, and evidence of successful installation and testing provides substantial support to the overall railway safety case. While the use of StEJ continues to benefit safety assurance delivery, it is unlikely that the process will be extended for entry into Passenger</p>	<p>[redacted]</p> <p>Agree. Significant effort has been applied to continue processing the safety assurance documentation with RFLI and ITAP to fully cover the mass evacuation exercises scheduled to take place during the second phase of Trial Operations and possible for initial Revenue Service as well. The agreed strategy is that all further updates to the SJs to address residual RFLI comments will be for a Revenue Service ready status. The changes to assets in the December blockade works will be addressed by the necessary assurance evidence going through the RFLI change process and captured in an updated COS SJ for the second phase of entry into Trial Operations and related Risk Statement Summary.</p> <p>The changes to assets in the December Blockade works will be addressed by the necessary assurance evidence going through the RFLI change process and captured in an updated COS SJ for the second phase of entry into Trial Operations and related Risk Statement Summary that gives the latest status against all SJ</p>
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<p>Future Stages</p>	<p>Service, when the expectation is that all residual safety-related issues from the Programme will be fully closed. The large workload that remains leads us to the view that completion of assurance delivery before the target start of Trial Operations Phase 2 will be challenging, with possible implications for earliest Passenger Service. In the meantime, CRL continues to assess the railway configuration for Passenger Service.</p> <p>Modelling of the Stage 5B and Stage 5C timetables has continued. The Stage 5B model now incorporates both of the NR surface sections and the Central Section and it can be updated as additional Central Section performance data becomes available. The model is undergoing further refinement, with a purpose of demonstrating the success factors that Stage 5B service requires from its assets and procedures. This is likely to assist in the commitment decision to Stage 5B opening.</p> <p>The Stage 5C modelling exercise is concentrating upon a service pattern that, to date, satisfies most stakeholders. NR and MTREL are expected to conclude modelling by January 2022 to support the submission date of [REDACTED] for the [REDACTED] timetable change.</p>	<p>Dependencies, whether fully closed or StEJ-mitigated for Trial Operations Phase 2. The same approach will then be applied to the dependencies from the updated SJs for Revenue Service. There will be StEJ-mitigated SJ dependencies against the initial Stage 3A Revenue Service that reflects the outstanding works at Cat 3 status - complete Post Revenue Service. This particularly reflects signalling, Communications and Control, Tunnel Vent Systems and Bond Street station works going forward for which safety-related issues need to have risk judgements applied as they cannot be fully closed.</p> <p>Noted.</p> <p>Network Rail has completed development of a four-hour timetable period incorporating changes to GWR off-peak services agreed with DfT designed to better enable the Elizabeth line Stage 5c service to operate reliably. This timetable will then be subject to performance modelling with results due by [REDACTED] February 2022 to support a</p>
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Appendix – CRL Response to Period 8 PRep Report

	<p>The key challenge facing all Stages is whether reliability growth can grow sufficiently fast to meet the implementation schedule. The fixes and reliability improvements in ELR100 have generally been successful, and the next layer of faults that are not expected to be resolved by ELR110, ELR200, ELR210 and other software upgrades, now needs to be addressed. Past experience has shown that not all of the fixes designed into software upgrades will be achieved, and resolution of extended Sectional Run Times provides an example. ELR100 was expected to reduce journey times overall by 90 seconds allowing contingency to be built into the timetable; the reduction achieved was 37 seconds, and this will need to be addressed in a software upgrade before Stage 5B.</p> <p>The delivery schedule assumes that a decision to commit to a [REDACTED] Stage 5B opening is made in late [REDACTED], which is the point at which MTREL and RfLI are likely to need evidence that a 24 TPH service can operate reliably. Meaningful Elizabeth Line revenue benefits will only be realised once Stages 5B and 5C are opened.</p>	<p>timetable bid for [REDACTED] in line with the Network Rail planning timeline.</p> <p>Service Performance of the railway is challenged by the layer of faults that have become prominent since Y0640 (ELR100) was commissioned in December 2021. Some of these are new, some fixes have been accelerated to ELR110, others are committed to later releases while others are under investigation with no fix yet committed. Sectional Run Times gain another fix in ELR200. Timetable loading issues are particularly challenging since Y0640, with mitigation actions demanding significant effort in the Control Room and timetable gaps exacerbating known issues with head codes. Fleet updates (H5.4) will improve performance in January 2022, together with upgrades being delivered by ELR110, TVS and PSD software. There is a considerable gap to close and performance will be reviewed in January 2022 as part of the gate decision to re-forecast the second phase of Trial Operations. The wider schedule for reliability growth will be reviewed at the same time.</p> <p>Whilst [REDACTED] is the target, Stage 5B can be implemented at any point between the May and December timetable change dates, with [REDACTED].</p>
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Crossrail Project Representative

Crossrail Joint Sponsor Team

Sponsor Summary

Project Status Report 157

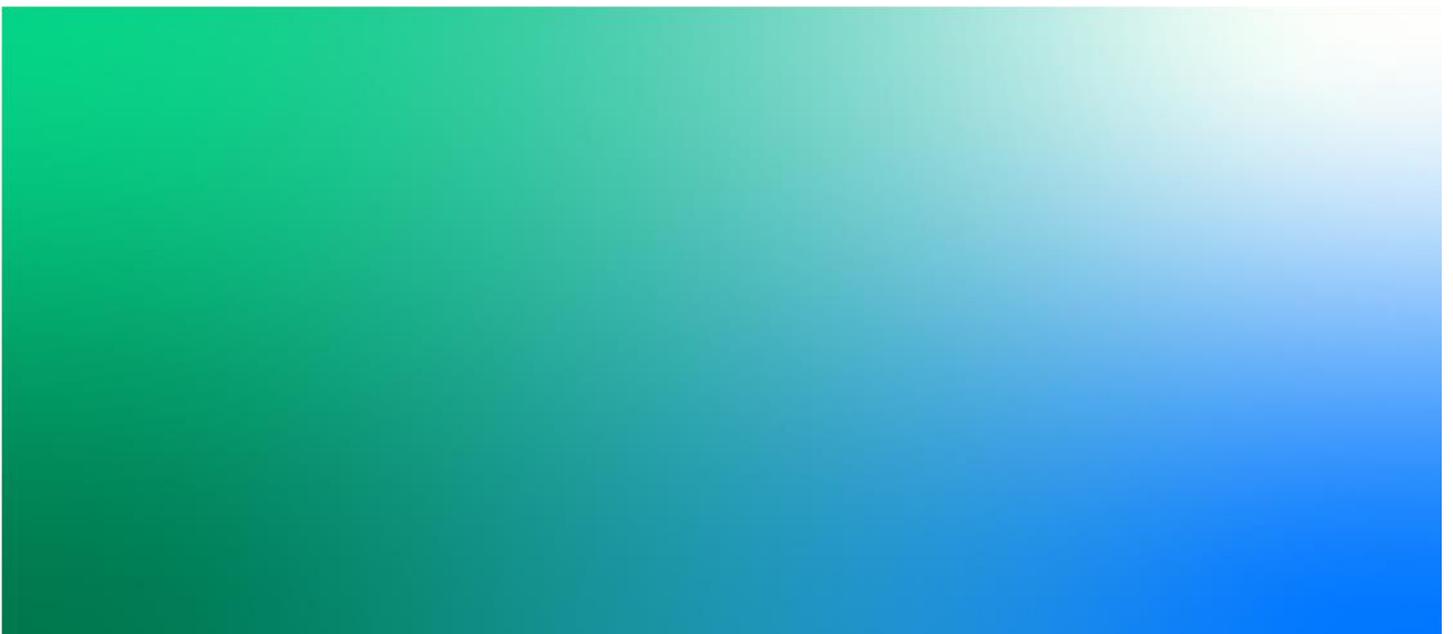
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Note: This report relies on the information set out in CRL's Period 8 reports augmented by more current information received by PRep during the course of our routine discussions with CRL since the Period close on 12 November 2021. Note that information emerging after the close of Period 8 is subject to formal confirmation by CRL in its Period 8 reports. This report is supplemented by our weekly reports to JST and regular meetings with JST staff.

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1.	6 December 2021	PSR 157 Period 8 FY 2021-22 Sponsor Summary v1.5 ~ Draft	████	████	████	████
2.	10 December 2021	PSR 157 Period 8 FY 2021-22 Sponsor Summary v1.9 ~ Final	████	████	████	████

Sponsor Summary

1. Headlines

1.1 Progress and Look Ahead

Entry into Trial Operations Phase 1 was achieved on 20 November 2021, as part of a phased approach to Trial Operations; while a notable milestone, it does not constitute 'full' Trial Operations. This is because railway infrastructure and associated safety assurance delivery has not yet been completed, requiring the deferral of mass evacuation exercises to Trial Operations Phase 2 in January 2022. Nevertheless, the phased approach to Trial Operations is pragmatic, allowing delivery momentum to be maintained, staff exercises to take place, and reliability to be built, pending completion of works.

Planning continues for the major works to be carried out prior to entry into Trial Operations Phase 2, currently scheduled for ■ January 2022. These include: Tunnel Ventilation System (TVS) works, Platform Screen Door (PSD) modifications, Voltage Transformer (VT) replacement and rolling stock and signalling software upgrades. Works access at the interfaces with NR is challenging and has the potential to impact the schedule. PSD modifications have become more protracted than CRL first anticipated, with safety being of prime concern. Three tests remain to confirm Auto-Reverse functionality, and these are scheduled for early January 2022. With sign-off of safety assurance for the use of Auto-Reverse functionality in passenger service proving challenging, alternative arrangements are being investigated including possible timetable changes and additional drivers.

Much of the success in CRL achieving Trial Operations Phase 1 was down to the safety assurance effort, particularly in the two weeks approaching the start date. The adoption of the two-phase approach to Trial Operations meant that the assurance requirements for entry were able to be reduced from those that would otherwise have applied. While this relieved the immediate workload and helped secure the 20 November 2021 milestone, it also had the effect of deferring the most problematic elements of submission delivery and review into the period ahead of the start of Phase 2 on ■ January 2022. As a consequence, much pressure remains on the completion of safety assurance in the available timescales, which includes the closure of approximately 500 EOWs before entry into Passenger Service¹; CRL is seeking to clarify the actual number. The safety assurance process is expected to undergo further review in Period 9, with CRL and RfLI looking to identify ways of ensuring that target dates can be met using the available resources. However, it is difficult to see where the necessary gains might be made, given the limited periods between completion of works, Trial Operations Phase 2, and Passenger Service, and deterministic dates are under threat.

Completion of Canary Wharf Station requires the delivery of LV electrical ACs and fire systems certification; inspections by the Fire Brigade are then necessary before an Authority to Use (ATU) can be issued. While CRL works closely with RfLI to achieve BIU, additional scope continues to emerge which increases the demands on the combined resources that remain and add to the existing pressure on the target date of ■ December 2021². Works completion, principally related to fire systems, cannot slip beyond the T-4 gate review scheduled for mid-December 2021 without likely impact upon entry into Trial Operations Phase 2. Further work is also expected after BIU to fully comply with RfLI requirements, and this has yet to be fully quantified. The station might not be

¹ Crossrail Weekly Performance Review, Week 2 Period 9 FY2021/22.

² ELDG meeting held on 9 December 2021 confirmed BIU slippage to ■ December 2021 (Slide No. 15).

completed in time for earliest Stage 3 Passenger Service, and the consequences of a partial opening are unclear. These uncertainties are applying further cost pressure.

The final configuration plan for Bond Street Station, its delivery, and the timing of BIU, was expected to be reviewed at a Go/No Go meeting on 2 December 2021, but the outcome is not yet known. CRL will consider the benefits of a [REDACTED]

[REDACTED]³. [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

The railway has generally performed well since the October 2021 Blockade. However, while the ELR100 and TVS commissionings have largely delivered the anticipated benefits, the railway is not performing at the levels expected for Trial Operations. There remains a range of legacy and unexpected emerging issues, which are conspiring to add to operator workload. Emerging issues, such as Timetable Processor and Wayside Cabinet Units, are causing the overall performance of the railway to be compromised; these are expected to be resolved with the implementation of ELR110.

RfLI is implementing the train software H5.3 on services to Heathrow Airport, to prove deployment and achieve a progressive roll-out onto the Elizabeth Line ahead of mid-December 2021; initial indications are that deployment has gone well. In combination with signalling software ELR110, H5.3 is planned to deliver significant reliability improvement⁴. However, given past performance further reliability growth delay is possible, which may yet have implications for entry to Stages 3 and 5B.

The deterministic date for the start of Stage 3 Passenger Service on [REDACTED] March 2022 is predicated on the completion of all remaining works, delivery of associated safety assurance and attainment of required levels of railway reliability; achievement of these will be challenging. As a result of starting Trial Operations Phase 1, CRL's P50 date for the start of Passenger Service improved slightly to [REDACTED] May 2022⁵, and the P80 date remains within the declared opening window of the first half of 2022. The success of the works up to early January 2022 will indicate whether Passenger Service is more likely to start on the P50 date. No change is indicated for the P50 date for Stage 5B opening of [REDACTED]; however, the P50 Stage 5C opening date has deteriorated by 6 days to [REDACTED], due to increasing reliability risk and the potential for additional software updates. There is a growing risk that the [REDACTED] date for Stage 5B opening will not be achieved, given the pressures on Stage 3 opening.

Sponsors' particular attention is drawn to the following:

- The Elizabeth Line is not in a safety-assured position for full Trial Operations, and there is limited time during Trial Operations Phase 2 for securing authority for entry into Passenger Service.
- Railway reliability growth relies heavily upon the success of critical rail system software upgrades, and scope for operational or schedule mitigation to meet target dates is limited.
- Finalisation of Canary Wharf Station completion scope remains challenging, and full station availability to support earliest Stage 3 Passenger Service opening is uncertain.
- The start dates for Passenger Service and Stages 5B and 5C are critically linked by reliability growth, and several technical issues remain beyond Stage 3 for resolution.

³ ELDG meeting held on 9 December 2021 confirmed [REDACTED].

⁴ Crossrail Weekly Dashboard, Week 4 Period 7.

⁵ Elizabeth Line Delivery Group Meeting held on 9 December 2021.

1.2 Health and Safety

One High Potential Near Miss was reported by CRL in Period 8, as a result of a lifting incident at Bond Street Station. Overall safety indicators remain within those set by the Programme. There have been several incidents of operational procedure non-compliance, and System Testing with a Train (STT) has been paused until a review has been completed and a plan to move forward is prepared.

2. Programme Overview

2.1 Schedule

Entry into Trial Operations Phase 1 was achieved on 20 November 2021. In practical terms, this allows CRL to continue and close-out workstreams previously allocated to the Trial Running period, and to start lower risk Trial Operations exercises and activities. There is no change to the Cardinal Milestone dates reported in Period 7.

The recent resequencing of activities to align with the two-phase approach shifts management focus and schedule pressure towards the start of Trial Operations Phase 2, and the start of the higher risk mass evacuation exercises, planned from the ■ January 2022. The schedule logic shows the completion of the supporting safety assurance pre-requisites, delivery of ELR110 software and upgrades to the TVS during the two December 2021 Blockades, as the main activities leading up to the start of Phase 2.

The main challenges to meeting the target start date of ■ March 2022 for Stage 3 Passenger Service are the completion of necessary works, delivery of safety assurance and the achievement of acceptable levels of railway reliability.

Canary Wharf Station delivery has slipped significantly against the schedule during the period. CRL has mitigated this by making this activity a predecessor to the start of Trial Operations Phase 2 rather than to Phase 1. The current forecast date for Canary Wharf Station BIU is ■ December 2021⁶. The Bond Street Station SC3 ROGS forecast date was to be agreed at a hold point meeting on 2 December 2021.

2.2 Commercial and Risk

CRL's Period 8 AFCDC is provisionally reported⁷ as stable at £15,939m. This is the seventh consecutive period that CRL has reported its forecast around £15,939m and £15,940m, suggesting ongoing stability and containment of emerging pressures. However, pressures continue to emerge, albeit from limited and identified cost centres, which we believe will be covered by risk and provision allowances; at Period 8, CRL reports these allowances to be ■■■■■.

The change to a two-phase approach to Trial Operations to accommodate delayed construction and assurance activities is affecting CRL's opportunity to avoid spending its prolongation risk. Although the COWD achieved in Period 8 was ■■■■■, CTG only reduced by ■■■■■; the remaining ■■■■■⁸ has been transferred from Risk and Provision allowances to offset emerging cost pressures. Milestone achievement is moving towards P50 dates and P50 risk provisions are likely to be drawn down.

⁶ ELDG meeting held on 9 December 2021 confirmed BIU slippage to ■■■■■ (Slide No. 15).

⁷ Executive Programme Performance Review, Part B meeting held on 1 December 2021.

⁸ Consequential rounding: CRL EPPR report ■■■■■ offset plus ■■■■■ transfer.

The Period 8 provisional AFCDC of £15,939m is £150m above the current funding threshold, and £125m under the £1,071bn funding request limit of £16,064m. The cumulative sum of Project, Programme and Prolongation Risk at Period 8 was reduced by ██████ to ██████. This reduction did not include retirement or elimination of risk but was mainly used to offset emerging cost pressures.

While demobilisation of the station Tier 1 contractors is maintaining schedule, the demobilisation of the routeway contractors will be affected by ██████ and the delivery of safety assurance associated with the TVS, VTs, PSDs and OHLE maintenance. In Period 8, this has resulted in new prolongation costs and may also create potential new risks.

2.3 Organisation

CRL continues to monitor its resource levels. CRL's full time equivalent resource in Period 8 is forecast at 978, against a Period 7 total of 956⁹. CRL continues to forecast that demobilisation will continue into Period 10, aligned to a reduced organisation structure in early 2022. A more significant drop-off in its resources is forecast in Periods 12 and 13 which is aligned with the deterministic date for the start of Passenger Service, and with the new operating structure for the Elizabeth Line, in which CRL only provides programme close-out support.

Demobilisation of the station Tier 1 contractors continues according to the schedule, with four stations now fully demobilised, and with Paddington Station partially demobilised. The balance of the Tier 1 contractors have agreed plans for demobilisation by the end of 2021. Significant resource levels remain at Bond Street, Canary Wharf and Whitechapel Stations, and with Routeway and C660.

As CRL transfers responsibility for ownership and operation of the railway to RfLI, CRL will progressively reduce its own meeting workload and reporting requirements. This is to be expected as the Programme approaches Passenger Service.

2.4 Stage 3 Trial Running, Trial Operations and Passenger Service

The commissioning of ELR100 during the October 2021 Blockade has delivered substantial improvements in mileage achieved and reliability during subsequent Trial Running. This is encouraging for Trial Operations, with the Route Control Centre (RCC) now able to manage and recover faster from incidents. However, new issues continue to emerge, such as signalling interlocking at wayside locations, that might have previously been masked during Timetable Trials; this has resulted in two major suspensions of the railway. This issue is being urgently addressed between CRL and C620.

Operational scenario testing has been carried out to simulate a 24 TPH service and has included the first 2½ minute headway exercise. While the initial results seem encouraging, the tests have been limited to 8 trains in service, and the true demonstration of 24 TPH running will be undertaken in early January 2022.

CRL has commitment from its suppliers to have delivered all replacement VTs in December 2021, ahead of planned installation in the January 2022 Blockade. However, we understand that product testing continues for the tunnel versions, access arrangements need to be confirmed with NR for 3 VTs, and assurance evidence will need to be processed efficiently to meet the installation schedule.

An updated access plan is required to address ██████ that are becoming apparent, such as for VT installation in the Central Section. Access will also be required to address a recent concern with stalling TVS fans in congestion mode at certain locations. This will require ██████,

⁹ CRL Executive Group meeting held on 16 November 2021.

although it is not clear at present where [REDACTED] access can be made available, and other planned activities may be comprised. An update to the access plan is also expected to capture the works that are required between now and the start of Stages 5B and 5C.

CRL has secured supplier commitment to install modifications that will rectify the PSD reliability issues that emerged during Trial Running, but resolution of the “close and lock” function still requires definition and agreement between stakeholders. The scope of this work has grown since it was first identified, and now not only requires physical modifications, but also software upgrades. Given that safety is paramount, resolution of this issue may not prove as straightforward as initially expected. However, it is acknowledged that this is not a critical delivery issue for Passenger Service, and final resolution can be deferred until after Stage 3 has opened.

Testing for the Auto-Reverse functionality has been paused in the period, because safety mitigations have not yet been agreed and documented in a revised final safety argument. However, an interim way forwards has been agreed that will address stakeholders concerns and will allow the 3 remaining tests to take place in early January 2022. While Auto-Reverse functionality is not required for entry into Passenger Service, it is for Stage 5B. [REDACTED]

Further improvement in railway performance is expected with the deployment of ELR110 in December 2021, and the H5.3 train software update; this has been deployed on the simulator and is already being trialled on Heathrow Airport services. The H5.3 train reliability improvement software remains on plan for deployment on the fleet to run in the Central Section from 17 December 2021. The contractor is predicting a sharp rise in performance from January 2022, but we remain cautious as to whether the anticipated improvements will be delivered in full.

CRL continues to manage a wide range of rail systems issues. A working group established to address excessive RCC alarms is making encouraging progress, with approximately 900 erroneous alarms now addressed. Delivery of crank assemblies for Pudding Mill Lane Auto-Transformer Station (ATS) is planned in time for installation and ATS re-commissioning in early February 2022. Other issues, such as communications and control performance resilience and HV cable immersion tests vary in complexity and carry with them different risks to the achievement of both Trial Operations and Passenger Service, and all are being tracked to completion centrally by CRL.

2.5 Stations Commissioning and Handover

The Farringdon Station delivery team successfully achieved full completion of the Employers Completion Process (ECP), and contract completion was formally signed-off. CRL continues to manage the remaining stations to a similar close-out position within 90 days of BIU.

Canary Wharf Station BIU will require the completion of cable replacement works, activities relating to certification for fire, lighting and mechanical elements, outstanding O&M Manuals, and LV distribution boards; closure of a significant number of Dependencies will also be necessary. Slippage of works beyond this date may threaten the start of Trial Operations Phase 2 in [REDACTED] January 2022.

The Bond Street Station delivery team continues to drive the opening of the [REDACTED] by the end of [REDACTED] with supplier commitment to works completion by Christmas 2021. Confirmation of the [REDACTED] opening date was expected at a Go/No Go meeting on 2 December 2021¹⁰. Concerns with

¹⁰ ELDG meeting held on 9 December 2021 indicated that the [REDACTED].

additional testing and commissioning resources, and with statutory requirements, will need to be addressed to meet this date. [REDACTED] opening will be considered at the T-8 review.

2.6 Assurance

CRL and RfLI secured ITAP acceptance of the necessary safety submissions to achieve the start of Phase 1 of Trial Operations on 20 November 2021. While the number of documents processed in a relatively short period was significant, RfLI determined that the assurance workload could be scaled-down to reflect the marginal change in safety risk associated with Phase 1, rather than the step-change in safety risk which will take place at the start of Phase 2. This had the effect of reducing overall workload (RfLI's in particular) to allow the Phase 1 target date to be met, but only by deferring scope into the already saturated critical period ahead of Trial Operations Phase 2.

CRL remains focussed on the completion of VT, PSD and TVS works because these are critical safety systems, and evidence of successful installation and testing provides substantial support to the overall railway safety case. While the use of StEJ continues to benefit safety assurance delivery, it is unlikely that the process will be extended for entry into Passenger Service, when the expectation is that all residual safety-related issues from the Programme will be fully closed. The large workload that remains leads us to the view that completion of assurance delivery before the target start of Trial Operations Phase 2 will be challenging, with possible implications for earliest Passenger Service. In the meantime, CRL continues to assess the railway configuration for Passenger Service.

2.7 Future Stages

Modelling of the Stage 5B and Stage 5C timetables has continued. The Stage 5B model now incorporates both of the NR surface sections and the Central Section and it can be updated as additional Central Section performance data becomes available. The model is undergoing further refinement, with a purpose of demonstrating the success factors that Stage 5B service requires from its assets and procedures. This is likely to assist in the commitment decision to Stage 5B opening.

The Stage 5C modelling exercise is concentrating upon a service pattern that, to date, satisfies most stakeholders. NR and MTREL are expected to conclude modelling by January 2022 to support the submission date of [REDACTED] for the [REDACTED] timetable change.

The key challenge facing all Stages is whether reliability growth can grow sufficiently fast to meet the implementation schedule. The fixes and reliability improvements in ELR100 have generally been successful, and the next layer of faults that are not expected to be resolved by ELR110, ELR200, ELR210 and other software upgrades, now needs to be addressed. Past experience has shown that not all of the fixes designed into software upgrades will be achieved, and resolution of extended Sectional Run Times provides an example. ELR100 was expected to reduce journey times overall by 90 seconds allowing contingency to be built into the timetable; the reduction achieved was 37 seconds, and this will need to be addressed in a software upgrade before Stage 5B.

The delivery schedule assumes that a decision to commit to a [REDACTED] Stage 5B opening is made in late [REDACTED] which is the point at which MTREL and RfLI are likely to need evidence that a 24 TPH service can operate reliably. Meaningful Elizabeth Line revenue benefits will only be realised once Stages 5B and 5C are opened.