



Independent review of Crossrail – Financial and Commercial

Prepared for TfL and DfT

23 January 2019

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Independent review of Crossrail
Financial and Commercial matters



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Glossary

AFDCD	Anticipated Final CRL Direct Cost
AFC	Anticipated Final Cost
ARM	Active Risk Management
BRS	Business Rate Supplement
CBTC	Communications Based Train Control
CCR	Cost Consideration Report
CCSA	Contract Commercial Status Analysis
CCSC	Commercial and Change Sub-Committee
CD	Commercial Director
CEO	Chief Executive Officer
CFO	Chief Finance Officer
CMS	Central Management System
COS	Central Operating Section
COWD	Cost of Works Done
CRL	Crossrail Limited
DfT	Department for Transport
DOO	Driver Only Operation
EIC	Executive and Investment Committee
ELRB	Elizabeth line Readiness Board
ELSSG	Elizabeth line Strategic Steering Group
FD	Finance Director

FLU	Full Length Unit
FRC	Financial Reporting Council
GLA	Greater London Authority
H&S	Health & Safety
HMG	Her Majesty's Government
HMT	Her Majesty's Treasury
IAAP	Integrated Assurance and Approval Plan
IA	Internal Audit
ICE	Institution of Civil Engineers
IM	Infrastructure Manager
IP	Intervention Point
IPA	Infrastructure and Projects Authority
JST	Joint Sponsor Team
KPI	Key Performance Indicator
LUL	London Underground Limited
MD	Managing Director
MTR	MTR Corporation (Crossrail) Limited
MOHS	Master Operational Handover Schedule
NEC	New Engineering Contract
NED	Non-Executive Director
NR	Network Rail
ONW	On Network Works

ODA	Olympic Delivery Authority
OSEP	Operations and Systems Expert Panel
PCD	Programme Controls Director
PDA	Project Development Agreement
PDB	Programme Delivery Board
PM	CRL Project Manager
P Rep	Project Representative
QCRA	Quantitative Cost Risk Analysis
QRA	Quantified Risk Assessment
RAP	Remedial Action Plan
RemCo	Remuneration Committee
RfL	Rail for London
RfLI	Rail for London Infrastructure
RLU	Reduced Length Unit
SA	Sponsor Agreement
SACR	Semi Annual Construction Report
SB	Sponsor Board
SC	Staged Completion
SoS	Secretary of State
SQRA	Schedule Quantified Risk Assessment
TCR	Tottenham Court Road Station
TEV	True Expected Value

TfL	Transport for London
TOSD	Tier One Contractor Substantial Demobilisation
tph	Trains per hour
URT	Unresolved trends

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Important notice

This Report has been prepared on the basis set out in the Call-Off Agreement with Transport for London ('TfL') and the Department for Transport ('DfT') collectively and individually ('the Client') dated as commencing 21 September 2018 (the 'Services Contract'), and should be read in conjunction with the Terms of Reference prepared by TfL.

Nothing in this report constitutes a valuation or legal advice nor an audit of the project.

In accordance with the Terms of Reference, KPMG has been requested by the Sponsors to make recommendations in relation to the financial and commercial management of the delivery entity, CRL.

Our recommendations include references to 'CRL should' or 'CRL to', such terminology is used throughout this document. These recommendations have been provided solely for the benefit of the Client alone, these recommendations have not been prepared for the benefit of any other entity nor for any other person or organisation who may have a role in the implementation of any recommendation.

We have not verified the reliability or accuracy of any information obtained in the course of our work, other than in the limited circumstances set out in the Terms of Reference and except where expressly stated in this Report.

This Report has not been designed to be of benefit to anyone except the Client. In preparing this Draft Report we have not taken into account the interests, needs or circumstances of anyone apart from the Client, even though we may have been aware that others might read this Draft Report. We have prepared this Report for the benefit of the Client alone.

This Report is not suitable to be relied on by any party wishing to acquire rights against KPMG LLP (other than the Client) for any purpose or in any context. Any party other than the Client that obtains access to this Report or a copy (under the Freedom of Information Act 2000, the Freedom of Information (Scotland) Act 2002, through the Client's Publication Scheme or otherwise) and chooses to rely on this Report (or any part of it) does so at its own risk. To the fullest extent permitted by law, KPMG LLP does not assume any responsibility and will not accept any liability in respect of this Report to any party other than the Client.

In particular, and without limiting the general statement above, since we have prepared this Report for the benefit of the Client alone, this Report has not been prepared for the benefit of any other local authority or transportation authority nor for any other person or organisation who might have an interest in the matters discussed in this Draft Report, including for example those who work in the transportation sector or those who provide goods or services to those who operate in the transportation sector.

The contents of this document include matters which are commercially sensitive to TfL, Crossrail Limited (CRL) and potentially other parties and disclosure of this document in its entirety would, or would be likely to, prejudice the commercial interests of TfL, its subsidiary companies and / or other parties

1 Executive summary

1.1 Introduction

1.1.1 Background

At the end of August 2018 Crossrail Limited (CRL) announced that the opening of Stage 3, the Central Operating Section (COS), of the Crossrail project (the project) would be delayed from December 2018 to Autumn 2019. An Adverse Event Notice, in accordance with clause 22 of the Project Development Agreement (PDA), was issued to Sponsors on 30 August 2018.

Transport for London (TfL), a joint sponsor with the Department for Transport (DfT), appointed KPMG on behalf of both Sponsors in late September 2018 to carry out two independent reviews of the Project.

Prior to the appointment of KPMG and after receipt of the Adverse Event Notice, the Sponsors requested CRL to prepare a Remedial Action Plan (RAP 1). It was issued on 18 September 2018 and was followed by an update (RAP 2) on 2 October 2018. RAP 1 and RAP 2 are jointly referred to as the 'RAP' in this report.

KPMG was asked by Sponsors to review RAP 1 shortly after it was released in September 2018. This review is guided by the Terms of Reference provided by the Sponsors to assess the reliability and robustness of the revised schedule and cost put forward by CRL. RAP 2 was issued during the course of our assessment and extended the scope of our review to include RAP 2.

CRL was also at the time of our fieldwork updating its Master Operational Handover Schedule (MOHS) that was due to be issued in October 2018. However, at the time of finalising our fieldwork in December 2018 the updated MOHS had not been issued and our reports do not take into consideration any time or cost information other than that contained within the RAP documents except where expressly stated in this report.

1.1.2 Scope of KPMG's work

The scope of our reviews were separately defined in two sets of Terms of Reference:

- Financial and commercial independent review;
- Governance independent review.

This draft report addresses the financial and commercial Terms of Reference (which are set out at Appendix 1). Our governance review is covered in a separate report.

1.1.3 This report

This report has considered the particular financial and commercial implications arising from the current stressed¹ status of the Crossrail project, and from the uncertain project cost and completion timelines. The scope of work we were asked to address in our review of financial and commercial matters, is attached as Appendix 1. It is important to note the scope requires that this review should address "*CRL's assessment of the ongoing funding requirement, cash forecast and commercial and governance arrangements*". In addressing the ongoing requirements we were guided to have regard to the preceding 12 months.

Accordingly this report does not seek to review the operation of CRL or its funding, cash forecast, commercial management and governance arrangements in earlier years. We note the many reported

¹ "Stressed" in terms of the project having needed on 10 December 2018 to significantly change expectations as to outturn timeline for Stage 3 Opening and as to cost, and the related significant uncertainties and related challenges which remain to be addressed

achievements of the Crossrail project in its journey and inter alia the Crossrail Learning Legacy it has shared.

An important objective of this report is to help Sponsors to identify the steps required to be taken at pace to enable CRL to move forward strongly from the current stressed status of the project to help it to achieve its objectives with a particular emphasis on completion time and cost.

The findings and recommendations presented in this report reflect fieldwork which concluded on Friday 7 December 2018. The report has not been updated for new information released after this date save for making reference to TfL's press statement issued on the morning of 10 December 2018.

This report and the recommendations contained within it have been drafted in line with the direction of the Terms of Reference, the focus being on identifying improvements to financial and commercial arrangements to address the specific challenges now facing the Crossrail project. Changes to the financial and commercial arrangements for the Crossrail project have to take into account historical issues but must also, in particular, be designed to meet the needs of the remaining programme of work. Enhanced financial and commercial arrangements need to be designed to provide Sponsors and stakeholders with confidence that CRL will complete the project within the newly defined affordability envelope, as well as within revised timelines which are still subject to development by CRL and agreement with Sponsors. CRL will also need to agree with Sponsors that updated financial and commercial frameworks of control and oversight are in place and operating effectively. These same arrangements must also provide CRL, as the organisation responsible for the delivery of Crossrail, with the freedoms necessary to address programme delivery issues, manage timely and cost effective delivery to completion, and manage complex integration challenges.

The programme performance issues and the recent announcements of programme cost overruns and delays mean that trust and confidence between Sponsors and CRL has been weakened. Revised governance structures addressed in our separate report on governance matters should work alongside action already taken by Sponsors and CRL to enhance CRL management and to help rebuild trust. Transparency and open communication between Sponsors and CRL will be critical in underpinning the structural recommendations both in this report and in our separate report addressing the governance Terms of Reference.

Action to address the recommendations contained in this report is required as soon as possible so that revised arrangements are in place and operating to support Sponsors, the CRL Board and CRL Executive team.

The work we have performed during the course of this independent review, leads us to consider the most probable outturn is that the Anticipated Final CRL Direct Cost (AFCDC) will lie somewhere between the mid-range and the pessimistic scenario (see 1.7.2.2 and Section 4) i.e. requiring additional funding of between £1.6bn and £2.0bn² respectively over and above the IP 2 limit. The outturn cost which will actually be achieved critically depends on:

- The extent to which appropriate steps are rapidly taken by Sponsors and CRL to address the issues covered in this report, and in our related governance report, which are the basis for our recommendations provided to Sponsors for consideration; and
- Whether additional significant risks materialise which have a material impact and which have not already been identified by CRL within its RAP 2 document.

Prior to taking account of the impact of appropriate and timely actions being taken in response to the issues highlighted in this report, and in our governance report, we consider there to be around an 80% likelihood that costs will be contained below the pessimistic scenario.

[REDACTED]. To achieve Stage 3 opening by [REDACTED] CRL is investigating targeting those systems essential to

² The pessimistic scenario of an additional £2.0bn of funding over the IP 2 limit (£12.5bn for AFCDC) equates to an outturn AFCDC of £14.5bn

opening, leaving non-essential systems to be completed after opening, but we expect such related post-opening costs should be able to be contained within the pessimistic scenario within our sensitivity analysis assuming Stage 3 opening occurs in or close to [REDACTED] and assuming delays in achieving tier one contractor³ substantial demobilisation are sufficiently managed.

The achievable Stage 3 opening date is a function of many unknowns as well as the steps being and to be taken by CRL to de-risk that date [REDACTED]

[REDACTED]. In the event the Stage 3 opening date were to slip materially later than [REDACTED] accompanied by added delay to substantial demobilisation of the principal contracts, there is a significantly reduced likelihood that costs will be contained below the pessimistic scenario.

1.2 Crossrail programme – history and context

The Crossrail Act 2008 permitted the construction of the Crossrail railway from Maidenhead and Heathrow in the west to Shenfield and Abbey Wood in the east, with new rail tunnels (and stations) under central London as required. The funding deal for the scheme was complex but the basic principle was simple – the cost would be shared between the Government, TfL and the business community.

Crossrail broke ground on 15 May 2009 at Canary Wharf, when the Mayor and the Transport Secretary launched the first pile into the North Dock in Docklands at the site of the new Canary Wharf station.

In 2010, the Government's Comprehensive Spending Review confirmed savings of over £1bn in projected Crossrail costs. This was reported as due chiefly to a revision of the tunnelling strategy⁴ and due to "improved station and engineering solutions and a more efficient construction timetable"⁵. This meant that Crossrail services would commence through the COS in 2018 rather than 2017, followed by a phased introduction of services across the rest of the route, but it also allowed the funding envelope needed to deliver Crossrail to be reduced to £14.8⁶bn from £15.9bn.

Crossrail tunnelling began in May 2012 and ended in May 2015. As noted above, we have not been asked to review the overall Crossrail project and its many achievements. For context we note from Crossrail's own website⁷ that it summarises the project as follows:

"Crossrail is among the most significant infrastructure projects ever undertaken in the UK. From improving journey times across London, to easing congestion and offering better connections, Elizabeth line will change the way people travel around the capital."

It also notes the following general information:

- ***"Crossrail Limited is building the Elizabeth line - a new railway for London and the South East, running from Reading and Heathrow in the west, through 42km of new tunnels under London to Shenfield and Abbey Wood in the east."***
- ***The Crossrail project is currently Europe's largest infrastructure project.***
- ***The new railway, which will be known as the Elizabeth line when services begin through central London, will be fully integrated with London's existing transport network and will be operated by Transport for London.***
- ***The Elizabeth line will stretch more than 60 miles / over 100km from Reading and Heathrow in the west through central tunnels across to Shenfield and Abbey Wood in the east.***
- ***An estimated 200 million annual passengers will use Crossrail.***
- ***The Elizabeth line will serve 41 stations including 10 new stations at Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street, Whitechapel, Canary Wharf, Custom House, Woolwich and Abbey Wood.***

³ Including tier one contractor supply chains

⁴ <http://www.crossrail.co.uk/route/crossrail-from-its-early-beginnings>

⁵ Crossrail Limited: Programme Overview Report, December 2010

⁶ Including NR ONW and Depot costs

⁷ Elements of this sub-section are drawn from the contents of the CRL website as at December 2018

- **Construction of the new railway will support regeneration across the capital and add an estimated £42bn to the economy of the UK.**
- **Over 130 million working hours have been completed on the Crossrail project so far.”**

We note that CRL management has highlighted to us “*the many years of successful delivery, the completion of the largest ever tunnelling works, station civil works, [and] implementation of much of the highly complex track, including floating track slab works, through the centre of London with very little disruption*”.

The project has been subject to reviews and independent scrutiny. One such example was a July 2014 Public Accounts Committee (PAC) report. The PAC July 2014 report noted “*The Crossrail programme is proceeding well and is on course to deliver value for money to the taxpayer. The joint sponsors of the Crossrail programme, the Department for Transport (the Department) and Transport for London, are working well with the delivery organisation, Crossrail Limited, to deliver the programme, which at present is broadly on schedule and being delivered within budget*”. This report however cautioned that “*construction is not yet complete, and considerable risks remain in delivering the programme by 2019, particularly managing the transition from building the railway to operating it, and delivering the Crossrail trains*”.

In the same year a National Audit Office (NAO) report noted that “*During the construction phase, the governance arrangements and oversight of the project have ensured tight management of the programme so that delivery to both cost and schedule are well managed.*”

The NAO 2014 report also noted a need to consider the future transition from construction to operations. It recommended that “*the Department [DfT] now needs to [f]inalise its plans for the development of governance arrangements as appropriate for the transition from construction to operations, over the next five years. The Department should work with Transport for London, Crossrail Limited and Network Rail to produce a transition plan of similar clarity to the founding programme agreements.*”

During interviews for this report the DfT noted that following the NAO recommendations, action⁸ had been taken to consider the future governance arrangements required for the transition from construction to operations.

This report has considered the particular governance implications arising from the departure from “business as usual” to the current stressed status of the Crossrail project, including from the uncertain project cost and completion timelines.

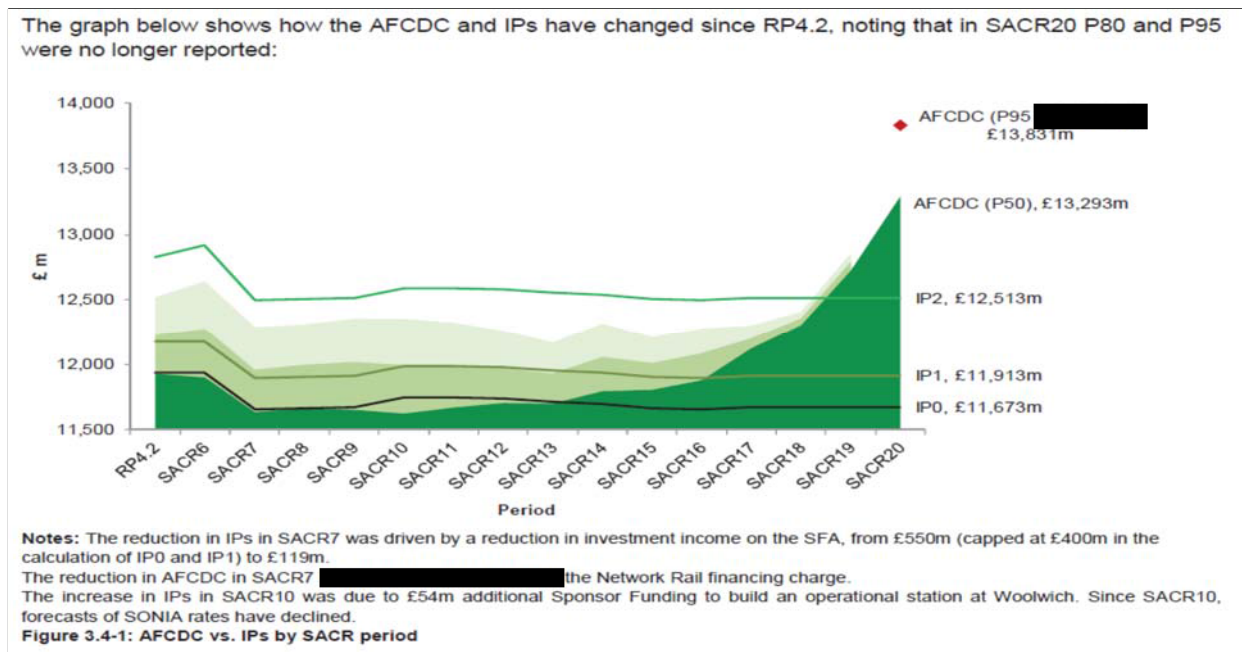
With regard to forecast outturn cost, we note that CRL’s recent 6 monthly Semi-Annual Construction Report (SACR) 20⁹ report summarises the Anticipated Final CRL Direct Costs (AFCDC) as reported over the last 7 years or so. We note that total Crossrail Project costs (which had an affordability envelope of £14.8bn) comprise in addition to AFCDC, the Network Rail (NR) On Network Works (ONW) costs and Depot costs. This report is only concerned with matters related to AFCDC.

The reported AFCDC over the last 7 years or so, is set out in the graph at Figure 1 culminating in the recent increase in AFCDC referred to under section 1.3. The graph shows the reported AFCDC in each SACR report (these are produced 6 monthly). The dark green area represents what was reported as P50, and the lighter greens, P80 and P95 which have converged as the project has progressed. One can see significant increases in reported P50 AFCDC after SACR 16, and in reported P95 AFCDC after SACR 18, based on the graph.

⁸ It was not part of our Terms of Reference to review actions taken in response to the NAO 2014 report and we have not sought to do so.

⁹ SACR 20 covers the period from 1 April to 15 September 2018

Figure 1: Crossrail - Change in AFCDC and Intervention Points (IPs) since RP4.2 in May 2011



Source: SACR 20

Note: Each SACR covers a 6 month period ending March or September with SACR 20 being the period 1 April to 15 September 2018. The P50 number of £13,293m shown in the above graph (as extracted from SACR 20) was the AFCDC P50 value reported by CRL in its Period 06 Board Report. SACR 20 used the P95 [redacted] dates value of £13,831m, as agreed with Sponsors as the AFCDC for the purposes of SACR 20. This reflected the latest information available through RAP2.

1.3 Recently announced outturn cost and funding

CRL has recently announced a significant increase in cost to completion and the delayed opening of the Elizabeth line. To complete the project, there remains significant work to be performed, in particular the completion of the stations, train testing, systems integration and transition to operations. At the time we were completing our fieldwork, CRL was developing a revised MOHS and estimated cost to completion.

On 26 October 2018, the Government announced, as an interim measure, that £350 million of short term repayable financing would be made available to the Mayor for the year 2018_19. The purpose was to “ensure that full momentum is maintained behind Crossrail”.

On 10 December 2018 TfL issued a press release which stated inter alia:

“The emerging findings of the KPMG review into Crossrail Ltd’s finances indicate the likely capital cost impact of the delay to the project announced in August could be in the region of between £1.6bn and £2bn¹⁰. That includes the £300m already contributed by the Department for Transport (DfT) and TfL in July 2018, leaving an estimated £1.3bn to £1.7bn to complete the project.

The Mayor of London and the Government have agreed a financial package to cover this. The Greater London Authority (GLA) will borrow up to £1.3bn from the DfT. The GLA will repay this loan from the existing Business Rate Supplement (BRS) and Mayoral Community Infrastructure Levy (MCIL). The GLA will also provide a £100m cash contribution, taking its total contribution to £1.4bn which it will provide as a grant to TfL for the Crossrail project.

¹⁰ This equates to a forecast outturn AFCDC of £14.1bn to £14.5bn respectively, as compared with a budget of £12.5bn.

Because the final costs of the Crossrail project are yet to be confirmed, a contingency arrangement has also been agreed between TfL and the Government. This will be in the form of a loan facility from the DfT of up to £750m, should the higher end of the estimate be realised.

This combined financing deal will replace the need for the £350 million interim financing package offered by the Government in October.”

1.4 CRL Board changes

Changes have already been implemented with regard to CRL leadership. The Chair of the CRL Board has resigned, a replacement is being sought, and there is a new Executive management team in place within CRL. The new Chief Executive Officer (CEO) and Finance Director (FD)¹¹, are both TfL secondees, appointed at the behest of Sponsors.

1.5 Principles and report assumptions

A set of principles guided the development of the recommendations in this report. The principles are derived from the assessment of the current project status, the current operation of the financial and commercial arrangements and the specific requirements of the forward programme. As such the recommendations in this document should do the following:

- Reflect the stressed status¹² of the project.
- Support the rebuilding of trust between Sponsors, CRL Board and CRL Executive.
- Deal with any identified deficiencies in the current financial and commercial arrangements in the context of the situation in which the programme now finds itself.
- Support increased transparency at all levels of the programme.
- Be forward looking, aimed at supporting the project through to completion.
- Be proportionate and practicable. Recommendations must be capable of implementation within timeframes that have a practical and timely effect on the project.
- Maintain clarity and separation of Sponsor and CRL roles.

The following assumptions informed the recommendations contained in this report:

- Sponsors will agree additional funding facilities sufficient to cover the expected costs of the effective execution of the balance of the programme, together with appropriate mechanisms for bearing risk and holding contingency.
- Neither Sponsor has, nor will choose to exercise its “Put” and “Call” rights at this stage.
- Sponsors will remain jointly accountable for the overall programme. The joint Sponsor Board (SB) will continue. Sponsors will not assume formal delivery responsibility.
- CRL will remain the responsible body for the completion of the project in line with the responsibilities articulated in the PDA, this includes management and integration of the whole programme to deliver an operational railway. The CRL Board will continue, but with potential revisions in composition and autonomy.
- Sponsors have confirmed that the CRL Board and Executive team will be given the opportunity and responsibility to address the current issues and deliver the remaining programme.

¹¹ We have used FD to refer to the role of Finance Director previously held by Mathew Duncan but note that David Hendry appointed with similar responsibilities holds the title of CFO. We have used the term ‘FD’ to refer to either the previous FD role or the new CFO role.

¹² “Stressed” in terms of having needed on 10 December 2018 to significantly change expectations as to outturn timeline for Stage 3 Opening and as to cost, and the related significant uncertainties and related challenges which remain to be addressed.

1.6 Our overall approach

Our overall approach to addressing the financial and commercial Terms of Reference was to review documentation provided by CRL and TfL, and hold interviews with certain senior CRL staff, as well as with CRL project managers (PMs) and business managers for the significant live contracts within the Crossrail project. Whilst we had access to certain information received by CRL from Contractors, such as copies of Contractor programmes as provided to CRL, it was not part of our Terms of Reference to seek information direct from Contractors.

The main stages of our review in addressing each element of our Terms of Reference were to address the following:

- Consider the status of the project programme, including contract inter-dependencies.
- Review the costs estimates within RAP1 and RAP2.
- Review the risks, uncertainties, assumptions and exclusions within CRL's estimates and forecasts within the RAP.
- Carry out a review of CRL's funding model.
- Review financial and commercial contract control and governance processes.
- Complete such other tasks as were relevant to our Terms of Reference.

Our overall findings and critical recommendations are summarised at Section 1.7 below followed by our observations and recommendations on moving forwards at Section 1.8. An introduction and additional information on our approach is contained at Sections 2 and 3 respectively. Our detailed findings and the full detail of all our recommendations are set out in the supporting Sections 4 to 12 and in the appendices. For a full understanding of the matters considered the reader should consult the relevant sections and appendices as appropriate.

1.7 Overview of key findings and critical recommendations

1.7.1 General points

Our findings, as previously noted, are drawn from a review of documents and information provided which principally relates to the 12 months up to our fieldwork. In this Executive Summary we have set out an overview of key findings together with critical recommendations. After each critical recommendation we have included the recommendation number in brackets so that the reader can consult the detailed recommendation in Sections 4-12 where, in many cases, there is significant additional detail as well as further recommendations, sometimes related.

The drafting of a detailed recommendation means that we have concluded a change is required either because Crossrail's needs have changed given the project is no longer in a "business as usual" state, or because we found evidence / examples that an important control or process was missing or was not designed and / or operating in line with good practice. The inclusion of a finding / recommendation does not therefore mean that the area has not been operating appropriately throughout the entire Crossrail programme, but it does mean that a change / improvement is now, in our view, needed.

1.7.2 Schedule, Cost and Risk

1.7.2.1 Programme

We reviewed the RAP 1 and RAP 2 timelines to determine the robustness of the dates put forward by CRL for the completion and opening of Stage 3, the Central Operating Section (COS).

RAP 1 presented high level timelines for three schedule scenarios; we focused our review on schedule scenario 2, the preferred CRL schedule option. We examined the critical path which runs through dynamic testing and our further analysis established the critical dependencies and other key risks to the programme.

We also considered the extent to which the RAP incorporated the recommendations in the Rannachan¹³ and Boss¹⁴ reports.

For RAP 2, the emphasis was on the assumptions made for dynamic testing and the tier one contractors' substantial demobilisation dates. RAP 2 introduced the concept of [REDACTED] dates for each of the principal live contracts and we focused our review on testing the robustness of these dates by examining the planning process and assessment of risks used to arrive at the [REDACTED] dates.

We also examined the contractors' schedules focusing on the 13 principal live contracts for the routeway, stations and systemwide. We interviewed CRL staff to validate the schedule risks and assumptions made in producing the RAPs, and to identify any gaps in the CRL senior management's and PMs' views on the achievability of the contracts key dates.

Within RAP 1 and RAP 2, the proposed MOHS is presented as a high level timeline, not a detailed bottom up schedule. Our review of the RAP 1 timeline identified a lack of evidence that the critical dependencies, in particular the dependencies outside of CRL's direct control, had been adequately addressed in the proposed programme showing the Stage 3 opening in July 2019.

The RAP 2 timeline shows a target [REDACTED] and attempts to address the critical dependency risks by introducing [REDACTED] dates which includes an "assumed increase of [REDACTED] in the period needed for dynamic testing along with an increase in the duration of Trial Operations from [REDACTED]"¹⁵. We note significant uncertainty remains around the likely timing of readiness to enter the planned dynamic testing phase and the time likely to be required.

We separately note that the time added in moving from [REDACTED] dates would not be sufficient to accommodate the realisation of a strategic risk such as a severe fire or major software bug, if one were to occur.

Key findings include:

- The [REDACTED] dates in the RAP are [REDACTED] dates, derived from a top-down view of the remaining scope of work. [REDACTED]
- Within the RAP there is much more emphasis on the entry criteria for the start of dynamic testing than the scope of what needs to happen to successfully conclude the dynamic testing;
- Changes to the dynamic testing timeline will have comparatively small impacts on the outturn costs, as compared with the station contracts which have significant potential to impact the outturn costs. The [REDACTED] contract installation and testing activities are critical to the completion of the station contracts and there is still a high level of uncertainty around the interfaces between these contracts. It is imperative that a comprehensive station and systems integration programme is developed and put in place at the earliest opportunity.

1.7.2.2 Cost review

The RAP 1 and 2 cost estimates are derived from high level timelines to Stage 3 completion, not detailed schedules.

Our review found that the critical timeline to the opening of the railway runs through the dynamic testing programme which tests the rolling stock with the infrastructure, particularly the signalling. However, this is not the main cost driver. Cost outturn is mainly dependent on the timing of completion of the infrastructure works, particularly the station fit out, tunnel fit out and communication systems contracts and the single

¹³ Crossrail MOHS Schedule Peer Review prepared by Ian Rannachan dated September 2018

¹⁴ Crossrail Schedule Assurance Review by John Boss dated 17 September 2018

most significant impact on outturn costs will be the date from which, and extent to which, substantial demobilisation of the contractors and their supply chain teams occurs on the major station contracts.

Demobilisation of main contractor and supply chain resources must be achieved to reduce significantly the current expenditure rate of approaching £30m per week. Dates for contractor demobilisation are identified as key dates in the RAP but are not contractual requirements.

[REDACTED]

Achievable progress by Contractors and their supply chains in completing the key activities remaining and the impact of interfaces between some of the key contracts, which in turn will impact the timing of Contractor (tier one and their supply chains) substantial demobilisation, remains a key uncertainty when forecasting outturn costs.

We modelled the AFCDC (ie the CRL direct costs to complete the project, being the Crossrail project costs excluding the NR ONW and Depot costs etc.), based on a top down assessment, using cost run rates applied over assumed programme durations for each key contract so as to create a series of scenarios. CRL used a similar approach but based its analysis on estimating an addition to its previous outturn cost forecast rather than using the cost of work done to date as a base and adding to it a revised estimate of the costs to complete the project.

In choosing our illustrative scenarios for costs to complete the project we deliberately adopted a simplified set of assumptions corresponding with the level of information available. The range of the scenarios was set to encapsulate a carefully considered range of expected performance, adopting cost run rates and the periods over which they were sustained as the key variables. We did not see fit to examine all possible outcomes in detail. For example the tail of activities remaining after the date assumed in RAP 2 for Stage 3 opening ([REDACTED]) is subject to significant uncertainty, and is linked to decisions not yet made by CRL (eg about [REDACTED]). Our more pessimistic scenarios have regard to the potential impact of these and other factors.

The approach we adopted was the most appropriate based on the information available, the access provided and the timescale which was short given Sponsors' pressing need for outputs which could inform funding decisions in early December. A more precise analysis would have been difficult to create given the issues at large in relation to the programme, and the limitations in the availability of relevant up to date detailed data from CRL

To create our alternative cost assessment we used our model to perform a sensitivity analysis¹⁷ of six scenarios based on combinations of:

- Three completion date assumptions for each of the 13 principal live contracts taken from:
 - RAP 2;
 - The views of CRL PMs gained through interviews; and
 - Additional delays assumed by KPMG based on information received including during our interviews of CRL staff.
- Two 'substantial demobilisation' date assumptions for the 13 principal live contracts:
 - In accordance with the completion programme within the RAP; and

- Further delayed until the contractual stage completion date for handover to the Infrastructure Manager (IM).

The most optimistic scenario (no. 1), was based on information from the PMs and a completion programme in line with the RAP, and gave a cost outturn similar to what was described as the P95 cost in RAP 2, inferring that a RAP 2 cost is unlikely to be a P95 value and is more like a target value for the Project.

The most pessimistic of the scenarios (no. 6) assumed a slower run down of the spend rate combined with delays to key dates. It resulted in a cost of £0.7bn greater than the RAP2 outturn cost of £13.8bn, giving an outturn cost of £14.5bn which represents £2.0bn¹⁸ additional funding compared with the Intervention Point (IP) 2 amount.

The mid-range scenario is around £0.3bn greater than the RAP 2 £13.8bn outturn cost and requires additional funding of £1.6bn versus IP 2. We also put the output from this scenario through CRL's funding model (see Section 8).

We consider the most probable outturn is that costs will lie somewhere between the mid-range and the pessimistic scenario i.e. requiring additional funding of between £1.6bn and £2.0bn over and above the IP 2 limit. The outturn cost which will actually be achieved critically depends on:

- The extent to which appropriate steps are rapidly taken by Sponsors and CRL to address the issues covered in this report, and in our related governance report, which are the basis for our recommendations provided to Sponsors for consideration.
- Whether additional significant risks materialise which have a material impact and which have not already been identified by CRL within its RAP 2 document.

Prior to taking account of the impact of appropriate and timely actions being taken in response to the issues highlighted in this report, and in our Governance report, we consider there to be around an 80% likelihood that costs will be contained below the pessimistic scenario.

[REDACTED]. To achieve Stage 3 opening by [REDACTED] CRL is investigating targeting those systems essential to opening, leaving non-essential systems to be completed after opening, but we expect such related post-opening costs should be able to be contained within the pessimistic scenario within our sensitivity analysis assuming Stage 3 opening occurs in or close to [REDACTED] and assuming delays in achieving tier one contractor¹⁹ substantial demobilisation are sufficiently managed.

In the event the Stage 3 opening date were to slip materially later than [REDACTED] accompanied by added delay to substantial demobilisation of the principal contracts, there is a significantly reduced likelihood that costs will be contained below the pessimistic scenario.

1.7.2.3 Risks and uncertainties

RAP 1 and RAP 2 contain an analysis of risk to provide a contingency allowance for estimating uncertainty as well as for unknown risk events.

Section 6 describes our approach and observations on the RAP's treatment of risks and uncertainties.

Key findings include:

- There are some inconsistencies in how risk has been calculated in RAP 1 which result in an incomplete assessment of risk.
- In RAP 2, infrastructure risks, dynamic testing risks and catastrophic risks have been modelled together using a Monte Carlo analysis. While this is a reasonable approach for modelling risk generally, the

¹⁸ IP2 or budget for AFCDC was £12.5bn, and hence an outturn cost of £14.5bn would lead to a need for £2bn additional funding

¹⁹ Including tier one contractor supply chains

modelling of the high-impact / low-probability risks (strategic risks) in this way results in contingency sums which are far lower than would be required should those risks materialise. This is not an appropriate way to assess these types of strategic risks, and we would expect these to be excluded from the contingency calculation and separately presented with ranges of potential schedule and cost impact rather than as single point estimates included in the Monte Carlo risk analysis.

1.7.2.4 Assumptions and exclusions

The RAP makes assumptions which exclude certain activities and risks from the CRL schedule and cost estimates (which are other than catastrophic risks in nature). Section 7 describes our approach and observations to the RAP's assumptions and exclusions.

Key findings include:

- The dynamic testing programme is uncertain, it does not allow for further delays in the provision of an homologated train or if [REDACTED] fails to complete the necessary routeway installation to support commencement of 5/2 dynamic testing. While there are inherent risks within the dynamic testing process outside of CRL control, we would expect a prudent schedule period for the 5/2 dynamic testing process to be included in the MOHS. Risks associated with contract [REDACTED] should be accounted for by CRL.
- The RAP excludes some infrastructure risks. The completion of the infrastructure works is a CRL responsibility and we would expect the MOHS and RAP cost estimate to take into account all the risks associated with completing the infrastructure works.
- NR possessions – Not all possessions required for transition testing shown on the MOHS have been secured with NR. While the availability of possessions is outside of the control of CRL, we would expect CRL to demonstrate how it plans to mitigate the risks surrounding securing NR possessions to support its programme delivery.
- Lack of clarity as to the basis for the duration apportioned for trial operations. At this stage in the programme we would expect the duration for the trial operations to be based on a detailed plan agreed with the IM and the operator and to include contingency for unforeseen delays whilst recognising that revision may be required.

1.7.2.5 Key recommendations for schedule, cost and risk

Key recommendations for consideration are that Sponsors should satisfy themselves (including where appropriate through independent assurance) that:

- CRL adopt a bottom-up approach to developing the schedule with appropriate assessment of agreed inputs from the tier one contractors²⁰ and the critical dependant third parties (rec. 4.3).
- In compiling the schedule and related cost estimate, CRL:
 - Account sufficiently for the risks associated with, and potential delays to, completing the [REDACTED] contract (rec. 7.1).
 - Allow for sufficient float in the dynamic testing programme, given the uncertainty of this activity (rec.7.2).
 - Ensure there is a clear scope of output specifications for the dynamic testing that defines what success would look like. The scope should be accompanied by a detailed schedule that is communicated to all relevant parties (rec. 4.4).

²⁰ "appropriate assessment of agreed inputs from the Tier 1 contractors" does not mean simply adopting the contractors' positions but it does mean having reached agreement with contractors on milestones and then assessing if an assumed delay or acceleration in performance should be incorporated in the schedule. It also means being clear as to the basis for and reasons for any such assumed delay or acceleration, and for how the contractor performance will be driven to achieve the assumed milestones. Careful monitoring of actual progress will be needed leading to, where appropriate, schedule revisions if actual progress against an agreed or assumed milestone differs from expected performance. It also means ensuring that contractors are responding on their own behalf and that they have in turn obtained appropriate commitments from their own supply chain to meet the requirements of their schedule including as to sufficiency of available resources.

- Include sufficient amounts to address the risks (excluding catastrophic risks) associated with completing all the infrastructure works (rec.7.3).
- Incorporate in the schedule the critical NR possessions, enabling capture of those which are already confirmed (rec.7.4)
- Include allowance for a sufficient duration for trial operations based on a detailed plan agreed with the infrastructure manager and the operator and to include contingency for unforeseen delays (rec.7.5).
- CRL undertake a more detailed outturn cost estimate once the updated completion programme (see Section 4) has been prepared and approved (rec. 5.2).

In addition we recommend that:

- Sponsors should request a bottom-up cost estimate, built on dates drawn from an updated MOHS²¹. It should be independently verified that the updated MOHS is robust and takes appropriate account of contractors' views on performance and delay (recs. 6.1 and 11.6) and that the resulting cost estimate has been robustly and reasonably prepared.
- It is imperative that a comprehensive station and systems integration programme is developed and put in place at the earliest opportunity (rec.4.5).
- In relation to risks, we recommend that CRL should
 - Adopt a consistent approach in the modelling of schedule risk, commercial risk and contingencies (rec. 6.2).
 - Reconsider the programme risks excluded from the cost model, in particular the excluded infrastructure risks which are CRL's responsibility to manage and / or mitigate (rec.5.3).
 - Reassess the risks addressed by the Additional Quantitative Risk Analysis (QRA) presented in RAP 2 and develop a comprehensive risk register for contingency held at sponsor level. The catastrophic risks should be listed and managed separately. The risk management plan should identify the ownership of these risks. The catastrophic and high-impact, low-probability risks, should be presented as ranges of schedule and cost impact, rather than point estimates. Remaining risks should be analysed to develop three point estimates of schedule and cost impact (rec.6.3).
- Sponsors to obtain independent assurance that CRL has ensured effective programme controls are in place to support the efficient delivery of the balance of the programme (rec. 5.4).
- Sponsors to consider the extent to which CRL has taken adequate steps to mitigate the likelihood and potential impact of a catastrophic event and whether or not potential contingent funding arrangements should be put in place to address such an event (rec 5.1).

1.7.3 CRL's funding model

We reviewed the Sponsor Funding Account (SFA) balance calculations (i.e. additional funding requirements) in CRL's RAP 2 Model. As we would expect, the calculations do not include NR ONW, full rolling stock²² or the Old Oak depot cost. Nor do they reflect the benefit of the additional £300m of funding for CRL agreed in July.

The calculations are driven by direct, indirect and risk-related capital cost assumptions (including assumed profiles over time) and other inputs such as NR financing costs, traction power works funding assumptions, working capital assumptions and cash payment profiles for some costs (e.g. [REDACTED]), and insurance).

Our review focussed on the P6 2018_19 SFA balance and assumptions that drive the change in the SFA balance after that date. The Model had not yet been subjected to testing procedures by CRL to check

²¹ See section 2.6

²² Cost includes the £13 million for the Reading additional rolling stock.

formulaic integrity. CRL's Auditor Grant Thornton reviewed a previous version in March 2017, but only looked at the AFC and AFCDC calculations, rather than the SFA balance.

Our key findings include:

- The Model reflects a P50 view of cost and risk, rather than P95. We understand this is in line with PDA requirements. The Model reflects a P50 AFCDC that is similar to the £13,679m in RAP 2, except for a variance of £14m which was essentially an error and should not have been included. The P95 cost in RAP 2 amounts to £13,831m for comparison.
- The Model shows an SFA deficit at project completion of £1,180m, i.e. £880m in addition to the £300m already committed at the time the Model was produced. In comparison, RAP 2 indicates an additional funding requirement for £1,019m due to the variances mentioned above.
- There are a number of subjective / judgemental assessments related to both levels of **costs** ([REDACTED]); and assumed **timing** of cash outflows (the two period lag for accruals; timing of [REDACTED] of financing costs to be paid to [REDACTED]; timing of unwinding of the £100m ACWP to COWD adjustment; timing of unwinding of provisions of £31m²³; timing of [REDACTED] all of which may impact the model forecast SFA cash balance at any specific period end.
- [REDACTED]
- We also identified a variance of £38m between the calculated P6 2018_19 SFA balance, from which the Model rolls forward, and the actual SFA balance. CRL advised that the difference is driven by a recent spike in accruals (i.e. costs incurred but not yet paid out). CRL noted that ten contracts account for £38m of the total £50m accruals increase.

We looked at the potential impact of the 'alternative cost assessment' (scenario 3), as described in Section 5, on the SFA cash balance from P7 2018_19 onwards. This indicates that scenario 3 would require Sponsors to make allowance for £312m of additional funding by the end of the Crossrail project, over and above the £1,019m apparent from RAP 2 (P50). Of this £312m, £73m would arise by 31 March 2019²⁴. We note that the model also shows that the cumulative cash outflows which yield £1,019m adverse to IP2 by the end of the project, show a cumulative net cash outflow of £652m by 31 March 2019, making an overall £725m²⁵ cash funding shortfall by 31 March 2019 based on the assumptions in the inputs and model, and before taking account of the £300m funding amount already agreed.

We tested the logical integrity of the arithmetical operations in the Model formulae and calculations under the assumptions and input data for the base case ('Current (P50)' scenario). Specifically, for each unique formula, we inspected the formulaic code and documented instances of apparent arithmetical inaccuracy or deviation from the intended logic²⁶.

On completion of our testing on the initial version, we issued a number of queries, some of which related to how Model assumptions were being applied, and others to the formulae logic used within the Model. We have since received an amended version of the Model ('CIM v405_CP2+ Scenario v02.xlsm') and responses to our queries. Following testing of the amended version, and assessing the responses to our queries, we have 37 points remaining. Of these, 35 are assumptions-related comments raised during our work, which may help the users' understanding of the Model, and 2 findings on the logical integrity of the Model but which do not impact the Model's ability to achieve materially the purpose which it was designed

²³ The Model also effectively assumes that the sum of £31m set aside for provisions unwinds, meaning that in effect the first £31m of the Model's remaining £223m programme contingency is already spent (unless the provision costs are not ultimately incurred). This is a timing assumption issue given that the Model includes in aggregate costs in line with RAP 2 subject to the variances highlighted in this report.

²⁴ Assuming one adopts the assumptions in the funding model around timing of cash flows

²⁵ £652m plus £73m. The balance of the cash shortfall arises after March 2019.

²⁶ "Intended logic" as implied by the Model structure and construction or as explicitly stated in the cell label or management's documented understanding of the Model.

to meet, insofar as its logical integrity under the base case assumptions and input data is concerned. These are set out at Appendix 12.

Key recommendations for consideration include:

- If Sponsors wish to make allowance in additional funding for costs to come in at the P95/Additional P95 QRA level then we recommend that the Sponsors instruct CRL to prepare a Model reflecting the full P95 costs and Additional P95 QRA, rather than P50 (rec. 8.1).
- Sponsors may wish to consider whether there is a risk that the position of the [REDACTED] in December 2016, and whether this should be reflected in the cost assumptions in a future Model version (rec. 8.3).
- There are a number of subjective assessments related to both costs and timing of cash outflows which may impact the SFA cash balance. To increase the robustness and level of confidence in these assumptions, we recommend that Sponsors should request CRL to develop these assumptions further (rec. 8.4).
- Sponsors should consider whether the assumption on the timing of unwinding the sum set aside for provision for disputed sums is appropriate (rec.8.5).

Finally to reflect the potential impact of the issues highlighted in this report, Sponsors should consider asking CRL to Model the higher levels of costs which were illustratively assumed by the various scenarios explored in Section 5. It would be sensible to have regard both to scenario 3 representing roughly the mid-point of the assumptions explored as well scenario 6 representing the most pessimistic scenario. Together with the adoption of appropriate assumptions as to timing of cash flows, this would enable Sponsors to have a view of the impact of those scenarios over time.

1.7.4 Financial controls

Our review, described in Section 9, was carried out under the four headings of people, processes, financial reporting and assurance. Our key findings and critical recommendations for consideration are outlined below.

Key findings include:

The headcount reduction in CRL's finance department due to the planned demobilisation has led to some weaknesses in financial processes and controls.

CRL's financial controls as operated are in need of some improvement in order to be aligned with good practice:

- CRL's finance department currently has insufficient resources to ensure effective financial control until the completion of the programme; in particular it has not been providing sufficient constructive challenge to commercial forecasting and reporting
- Discussion with management indicated that the headcount reduction in the finance department due to planned demobilisation has reduced the interface by the project accountants with the project delivery teams, which will have sharply diminished discussion and review of areas such as nature and value of COWD accruals, level of open purchase orders and authorisation of purchase order uplifts as well as reducing more generally constructive challenge of commercial forecasts
- There is no consolidated finance procedures manual
- During our fieldwork we were told that CRL did not intend to prepare a business plan for 2019_20
- The CRL Audit Committee met for the last time in June 2018 and was in effect disbanded in July 2018. Proposals for revised arrangements relating to Audit Committee matters were approved by the CRL Board in July 2018 (further details can be found at Section 12.4.3). The coverage provided by internal assurance is too narrow and fails to adequately address commercial and financial controls

- CRL does not currently have a head of risk with an overall responsibility for both programme risks and corporate risks.

Critical recommendations for consideration include:

- Streamline the content of CRL Board Reports; add additional metrics to report on actual productivity at a contract level (for key contracts) over time with comparison against plan, and assumptions underpinning costs and time to go calculations so as to provide transparency on past, current, and future assumed productivity for each key contract (rec. 9.1).
- Revise the current demobilisation plan to align with a realistic assessment of the probable programme timeline; appoint resources needed to sustain effective control through the balance of the programme (rec. 9.2).
- Produce guidance on the appropriate extent, areas, frequency and processes which project finance staff and others in finance should follow to ensure there is sufficient constructive challenge to key commercial / project activities (rec. 9.3).
- Prepare a tailored business plan for the 2019_20 financial year suitable for supporting the effective execution of the business' objectives (rec. 9.6).

1.7.5 Commercial reporting, oversight, controls and processes

CRL performance monitoring and reporting has not led to timely / adequate²⁷ advance notice being provided of the need to materially change the Stage 3 opening date and the resulting significant cost impact.

Cost scenarios prepared by CRL at Sponsors' request and tabled at the March 2018 SB, critically did not take account of the potential impact of any material irrecoverable delays in infrastructure works which had a much more substantial cost run rate than the issues addressed in the scenarios²⁸.

Effective reporting of programme status relies inter alia on:

- Effective contract management, monitoring and oversight by contractors of their supply chains; of contractors and supply chains by CRL; and on
- Effective reporting systems and flows of information up through CRL from project and commercial teams, through to management, on to EIC, and then to the CRL Board and thereafter to Sponsors.

The resultant reporting within and by CRL was neither sufficiently timely nor sufficiently clear as to the impacts and magnitude of the range of probable consequences of the issues within the programme.

CRL management explained to us that its understanding of the project costs and timeline as reported through the project management teams and systems was evolving and changing at pace during the first half of 2018. It is also explained that there were many challenges to schedule and milestones and that a

²⁷ "adequacy" when assessed in the context of the length of the Crossrail programme and the magnitude of changes to forecast time and cost outturn recently announced

²⁸ Scenario A (with 3 different options) assumed no delay to Stage 3 opening but with the potential need to accelerate. Scenario B considered 3 different delay options but in all cases assumed that all infrastructure works would still be finished as planned and that delay would arise during systems or dynamic or software testing or due to the lack of a viable train. Allowance was made for around [REDACTED] month costs for maintenance, upkeep and safe operation of the infrastructure in the event of a prolonged train control and/or system operating delay. A [REDACTED] delay scenario assumed delay due to a serious event that caused wholesale re-programming. We note that Jacobs' Cost Scenario Report of June 2018 reported that at a meeting with the Joint Sponsor Team (JST) in March 2018, CRL had stated that it felt the book-ends of the cost projections lay between Scenario A, Range 2 and Scenario B, Range: [REDACTED] delay, equating to a £200m to £300m increase in cost above IP2 at P50.

variety of actions were being taken to address the challenges identified. It is evident that there were formal discussions²⁹ taking place between CRL and Sponsors around these matters.

Evidence of formal discussions around these matters is apparent from, for example, the minutes of the June 2018 SB which record that Sponsors asked CRL to provide information for the next checkpoint (in effect the July SB) on: confidence in December delivery, alternative options to December, including a delayed opening or a reduced frequency or partial opening. We note that a document entitled “Stages 2-5 Readiness” dated 25 June 2018 and tabled by CRL at the June SB showed the Stage 3 opening date of 9 December as “Green” with no variance against a 9 December 2018 opening date although a significant number of the preceding Stage 3 milestones and activities were clearly shown as red or amber as shown in Table 1:

Table 1: Stages 2-5 Readiness Milestone / Activities

Milestone / Activity	Green	Amber	Red
Dynamic Testing	4	1	3
Pre-Trial Running	4	2	3
Combined Elizabeth line trials	1	4	0
Passenger Service	5	0	0
LU and RfLI Stations – Staged Completion for familiarisation and Trial Ops	7	1	0
Infrastructure, Trains and Testing	0	2	4
MTR, NR, LU and RFLI readiness	0	4	1

It is also evident that there was regular reporting each period on forecast cost outturn and timeline inter alia in the CRL Board reports during 2018³⁰ and in Project Representative (P Rep) reports³¹. We have based our comments and recommendations on what is recorded in the papers and documents that we have reviewed including the formal minutes of meetings.

It is clear from the reporting of CRL and of the P Rep that a large volume of work was being undertaken to mitigate delays, re-sequence works and search for alternative approaches to testing and commissioning to maintain the opening date. A feature of the increasing stretch or optimism however was a failure to identify, and / or report on a timely basis, the point at which it became unrealistic to expect all remaining activities to

²⁹ During the course of confirming factual accuracy of this report with CRL we were advised that there had also been informal discussions. No details were provided and it was outside of our Terms of Reference to investigate whether and, if so, what informal discussions had occurred.

³⁰ We note in this regard that the Crossrail Cost Scenario Review report prepared by Jacobs and dated 19 June 2018³⁰ stated: “In early March 2018 CRL presented to JST its document entitled AFDCDC Scenarios whereby it proposed two scenarios and developed costs for three options within those scenarios, in order to establish and describe an estimated upper and lower limit of funding requirements (known as the ‘book-ends’). During this meeting CRL stated that it felt the book-ends of the cost projections lay between Scenario A, Range 2 and Scenario B, Range 3 month delay, equating to a £200m to £300m increase in cost above IP2 at P50.”

We note the CRL Board Report for period 4 2018_19 [24 June to 21 July 2018] shared with Sponsors addressed “Are we on time” inter alia as follows:

“Overall delivery is 94.4% complete vs. planned of 96.3%. 0.6% was achieved in the Period against the plan of 0.7%. Work remains ongoing to evaluate the impact of schedule delays to critical path activities on Stage 3. Alternative scenarios have been identified and communicated, with an executive review planned in Period 5. The drive to complete all physical works and handover each element to the IMs in accordance with the agreed stage completion dates remains resolute.”

The same CRL Board Report commented overall: “Steady but vital progress continues to be made across the project, but in order to mitigate further schedule slippage, each contract is working on detailed plans to demonstrate the steps they are taking towards handing over their sites to the IMs. Despite this, significant overall schedule pressures exist across the programme and work remains ongoing at a project level to identify and evaluate the impact of schedule delays on critical path activities ahead of Stage 3. Alternative scenarios have been developed with Executive, Board and Sponsor reviews planned in August and September to discuss the schedule pressures and proposals for a revised delivery strategy. The drive to complete all physical works and handover of each element to the IMs in accordance with agreed stage completion dates remains resolute as this is key in minimising further cost growth.

Overall, the project has now reached 94.4% complete. In the Period, the AFDCDC remained unchanged at £12,810m (£297m above IP2). In the next few weeks, further defined-cost reviews will be held with key contracts in our ongoing review of emerging costs and additional cost increases in light of schedule pressures. These increases are in the process of validation ahead of being reported next Period.”

³¹ The role of P Rep is performed by Jacobs. See Governance report Appendix 5 for example relevant extracts from P Rep reports during March to August 2018.

be completed within the diminishing timeframe for planned Stage 3 opening and which should have led to revised expectations as to time and cost outturn being developed and reported.

More generally, we consider there was insufficient information in CRL Board reports (i) around actual and likely performance of individual contracts and related integration activities to enable an accurate and sufficient understanding of their likely outturn and impact on the programme; and (ii) of useful trend and other analysis to enable an adequate understanding of historic performance against plan in the context of assessing forecast cost and time to completion.

Finally we note that since 2017 the CRL risk management process has been split between the site teams who perform qualitative risk assessments (previously they also performed detailed quantitative assessments) and the central management risk team which now performs the quantitative analysis across the project. The latter has been reduced to two people as part of the demobilisation plans aligned to a Stage 3 December 2018 opening.

1.7.6 Remainder of the project – CRL reporting

Sponsors should remain accountable for the successful delivery of the whole Crossrail programme, (to a timescale that has yet to be determined and a budget that is heavily dependent on the time to complete the infrastructure works) with CRL in turn held responsible for the successful integration and delivery to an agreed timeline and budget (Governance Report 4.1). It will be critical for the Sponsors to satisfy themselves around the development of the delivery plans with associated estimates of time, cost, risk and assessment of scope adjustments required to open the Elizabeth line as early as practicable (rec. 11.1).

Once the plan is agreed, the Sponsors and CRL will both need to establish adequate controls, reporting and assurance that the programme is on track or that adequate action is taken at the appropriate time to maintain progress within budget.

Critical recommendations during the initial planning phase include:

- Establish the reserved matters that require CRL to seek Sponsor approval (rec. 10.2).
- Agree timescales for the development of the initial programme by the new CRL CEO and then the development of that programme (rec. 11.5, 11.6).
- Obtain independent assurance of the CRL programme with a deep dive into the estimates for time and cost and providing scenarios based on various scope and other options (rec. 11.5).
- Review the funding envelope and define the process for the timing and release of additional funding against identified risks (rec. 10.1).

Critical recommendations after the agreement of the initial programme include:

- Agree the critical milestones that provide the Sponsors with a transparent view of performance (rec. 10.3).
- Define the method for obtaining assurance that CRL reporting is sufficient, accurate and transparent (Exec 1³²).
- Agree the metrics and analysis required from CRL in its performance reporting to allow the Sponsors to make their own assessment of whether the progress being achieved is in line with the plan (rec. 11.2, 11.7).
- Define what Sponsors wish to receive from CRL in the form of variance analysis and a summary of mitigation actions where performance achieved is behind that planned (10.3)

³² Recommendations which only appear in the Executive Summary are in table 2 within Section 1.8.3

1.7.7 CRL Board Committees

Trust between Sponsors and the CRL Board has been undermined by reporting that did not sufficiently surface the probable impact of or the magnitude of the emerging performance issues soon enough.

The CRL Board has been through a period of extensive change. A majority of its membership has changed during 2018, including individuals performing the role of Chair and CEO³³.

Our recommendations consider the further skills and experience which would augment the current CRL Board given the nature of the remaining phases of the project, and also address the roles of the Committees of the Board.

The CRL Board continued, until relatively recently, to pursue a pre-planned demobilisation of central resources around a December 2018 Stage 3 opening. This included disbanding the CRL Audit Committee in effect in July 2018 and re-allocation of its responsibilities (further details can be found at Section 12.4.3).

There was a much reduced level of internal audit coverage in 2017_18 and 2018_19, with insufficient coverage in particular in the critical areas of finance and commercial controls.

Demobilisation reduced central risk oversight and central reporting around commercial and financial risks although CRL considers it did not impact risk management and mitigation at a project level as demobilisation was only focussed on central resources.

Critical recommendations for consideration in relation to CRL Board Committees include:

- Sponsors should work with CRL to enhance the capabilities and expertise of the CRL Board through the nomination of new Non-Executive Directors (NEDs) with expertise matched to the current and future requirements of the programme (rec. 12.6).
- CRL to recognise that greater openness and transparency with Sponsors and timely communication of relevant information is required to reflect the changed circumstances of the project and to set out to Sponsors how CRL will cascade enhanced expectations regarding behaviours, transparency, and culture throughout its organisation (rec. 12.1).
- CRL to re-establish the CRL Audit Committee and Risk Sub-Committee as a single combined Committee (the Audit and Risk Committee). The remit of the Audit and Risk Committee should be consistent with standard good practice for an organisation such as Crossrail (rec. 12.2).
- The breadth, resources and focus of CRL's internal assurance programme should be enhanced so that there is sufficient focus on project delivery and corporate risks, internal financial and commercial controls and on reporting (rec. 12.2).
- With regard to the reporting of risk we recommend consideration is given to more frequent reporting to EIC, to introducing reporting to the CRL Audit and Risk Committee once formed³⁴, to re-assessing the sufficiency of central risk resources and to reinstating risk quantification at project level (rec. 12.2).

³³ In the period since March 2018, all three individuals performing the role of Executive Director have changed. There has also been change to CRL NEDs. In April 2018 there were six NEDs, as of December 2018 there were five NEDs. One of the existing NEDs has become the CEO. Three former NEDs reached the end of their terms of office in June 2018, these three individuals were replaced by three new NEDs, appointed in July 2018.

³⁴ The Audit and Risk Committee should be formed as soon as possible.

1.8 Moving forwards

1.8.1 Addressing the issues

We have set out above and through this report, and in our other report on governance arrangements, a number of recommendations for consideration to address the issues identified.

We have noted that the issues we have highlighted need to be addressed at pace if Sponsors and CRL are to give themselves a good chance of managing the completion of the programme within the cost envelope announced on 10 December 2018.

There will still be significant challenges to be faced in completing the infrastructure works, the routeway, systems, signalling and systems integration and dynamic testing and then in commissioning.

Addressing the issues highlighted in this report and in the separate governance report will mean that the Sponsors and the project will be better placed to identify challenges in a timely way, will have the right expertise on hand, will have better visibility of performance and emerging commercial issues and will be able to deal with challenges promptly. Improvements to reporting and programme sponsorship etc. will not in themselves make the difficulties of completing the project go away, but they will facilitate early visibility of issues and identification of the right actions and interventions, enable transparency and provide an environment in which the complexities of completing this project successfully have a much enhanced chance of being overcome more smoothly.

1.8.2 Early visibility of emerging critical issues and recommendations

An early outline for consideration by Sponsors of issues and our critical recommendations emerging from completing the fieldwork in addressing both Terms of Reference, was shared with Sponsors at the 15 November 2018 SB. At Sponsors' request we then supported Sponsors in sharing the critical recommendations relevant to CRL with members of the CRL Executive on 22 November 2018. This was so as to provide a basis for CRL's early consideration of the identified issues and to allow CRL to accelerate actions in response, given our strong recommendation to Sponsors that both Sponsors and CRL taking the right actions at pace to address the issues identified was critical to constraining project outturn costs. The issues discussed on 22 November 2018 with members of the CRL Executive which were relevant to this report were as set out below.

- Developing a robust updated MOHS
- Developing a robust updated cost estimate
- Improving CRL reporting including enhancing metrics, setting milestones for reporting against and establishing early warning reporting
- Resourcing – identifying and addressing central resource gaps
- Enhancing certain management controls and re-setting financial controls
- Defining, assessing and approving commercial strategy
- Driving contractor performance
- Reinforcing culture and cascading enhanced expectations around openness in reporting throughout the project and avoiding optimism bias
- Addressing the identified issues from our reviews and the related practical day to day management steps recommended to oversee timely implementation
- Strengthening three lines of defence including broadening internal assurance coverage of commercial and financial matters
- Establishing the Audit and Risk Committee

1.8.3 Remainder of the project – CRL reporting, addressing our recommendations, and related Sponsor Assurance

Sponsors will face significant challenges, going forwards, in assessing CRL reporting and related Sponsor Assurance, and in implementing our recommendations. In particular key challenges will include Sponsors' need to assess;

- Whether the pace of change in the nature, quality and extent of CRL reporting is providing sufficient transparency and a realistic assessment of progress and forecast outturn as to time and cost; and
- The extent to which the recommendations in this report and the related governance report have been implemented and whether the manner and pace of their implementation by Sponsors and CRL is sufficiently addressing the underlying issues they were designed to address. This will be particularly challenging given the relatively short amount of time within which some of these matters need to be implemented. This, together with the pace of the programme, may therefore necessitate, with Sponsor agreement, the application of judgement in some instances as to the sensible degree of pragmatism which should be applied when determining the design of what should be implemented.

We have therefore recommended that Sponsors:

- Seek independent advice on these matters (Exec 1).
- Create an action plan and ensure CRL creates their own action plan using a similar overall design, to be agreed with Sponsors (Exec 2).
- Develop an approach to the oversight and monitoring of the implementation of the consolidated action plans (Exec 2).

Table 2: Executive Summary Recommendations

EXECUTIVE SUMMARY RECOMMENDATIONS	
Exec 1	<p>Sponsors to define the method for obtaining assurance that CRL reporting is sufficient, accurate and transparent.</p> <p>Sponsors to consider obtaining regular and independent advice which enables them:</p> <ul style="list-style-type: none"> • To judge whether P Rep’s current remit and outputs are providing sufficient assurance to Sponsors across the full range of programme challenges or whether additional steps are required to assess and consider the information being received in relation to the programme; • To assess whether the pace of change in the nature, quality, and extent of, CRL reporting around programme progress, forecast cost outturn and key risks is likely to provide sufficient transparency of programme status, likely outturn, and key risks net of mitigating actions being taken. In particular whether the metrics being reported are sufficiently reliable and tailored to the differing needs of construction, systems and integration etc activities to provide sufficient visibility of current and expected performance and outturn; • To assess periodically and more deeply (for example at pre-defined stages) if project status and likely cost and time outturn broadly aligns with that being reported; • To assess whether the shape and pace of addressing the issues highlighted by / implementing the recommendations in this independent report on the review of financial and commercial matters and in the related report on governance arrangements, is progressing as it ought and whether the actual steps being taken are sufficiently addressing the underlying issues.
Exec 2	<p>Sponsors to draw up an action plan comprising the recommendations for Sponsors set out in this and the related governance report. Agree and record within the action plan, the actions to be taken, prioritisation, timelines, and responsible individuals.</p> <p>Define the extent of progress which Sponsors wish to see achieved from their own and CRL actions, by pre-set milestone dates in each of the critical priority areas, such as in the case of CRL, creation of a sufficient schedule, enhancing CRL reporting etc</p> <p>Define the means by which assessment will be made of the progress in implementing Sponsor and CRL actions and of the extent to which each underlying objective has been achieved. Define how these matters will be independently assured, and to whom and how frequently the implementation progress and results of the independent assurance will be reported.</p> <p>Agree with CRL an appropriate set of arrangements including initial agreement between Sponsors and CRL of the actions proposed to be taken by CRL and by when, arrangements for period visibility of a copy of the CRL action plan updated for progress in closing agreed actions and the results of CRL’s own regular monitoring, assessment and independent assurance of the implementation and impact of the actions.</p> <p>The initial agreement between Sponsors and CRL of actions to be taken will need careful consideration by Sponsors of:</p> <ul style="list-style-type: none"> • The prioritisation sequence proposed by CRL • The timeline proposed for implementation • How satisfactory completion of an action is proposed by CRL to be established • Where CRL concludes that the approach to addressing an issue needs to be varied from that outlined in a recommendation so as to enable more rapid addressing of the underlying issue, then Sponsors will need to satisfy themselves that the changed approach will be sufficient to address the underlying issue highlighted <p>Define how, how often and by whom, the rolled up action plan (Sponsors’ and CRL actions plans combined) will be reviewed and the means by which resulting required actions will be communicated and in turn followed up.</p>

2 Introduction

2.1 Background

At the end of August 2018 CRL announced to the Sponsors that the opening of Stage 3³⁵, the COS, of the Crossrail project would be delayed. An Adverse Event Notice, in accordance with clause 22 of the PDA, was issued on 30 August 2018. At the Crossrail Sponsor Board meeting on 3 September 2018 CRL presented a revised Stage 3 opening schedule and the associated preliminary cost implications. The revised schedule and cost forecast are known as the Checkpoint 2 (CP2) position.

Following the issue of the Adverse Event Notice, Sponsors asked CRL to prepare a Remedial Action Plan (RAP 1) for the Sponsor Board meeting on 20 September 2018. RAP 1 was issued on 18 September 2018 and addressed:

- A revised MOHS to address the delayed completion of stations, routeway and systemwide contracts
- Cost and commercial implications
- Business plan and management structure
- Revised Handover process.

RAP 1 referenced the first of two independent schedule review reports commissioned by Sponsors. This was the “Crossrail MOHS Schedule Peer Review” prepared by Ian Rannachan dated September 2018.

RAP 1 concluded inter alia:

“For SACR 20 (Period 6 2018/19), CRL will be reporting the CP2 risk allowances at P50 level within its AFCDC in line with its reporting responsibilities under the PDA. The SACR 20 AFCDC is therefore expected to be £13,279m, an increase of £469m from the reported P4 2018/19 figures upon which the CP2 cost forecast is based.

CRL suggest that it would be prudent for Sponsors to secure funds at the P95 level of £523m above the current available funding.

In addition, if Sponsors wish to take into account the independent Schedule Assurance Review they commissioned, CRL advise that there would be a further increase of £125m at P95 level above the £523m requirement of the CP2 P95 forecast.

The CP2 costs and risks are based on two specific schedule scenarios. Sponsors may wish to consider an additional general contingency in the event that further delays occur beyond the scenarios considered or some of the assumptions underpinning the forecast are not achieved.”

TfL, a joint sponsor with the DfT, appointed KPMG on behalf of both Sponsors in late September 2018 to carry out two independent reviews of the Project; financial and commercial, and governance.

CRL issued an update to the RAP (RAP 2) on 2 October 2018, during the course of KPMG’s work. RAP 2 referenced both independent schedule review reports (the second being the “Crossrail Schedule Assurance Review” by John Boss dated 17 September 2018).

RAP 2 concluded inter alia:

“CRL have reviewed the time, cost and risk allowances [REDACTED] sponsors of time, cost and risk allowances in accordance with the direction given at the 20 September 2018

³⁵ Stage 3 is the Central Operating Section between Paddington and Abbey Wood

Sponsor Board. The [redacted] dates take into account the independent Schedule Assurance Reviews commissioned by Sponsors.

In addition to the [redacted] dates, a quantified risk analysis (the Additional QRA³⁶) has been undertaken for risks associated with the assumptions and clarifications contained in the Remedial Action Plan which include for finding, for example, a SIL4 issue in dynamic testing.

The [redacted] date indicates a further delay in the Stage 3 opening. This is due to an assumed increase of [redacted] in the period needed for dynamic testing along with an increase in the duration of Trial Operations from [redacted]. The [redacted] dates also result in an outturn cost (excluding the Additional QRA) at P95 level of £13,677m. This is an increase above IP2 of £1,165m indicating that £865m is required further to the £300m of additional funding already committed.

Sponsors may also wish to make an allowance for the Additional QRA at P95 of £154m.”

CRL’s RAP 1 cost estimate is calculated as an addition to the CRL forecast of AFCDC at Period 4 2018_19 (P04), including risk allowances described as being at P50, P80 and P95 values. The RAP 1 costs are based on schedule scenarios (described in RAP 1) which includes Stage 3 opening in August 2019 whereas the AFCDC reported at P04 2018_19 assumed Stage 3 opening in December 2018. The RAP 2 cost estimate is calculated as an addition to the RAP 1 cost estimate and makes allowance for further delays (including to Stage 3 opening through the addition of 2 months for dynamic testing and a further 3 weeks for trial operations) beyond the programme dates assumed in RAP 1 and shown as early date October 2019 and late date December 2019. The RAP 2 additions are shown as point estimate increases above the RAP 1 estimate to account for prolongation beyond the dates shown in RAP 1. RAP 2 also includes P50, P80 and P95 values for additional risks identified by CRL but not included in its base cost estimate.

2.2 The Crossrail scheme

2.2.1 Crossrail layout

The layout of the Crossrail scheme (Elizabeth line) is shown in Figure 2.

Figure 2: Layout of the Crossrail scheme



³⁶ QRA is Quantified Risk Assessment

2.2.2 Stages of the Crossrail scheme

The stages of Crossrail are as follows³⁷:

Stage 1 – Opened June 2017

Introduction of a Reduced Length Unit (RLU) fleet.

The first phase of TfL Rail services started running between Liverpool Street and Shenfield ahead of the opening of the Elizabeth line. These services were previously operated as part of the Greater Anglia franchise.

Stage 2 Phase 1 – opened May 2018

This comprises:

- 2 trains per hour (tph) Class 345 RLU with AWS / TPWS Paddington to Hayes and Harlington (excluding Hanwell)
- 2 tph Class 360 Connect style service Paddington to Heathrow Central Terminal Area, including Hanwell
- 2tph Class 360 Inter terminal transfer service between Heathrow Central Terminal Area to Terminal 4
- Platform extensions and Driver Only Operation CCTV

Stage 2 Phase 2

- 4 tph Paddington to Heathrow T4, 9-car class 345 with ETCS

Stage 3 – Central Operating Section

Launch of the Elizabeth line, which will initially operate as three services:

- Paddington (Elizabeth line station) to Abbey Wood via central London
- Paddington (mainline station) to Heathrow (Terminals 2 & 3 and 4)
- Liverpool Street (mainline station) to Shenfield

Known as the new Central Operating Section, Stage 3 consists of running a class 345 FLU service with Communications Based Train Control (CBTC) on CRL-built & NR-built infrastructure under the safety management systems of RFLI, MTRC and LUL.

Stage 4

Direct services will operate between Paddington – Shenfield and Paddington – Abbey Wood. Services from Paddington to Heathrow will continue to start and terminate at the mainline station

Stage 5

Reading and Heathrow to Abbey Wood (including Stage 5A involving Crossrail trains running between Paddington and Reading)

This report is concerned with the programme to completion and cost of Stage 3, the COS. We requested from CRL the current costs, schedule and underlying assumptions relating to the completion of Stages 4 and 5 and were informed that such information was not complete but CRL expected the cost to be relatively low [REDACTED] in the context of the overall AFCD. We understand that the costs due to Stages 4 and 5 are largely related to completion and commissioning of signalling and communications works. At present, the timeline to completion appears unclear and there remains a risk that the opening of Stages 4 and 5 could be delayed, adversely affecting train operations, but the direct CRL cost of such a delay would be relatively

³⁷ Includes information extracted from CRL Board Report Period 08 2018_19 and P Rep reports Period 01 2017_18 and Period 08 2018_19

low. The key Stage 4 and 5 activities and inter-dependencies should be scheduled out and the related costs estimated respectively.

2.3 Current status of the Project

At the time of RAP1, which was built up by making adjustments to Period 4 2018_19 reported AFDCD, there were 13 significant contracts in progress. Their expected cost outturn and relationship to the expected Programme cost outturn by reference to both RAP 1 and RAP 2 positions, is summarised in Table 3.

Table 3: Status of Crossrail Project

	Forecast outturn cost
	£m
13 principal live contracts ¹	4,105
Other contracts and indirect costs ¹	8,659
Risk ¹	46
Total Anticipated Final CRL Direct Cost (AFDCD) at P4 2018_19 (P50)	12,810
RAP 1 point estimate increase	268
RAP 1 P95 risk	257
RAP 2 increase for [REDACTED]	342
RAP 2 additional QRA (P95)	154
Total at approximately P95 confidence level	13,831
Cost of Work Done at P6 2018_19	12,564
Cost to Go³⁸	1,267

Source: ¹ CRL Board Report P04 2018-19 Page 15

2.4 Scope of KPMG's work

KPMG was asked to carry out the review of RAP 1 in October 2018, shortly after it was released in September 2018. Our review was guided by the Terms of References provided by the Sponsors to focus on assessing the reliability and robustness of the revised schedule and cost put forwards by CRL for the Stage 3 opening (see below). During the course of our review of RAP 1, CRL issued its RAP 2 on 18 October 2018 which led to the scope of our review being extended to include RAP 2. CRL was also at the time updating its MOHS that was first due to be issued later in October 2018, then in November and then in early December.

The Sponsors asked KPMG to complete our work on the RAP (RAP 1 and then RAP 2) documents without consideration of the potential content of the updated MOHS. The Sponsors indicated that they would want KPMG to review the updated MOHS once it was formally issued to consider the impact of the updated MOHS on the alternative indicative cost scenarios that KPMG had produced from the review of the RAP documents. At the time of finalising our fieldwork in December 2018 the updated MOHS had not been issued and our reports do not take into consideration any time or cost information except where expressly stated in this report.

The scope of our work was defined in two sets of Terms of Reference documents summarised below.

³⁸ Cost to Go relates to costs of work to be performed after Period 06 2018_19.

- Financial and commercial independent review to consider if CRL's financial modelling and forecasts reflect the true financial position of CRL, together with a review of commercial and contract management and governance to consider:
 - Whether appropriate and effective controls are in place.
 - Inputs to financial models, including risks and uncertainty, together with assumptions made.
 - Commercial reporting and oversight arrangements.
- Governance review to address governance arrangements for oversight by DfT and TfL and to consider matters such as:
 - The composition and performance of the CRL Board, its project control and reporting arrangements.
 - The appropriateness of and the need for strengthening controls and reporting processes.

2.5 This document

This document addresses the financial and commercial Terms of Reference summarised above and included in full in Appendix 1. Our governance review is covered in a separate report.

Section 3 provides a brief outline of the structure of this report and alignment with the Terms of Reference.

Minor apparent discrepancies may appear in some of the tables of this document as a result of rounding and limiting significant figures for simplicity.

2.6 Other important matters

2.6.1 Schedule

Throughout our review, and prior to the 5 December 2018 CRL Board meeting, we were advised that CRL was working on an updated draft MOHS (CRL's performance monitoring schedule) which was expected to be available from 5 December 2018. We understood that the draft MOHS would need further revision thereafter as CRL would have had insufficient time to complete its ongoing review of work to be completed at TCR station and, had not started similar reviews on the other major contracts.

In this report we have recommended the creation of a bottom up logic driven schedule at a sufficient level to enable effective management of the programme. In our view this should, at a minimum, be sufficient to enable effective monitoring of:

- Outturn cost, by enabling the measurement and reporting of progress against the key factors which drive cost outturn (principally the timely realisation of Tier One Substantial Demobilisation (TOSD) on the main contracts); and
- Time, by enabling measurement of progress against key activities on the critical path which have the greatest uncertainty and risk attached to them in terms of impact on the overall timeline (principally systems / integration and dynamic testing).

The revised draft MOHS was not issued or shared with Sponsors as expected on 5 December 2018. In the absence of a MOHS, CRL will need to develop a plan to manage the programme that needs to be agreed with Sponsors which sets out the approach to delivering the opening of Stage 3.

While our recommendation set out in this report is for a detailed bottom-up logic linked schedule to be produced to manage the programme for completion, we understand that the situation has changed from when our fieldwork was completed. Though the recommended principle still applies, we realise this can be achieved in a different way, such as the preparation of a similar schedule but at a higher level. Whatever CRL prepares, we recognise that developing an 'appropriate' logic driven programme will need to balance the time required to develop it versus the time left in the programme, but that what is developed needs to

deliver a suitable and effective way of managing controls and of monitoring performance within the constraints of the current position CRL find themselves in.

The forecast opening date for Stage 3 resulting from the revised MOHS when it is prepared, is in our view better expressed, at present, as a range of dates given the significant uncertainties which remain to be addressed. As uncertainty is reduced it should be possible to narrow the range.

Appropriate metrics to measure progress and performance against key activities and milestones on the path to Stage 3 opening need to be developed, and reported against each period, and the overall approach discussed and agreed with Sponsors. The level of granularity in the MOHS / Schedule will need to be determined to suit the availability of data and resources to develop it, and what is needed to manage effectively the programme and to enable effective measurement and reporting of progress. In the context of the resources to develop the MOHS / Schedule, we note the significantly reduced level of central project controls staff now remaining within CRL. This will delay CRL's ability to develop a new bottom-up integrated logic driven programme as will the lack of some of the critical data needed.

We are strongly of the view that an enhanced suite of reporting metrics needs to be designed and developed focussed on the key activities to be completed within milestones. The metrics selected need to have careful regard to the identification of sub-activities and measurement of progress for the most challenging of the key activities so that levels of difficulty are properly distinguished in assessing cost and time of work done and work to go. The enhanced metrics need to address the separate key factors which critically drive "cost" and "time", as referred to above.

Progress needs to be regularly and reliably measured using those metrics, and transparently reported. This should provide sufficient visibility of progress and enable, when appropriate, informed revision to forecast cost and time outturn. Such an approach should significantly help to restore trust and confidence in the overall programme outturn.

3 Approach to the review

3.1 Overall approach

Our approach was to review documentation provided by CRL and TfL, and hold interviews with Sponsors, CRL Directors, senior CRL staff, PMs, business managers, and the P Rep. Our review was at a comparatively high level without deep-dive investigations in view of the breadth of the subject and the comparatively short timescale available. The findings and recommendations presented in this draft report reflect fieldwork which started at the end of September 2018 and concluded on Friday 7 December 2018. This report has not been updated for information released after that date save to refer to the press statement released by TfL on 10 December 2018.

From the information gathered we were able to form views of key project dependencies and methods used for estimating costs to completion for the live contracts. We also gained information on internal processes and controls used for top level management of the project. A significant part of our work involved testing a range of illustrative scenarios we developed around the RAP estimates of time and cost to completion of the project.

3.2 Stages of review

We were initially requested to review RAP1, and then RAP 2 after it became available.

During progress review meetings with the Sponsors we were asked to address specific areas as they emerged, such as:

- Reviews with CRL appointed project and business managers on the six key live contracts to determine their views of programme and costs to completion.
- Reviews similar to the above on the remaining seven key contracts.
- Progress made with settlement negotiations for the 13 principal live contracts.

The main stages of our review were:

- Consider the programme and contract inter-dependencies. Starting from RAP 1 and the draft MOHS, review the high level programme interfaces, constraints and recent progress within the principal live contracts. We established a range of likely completion dates.
- Review the costs estimates within RAP 1 and RAP 2 for the principal live contracts. These were based on cost 'run rates' for different scenarios, along with allocations for risk and uncertainty, which we challenged and made our own assessments of possible scenarios within a sensitivity analysis.
- Carry out a review of CRL's financial model. We reviewed the Sponsor Funding Account (SFA) cash balance calculations (i.e. additional funding requirements) in the CRL model associated with RAP 2. Our review focussed on the inputs and assumptions that drive the changes in the SFA cash balance after P6 FY19 (which ended on 15 September 2018), to project completion. The model review work included:
 - Consideration of indirect costs in which we reviewed the relevant components within the total Project cost within the RAP total forecast of £13.8 billion
 - Review financial and commercial contract control and governance. We reviewed CRL's processes.

A review meeting was held with the Sponsor Board on 15 October 2018, at which we discussed our emerging thoughts in relation to the basis of the RAP cost estimate, MOHS and governance and assurance arrangements.

A further review meeting was held with the Sponsor Board on 24 October 2018 at which we discussed our emerging findings in relation to the programme and cost forecasts for four major station, routeway, signalling and communications contracts. Our views were informed by having gathered more detailed information and carried out interviews with site based PMs and business managers at seven significant live contracts. We subsequently gathered further information on four stations, shafts and portals contracts, together with the platform screen doors, Plumstead depot and Indirect costs.

An early outline for consideration by Sponsors, of our critical recommendations emerging from completing the fieldwork in addressing both Terms of Reference, was shared with Sponsors at the 15 November 2018 SB. At Sponsors' request we then supported Sponsors in sharing the critical recommendations relevant to CRL with members of the CRL Executive on 22 November 2018. This was so as to provide a basis for CRL's early consideration of the identified issues and for CRL's accelerated actions in response, given our strong recommendation to Sponsors that both Sponsors and CRL taking the right actions at pace to address the issues identified was critical to constraining project outturn costs. More information as included at Section 1.8.2.

3.3 Mapping of ToR requirements against report sections

The scope within the ToR includes a review of CRL's financial modelling and forecasts for all stages of the opening to determine the extent to which they reflect the true financial position of CRL, including but not limited to the items below. We have highlighted in italics areas of scope which are common to or overlap both our reports.

Table 4: KPMG Scope Items and relevant report section

Scope item	Report section
Financial Scope and Project Forecast Outturn Scope	
Determining whether appropriate and effective financial controls are in place and processes used to produce the forecasts are consistent with good practice and have been subject to appropriate quality checks.	Financial controls and Review of CRL's funding model
Reviewing the material inputs to those models, to determine if they are well founded on an appropriate assessment of the estimate cost at completion for each remaining contract or activity.	Cost review and Review of CRL's funding model
Assessing whether the allowances made in the financial models for risk and uncertainty are reasonable and consistent with the schedule scenarios presented by CRL and the independent (Rannachan) review.	Risks and uncertainties
Determining if assumptions and exclusions are appropriate and have been priced as risk, or quantified but excluded from the analysis, or have not been quantified.	Assumptions and exclusions
Reviewing the assumptions adopted in relation to critical dependencies outside of CRL's control such as the timing of availability of trains for dynamic testing and considering how the risk of a range of related outcomes has been assessed and addressed in CRL's forecast outturn cost and schedule.	Programme review
Reviewing any material subjective assessments or adjustments that form part of the inputs or modelling and conclude if they are appropriate.	Review of CRL's funding model
If required, the preparation of alternative forecasts, which reflect the findings and conclusions of the consultant should they differ from CRL's views.	Cost review
Commercial & Governance Scope	
Assess whether appropriate and effective commercial controls are in place.	Commercial controls and processes
Assess whether appropriate and effective commercial and contract management processes are in place.	Commercial controls and processes <i>[Both reports]</i>
Review commercial reporting/tracking and oversight arrangements in place and whether effective reporting to the Crossrail Board and Sponsors has taken place over the last 12 months.	Commercial governance and control; and Commercial reporting and oversight <i>[Governance report scope addressed recommendations going forwards]</i>
Considering the role and performance of the committees of the CRL Board, including its Audit Committee (recently subsumed into the CRL board);	Commercial governance and control; and CRL Board committees <i>[Both reports]</i>
Make recommendations on any changes to the control or governance environment from the reviews above.	Commercial controls and processes <i>[Same requirement in both reports]</i>

4 Programme review

This section of our report addresses a single requirement from the Terms of Reference:

- Reviewing the assumptions adopted in relation to critical dependencies outside of CRL's control such as the timing of availability of trains for dynamic testing and considering how the risk of a range of related outcomes has been assessed and addressed in CRL's forecast outturn cost and schedule.

4.1 Summary of findings

Within RAP 1 and RAP 2, the proposed MOHS is presented as a high level timeline, not a detailed bottom up schedule. Our review of the RAP 1 timeline identified a lack of evidence that the critical dependencies, in particular the dependencies outside of CRL's direct control, had been adequately addressed in the proposed programme showing the Stage 3 opening in July 2019.

The RAP 2 timeline shows a target [REDACTED] and attempts to address the critical dependency risks by introducing [REDACTED] which includes an "assumed increase of [REDACTED] in the period needed for dynamic testing along with an increase in the duration of Trial Operations from [REDACTED]³⁹. We note that the time added would not be sufficient to accommodate the realisation of strategic risks such as a severe fire or major software bug, if one was to occur. Key findings include:

- The [REDACTED] dates in the RAP are optimistic dates, derived from a top-down view of the remaining scope of work. [REDACTED]. CRL needs to adopt a bottom-up approach to developing the schedule with appropriate assessment of agreed inputs from the tier one contractors and the critical dependant third parties.
- Within the RAP there is much more emphasis on the entry criteria for the start of dynamic testing than on what happens during the dynamic testing. There needs to be a clearer definition of what dynamic testing success would look like, accompanied by a detailed schedule that is communicated to all relevant parties.
- Changes to the dynamic testing timeline have minimal impact on the outturn costs, whereas the station contracts have significant potential to impact the outturn costs. The [REDACTED] contract installation and testing activities are critical to the completion of the station contracts and there is still a high level of uncertainty around the interfaces between these contracts. It is imperative that a comprehensive station and systems integration programme is developed and put in place at the earliest opportunity.

4.2 Recommendations

Our additional recommendations on programme are given in Table 5. These should be considered in the context of related recommendations in other Sections and the note at Section 2.6.

³⁹ We note that RAP 2 appears to extend the period for dynamic testing from 20 to 23 weeks and to include an additional 4 weeks allowance making an extra 7 weeks in total.

Table 5: Recommendations for programme

Programme recommendations for consideration		
<i>Sponsors to carry out an independent assessment of the CRL schedule and assumptions and to agree a new baselined programme to which CRL will be held accountable</i>		
<i>CRL to adopt a bottom-up approach to developing a logic driven schedule, to establish a clear scope for the dynamic testing and to develop a comprehensive programme for stations and systems integration.</i>		
Owner	Ref	Recommendations for consideration
Programme review		
Sponsors	4.1	To carry out an independent assessment of the CRL schedule and the assumptions underpinning the schedule
	4.2	To agree a new baselined programme to which CRL will be held accountable and against which its performance will be measured.
CRL	4.3	To adopt a bottom-up approach to developing a logic driven ⁴⁰ schedule taking account of sufficient CRL assessments of agreed inputs from the tier one contractors, and the critical dependant third parties. To ensure tier one contractors have obtained appropriate commitments from their supply chain particularly as to appropriate resource availability to meet the schedule requirements.
	4.4	To establish a clear scope of output specifications for the dynamic testing that defines what success would look like. The scope should be accompanied by a detailed schedule that is communicated to all relevant parties.
	4.5	To develop a comprehensive programme for station and systems integration which should be put in place at the earliest opportunity

4.3 Schedule overview

We reviewed the RAP 1 and RAP 2 timelines to determine the robustness of the dates put forward by CRL for the completion and opening of Stage 3, the COS. Our overall findings are given above and we describe our approach and more details on findings below. A full description of our schedule review is given in Appendix 2.

RAP 1 presented high level timelines for three schedule scenarios; we focused our review on schedule scenario 2, the preferred CRL schedule option. We examined the critical path which runs through dynamic testing and our further analysis established the critical dependencies and other key risks to the programme. We also considered the extent to which the RAP incorporated the recommendations in the Rannachan and Boss reports.

For RAP 2, the emphasis was on the dynamic testing and the tier one contractors' substantial demobilisation dates. RAP 2 introduced the concept of [REDACTED] dates for each of the principal live contracts and we focused our review on testing the robustness of these dates by examining the planning process and assessment of risks used to arrive at the [REDACTED]

As part of our review, we examined the most recent version of the contractors' schedules provided to us by CRL focusing on the 13 principal live contracts for routeway, stations and systemwide. We interviewed CRL staff to validate the schedule risks and assumptions made in producing the RAP, and to identify any gaps in the CRL senior management's and CRL project managers' views on the achievability of the contracts key dates.

Our findings are further detailed in Appendix 2 and summarised below.

⁴⁰ See Section 2.6

4.4 Key dates

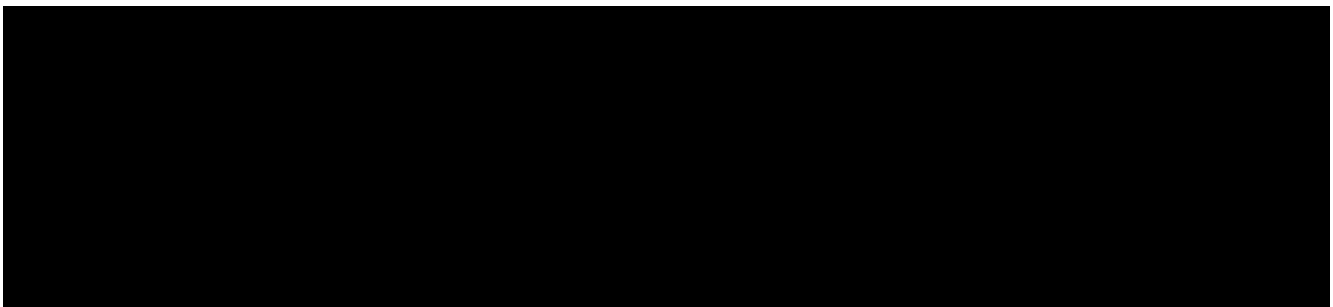
The RAP timelines include three key milestone dates for each of the principal live contracts:

- Tier One Contractor Substantial Demobilisation (TOSD), which is when the majority of the installation and testing work is completed. TOSD is not an NEC contractual term but is when the contractor is expected to demobilise substantially.
- Staged Completion (SC) describes the point after TOSD when the assets are taken over by the Infrastructure Manager (IM), SC is not an NEC contractual term. The period between TOSD and SC is when the remaining works are finished off and assurance activities are undertaken to bring the assets into use.
- The Handover (HO) date is when CRL has completed all the contractual documentation, such as record drawings, and is equivalent to NEC Completion. There are nine specific criteria to achieve handover and we understand that it is acceptable for this process to continue after the public opening, provided all safety critical matters have been addressed by the SC date.

4.5 RAP 1 assumptions and key findings

CRL built the RAP 1 timeline using a top-down planning approach based on the CRL senior management's view of the contractors' current programme and historical performance. This included a number of risks and assumptions to produce a set of target dates for the programme key milestones for the principal live contracts.

Figure 3 summarises the RAP 1 scenario 2 high level programme which extends the initial programme of Stage 3 opening in December 2018 by seven months. RAP 1 scenario 2 shows the target date for the completion of all enabling works in [REDACTED] for the start of the dynamic testing immediately after. The dynamic testing is shown in RAP 1 as starting on a straight double shift ('5/2') for 20 weeks, followed by the handover of the routeway to the IM for the start of the trial running. [REDACTED] are allowed for the trial running and trial operations leading up to the Stage 3 opening in [REDACTED]



We observed a level of uncertainty around the start date of the dynamic testing which is dependent on the readiness of rolling stock and routeway, and completion of all the essential systemwide works. During our review, we established that not all the critical dependencies driving the start of the dynamic testing are within CRL's control, principally the readiness of rolling stock.

Earlier in 2018, the CRL Executive Board commissioned two independent schedule assurance reviews of the Crossrail Stage 3 programme. The reviews were commissioned following concerns that the Stage 3 work was falling behind schedule. The two reviews were carried out by independent consultants Ian Rannachan and John Boss who highlighted some of the key concerns around the start of the dynamic testing. A summary of the findings of these reports is presented below.

4.5.1 The Rannachan Report

The Rannachan Report was prepared over a three week period in August 2018 and submitted in September 2018. The objective of the report was to review the CRL MOHS and establish:

- Whether dynamic testing can be started at the planned time.
- When stations will complete phase 3 testing which is the static integration testing of the lifts and escalators, fire system and station operation room.
- The logic and scope of the period allowed to carry out trial running and trial operations.

The Rannachan report considers that the MOHS which aims for an [REDACTED] opening would be difficult to deliver. This is because the two identified critical paths, routeway and train testing, would not have progressed sufficiently to allow the start of the dynamic testing to commence on time. In addition, the report considers that the assumption allowed for the duration of dynamic testing is ambitious.

The report recommends that work in the routeway should be extended until [REDACTED], to allow as much as possible to be done before the start of the dynamic testing, particularly because it may be less efficient and more disruptive and expensive to come back to finish the routeway work during the dynamic testing. It proposes that the dynamic testing should start in [REDACTED] with five 4-week passes instead of four. It also recommends [REDACTED] to be allowed for trial running, trial operations and reliability risk leading to an [REDACTED] opening.

4.5.2 The Boss Report

The second independent schedule assurance review of the revised Stage 3 opening schedule was carried out by John Boss in September 2018. The assessment focuses on reviewing whether the assumptions and durations are realistic, if the programme is robust, dependencies and risks are understood and mitigations identified.

The Boss report concludes that an opening date of autumn 2019 for Stage 3 is achievable but recognises the uncertainties surrounding dynamic testing. The report stresses the importance of putting the trains into the COS for testing at the earliest possible opportunity in order to build train functional reliability growth, which it believes would be required to start full dynamic testing. This approach is the main difference from the approach recommended in the Rannachan report.

4.5.3 RAP 1 conclusions

The issuing of RAP 1 broadly coincided with the publication of the Rannachan and Boss reports' findings. We observed that none of the recommendations from the Rannachan and Boss reports were incorporated in RAP 1 although RAP 1 states: *"if Sponsors wish to take into account the independent Schedule Assurance Review they commissioned, CRL advise that there would be a further increase of £125m at P95 level above the £523m requirement of the CP2 P95 forecast."* Figure 4 summarises and compares the high level programmes from the RAP 1, Rannachan and Boss reports.

The RAP 1 programme is caveated with a number of assumptions, some of which are outside CRL's control. The RAP 1 schedule risks and assumptions are covered in sections 6 and 7 of this report.

We reviewed the assumptions and the critical dependencies that were outside CRL's control to understand how they had been assessed and to what extent they had been addressed in the RAP 1 (see also sections 6 and 7). Firstly, we considered the assumption on the readiness of the trains. There are 29 static tests which we were told the train ought to pass before it can go through dynamic testing. We learnt that none of the trains have achieved the pass threshold and that the likelihood of the trains meeting all 29 tests criteria before the planned start⁴¹ of the dynamic testing was very low.

Secondly, we considered the assumptions regarding the acceleration of the installation release notes (IRN) and the additional SCADA and radio testing resources that would be secured from the market to complete all the critical communication works. We understand that the contractor plans to recruit internationally due to the shortage of SCADA and radio testing resources in the UK. CRL has a recruitment plan and hold regular progress update meetings to monitor the situation. However, we understand that progress on the recruitment process has been very slow and that the productivity of work required to fulfil the IRNs has not significantly improved to address the backlog referred to in recent CRL Board Reports⁴².

Thirdly, we considered the assumption regarding the availability of NR possessions. The routeway programme is dependent on NR making possessions available for the transitions testing on the Great Western and Great Eastern main lines. We discovered during our review that not all the required NR possessions have been secured due to other competing priority projects such as High Speed 2 (HS2). The last possession window required by CRL has been awarded to HS2 but we understand that CRL is in discussions with HS2 to transfer the possessions to Crossrail.

Finally, we considered the assumption on the duration of the dynamic testing programme. The 20 weeks allowed in the RAP 1 for the dynamic testing is based on the assumption that no Safety Integrity Level (SIL) 4 issues are found during the dynamic tests. We observed a high level of uncertainty around the scope and duration for the dynamic testing. Without a defined scope, it is difficult to ascertain whether the duration allowed in the programme is likely to be enough time to complete the dynamic testing.

In conclusion, we consider that RAP 1 presents an overly optimistic programme which is confirmed by the Rannachan and the Boss reports.

4.6 RAP 2 assumptions and key findings

RAP 2 to a certain extent addressed the critical dependencies outside of CRL's direct control by including additional contingency in the programme. The report introduced the concept of [REDACTED] dates to the programme for each of the principal live contracts. Like RAP 1, RAP 2 was built using a top-down planning approach and focused on three areas:

- TOSD dates
- Start of the 5/2 dynamic testing, and
- Duration of dynamic testing activities.

The [REDACTED] dates are based on CRL senior management's view of the latest contractors' programmes, taking into account their reliability and achievability. CRL explain in RAP 2 that [REDACTED] dates: *"include a limited amount of time risk and float and will be used by CRL to manage the Contractors to a challenging programme. CRL is addressing the methods [by] which Contractors will be driven to achieve these dates"*.

The [REDACTED] dates are based on the CRL senior management's view on the current level of risk exposure and not from using a Quantitative Schedule Risk Analysis (QSRA), which would normally be considered good practice.

We understand that the production of the QSRA was stopped at the time of the Semi Annual Construction Report (SACR) 18⁴³ because it was deemed no longer beneficial to the CRL programme. We note that

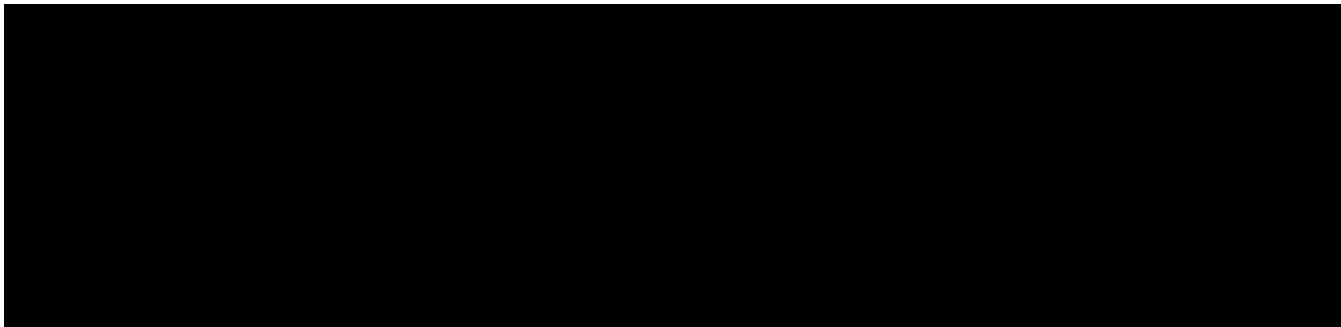
⁴¹ RAP 1 planned start date of mid-November 2018

⁴² For example Period 06 2018_19 CRL Board Report

⁴³ We note that the minutes of the final meeting of the Risk Sub-Committee on 12 January 2018 records that *"the final quarterly QRA was scheduled for March 2018 as part of the SACR19 process"*.

RAP 2 includes the results of what was described as an “Additional Quantitative Risk Analysis” which gave rise to an additional sum of cost on top of the Late date cost outturn.

CRL explain in RAP 2 that [REDACTED]: “take into account further risks other than those included in the quantified risk analysis, a Force Majeure type event or a fundamental system failure between train and signalling. The [REDACTED]” dates have been used to provide Sponsors with a more prudent position which they may wish to adopt for the outturn time and cost.” The RAP 2 schedule risks and assumptions are further covered in Appendix 4.



RAP 2 programme as presented in Figure 5 shows the completion of all enabling works to start the dynamic testing in [REDACTED]. This is [REDACTED] than the date in RAP 1. Stage 3 opening is shown as [REDACTED] than the date in RAP 1.

The two critical paths for the Stage 3 opening programme relate to the dynamic testing and the infrastructure readiness i.e. availability of the tunnels, stations and signalling. In RAP1, dynamic testing sequence was highlighted as the critical path and the completion of the infrastructure is shown but is not identified as being critical. The failure of RAP 1 to recognise the infrastructure readiness, including station completion, as one of the critical paths in the programme would have caused CRL to misjudge its position to handover the stations to the IM in [REDACTED] for the start of the trial running and trial operations.

4.6.1 Dynamic testing

The 29 static tests forming the entry criteria for the rolling stock to start 5/2 dynamic testing has been further reviewed by CRL and CRL is now considering putting through the trains for dynamic testing once a shorter list of essential tests has been passed. The initial planned start date of early [REDACTED] in RAP 1 was later revised to [REDACTED] in RAP 2. We were advised by CRL that the revision to the dates was based on CRL taking a realistic view of the potential delay from the lack of rolling stock readiness and that they therefore included some time risk allowance. The completion of the routeway works to allow dynamic testing to start has also been delayed.

CRL has altered its approach to starting the dynamic tests to build extra resilience. The dynamic testing was initially planned to start on a straight 5/2 shift for a 20 weeks period. This has been revised to start on a single shift for three weeks, and then moving onto a 5/2 shift in January 2019 [REDACTED]. The new approach coincides with Boss’s recommendation of starting dynamic testing gradually in order to build train reliability.

⁴⁴ RAP 1 IM handover date



The scope and plan for the dynamic testing was still not well developed at the time of our review and the testing process is uncertain, so it is not possible to be entirely certain whether the [redacted] duration allocated is sufficient although the duration has been increased by [redacted] from the RAP 1 duration. The RAP 2 [redacted] date allows for an additional [redacted] in dynamic testing to cover areas of uncertainty. However, it should be noted that this period does not provide sufficient contingency if a strategic risk such as a fire or SIL4 issue were to occur. While we understand that the likelihood of a SIL4 incident is very low, we understand an occurrence could add 16 to 20 weeks to the programme.

4.6.2 Infrastructure readiness

The completion of all tunnel fit-outs and signalling is essential for the dynamic tests. The stations are not essential to dynamic testing: only the shafts are, but dynamic testing can be constrained if significant construction activities are happening on a station site. Staged completion of the stations is essential for handover to the IM for the start of the trial running and trial operations.



We understand that the stations programme is still under development and the dates currently reported in the RAP are likely to change.

There are specific stations with known programme issues such as [redacted] station. RAP 2 shows the [redacted] station a month later than the RAP 2 [redacted] date for handover to the IM [redacted].



- [redacted] – RAP 2 staged completion [redacted]
- [redacted] – RAP 2 staged completion [redacted]
- [redacted] – RAP 2 staged completion [redacted]

To obtain a more up to date assessment of the key dates, we interviewed the CRL project managers on the confidence level around achieving the TOSD and staged completion [redacted] dates in the RAP 2 report. [redacted]



[REDACTED]

[REDACTED]

By way of example, the PMs view was that [REDACTED] station's realistic date for staged completion is end of [REDACTED] than the RAP 2 staged completion [REDACTED] date. It should be noted that the RAP [REDACTED] dates shows the station staged completion in [REDACTED]. The lateness generally in the dates is driven by risks surrounding [REDACTED].

The biggest challenge for the station contracts is the interfacing with the [REDACTED] Communication & Controls and [REDACTED] Signalling contracts, and managing the performance of the tier one contractors. The RAP 2 [REDACTED] dates make provision for some risk time but certain risks remain outside CRL's control, such as sub-contractor insolvency and recruitment of scarce specialist resources.

4.7 Comments and recommendations

Although we understand CRL is targeting achieving the [REDACTED] dates, our review of the principal live contracts indicated that the [REDACTED] dates in the RAP 2 report are optimistic dates. The [REDACTED] dates in the RAP were derived from a top-down view of the remaining scope of work. [REDACTED]

To understand fully the efforts required to complete the remaining scope and produce a robust programme, CRL needs to adopt a bottom-up approach which takes appropriate account of inputs from the tier one contractors and sub-contractors and the critical dependant third parties. It then needs to develop a logic driven MOHS with assumptions that have the buy-in where relevant of the delivering parties and set this as the baseline for monitoring and control⁴⁵.

We observed that there is much more emphasis on the entry criteria for the start of dynamic testing than on activities during the dynamic testing. There needs to be a clear scope of outcome specifications for dynamic testing that defines what success would look like. The scope should be accompanied by a sufficiently detailed schedule that is communicated to all relevant parties.

⁴⁵ See Section 2.6

It is important to note that dynamic testing has relatively minimal impact on the outturn costs, whereas delay to the station contracts has significant potential to increase the outturn costs. The [REDACTED] communications and [REDACTED] signalling contracts are critical dependents to the station contracts and there is still a high level of uncertainty around interfaces between these contracts. It is imperative that a comprehensive integration programme is developed and put in place at the earliest opportunity.

5 Cost review

This section of our report addresses two requirements from the Terms of Reference:

- Reviewing the material inputs to those models [CRL's financial modelling], to determine if they are well founded on an appropriate assessment of the estimate cost at completion for each remaining contract or activity.
- Assessing whether the allowances made in the financial models for risk and uncertainty are reasonable and consistent with the schedule scenarios presented by CRL and the independent (Rannachan) review.
- We have set out below our key findings, followed by recommendations, and then our detailed findings.

5.1 Summary of findings

A short summary of the key findings of our cost review is outlined below:

- The RAP 1 and 2 cost estimates are derived from high level timelines to Stage 3 completion, not detailed schedules. RAP 2 includes [REDACTED] which [REDACTED] broadly take into account the Rannachan Report recommendations, and [REDACTED] dates incorporating a [REDACTED] showing a Stage 3 opening date of [REDACTED] (see section 4).
- The critical timeline to the opening of the railway runs through the dynamic testing. However, this is not the main cost driver for the infrastructure works, which are driven by the timeline to complete the station fit out, tunnel fit out and communication systems contracts.
- [REDACTED]
- It appears unlikely that all the communications systems work can be completed by [REDACTED]. To achieve Stage 3 opening by the [REDACTED], CRL is investigating targeting those systems essential to opening, leaving non-essential systems to be completed after opening, but we expect such related post-opening costs should be able to be contained within the pessimistic scenario within our sensitivity analysis assuming Stage 3 opening occurs in or close to [REDACTED]
- Our sensitivity analysis⁴⁶ for the [REDACTED] dates timeline shows.
 - The cost of the optimistic scenario is similar to the RAP 2 P95 value. This indicates that for these and other reasons the RAP 2 estimate is not a P95 value.
 - The pessimistic scenario would require around £0.7bn⁴⁷ of additional funding compared to RAP2.
 - The actual costs are expected to lie somewhere between the mid-range and pessimistic scenarios, requiring between around £0.3bn and £0.7bn of additional funding compared to RAP2, assuming appropriate steps are taken on a timely basis to address the issues in this report and the related governance report, and that no major unforeseen risk materialises which was not addressed in the RAP.
 - Prior to taking account of the impact of appropriate and timely actions in response to the issues highlighted in this report, and in the Governance report, we consider there to be an 80% likelihood that costs will be contained below the pessimistic scenario.
 - In the event the Stage 3 opening date were to slip materially later than [REDACTED] accompanied by added delay to substantial demobilisation of the principal contracts, there is a significantly reduced likelihood that costs will be contained below the pessimistic scenario.

⁴⁶ The analysis which excluded the NR ONW, was not a downside or worst case scenario assessment and did not consider the potential impact of catastrophic risks, such as a severe tunnel fire.

⁴⁷ The additional £0.7bn of funding would cover outturn cost increasing from £13.8bn to £14.5bn.

- RAP 2 identifies 20 additional risks (see Appendix 4) which are not allowed for in the cost estimate or the [REDACTED] dates timeline. Of these, eleven relate to infrastructure works within CRL control, five relate to dynamic testing and four are catastrophic risks outside CRL control which Sponsors need to be aware of.

5.2 Cost review recommendations

Recommendations from our cost review are given in Table 6. These should be considered in the context of related recommendations in other Sections.

Table 6: Recommendations from our cost review

Cost Review recommendations for consideration		
<i>Sponsors to consider the extent to which CRL has taken adequate steps to mitigate the likelihood of potential catastrophic risks. CRL to undertake a more detailed cost estimate once the updated completion programme has been agreed and to reconsider excluded risks; to ensure effective programme controls</i>		
Owner	Ref	Recommendations for consideration by Sponsors
Cost estimates (see section 5 for supporting detail)		
Sponsors	5.1	Consider the extent to which CRL has taken adequate steps to mitigate the likelihood and potential impact of a catastrophic event and whether or not potential contingent funding arrangements should be put in place to address such an event.
CRL	5.2	To provide a higher confidence level on the outturn cost, CRL should undertake a more detailed cost estimate once the updated completion programme has been prepared and approved.
	5.3	Reconsider the programme risks excluded from the cost model, in particular the excluded infrastructure risks which are CRL's responsibility to manage and / or mitigate.
	5.4	Ensure effective programme controls to support the efficient delivery of the programme.
	5.5	The key Stage 4 and 5 activities and inter-dependencies should be scheduled out and related costs estimated.

5.3 Introduction

We carried out a review of the cost estimates included in RAP 1 and RAP 2. Those estimates were developed from top down estimates based on assumed rates of expenditure (run rates) for various scenarios and assumptions. We then tested a broader range of scenarios within an alternative cost assessment, using different programme and run rate assumptions to present an illustrative range of possible outcomes. The approach was the most appropriate based on the information available, the access provided and the timescale. The results of a medium range scenario (scenario 3) were fed into CRL's financial model (Section 8) to test the impact on funding requirements.

5.4 RAP cost estimates

5.4.1 Basis of estimates

The RAP 1 and RAP 2 cost estimates were top down estimates based on the application of periodic cost run rates to activity durations derived from the MOHS key dates, plus allowances for risk. The MOHS key dates are based on current CRL management's views, rather than a detailed schedule to completion. The run rates used are based on CRL management's judgement of the recent cost expenditure rates across the key live contracts. A similar approach was used for the assessment of the indirect costs such as project management.

5.4.2 RAP 1

The RAP 1 point estimate was calculated as an addition to the CRL forecast of AFCDC at Period 4 2018_19 (P04), and was based on schedule scenario 2 as described in RAP 1. In addition to the point estimate, risk at P50, P80 and P95 values were calculated, based on slippage from schedule scenario 2 to schedule scenario 3 as described in RAP 1.

5.4.3 RAP 2

The RAP 2 cost estimate was calculated as an addition to the RAP 1 cost estimate, and made allowance for further delays to the programme assumed in RAP 1 defined through [REDACTED], as described in section 4 above. The RAP 2 additions were shown as point estimate increases above the RAP 1 estimate to account for programme extension to the [REDACTED].

RAP 2 also included P50, P80 and P95 values for additional risks identified by CRL but not included in the base RAP 2 cost estimate. The full programme cost of RAP 2⁴⁸ should include these risks. The additional risks in effect excluded allowances for catastrophic events⁴⁹.

Combining the RAP 1 and RAP 2 P95 values gives the total cost estimate shown in Table 7. This is not strictly a P95 value due to the simplified method of calculation, but is intended to be an equivalent upper bound figure.

Table 7: Summary of RAP 1 and 2 P95 total cost estimates

Description	Amount £m
IP2 Budget	12,512
Cost increases above IP2	203
P50 Programme Risk	95
P4 2018-19 AFCDC (P50)	12,810
RAP 1 Point estimate increase	268
Risk (P95)	257
CP2 AFCDC (P95)	13,335
RAP 2 Point estimate increase ([REDACTED])	342
Additional Risk (P95)	154
Total AFCDC (approximately P95)	13,831
Cost of work done (COWD) end P6 2018_19	12,564
Cost to go (approximately P95) at end of P6 2018-19	1,267
Additional funding requirement above IP2 Budget	1,319

5.4.4 RAP risk calculation

Different approaches were taken to calculate the risk allowances in RAP 1 and RAP 2. Detail on these approaches can be found in section 6 of this report.

5.4.5 RAP assumptions and exclusions

The RAP 1 and RAP 2 estimates were based on a number of specific assumptions and exclusions. We address the relevant schedule and cost assumptions in section 7 of this report and have assessed the approach followed in RAP 1 and RAP 2 in relation to each of those assumptions and exclusions.

⁴⁸ The RAP dated 18 September 2018 stated: 'CRL is in the process of revising its MOHS following the submission of the Adverse Event Notice. The revision will be in line with the decision taken by the CRL Board on 29 August 2018 which approved adoption of the Scenario 2 schedule as the revised baseline for the MOHS up to the start of Trial Running for Stage 3'. Schedule 2 was described in the SB Minutes of 3 September 2018 as being based on a Stage 3 Opening of [REDACTED]. The RAP 1 cost estimate was based on a Stage 3 opening date of [REDACTED].

⁴⁹ A very low probability was ascribed within the Additional QRA calculations to the occurrence of a serious fire. We have separately commented that such catastrophic events should be reported separately with a range of potential impact indicated. Their inclusion within the risk analysis with a very low probability in effect simply leads to a negligible value being included within the risk analysis.

We concluded that there are some assumptions / cost exclusions relating to the completion of routeway, station and communications works which should not be excluded, as these works are the responsibility of CRL to manage. These are addressed in Table 36 at Appendix 4.

The assumptions and exclusions include the 'additional risks' listed in RAP 2, which were not accounted for in arriving at the RAP 2 [REDACTED] dates timeline. The additional risks include some infrastructure risks which would not normally be excluded from the programme, as it is CRL's responsibility to manage/mitigate these risks. There are some dynamic testing risks that could potentially be excluded on the basis that they are not under the full control of CRL. However, CRL's rolling stock/infrastructure integration role, means they could still reasonably be included within the CRL scope. There are also some catastrophic risks which Sponsors need to be aware of, but they would not normally be allowed for within the programme schedule or budget, but would instead be separately drawn to Sponsors attention with information on the potential range of impacts and mitigation steps being taken.

5.4.6 Comments

The RAP 1 and RAP 2 cost estimates are high level and are not based on a detailed assessment of the activities required to complete the programme, because a detailed updated MOHS had not been completed at the time they were prepared. There is a significant risk that the RAP 2 cost estimate could be inaccurate, as there is no agreed completion schedule (MOHS) and key contractors have yet to commit to such a schedule.

The RAP 2 [REDACTED] dates timeline broadly aligns with recommendations of the Rannachan Report and the [REDACTED] dates timeline makes some allowance for further delays beyond the Rannachan schedule. However, several of the RAP 2 'additional risks' are not included within the MOHS and have not been fully priced. Some of the additional risks are the responsibility of CRL and should have been included in the MOHS and cost estimate. Hence, the RAP2 estimate did not provide a comprehensive assessment of the costs and risks up to Stage 3 completion.

5.5 Alternative cost assessment

5.5.1 Approach

In order to provide Sponsors with a cost comparator for the RAP 2 estimate, we performed a sensitivity analysis of the total programme cost through the use of illustrative scenarios to assess the costs for the remaining key contracts and indirect costs (excluding non CRL costs such as NR ONW). The purpose of the cost comparator was to inform the Sponsors' assessment of whether the budget set out in RAP 2 would be sufficient to fund the programme, taking into account risks to the Stage 3 opening date of [REDACTED] adopted in RAP 2. Our high level analysis was not intended as a downside assessment, nor to provide a definitive range of potential outcomes. Our analysis also excluded the impact of extreme high-impact low-probability risks.

We did not undertake a bottom-up cost estimate as this was not part of our scope of work.

Our analysis considered the cost to complete the works based on the milestone dates in the RAP 2 [REDACTED] dates timeline, including contractor demobilisation dates. CRL used a similar approach but based on estimating an addition to their previous cost forecast rather than working from the cost of work done to date.

We used assumptions regarding changes to milestone dates and run rates to derive six scenarios to assess the cost to complete, each of which was added in turn to the Cost of Work Done (COWD) at the end of P06 2018_19 to derive a total programme cost for each key contract under each scenario. Our analysis was based on cost and schedule data within RAP 1 and RAP 2, the previous 6 periods of reported contractor cost data and discussions with senior CRL personnel.

We did not assess the cost impact of significant delays to the dynamic testing. While this activity is critical to the start of trial running/operation and the opening of Stage 3 it does not affect the completion of the main construction works and, hence, does not have a significant influence on the total cost of the infrastructure and hence the total outturn cost of the project.

5.5.2 Risk

Our scenario analysis modelled delays to the programme beyond the dates provided in RAP 2 and the consequential cost impacts of such delays. To do this we considered two types of risk.

- **Time risk:** the risk of delay beyond the dates included within RAP 2, represented by the RAP 2 additional risk register. Appendix 2 describes our assessment of the additional delays for these risks.
- **Run rate risk:** the risk that run rates (i.e. periodic expenditure on construction) do not reduce towards contract completion at the rate assumed by CRL, particularly after main contractor demobilisation.

There will always be a small probability of a catastrophic risk arising, for which no significant cost or schedule allowance has been included in the RAP and which has not been incorporated into our scenarios analysis. Sponsors should consider the extent to which CRL has taken adequate steps to mitigate the likelihood and potential impact of such catastrophic events and whether or not potential contingent funding arrangements should address such events.

In order to provide a like-for-like comparison with our assessment which includes risk, the cost adjustments and programme risk values included in the P4 AFDCDC, RAP 1 and RAP 2 estimates were allocated across the individual key contracts, based on the allocation assumed by CRL and, for unallocated risks, based on the descriptions and categorisations shown in the CRL risk registers. This method provided an equivalent RAP 2 total cost for each contract against which the scenario analysis results could be compared (see Appendix 3).

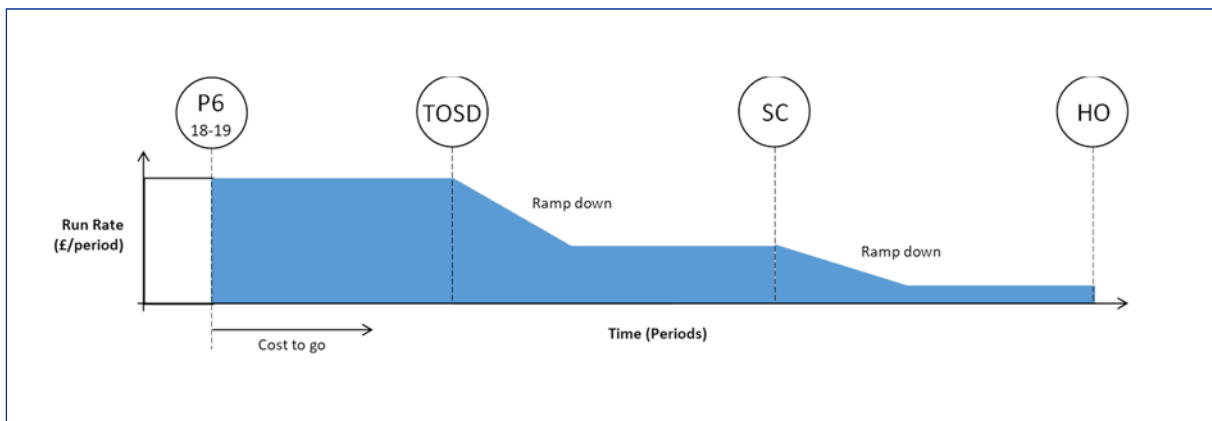
5.5.3 Cost run rates

The cost run rates used in our assessment were based on individual rates for each contract up to the Tier One Substantial Demobilisation (TOSD) date, with reduced rates after that point up to Stage Completion (SC) and NEC Handover (HO).

In determining the run rates for each contract we met with the Project Managers (PMs) to understand contract specific issues and the applicability of historic run rates for forecasting costs to complete. In our analysis we adopted either the 6-month average historic cost run rate, or where the PMs had used a higher rate in their assessment we used that rate. We used the chosen run rate up to the TOSD date, a lower rate after TOSD up to SC and a further reduced rate between SC and HO. We assumed a ramp down of the run rate after TOSD (generally over 2 months), with a further ramp down after SC (generally over 2 months). For our analysis two run rate cases were assumed.

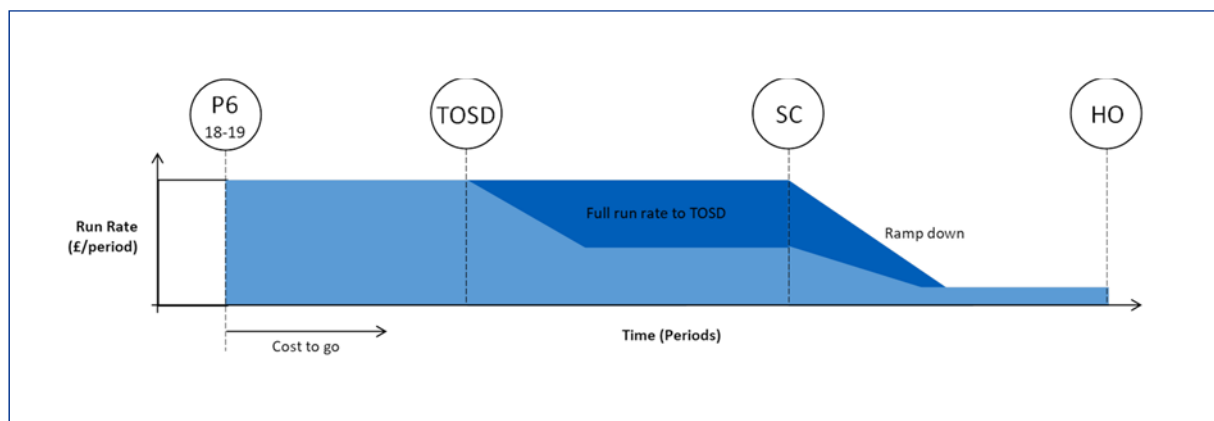
- Run rate ramping down at the key dates, as assumed by CRL in the RAP estimates and shown in Figure 8.
- Run rates not ramping down at the planned TOSD date, but instead continuing to run unchanged to the SC date, as shown in Figure 9, representing a more pessimistic view, consistent with [REDACTED] and the uncertainty at the time of our fieldwork as to the precise activities which remained to be completed (including due to re-work as well as where additional work was unexpectedly required).

Figure 8: Ramped down run rate profile



Source: KPMG approach to taking reported costs to date to P06 2018_19 and applying cost run rate assumptions against varying TOSD and SC dates where ramp down is assumed at planned TOSD

Figure 9: Profile with no ramp down at planned TOSD



Source: KPMG approach to taking reported costs to date to P06 2018_19 and applying cost run rate assumptions against varying TOSD and SC dates where no ramp down is assumed at planned TOSD

For the [REDACTED] contract, applying the full run rate to the SC date was not considered to be a realistic case, as TOSD must occur before 5/2 dynamic testing can commence. In this case the 6 month average rate was applied for an additional [REDACTED], rather than assuming that the full rate continues to SC, to represent the risk of a delay to demobilisation.

For [REDACTED], no TOSD date applies. Hence, in all scenarios for these contracts the 6 month average run rate was applied up to SC.

As SC comprises handover to the infrastructure manager, we assumed that this would be the latest date for the start of the ramp down of tier one contractor demobilisation.

5.5.4 Key contract dates

The key dates used to develop the illustrative scenarios were the [REDACTED] dates' provided in RAP 2, and dates derived from discussions with the PMs. We also considered the impact of additional delays due to risks

included in the RAP 2 additional risk register. The RAP 2 [redacted] dates were not considered in our analysis as they do not represent a pessimistic case upon which P95 funding requirements would be based. Three date cases were assumed:

- PM's View of schedule, representing a more up to date view than RAP 2
- [redacted] dates, as assumed in RAP2
- Additional delays beyond the [redacted] dates representing adjustment of the [redacted] dates for the additional risks identified in RAP2.

The delay impact of the additional risks in RAP 2 was assessed at key contract level by allowing additional periods beyond the RAP 2 [redacted] dates based on the information provided in the additional risk register. Our assessment excluded the impact of catastrophic risks such as a severe tunnel fire.

5.5.5 Illustrative scenarios

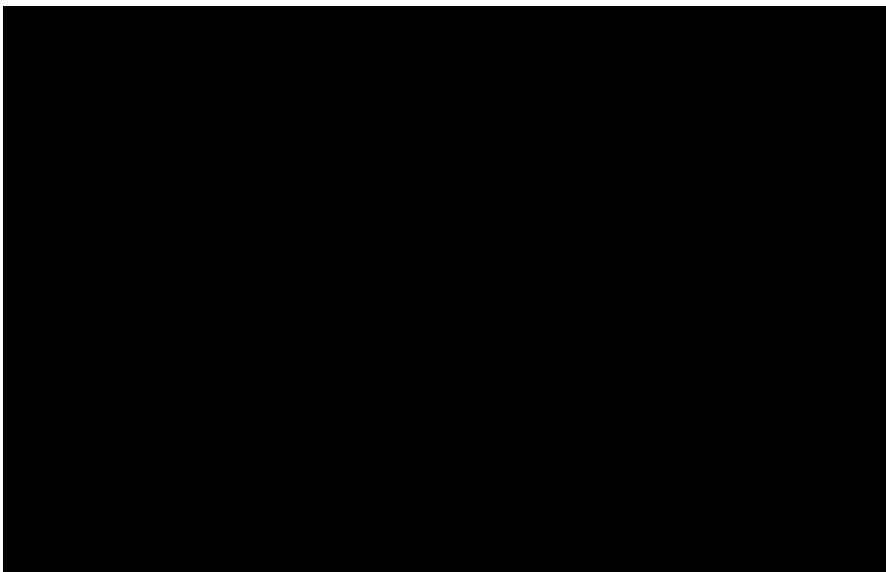
We combined the two run rate cases and three date cases to give six scenarios as illustrated in Figure 10.

Figure 10: Scenarios

		Date Assumption		
		Dates based on PM View	RAP 2 [redacted] dates	Additional delays beyond [redacted] dates, excluding for catastrophic risks
Run Rate Assumption	Last six months average rate up to planned demobilisation, reduced rate to completion	Scenario 1 PM View/ 6m run rate to demobilisation	Scenario 2 RAP Late dates/6m run rate to demobilisation	Scenario 3 Additional delay/6m run rate to demobilisation
	Last six months average rate up to completion (no reduction at planned demobilisation)	Scenario 4 PM View/ 6m run rate to completion	Scenario 5 RAP Late dates/6m run rate to completion	Scenario 6 Additional delay/6m run rate to completion

5.5.6 Contracts analysed

The 13 key contracts listed below were subject to the scenario analysis:



The scenario analysis also included the indirect costs, which represent the CRL organisation costs made up of four cost categories: Corporate, Support, Programme and Operations. For the indirect costs we assumed the following key dates for the [REDACTED] date scenarios:

- A TOSD equivalent date mid 2019
- An SC date equivalent to when Stage 3 is assumed to be complete / open at [REDACTED]
- An HO date equivalent to when all works are assumed to be complete [REDACTED].

5.5.7 Indirect costs

When assessing the indirect cost run rates we used as a proxy for the profile:

- The average run rate for the last six months which we assumed would continue up to the equivalent TOSD date.
- For the run rate to SC we halved the historic 6 month average rate.
- For the run rate to HO we used a quarter of the historic 6 month average rate.
- The PM's view was assumed to be the same as the [REDACTED]

5.5.8 Other smaller contracts

There are multiple smaller contracts and other expenditure that we have not been able assess through the same approach (i.e. through meeting with the individual PMs and by analysing individual contract historic cost run rates etc.), given the limited time available. The costs to go included in RAP 2 for these Other Contracts total around £182 million including allowances for P95 risk. In order to provide an illustrative overall cost of the Other Contracts for each scenario, we applied a percentage adjustment to the RAP 2 values for these costs derived from the average difference between the RAP 2 value and the value from the scenario analysis of the 13 key contracts and indirect costs. This gave illustrative total costs for the Other Contracts for each scenario.

5.5.9 Results

Table 8 summarises the results of our analysis for each scenario, showing a range of total programme costs. It should be noted that this summary assumes all contracts follow the same scenario, which may not be the case as different scenarios could occur on separate contracts or individual contracts could have outcomes that are between pairs of scenarios or above the [REDACTED]. However, there is some interdependency between contracts, particularly with the stations and systemwide contracts such as Communications and Controls which means that several contracts could outturn in line with a single scenario. Scenario 1 is the optimistic case and scenario 6 the pessimistic case within our analysis. We have then rolled up the calculations for all the different contracts and components to produce the table below.

⁵⁰ This Stage 3 completion / opening date is an assumption based on information available at the time of our review and does not take account of subsequent work being undertaken by CRL to develop a revised programme so it is possible this date may be later than we have assumed

⁵¹ This has been assumed to be 6 months later than the assumed date for opening Stage 3

Table 8: Scenario analysis results (£ billion)

Scenario	Total cost to go	Total programme cost	Cost to go variance (Scenario RAP2)	Variance as % of RAP 2 cost to go	Additional funding required vs IP2 budget*
Cost of Work Done to P6 2018_19		12.6			
RAP 2 incl. additional risks (P95)	1.2	13.8	0	0%	1.3
Scenario 1	1.2	13.8	0	1%	1.3
Scenario 2	1.4	14.0	0.2	16%	1.5
Scenario 3	1.5	14.1	0.3	25%	1.6
Scenario 4	1.5	14.1	0.3	20%	1.6
Scenario 5	1.7	14.3	0.5	38%	1.8
Scenario 6	1.9	14.5	0.7	52%	2.0

*IP2 budget £12.5bn

The results indicate that RAP 2 underestimates the P95 cost because:

- Scenario 1, based on the PM views of the schedule, indicates a cost to go which is similar to the RAP 2 P95 value.
- The scenario 2 cost to go, which is based on the RAP 2 [REDACTED] dates without additional delays, is 16% greater than the RAP 2 P95 value.
- The scenario 3 cost to go, which is based on [REDACTED] dates plus additional delays (equivalent in our view to the RAP 2 P95 schedule), is 25% greater than the RAP 2 P95 value.

If main contractor demobilisation is not achieved when planned but instead on average runs to the SC date⁵², as assumed in scenarios 4, 5 and 6, the cost to go would increase beyond the levels in scenarios 1 to 3 to the levels in scenarios 4, 5 and 6. The analysis shows increases in cost to go of 20%, 38% and 52% for scenarios 4, 5 and 6 respectively compared to the RAP 2 P95 value.

If a significant reduction in the run-rate on the major contracts on average occurs somewhere between TOSD and SC dates then the outturn cost would be expected to lie somewhere between scenarios 1 to 3, and 4 to 6.

The mid-range of the cost to go values from the scenario analysis is 25% greater than the RAP 2 P95 value (including additional risk), which is similar to the scenario 3 result.

[REDACTED]
A sense check of the illustrative scenario results is included in Table 34 at Appendix 3.

The results and our enquiries show:

- The timing of the station TOSD dates, when cost run rates start to reduce, and the pace of that reduction have the largest impact on the value of costs to go (as shown by scenarios 4, 5 and 6). [REDACTED]

⁵² Or the profile of main contractor costs including any long tail of activity and costs post the delayed TOSD date and potentially post the delayed Stage 3 opening date of December 2019, is such that the overall cost is equivalent to demobilisation on the major contracts on average running through to the SC date (this is a simplification we adopted for the purposes of our scenario analysis);

- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]

These, and other matters, are in effect taken into account to varying degrees by the assumptions underpinning our illustrative scenarios which are based on assumed high level changes in cost run rates and key dates. A more precise analysis would have been difficult to create given the above issues and limitations in the availability of relevant up to date detailed data from CRL.

In conclusion, given the schedule uncertainty and possibility of further delays, the cost estimate presented in RAP 2 appears to represent a target value and does not represent a P95 completion budget equivalent to an IP2 value. There are several areas of uncertainty which mean the costs could be significantly greater than estimated by CRL in RAP 2. Our illustrative scenarios show additional funding requirements which are up to £0.7bn greater than the RAP 2 estimate, with a mid-range value around £0.3bn greater than RAP 2.

The outturn costs could be lower or higher than that derived from the most pessimistic illustrative scenario, dependent in part upon the extent to which the right steps are promptly and effectively taken to re-set certain aspects of the programme and its management and oversight. The outturn costs will also be dependent in part on the occurrence of future unknown events and challenges which could cause greater delay and additional cost than has been assumed. The opportunity exists to achieve a lower outturn cost than scenario 6 if the right steps are taken and on a timely basis. We considered at the time we were completing our analysis and shared the outline of our key recommendations with CRL in late November 2018 that there was around an 80% likelihood of containing costs to below the pessimistic scenario, prior to the impact of CRL taking the right steps on a timely basis, which in turn would lead to that probability increasing.

5.6 Comments

Our comments on the cost review are:

- Both the RAP 1 and RAP 2 estimates are derived from high level timelines to Stage 3 completion, not detailed schedules of work required. RAP 2 defines a [REDACTED] Stage 3 opening than RAP 1 and includes [REDACTED] (see section 4). [REDACTED]
- The critical timeline to the opening of the railway runs through the dynamic testing programme that tests the performance of the rolling stock with the infrastructure, particularly the signalling. However, this is not the main cost driver for the infrastructure works. The main costs are driven by the timeline to complete the infrastructure works, particularly the station fit out, tunnel fit out and communication systems contracts.
- Demobilisation of main contractor resources must be achieved to reduce the current spend rate. [REDACTED]
[REDACTED] Speed of [REDACTED]

completing the works and hence the timing of achieving effective contractor demobilisation (i.e. a material step down in cost run rate) remains a key uncertainty when assessing the costs.

- It appears unlikely that the RAP 2 cost estimate is a P95 value, as scenario 1, the most optimistic scenario, gave a cost similar to that provided in RAP 2.
- Scenario 6, the most pessimistic scenario assumes a slower run down of the spend rate combined with delays to key dates, and requires around an extra £0.7bn in additional funding compared to RAP2.
- We expect the actual costs to lie somewhere between the mid-range and pessimistic scenario. However, this assumes the schedule remains broadly as defined in RAP2, i.e. opening Stage 3 which is planned to be [REDACTED] per RAP 2 is broadly achieved and that it does not materially slip past that date. If that date is broadly achieved then a factor in the level of outturn costs will be the thickness of the tail of remaining works which will have been agreed can be performed post Stage 3 opening, and hence the volume and duration of the tail of activity.
- The mid-range of the scenarios would require around £0.3bn in additional funding compared to RAP2.
- RAP 2 identifies additional risks which are not allowed for in the RAP2 base cost estimate or the [REDACTED], which CRL suggests Sponsors should consider when applying for additional funding. The additional risks are, in effect, exclusions from the RAP 2 base cost, although we have taken them into account in our illustrative scenarios. Of the 20 additional risks.
 - Eleven risks relate to infrastructure works which are within CRL control and would normally be included in the programme budget.
 - Five risks relate to dynamic testing and may have a high time impact but low infrastructure cost impact. CRL's rolling stock/infrastructure integration role means they could still reasonably be included within the CRL scope.
 - Four risks are catastrophic risks outside CRL's control which Sponsors need to be aware of. These risks would not normally be allowed for within the programme schedule or budget and have been excluded from our analysis. However, CRL should have plans in place to manage such risks.
- The completion schedule is still being developed by CRL and the key dates have yet to be finalised. Should these result in a material delay to the planned opening date for Stage 3 beyond [REDACTED] then the costs could be higher than our pessimistic case.
- Qualitatively, the [REDACTED] dates timeline giving a [REDACTED] Stage 3 opening date does not appear to represent a P95 timeline and we considered it to be in the P50 to P80 range.
- Given the current schedule uncertainty, we consider that a P95 confidence level could not be ascribed to scenario 6; any uncertainty within the RAP estimates will be reflected in our assessments.
- In any event, it appears unlikely that all the communications systems work will be completed by [REDACTED] given the current progress in completing [REDACTED] asset installations, and the apparent difficulty in securing resource to carry out the SCADA and radio testing. [REDACTED]
[REDACTED] However, we consider that the total costs could still be contained within our pessimistic scenario 6 if effective programme control is ensured, the right actions taken at pace and if main contractor demobilisation is on average achieved much sooner than SC but still later than the planned TOSD dates.
- Our assessment assumes CRL promptly takes the necessary steps to gain control of the programme. If programme control is not established promptly, demobilisation is significantly delayed or other unknown risks materialise, the costs could exceed our pessimistic case. These matters will need closely monitoring by Sponsors.
- CRL should undertake a more detailed cost estimate once a robust updated completion programme has been approved.

6 Risks and uncertainties

This section of our report addresses a single requirement from the Terms of Reference:

- Assessing whether the allowances made in the financial models for risk and uncertainty are reasonable and consistent with the schedule scenarios presented by CRL and the independent (“Rannachan”) review.

We have set out below our key findings, followed by recommendations, and then our detailed findings.

6.1 Summary of findings

Our key findings are as follows:

- There are some inconsistencies in how risk has been calculated in RAP 1 which result in an incomplete assessment of risk. Some risk durations in the RAP 1 schedule risk analysis do not align with the risk dates provided by delivery teams, which also impacts the risk allocation.
- In RAP 2, infrastructure risks, dynamic testing risks and catastrophic risks have been modelled together using a Monte Carlo analysis. While this is a reasonable approach for modelling risk generally, the modelling of the high-impact / low-probability risks (strategic risks) in this way results in contingency sums which are far lower than would be required should those risks materialise. This is not an appropriate way to assess these types of strategic risks, and we would expect these to be excluded from the contingency and separately presented with ranges of potential schedule and cost impact rather than as single point estimates included in the Monte Carlo risk analysis.

6.2 Recommendations

Our recommendations on risks and uncertainties are given in Table 9.

Table 9: Recommendations for risks and uncertainties

Risks and Uncertainties recommendations for consideration		
<i>Sponsors to request a bottom-up cost estimate built on dates from an updated robust schedule which takes account of contractors' views on performance and delay; CRL to take appropriate account of all significant risks in compiling their updated cost estimate and to present high-impact, low probability events separately as a range of schedule and cost impact.</i>		
Owner	Ref	Recommendations for consideration
Sponsors	6.1	To request a bottom-up cost estimate, built on dates drawn from an updated MOHS. It should be independently verified that the updated MOHS ⁵³ is robust and takes appropriate account of contractors' views on performance and delay. (See separate recommendations on preparation of a revised MOHS / Schedule).
CRL	6.2	To adopt a consistent approach in the modelling of schedule risk, commercial risk and contingencies.
	6.3	To reassess the Additional QRA risks presented in RAP 2 to develop a comprehensive risk register for contingency held at CRL and sponsor level. This risk register should exclude catastrophic and high-impact, low-probability risks, as these should be separately presented with ranges of potential schedule and cost impact. The risk register should be re-assessed to include three point estimates of schedule and cost impact for each risk.

⁵³ See section 2.6

6.3 CRL's overall approach

The business-as-usual risk management process conducted by CRL is comprised of the quarterly risk analysis managed at programme level, as well as the Unresolved Trend (URT) process which is managed at project level and is ongoing. The URT process informs the quarterly risk allocation at programme level, and the quarterly risk process informs the programme AFCDC each period.

At period 5, RAP 1 was developed to estimate the cost to complete Stage 3 of the programme over and above the period 4 AFCDC. RAP 2 was subsequently released with additions over and above the Period 4 AFCDC and RAP 1, to align with updated schedule information. In an effort to relate the business-as-usual risk process to the RAP process, the programme level risk analyses conducted in Period 6 and Period 7 were then made to reflect the risk position developed in RAP 1 and RAP 2.

The risk analyses undertaken at RAP 1 and RAP 2 were conducted by the CRL management team and were presented in terms of risk allocations at a P50, P80 and P95 position. These analyses quantified known risks and detailed several exclusions and assumptions made. Further, RAP 1 also included a small amount for general contingency, allocated for uncertainty. Risks identified in RAP 1 were separated into schedule risk and 'other' commercial risk, which were modelled using Monte Carlo simulations. Contingency was also included within the risk sums without modelling. Risks identified in RAP 2 included schedule and commercial risks which were excluded from RAP 1, as well as several high-impact, low-probability risks. These were analysed together and modelled by CRL using a Monte Carlo simulation.

For additional detail regarding the risk process undertaken in RAP 1 and RAP 2, please see Appendix 7.

6.4 Comments

In RAP 1, risk allowances have been split into schedule risk, commercial risk and contingencies. There are some inconsistencies in how the risk has been calculated:

- Schedule risk and commercial risk have been modelled using a Monte Carlo analysis, but contingencies have not been modelled. Furthermore, separate P50, P80 and P95 figures have been added together to produce total RAP 1 risk figures. Good practice denotes that this approach is not correct as adding these figures together does not produce true total P50, P80 and P95 figures.
- Some run rates used in the schedule risk analysis have been reduced by about 50% when compared to the run rates used in the RAP 1 point estimate, resulting in a reduction of the impact costs. The assumption on which this reduction was based – that not all construction resources on a project will be impacted should a delay occur – is a reasonable one.
- Some risk durations in the schedule risk analysis do not align with risk dates provided by the delivery directors, and some schedule risks are missing from the risk analysis. The reasons for these discrepancies are not clear.

In the RAP 2 additional risk register, infrastructure risks, dynamic testing risks and catastrophic risks have been modelled together using a Monte Carlo analysis. While this is a reasonable approach for modelling risk generally, the resultant costs due to the very low probabilities assigned to the high-impact / low-probability risks (strategic risks) are far lower than they would be should those risks materialise. This is not an appropriate way to assess these types of strategic risks, and we would expect these to be excluded from the contingency calculation. The strategic risks should be separately presented with ranges of potential schedule and cost impact. However, the RAP 2 analysis includes single point estimates for the strategic risks included in the Monte Carlo analysis.

The discrepancies in risk dates and missing risk items in the schedule risk analysis in RAP 1 suggest that the total risk allocation in RAP 1 may not accurately represent schedule scenario 3 as presented by CRL. Further, the risk allocation does not cover delay to the dates presented in the independent Rannachan review, as schedule scenario 3 shows an earlier completion date than the Rannachan review shows. However, this has been mitigated in RAP 2 as the [REDACTED] dates which have been presented, together with the associated risk analysis completed, are consistent with the Rannachan review.

We recommend Sponsors request a bottom-up cost estimate, built on the dates in the updated MOHS. It should be verified that the updated MOHS is robust and takes appropriate account of contractors' views on performance and delay. The use of three point estimating should be considered to assess the estimating uncertainty.

In addition to the bottom-up cost estimate, CRL should reassess the Additional risks presented in RAP 2 to develop a comprehensive risk register for contingency held at both CRL and sponsor level. This risk register should exclude catastrophic and high-impact, low-probability risks, as these should be separately presented as ranges of schedule and cost impact. The risk register should be re-assessed to include three point estimates of schedule and cost impact for each risk.

7 Assumptions and exclusions

This section of our report addresses a single requirement from the Terms of Reference:

- Determining if assumptions and exclusions are appropriate and have been priced as risk, or quantified but excluded from the analysis, or have not been quantified.

We have set out below our key findings, followed by recommendations, and then our detailed findings.

7.1 Summary of findings

The RAP makes some assumptions which exclude certain activities, and risks from the CRL schedule and cost estimates. Some of these are fundamental assumptions and would change not only the schedule but the estimated cost of completing the works. Our key findings are:

- The dynamic testing programme is uncertain, it does not allow for further delays in the provision of an homologated train or if [REDACTED] fails to complete the necessary routeway installation to support commencement of 5/2 dynamic testing. While there are inherent risks within the dynamic testing process outside of CRL control, we would expect a prudent schedule period for the 5/2 dynamic testing process to be included in the MOHS. Risks associated with contract [REDACTED] should be accounted for by CRL.
- Infrastructure: The RAP excludes some infrastructure risks. The completion of the infrastructure works is a CRL responsibility and we would expect the MOHS and RAP cost estimate to take into account all the risks associated with completing the infrastructure works.
- NR possessions – Not all possessions required for transition testing shown on the MOHS have been secured with NR. While the availability of possessions is outside of the control of CRL, we would expect CRL to demonstrate how it plans to mitigate the risks surrounding securing NR possessions to support its programme delivery.
- Lack of transparency as to the basis for the duration apportioned for trial operations. At this stage in the programme we would expect the duration for the trial operations to be based on a detailed plan agreed with the IM and the operator and to include contingency for unforeseen delays whilst recognising that revision may be required.

7.2 Recommendations

Our recommendations on assumptions and exclusions are given in Table 10.

Table 10: Recommendations for assumptions and exclusions

Assumptions and exclusions recommendations for consideration		
<i>CRL to account for risks associated with the C610 Systemwide contract; to include sufficient float in the dynamic testing programme; to identify and manage critical Network Rail possessions; and to include sufficient duration for trial operations.</i>		
Owner	Ref	Recommendations for consideration
CRL	7.1	To account sufficiently in preparing the cost estimates for the risks associated with and potential delays to completing the [REDACTED] contract.
	7.2	To allow for sufficient float in the dynamic testing programme, given the uncertainty of this activity.
	7.3	To include in the schedule and cost estimate sufficient amounts to address the risks (excluding catastrophic risks) associated with completing all the infrastructure works. The expected delay consequences on other activities of non-catastrophic risks materialising, should not be excluded, and a realistic allowance for time should be included for all activities such as completion of required documentation.
	7.4	To identify the critical NR possessions and to confirm whether these have been confirmed by NR and to schedule in accordingly and consider the consequences of a prudent level of lost possessions.
	7.5	To include allowance for a sufficient duration for trial operations based on a detailed plan developed with the operator and the infrastructure manager and to include contingency for unforeseen delays.

7.3 Approach and findings

We compared the schedule assumptions, risks and costing assumptions included in RAP 1 and 2 by grouping them into the following categories:

- Dynamic testing
- Rolling stock
- Infrastructure
- Network Rail
- Operations
- Revenue
- Catastrophic

Our full analysis is included in Appendix 4. While most of the assumptions and treatment of risks appears reasonable, there are some matters which have been excluded from the RAP cost estimate where we consider the approach to be unreasonable, as shown in Table 11 below.

Table 11: Unreasonable assumptions and excluded risks in RAP 1 and 2

Category	Assumption / Excluded Risk	Comments
Dynamic Testing	No specific risk has been allowed for any further delays in the provision of an homologated train.	The dynamic testing programme is uncertain. CRL should have mitigation plans in place for such an eventuality. A prudent approach would be to allow some float in the dynamic testing programme, given the uncertainty of this activity. The start of 5/2 dynamic testing is also dependent on the readiness of the routeway infrastructure.
	█ fails to complete necessary routeway installation to support commencement of 5/2 dynamic testing before the end of November 2018.	The █ contract is a CRL responsibility. The start of 5/2/ dynamic testing is dependent on handover from █. Premature commencement of 5/2 dynamic testing will prolong the █ completion works.
Infrastructure	Further slippage in station, shaft and portal (SS&P) programmes (including TOSD dates).	This is not a risk, it is a consequence of other risks (identified elsewhere by CRL) materialising that cause delays to the programme.
	GSM-R and stations radio programme is further delayed.	This is not a risk, it is a consequence of other risks materialising that cause delays to the programme.
	Delay in provision of required documentation (asset data, operation and maintenance manuals, IRNs, training plans etc.) impacts the completion programme.	It is CRL's responsibility to plan and manage the works. The timeline should take due account of the rate of completion of IRNs.
	Tier one contractors may not deliver all necessary safety evidence in time to obtain safety approval.	It is CRL's responsibility to plan and manage the works.
	Testing and Commissioning (T&C) personnel will be able to operate under Overhead Line Equipment (OLE) supply lines. This item is currently under review as working under live wires is not supported by some parties on safety grounds.	It appears likely that the █ works will be prioritised to focus on completing essential systems prior to Stage 3 opening, with the remainder of systems to be completed at a later date.
Network Rail	Further possessions are required with NR to undertake required fringe works (Westbourne Park and Pudding Mill Lane) and subsequent approvals by NR are not achieved.	CRL assumes NR will provide possessions to suit the completion programme. This may not be possible, and is a risk to the programme. Some allowance for missed possessions should be included in the schedule.
Operations	There is insufficient time to undertake trial operations activities.	This is not a risk, it is a consequence of other risks materialising delaying the start of the trial operations or arising during trial operations.

7.4 Comments

The RAP 2 schedule and cost estimates require to be updated to include the following risk areas:

Dynamic testing There are inherent risks within the dynamic testing process which mean that CRL cannot entirely control this activity. However, we would expect a prudent schedule period for the 5/2 dynamic testing process to be included in the MOHS.

The start of 5/2 dynamic testing is dependent on the [REDACTED] contractor vacating the routeway. The [REDACTED] contract is a CRL responsibility and the risks associated with it should be accounted for by CRL in the RAP and MOHS. Our scenario analysis (see section 5) includes scenarios which delay the completion of the [REDACTED] systemwide works.

Infrastructure The completion of the infrastructure works is a CRL responsibility and we would expect the MOHS and RAP cost estimate to take into account the risks associated with completing the infrastructure works (excluding catastrophic risks). Our scenario analysis includes cases which delay the completion of the stations, routeway, communications and signalling works.

Network Rail While the availability of NR possessions is outside of the control of CRL, we would expect the MOHS to identify the critical NR possessions and to confirm whether these have been confirmed by Network Rail and to schedule in accordingly and consider the consequences of a prudent level of lost possessions.

Operations At this stage in the programme we would expect the duration for the trial operations to be based on a detailed plan and include contingency for unforeseen delays. It is CRL's responsibility to ensure the infrastructure is made available to the infrastructure manager at the planned date in the required pre-agreed condition to allow trial running and trial operations to commence. Our scenario analysis includes cases which delay the completion of the stations, routeway, communications and signalling works.

8 Review of CRL's funding model

This section of our report addresses a number of elements of our Terms of Reference as outlined at section 3 and which for ease of reference are repeated below:

- Determining whether processes used to produce the forecasts have been subject to appropriate quality checks (See also section 9: Financial Controls).
- Reviewing the material inputs to CRL's financial modelling and forecasts, to determine if they are well founded on an appropriate assessment of the estimated cost at completion for each remaining contract or activity (see also Section 5: Cost Review).
- Reviewing any material subjective assessments or adjustments that form part of the inputs or modelling and conclude if they are appropriate.

The following sub-sections outline a summary of our findings, and then our recommendations.

8.1 Summary of findings

Our key findings are:

- The Model reflects a P50 view of cost and risk, rather than P95. We understand this is in line with PDA requirements. The Model reflects a P50 AF CDC that is similar to the £13,679m in RAP 2, except for a variance of £14m which was essentially an error and should not have been included. The P95 cost in RAP 2 amounts to £13,831m for comparison.
- The Model shows an SFA deficit at project completion of £1,180m, i.e. £880m in addition to the £300m already committed at the time the Model was produced. In comparison, RAP 2 indicates an additional funding requirement for £1,019m due to the variances mentioned above.
- [REDACTED]
- The Model contains subjective judgements relating to certain indirect costs ([REDACTED]) and to the timing of cash outflows (a two period lag for accruals; the £68m of financing costs to be paid to [REDACTED]; £31 million of provisions unwinding; unwinding of the £100 million ACWP to COWD adjustment; and [REDACTED]).
- We also identified a variance of £38m between the calculated P6 2018_19 SFA balance, from which the Model rolls forward, and the actual SFA balance. CRL advised that the difference is driven by a recent spike in accruals (i.e. costs incurred but not yet paid out). CRL noted that ten contracts account for £38m of the total £50m accruals increase.

The Model also effectively assumes that the sum set aside for provisions unwinds, meaning that the first £31m of the Model's remaining £223m programme contingency is already spent (unless the provision costs are not ultimately incurred).

We looked at the potential impact of the 'alternative cost assessment' (scenario 3), as described in Section 5, on the SFA cash balance from P7 2018_19 onwards. This indicates that scenario 3 would require Sponsors to make allowance for £312m of additional funding by the end of the Crossrail project, over and above the £1,019m apparent from RAP 2 (P50). Of this £312m, £73m would arise by 31 March 2019⁵⁴. We note that the model also shows that the cumulative cash outflows which yield £1,019m adverse to IP2 by the end of the project, show a cumulative net cash outflow of £652m by 31 March 2019, making an overall

⁵⁴ Assuming one adopts the assumptions in the funding model around timing of cash flows

£725m cash funding shortfall by 31 March 2019 based on the assumptions in the inputs and model, and before taking account of the £300m funding amount already agreed.

8.2 Recommendations

Our recommendations arising from a review of CRL’s funding model are given in Table 12.

Table 12: Recommendations for CRL’s funding model

Funding Model recommendations for consideration		
<i>Sponsors to ask CRL to Model the impact of the additional costs which were illustratively assumed by the various scenarios explored in section 5.</i>		
Owner	Ref	Recommendations for consideration by Sponsors
Sponsors	8.1	Make allowance in additional funding for costs to come in at the P95 / Additional P95 QRA level, then we recommend that the Sponsors instruct CRL to prepare a Model reflecting the full P95 costs and Additional P95 QRA, rather than P50 (i.e. relax the PDA requirement for that particular version of the Model). This will require CRL to profile all additional costs by period.
	8.2	Instruct CRL to prepare the revised Model in a way that reflects resolution of the two remaining findings from our review of the logical integrity of the Model. Sponsors may also wish to consider requesting an accompanying Record of Assumptions and/or Model user guide.
	8.3	Consider whether there is a risk that the position of the pension scheme has deteriorated since the last actuarial valuation in December 2016, and whether this should be reflected in the cost assumptions in a future Model version.
	8.4	Note that there are a number of subjective assessments related to both costs () and timing of cash outflows (the two period lag for accruals; the £68m of financing costs to be paid to ; £31m of provisions unwinding; unwinding of the £100m ACWP to COWD adjustment;) which may impact the SFA cash balance. To increase the robustness and level of confidence in these assumptions, we recommend that Sponsors should request CRL to develop these assumptions further to remove the subjectivity of any judgements that could impact the timing and quantum of additional funding required.
	8.5	Consider whether the assumption regarding provisions unwinding is appropriate and if, in the light of this information, the assumptions about remaining programme contingency are appropriate. Note: the provisions balance of £31m as at P6 2018_19 which we understand relates to disputes is assumed in the Model to unwind in future periods. Effectively, therefore, the Model assumes that, should these costs arise, they would need to be funded from the remaining £223m of programme contingency.
	8.6	
	8.7	
	8.8	Consider whether CRL’s assumptions in RAP 2 are likely to be realised, and if not the likely implications on Sponsor funding requirements. Note: CRL itself also highlighted some of its own key assumptions in the RAP 2, including that a
	8.9	To reflect the potential impact of issues highlighted in this report, Sponsors should consider asking CRL to model the additional costs illustratively assumed by the scenarios explored in section 5. It would be sensible to have regard both to scenario 3 representing roughly the mid-point of assumptions explored as well scenario 6 representing the most pessimistic scenario. Against scenario 6 we commented that we estimated there was around an 80% probability at present of not exceeding this illustrative outturn providing our key recommendations were implemented at pace and assuming no major as yet unforeseen event arises.

8.3 Introduction and approach

We have reviewed the SFA cash balance calculations (i.e. additional funding requirements) in the CRL financial model associated with RAP 2. To do so we were supplied with a copy of an Excel financial model of file name 'CIM v405_CP2+ Scenario' (the Model).

The Model excludes the costs associated with ONW, Old Oak Common depot and rolling stock (except for £13 million for the Reading additional rolling stock). The rest of this report only addresses what CRL reports to be included in its AFDCDC being Anticipated Final CRL Direct Costs which excludes ONW, depot and rolling stock costs although it includes integration costs to be incurred by CRL.

The Model also does not yet reflect the benefit of the additional £300 million of funding for CRL that was agreed in July, which CRL has advised was subsequently received in two instalments on 28 September and 5 October 2018.

The key SFA cash balance calculations are undertaken on the 'SFA' worksheet in the Model. We noted the following two rows:

- **'SFA Closing Balance' (row 84)**, which reflects the calculated SFA cash balance and which had a value of £157m as at the end of P6 2018-19.
- **'SFA (actuals from Finance)' (row 10)**, which reflects the actual SFA balance received from CRL's finance team and which had a value of £195m as at the end of Period 6 2018-19.

In discussions with CRL we established that the SFA calculations for future periods do not roll forward from the latest (i.e. Period 6 2018_19) SFA actual balance of £195m. Instead the Model calculates the SFA cash balance in each future period on the assumption that the balance at the end of Period 6 2018-19 was the £157m calculated figure, rather than the actual figure. CRL has advised that the £38m difference relates to a recent spike in accruals (i.e. costs incurred but not yet paid out). CRL analysis shows that over the past 18 periods the accruals balance has risen by around £50m. CRL noted that *'This increase has been driven by a few key Systems and Stations contracts'* for which CRL's analysis shows that the 'top 10 contracts' account for £38m of the total £50m increase in accruals. CRL also noted that the Model working capital assumptions (i.e. a simplified two-period lag between cost being incurred and cash payment for most costs) means that the variance between the actual and forecast SFA cash balance is likely to fluctuate over time.

Our review has included tracing back through the Model from the calculated SFA balance row (i.e. 'SFA' row 84) to identify the material inputs driving the calculation of this key output row for each period after Period 6 2018_19. As part of this review, we held a number of meetings with CRL to understand the rationale for the material assumptions that relate to these inputs and reviewed a number of supporting documents. In the meetings CRL confirmed that the cost inputs to Model are based on P50 costs under the graduated [REDACTED] scenario, plus the P50 Additional QRA.

We also established that the version of the Model associated with RAP 2 had not yet been subjected to testing procedures to check formulaic integrity. A previous version was reviewed by Grant Thornton in March 2017, but only in respect to the calculation of AFC and AFDCDC, rather than the SFA balance. We have subsequently carried out testing procedures at the request of Sponsors, the findings of which are discussed under 'Model testing procedures' below.

8.4 Inputs

The calculated SFA closing balance each period is driven by direct, indirect and risk-related capital cost assumptions (including their profile over time) and other inputs such as NR financing costs, traction power works funding assumptions, working capital assumptions and cash payment profiles for various costs (e.g. Canary Wharf Group, insurance).

As set out above, our review has largely focussed on the inputs and assumptions that drive changes in the SFA closing cash balance after Period 6 2018-19. These are summarised in Table 13 as follows.

Table 13: Summary of CRL's Model inputs and assumptions

Input (£m, nominal)	Total to Period 6 2018-19	Total between Period 7 2018-19 and P13 2018-19	Total from Period 1 2019-20 to completion	Total by completion
Calculated SFA opening balance		157	(652)	n/a
Sources of funding ⁵⁵	12,307	54	-	12,361 ⁵⁶
P50 Capital costs ⁵⁷	(9,657)	(593)	(157)	(10,406)
P50 Indirect costs	(1,755)	(78)	(56)	(1,888)
Accruals (direct/indirect) ⁵⁸	213	(35)	(178)	-
Other cash flows ⁵⁹	5	(14)	9	-
Future programme risk allowance (incl. Additional QRA at P50)	-	(76)	(147)	(223)
L&P	(858)	-	-	(858)
	(98)	(68)	-	(166)
Calculated SFA closing balance	157	(652)	(1,180)	(1,180)

Source: CIM v405_CP2+ Scenario

Note: These figures include a £14 million additional QRA cost figure that CRL advised was effectively erroneously included by CRL following the P6 QRA review (see below). This is included within the future programme risk allowance.

8.5 Principal findings

Our principal findings include:

- **AFDCD variance.** The AFDCD figure shown on the 'Control' worksheet in the Model is £13,693m. This is different to the AFDCD for the [REDACTED] in the P95 cost and Additional QRA at P95 scenario shown in Tables 1.1 and 1.2 on Page 2 of RAP 2 (which sum to £13,831m). CRL has advised that the Project Development Agreement (PDA) requires the Model to be based on a P50 view of costs. The variance of £139m therefore appears to arise because the Model is instead based on the P50 figures from Tables 1.1 and 1.2 (which sum to £13,679m), plus an additional (£14m) cost which we understand from CRL reflects additional QRA that was erroneously included by CRL following the Period 6 QRA review.
- **The Model does not reflect all required additional Sponsor funding.** As the inputs reflect graduated Late/P50 costs and P50 Additional QRA, rather than graduated Late/P95 costs and P95 Additional QRA, the Model does not reflect all of the additional required CRL funding stated in RAP 2.
- **SFA balance variance.** The Model shows an SFA deficit at project completion of (£1,180m), or (£880m) further to the (£300m) of additional funding already committed at the time the Model was produced. This contrasts with RAP 2, which states:
 - (£865m) is required by the end of the project, further to the already-agreed (£300m).
 - Sponsors may also wish to make an allowance for additional QRA at P95 of (£154m).

⁵⁵ TfL, SoS and interest on cash balance

⁵⁶ The total sources funding and the aggregate of all the costs entries are £13,541m or £152m less than the £13,693m identified as the P50 RAP 2 cost. The reason for this difference is some £151m of costs prior to January 2009, when the SFA was established. These costs do not feed into the Model's SFA cash balance calculation, which only picks up costs from January 2009 onwards. CRL has advised that these early AFDCD expenditures were funded by £120m received from DfT and £375m of early TfL funding. After paying the early costs, £344m of the £495m from TfL/DfT flows into the Model's SFA balance calculation, from P10 FY09

⁵⁷ [REDACTED]

⁵⁸ Adjustments to account for differences in timing between costs being incurred and cash payments for direct and indirect costs

⁵⁹ Other adjustments to account for differences in timing for cash payments by CRL for insurance, VAT, tax, [REDACTED] Reading trains, Traction Power, OSD and other direct cost provisions.

Together, these additional funding requirements set out in RAP 2 sum to (£1,019m). The Model figure of (£880m) reflects a variance of £139m, because the Model reflects P50 rather than P95 costs and P50 rather than P95 Additional QRA.

- NR financing charges. CRL pays NR's financing charges in respect to the approximately £2.3 billion of ONW being undertaken by NR, until a 'Transition Date' in December 2018, as specified in a recently amended protocol document. [REDACTED]
- Indirect costs. CRL considers one of the biggest risks to the Model's indirect cost assumptions to be staff costs. Of the £35.2 million additional indirect costs under the [REDACTED] scenario, £20m relates to additional staff costs. After discussing this with CRL, there appears to be an element of subjectivity in CRL's calculation of staff costs (see 'Subjective assessments' below).
- VAT. CRL has advised that it recovers the VAT it pays contractors from TfL in the period after payment. There will therefore be an SFA cash flow impact from VAT on the difference between the P50 costs / Additional QRA at P50 (reflected in the Model) and the higher P95 costs / Additional QRA at P95 set out in RAP 2 (and indeed any revised future costings). The difference between these figures is £138m (£152m minus the erroneous additional £14m included in the Model). At a 20% VAT rate, this could cause the periodic SFA cash requirement to be up to £28m higher than expected. This would be higher if future cost estimates are higher than RAP 2 P95 costs. The impact would unwind as VAT is recovered later, but would bring forward the timing of additional Sponsor funding in the interim periods.
- [REDACTED]
- Cash balance at 31 March 2019. RAP 2 states that the estimated SFA cash balance at 31 March 2019 is (£652m). We note that this figure does not reflect the £300m of additional Sponsor funding which has now been received. The (£652m) figure aligns to the closing SFA balance shown in the Model at Period 13 2018_19, which also does not reflect the additional £300m. This suggests that CRL expects the £138m of additional funding for the P95/Additional QRA at P95 costs (which are not reflected in the Model), to arise after March 2019. A revised Model reflecting full P95 cost and Additional QRA at P95 (rather than P50 cost and Additional QRA at P50), would clarify this timing issue.
- Direct cost provisions. The Model shows a direct cost provision balance at the end of Period 6 2018-19 of £31m. The Model assumes that this unwinds on a straight-line basis to zero by Period 5 2019-20. Any potential cost increases, for which the provision is currently made, are therefore effectively assumed to be funded from the Model's remaining programme risk of £223m. This could be interpreted to mean either that £31m of the Model's future contingency is already spent, or alternatively that the costs for which provision is being made won't be incurred.
- Timing of when the additional £300m is spent. RAP 2 states that by Period 10 2018_19 (December 2018), CRL will have exhausted the additional £300m of funding that was confirmed by Sponsors in late September. The point in the Model at which the SFA Closing Balance drops below (£300m), occurs in Period 11 2018-19 (6 Jan to 2 Feb 2019), rather than December 2018. However, as described above, the Model does not reflect the full P95 costs or Additional P95 QRA. Again, a revised Model reflecting P95 cost forecasts and P95 Additional QRA costs (rather than both at P50) would reduce this uncertainty.
- Key assumptions CRL itself highlighted in RAP 2. CRL itself also highlighted some of its own key assumptions in RAP 2, including that a [REDACTED]
- Overall assumed cash spend. the overall assumed cash spend in the seven periods to end Period 13 2018_19 is £809m which is just over £115m per period. We note this is close to but just slightly under the historic average per period cost of around £120m. The split of cash to go in the Model as between

pre and post the end of Period 13 2018_19 is impacted by a variety of assumptions but in overview by the assumed timing of costs incurred, and the assumed speed of unwind of accruals

8.6 Subjective assessments

The main subjective assessments include:

- NR financing costs. CRL funds NR for interest costs on NR's ONW costs until a specified date in the construction period. [REDACTED]
- Working capital assumptions. The Model assumes that most costs are paid out as cash two months after they are incurred, with exceptions including 50% of indirect costs (assumed to relate to costs including CRL's own staff costs) which are paid out in the period in which the cost is incurred. While CRL considers these working capital assumptions to be a reasonable fit with observed cash flows, the £38m variance between the Period 6 2018_19 calculated and actual SFA balance demonstrates the potential for volatility in this area, as does the recent increase in accruals.
- Cost timing – unwinding of ACWP versus COWD adjustment. There is an adjustment row in the Model inputs which aligns the Model's 'Actual Cost of Work Performed' (ACWP) contract cost inputs to the CRL P6 board report's Cost of Work Done (COWD) cost assumptions. We understand this essentially reflects the fact that the cost profiles input into the Model (ACWP) are two weeks delayed compared to COWD. At Period 6 2018_19, the cumulative balance of this cost adjustment input row was £100m. This cost adjustment is then assumed by CRL to unwind on a straight line basis at £8m per period between Period 7 2018_19 and Period 5 2019_20 inclusive. The cumulative total adjustment by the end of the project is zero, and it therefore has no impact on eventual AFCDC, but the straight line assumption impacts the timing of required additional Sponsor funding in interim periods.
- Timing of provisions unwinding: The Model includes a Direct Cost Provision for disputes balance of £31m as at Period 6 2018_19. This unwinds to a cumulative total of zero on a straight line basis (at £3m per period) from Period 7 2018_19 to P5 2019_20 inclusive. Provision assumptions therefore have no impact on eventual total AFCDC. In reality claims are likely to be negotiated or settled according to something different to the flat profile. The straight line assumption impacts the timing of required additional Sponsor funding. Please also see our related direct cost provision key finding above.
- Additional indirect staff costs ([REDACTED] CRL advised that these were not scaled or profiled based on a bottom-up view of people's employment cost and dates, due to time pressures associated with RAP 2. CRL also highlighted that these costs can fluctuate over time. We understand that work is underway by CRL to refine these assumptions.
- [REDACTED]
- [REDACTED]
- [REDACTED]

8.7 Model testing procedures

KPMG has undertaken procedures to test the logical integrity of the arithmetical operations in the Model formulae and calculations under the assumptions and input data for the 'Current (P50)' scenario. Specifically, for each unique formula, we inspected the formulaic code and documented instances where it contained apparent arithmetical inaccuracies or deviated from the apparent intended logic (as implied by the Model structure and construction, or as explicitly stated in the cell label, or in management's documented understanding of the Model).

On completion of initial version testing we issued 74 queries, of which 54 related to how assumptions were applied in the Model or to aid our understanding of the Model, and 20 related to the formulae logic used within the Model. We received an intermediate amended version ('CIM v405_CP2+ Scenario v02.xlsm') and a final version of the Model ('CIM v405_CP2+ Scenario v03.xlsm') and responses to all of our queries.

Following testing of the final version, and assessing the responses to our queries, we have 37 points remaining. Of these, 35 are assumptions-related comments raised during our work, which may help user understanding of the Model. The other two reflect findings on the logical integrity of the Model, but which relate principally to historic scenarios that have no impact on the current forecast and which we do not think materially impact the Model's ability to achieve the purpose which it was designed to meet, insofar as its logical integrity under the base case assumptions and input data is concerned. Details of all 37 points have been separately shared with CRL and are included at Appendix 12.

8.8 Impact of cost scenarios

We have undertaken a high-level assessment of the impact that the Alternative cost assessment (described in section 5), would have on the SFA cash balance from Period 7 2018_19 onwards. This is based on a scenario assessment of the periodic change in costs to complete between the following cost / risk scenarios:

- Current P50 cost / Additional QRA at P50 scenario as set out in the Model (noting that the Model erroneously includes the additional £14m of P6 QRA cost).
- Scenario 3 from the Alternative cost assessment, which reflects an alternative potential view of the periodic costs to complete for the following cost items:
 - 15 major remaining contracts (direct costs)
 - Other remaining contracts (direct costs)
 - Indirect costs.

We have assessed scenario 3 because it represents a medium level scenario in terms of impact. The scenario does not consider changes in costs except those listed above.

The analysis indicates that scenario 3 would require Sponsors to make allowance for **£312m** of additional funding, over and above the £1,019m (i.e. £865m + £154m) required under the RAP 2 P95 cost / additional P95 QRA scenario. Of this £312m, **£73m arises by 31 March 2019** which makes £725m in aggregate of additional funding requirement by 31 March 2019 (including the £300m already agreed and the further £352m identified in RAP 2). We note that this would imply a cash spend in the 7 periods to the end of Period 13 2018_19 of £882m (being £157m + £725m) and hence £126m per period.

Further details of this high-level assessment can be found in Appendix 5.

8.9 Other findings

Other findings from our review of the inputs driving the future periodic SFA balance include.

- SFA versus AFCDC variance (early project costs). The AFCDC includes (£151m) of costs prior to January 2009, when the SFA was established. These costs do not feed into the Model's SFA cash balance calculation, which only picks up costs from January 2009 onwards. CRL has advised that these early AFCDC expenditures were funded by £120m received from DfT and £375m of early TfL funding. After paying the early costs, £344m of the £495m from TfL/DfT flows into the Model's SFA balance calculation, from P10 FY09.
- Pension scheme liability. The P6 2018_19 Management Accounts Balance Sheet shows a pensions liability of (£26.1m). This cost is not included in the Model. We are advised that the Model reflects the actuarial valuation at 31 December 2016, which did not show a deficit, and that the Management Accounts reflect an alternative set of pension scheme assumptions required by accounting standards, which result in a deficit.

- COWD versus ACWP. As noted above, we are advised that the Model cost assumptions for individual contracts reflect the 'ACWP' view of costs (where costs arise two weeks later than in the 'COWD' view), with adjustments to align the Model to the CRL P6 board report's COWD view of costs to date. The board report states ACWP to Period 6 2018_19 to be £12,347m and COWD to be £12,564m. CRL provided a reconciliation between these figures and the figures in the Model, which shows that the **£217m** difference relates to:
 - 'Adjustment – ACWP rec to COWD (from Cost Assurance)': cumulative cost of **£100m** at P6 2018_19 ('Current inputs' row 563)
 - 'Direct Cost Provision': Cumulative cost of **£31m** at P6 2018_19 ('Current inputs' row 570)
 - 'Pain/gain share adjustment': Cumulative cost of **£23m** at P6 2018_19 (which CRL has advised is included within the individual contract cost lines within the Model inputs)
 - 'Incentive/milestones payment adjustment': Cumulative cost of **£64m** at P6 2018_19 (which CRL has also advised is included within the individual contract cost lines within the Model inputs)
 - 'Other adjustments': Total of (**£0.8m**), which CRL has also advised is included within the individual contract cost lines within the Model inputs.
- SFA balance at completion. The Model shows an SFA deficit by the end of the project of (£1,180m), or (£880m) further to the (£300m) of additional funding already committed at the time the Model was produced. After adjusting for the potential erroneous £14m figure noted above, this is materially consistent with the P50 figures in the RAP 2 (i.e. £809m + £58m = £867m).

8.10 Comments and recommendations

Based on our findings described above, our comments and recommendations include:

- If Sponsors wish to make allowance in additional funding for costs to come in at the P95/Additional P95 QRA level then we **recommend that the Sponsors instruct CRL to prepare a Model reflecting the full P95 costs and Additional P95 QRA**, rather than P50 (i.e. relax the PDA requirement for that particular version of the Model). This will require CRL to profile all additional costs by period.
- This Model version should reflect resolution of the two remaining findings from our review of the logical integrity of the model. Sponsors may also wish to consider requesting an accompanying Record of Assumptions and/or Model user guide.
- Sponsors should note that there are a number of **subjective assessments** related to both **costs** (e.g. [REDACTED]) and **timing** of cash outflows (the two period lag for accruals; the [REDACTED] financing costs to be paid to [REDACTED]; £31m of provisions unwinding; unwinding of the £100m ACWP to COWD adjustment; [REDACTED]) which may impact the SFA cash balance. To increase the robustness and level of confidence in these assumptions, we recommend that Sponsors should request CRL to develop these assumptions further to remove the subjectivity of any judgements that could impact the timing and quantum of additional funding required.
- [REDACTED]
- [REDACTED]
- Finally the impact overall on the programme outturn costs of the various issues highlighted in this report are addressed by the series of illustrative scenarios considered in section 5 where we have noted that there is at present around an 80% probability that the outturn costs will not exceed the most pessimistic scenario explored (being scenario 6) providing our key recommendations are implemented at pace and providing no major unforeseen event arises. We explored above the impact of scenario 3 on the timing of cash funding requirements at 31 March 2019. Sponsors will need to consider the impact of the other scenarios on the timing of funding requirements.

9 Financial controls

This section of our report addresses a single requirement from the Terms of Reference:

- Determining whether appropriate and effective financial controls are in place and processes used to produce the forecasts are consistent with good practice and have been subject to appropriate quality checks.

The following sub-section outlines a summary of our findings, and is then followed by our recommendations and then brief details of our approach. A more detailed commentary on our work and findings is included at Appendix 9.

9.1 Summary of findings

Our key findings were:

- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]
- █ [REDACTED]

9.2 Recommendations

Our recommendations on financial controls are given in Table 14.

Table 14: Recommendations for financial controls

Financial Controls recommendations for consideration		
<i>CRL to revise the content of period Board Reports to include transparent more granular reporting of productivity, past, current, and assumed; revise central resource levels in finance and risk etc. to align better with the needs of the programme; to enhance significantly the extent and quality of constructive challenge provided by finance to commercial / project teams; to minimise optimism bias in outturn reporting; and to enhance financial procedures and processes.</i>		
Owner	Ref	Recommendations for consideration by Sponsors
CRL	9.1	Revise the content of CRL Board Reports to streamline the existing contents. Add additional metrics to report on actual productivity at a contract level (for key contracts) over time with comparison against plan, and assumptions underpinning costs and time to go calculations so as to provide transparency on past, current, and future assumed productivity for each key contract. For areas where productivity is more challenging to measure such as systems and systems integration, devise metrics which report progress against the most difficult activities so as to enable transparency of past, current and future assumed progress.
	9.2	Review the current central resource and skills levels in key functions (finance, risk etc.) versus the levels needed to sustain effective control through the balance of the programme and ensure appropriate steps are in place to restore the resource levels required. Revise the current demobilisation plan to align with a realistic assessment of the probable programme timeline, after including sufficient flexibility in key resource areas in the event of further unforeseen delay.
	9.3	Produce guidance on the appropriate extent, areas, frequency and processes which project finance staff and others in finance should follow to ensure there is sufficient constructive challenge to key commercial / project activities which deliver, or provide the basis for, key inputs into the financial reporting. Ensure project finance staff have the appropriate skills and experience and training to follow the guidance in the manner intended.
	9.4	Produce a consolidated finance procedures manual (collating and where relevant enhancing guidance already in existence but adding critical additional material), which should outline key practices. This should be stored in one place such as on CRL's intranet in order to be visible to and accessible by relevant staff.
	9.5	Utilise a more granular approach for the forecasting and estimating process. Processes used to produce outturn forecasts should be enhanced, the effectiveness of assurance checks re-assessed, optimism bias in outturn forecasting reduced, and more constructive challenge applied by the finance department on a regular basis.
	9.6	Prepare a tailored business plan for the 2019/20 financial year suitable for supporting the effective execution of the business' objectives.
	9.7	Develop a dedicated corporate risk management procedure and a corporate risk register. Appoint a CRL risk lead who will be in charge of both the project risk and corporate risk management processes.

9.3 Approach

We undertook a review of the financial controls being applied on the Crossrail programme by the Finance department. This was undertaken by reviewing a number of policy and procedural documents and meetings with key staff in CRL's finance department.

Our review was carried out under four headings:

- **People:** In which we considered the appropriateness of the resourcing within the finance department. We considered whether the revised demobilisation plan has been properly established and whether sufficient consideration has been given to facilitating effective financial control for CRL in light of the prolongation of the Crossrail programme.
- **Processes:** Where we sought to understand whether key financial processes are appropriately documented in standard operating procedures and if these procedures are adequate to supporting a robust general control framework.
- **Reporting:** In which we considered whether periodic financial reports are designed and operating in a way that provides appropriate overview of financial performance, enables robust challenge, and drives management action and decision making by CRL.
- **Assurance:** Where we explored CRL's existing internal assurance framework in order to assess its robustness and adequacy.

Details of our approach and findings are included in Appendix 6. Our key findings and recommendations are also recorded at sections 9.1 and 9.2 above.

10 Commercial controls and processes

This section of our report addresses a number of elements of our Terms of Reference as outlined at section 3 and which for ease of reference are repeated below:



- Assess whether appropriate and effective commercial controls are in place.
- Assess whether appropriate and effective commercial and contract management processes are in place.
- Make recommendations on any changes to the control or governance environment from the reviews above.

Key commercial controls areas are covered in this Section, and Appendix 9 contains details of additional commercial controls areas such as compensation event management and the assessment of contractor programmes.

The following sub-section outlines a summary of our findings, and is then followed by our recommendations and then by a summary of our detailed findings.

10.1 Summary of findings

A summary of the key findings are outlined below:

- The holding of contingency at Sponsor level did not lead to the ability to make timely and effective interventions due to a combination of deficiencies in performance and progress reporting by CRL and an absence of a sufficient practical ability to intervene.
- CRL has commercial management processes in place and operating but we found examples (as instanced below) of processes and contract administration requirements not being followed.
- 
- CRL has had authority to make supplemental agreements with contractors without needing to refer back to the Sponsors as to the potential impact of those agreements.
- Since 2017 the CRL risk management process has been split between the site teams who perform qualitative risk assessments and the central management risk team which performs quantitative analysis across the projects. The latter has been reduced to two people as part of the demobilisation plans aligned to a Stage 3  opening.

10.2 Recommendations

Our recommendations on commercial controls and processes are given in Table 15. They should be considered in the context of related recommendations in other Sections.

⁶⁰ See Section 10.4 for additional information.

Table 15: Recommendations for commercial controls and processes

Commercial Controls and Processes recommendations for consideration		
<i>Commercial controls to be enhanced, particularly regarding commercial management and administration of contracts. Where Sponsors determine it to be relevant, CRL's delegation to be reviewed and a revised CRL delegation framework to be developed. Sponsors to reserve the opportunity to review CRL decisions on certain new supplemental and settlement agreements. CRL also to drive improvements in productivity and reset the commercial strategy for the completion of contract works. Sponsors to review the funding envelope and define a process for the timing and release of funding. Appropriate steps to be taken to enable the holding of contingency at Sponsor level to be an effective measure. An enhanced change management process should be implemented.</i>		
Owner	Ref	Recommendations for consideration by Sponsors (see section 10 for supporting detail)
Sponsors	10.1	<p>Sponsors to consider the following in confirming a new framework for the management of funding and contingency.</p> <ul style="list-style-type: none"> • The practical challenges which CRL currently faces in being able to identify credible cost estimates and therefore to derive reliable P50, P80 or P95 values for the operation of the existing or a revised framework. These challenges are likely to continue for some time and hence as an interim measure any plan to define values for contingency to be held at Sponsor and at Board level, with the rest at Programme level, may require the pre-definition of contingency values other than by reference to CRL declared values for P50, P80 and P95 outcomes and this should be addressed. • The holding of contingency at a Sponsor level is only effective if Sponsors have in place the following (and therefore related steps will need to be taken to ensure). <ul style="list-style-type: none"> - Sufficient and timely visibility to Sponsors of reliable information on current and expected outturn project performance. - Effective oversight for Sponsors including of risks and uncertainties together with planned actions. - Appropriate rights of intervention by Sponsors together with a practical ability to intervene on a timely basis when it seems likely that further commitments or actions or the absence of appropriate actions could take AFDCDC over the expected project outturn. • Whether the interests of additional stakeholders will need reflecting in some way (e.g. GLA, HMT).
	10.2	<p>Sponsors to agree the definition of additional Reserved Matters on which they have the right to require CRL to seek their pre-approval, and the mechanisms consequently required to be put in place. This would provide Sponsors with the option to require that Sponsors consider and approve or reject proposals as they are developed for such additional Reserved Matters. Sponsors should consider defining the additional Reserved Matters to include.</p> <ul style="list-style-type: none"> • Proposed material changes by CRL to the commercial arrangements around existing contracts (see separate recommendation). • Proposals for CRL to enter into new arrangements or take any decision which is expected to have a material adverse impact on, or which CRL consider will avoid a material adverse impact on, schedule or cost outturn. <p>For this purpose it will be necessary to define 'material changes' and 'material adverse'.</p> <ul style="list-style-type: none"> • Definition of, and adherence to, appropriate processes for timely pre-approval requests, provision of relevant information and documents to those charged with approval, and the granting or otherwise of approval including where necessary the seeking of independent advice to inform Sponsor decision-making, will be particularly important. This is so that Sponsor approval or otherwise can be provided on a timely basis, after appropriate consideration, and so that the programme is not unnecessarily impacted.
	10.3	<p>The Sponsors to agree with CRL a set of critical milestones to indicate CRL's performance in progressing the works to completion in line with the new baseline plan as recommended in 11.6.</p> <ul style="list-style-type: none"> • The determination of appropriate milestones by Sponsors and how these should be monitored and reported against by CRL should be the subject of independent advice to Sponsors. These milestones will then need to be advised to / agreed with CRL.

Commercial Controls and Processes recommendations for consideration

Commercial controls to be enhanced, particularly regarding commercial management and administration of contracts. Where Sponsors determine it to be relevant, CRL's delegation to be reviewed and a revised CRL delegation framework to be developed. Sponsors to reserve the opportunity to review CRL decisions on certain new supplemental and settlement agreements. CRL also to drive improvements in productivity and reset the commercial strategy for the completion of contract works. Sponsors to review the funding envelope and define a process for the timing and release of funding. Appropriate steps to be taken to enable the holding of contingency at Sponsor level to be an effective measure. An enhanced change management process should be implemented.

Owner	Ref	Recommendations for consideration by Sponsors (see section 10 for supporting detail)
		<ul style="list-style-type: none"> Sponsors to consider the rights Sponsors wish to have going forwards to intervene in the programme linked to programme performance as reflected in the milestones. Sponsors to also consider whether there may be other circumstances where they would seek additional rights to intervene. Furthermore consideration is required as to whether these rights need to differ from their current existing rights. Appropriate arrangements to support those rights will then need to be put in place. The advised milestones should be driven from the programme and CRL should provide variance analysis for all movements in milestones along with the plan to recover the delays. The purpose behind the milestones would be to flag early warnings of delays to the agreed baseline programme and to trigger a set of agreed actions to allow the Sponsors to understand the potential impact to time and cost and to monitor mitigation measures established by CRL. Sponsors should define their requirements for CRL to provide variance analysis and mitigation actions where performance achieved is behind that planned.
	10.4	Sponsors to have the opportunity to review and discuss CRL's decisions on proceeding with and signing any new supplemental or settlement agreements in relation to key contracts prior to their implementation. Sponsors should seek independent input (which could be from P Rep) as to the upsides / downsides of what is proposed, prior to determining whether they have any objection to each proposed agreement. For this purpose key contracts will need to be defined by Sponsors but is expected to include at least the top 10 to 15 contracts.
	10.5	Sponsors to request CRL produce a commercial close out strategy for all the open contracts, setting out their current views on contract outturn positions without having a new agreement in place and with a new agreement in place. This should take account of the dates being agreed with the contractors in the development of the updated MOHS.
CRL	10.6	CRL to review and amend its financial <i>Scheme of Authorities</i> to reflect the creation of the Investment Committee. Executive delegations should be reduced, and the Board, through the Investment Committee to assume greater responsibility.
	10.7	CRL to consider (and potentially take advice on) how they can best drive improvements in contractor and their supply chains' productivity in a way that delivers net benefits to the programme in time and cost. Their conclusions should be put to Sponsors in a short paper setting out the proposed approach and the costs and benefits expected to be involved. Sponsors to consider, seeking independent advice as appropriate, and confirming their approval or rejection as appropriate. The improvements should be captured in trend analysis within CRL and Sponsor reporting.
	10.8	CRL should reset the commercial strategy for the completion of contract works in line with the revised milestones and payment terms and it should be produced by CRL for review by the Sponsors. Compliance to the strategy should be recorded in the periodic reporting and divergence should require an explanation of the issues, impacts and mitigations.
	10.9	Improvements could be made to the operation of the contract and commercial controls in relation to the commercial management [REDACTED] of the contracts. [REDACTED] [REDACTED]

Commercial Controls and Processes recommendations for consideration

Commercial controls to be enhanced, particularly regarding commercial management and administration of contracts. Where Sponsors determine it to be relevant, CRL's delegation to be reviewed and a revised CRL delegation framework to be developed. Sponsors to reserve the opportunity to review CRL decisions on certain new supplemental and settlement agreements. CRL also to drive improvements in productivity and reset the commercial strategy for the completion of contract works. Sponsors to review the funding envelope and define a process for the timing and release of funding. Appropriate steps to be taken to enable the holding of contingency at Sponsor level to be an effective measure. An enhanced change management process should be implemented.

Owner	Ref	Recommendations for consideration by Sponsors (see section 10 for supporting detail)
	10.10	In light of the recently reported delays, the loss of whatever float was included in the CRL programme (at least until a new baseline is established) heightens the risk of consequential delay impacts. Understanding the critical interfaces between contracts and planning mitigating activities to lessen the impact of consequential delay impacts will require a re-assessment of project and programme level risks. We recommend that this be addressed as a matter of urgency and the outputs are taken into account in the updated MOHS, or at least the MOHS is tested to assess the potential impacts of these delays.
	10.11	There should be a clear record of actions arising from defined cost reviews enabling effective follow-up and monitoring as appropriate.
Both	10.12	CRL has been operating a comprehensive change management process since the beginning of the project. However, in the event that further change is required that impacts the baseline plan, then a change control process should be implemented that allows time for Sponsor review to understand what is changing and why it is changing. The criteria for escalating change for review to the Sponsors should be agreed between the Sponsors and CRL. An example might be to escalate all change that impacts the opening of Stage 3 by more than two weeks and / or outturn cost by £25m.

10.3 Introduction

Crossrail is a complex programme delivering work on multiple fronts through multiple individual contracts that need to be controlled and administered in a consistent and effective way. Detailed controls are in place for the administration and commercial management of the individual contracts. We have looked at the control procedures, we have questioned CRL staff and reviewed the various reports that result from the contract and commercial processes in order to assess how effectively these controls are implemented.

CRL operates a Contract Administration Manual (CAM) that sets out how the administration of the NEC3 contracts should be implemented. The responsibilities within the contracts are explicit and the CAM does not take precedence over the conditions of the contract. In addition there are a number of other commercial procedures, templates and guidance documents to support the administration of the contracts, the management of change and of contingency.

Further information is set out at Appendix 9.

10.4 Governance of contract and commercial controls

Historically the contractors' views of the commercial position on the contracts have diverged from the position taken by the CRL PMs.

In order to re-focus the contractors on delivering their scopes of work, and deal with process issues, the CRL CD negotiated supplemental agreements with the contractors. We have reviewed a number of the historic⁶¹ supplemental agreements and noted that in

⁶¹ We requested a sample of supplemental agreements relating to station contracts

Under the existing governance arrangements the CD negotiated these agreements with the contractors and sought approval from the Commercial and Change Sub-Committee (CCSC). The CRL Board was also appraised of progress. There is no current requirement for CRL to request Sponsor approval.

[REDACTED] the Sponsors who confirmed they have no objections to the approach taken by CRL at a meeting on 20 November 2018. A paper was duly presented (which we have not seen) and which led to confirmation being provided to CRL on 21 November 2018 that Sponsors had no objection to proposed settlement agreements on six of the contracts including [REDACTED].

Since the discussions were held regarding the two additional supplemental agreements mentioned above, we note that [REDACTED]

It is clear from discussions with the CRL CD that the approach taken on [REDACTED] cannot be applied to all station contracts. We suggest that CRL is asked by the Sponsors to produce a commercial close out strategy for all the open contracts, setting out its current views on contract outturn positions – both without having a new agreement in place, and with a new agreement in place. This should take account of the dates being agreed with the contractors in the development of the updated MOHS.

It is recommended that the Sponsors have the opportunity to review and discuss CRL's decisions on proceeding with and signing the new supplemental agreements prior to their implementation.

10.5 Comments and recommendations

Improvements could be made to the operation of the contract and commercial controls in relation to the commercial management [REDACTED] of the contracts. [REDACTED]

The commercial strategy through to completion and close out of the contracts should be produced by CRL for review by the Sponsors. Compliance with the strategy should be recorded in the periodic reporting and any divergence should require an explanation of the issues, impacts and mitigations.

10.6 Delegations

10.6.1 Sponsors' rights

CRL's delegation and levels of autonomy derive from the Sponsor Agreement (SA) and the PDA. These documents set out the specific matters and powers reserved to the Sponsors. These matters include:

- Appointment of the Chair, CEO and NEDs
- Any amendment or waiver to the PDA or Sponsors Requirements
- The requirement for CRL to produce a RAP to address Adverse Events, and
- Step-in rights for both TfL and DfT.

In the current situation where IP2 has been exceeded, Sponsors have the choice to retain or adapt the powers set out in the Project Documents.

10.6.2 CRL delegation

CRL has the freedom to operate, and to deliver the programme so long as it conforms to the parameters set by the SA and PDA. CRL operates a delegated authority framework, delegation flows from the Board and is cascaded through the organisation. This is reflected by the *Scheme of Authorities*, which is approved by the CRL Board. Key aspects of the *Scheme of Authorities* includes:

- Identification of bodies with authority for financial decisions. The key bodies are the Board and the CCSC, the EIC holds no delegated authority.
- Identification of the delegation held by individual Executive Directors. The CEO, Programme Director, FD/CFO hold Investment and Commitment Authorities, and the CD Commitment Authority only.
- The *Scheme of Authorities* has been revised twice recently (September 2017 and June 2018). In September 2017, the EIC assumed a greater role in the oversight of Investment Appraisals and the areas reserved for Board decisions were broadened. The June 2018 changes were direct consequence of the Board's concern to demonstrate governance procedures provided adequate control given IP2 had been exceeded.

A summary of Authorities to release and transfer contingency, of Investment Approval and Commitment Authority and commentary on the current position is outlined in Figure 11.

Figure 11: Delegated authority summary

Summary of existing delegated authorities for funding, investment and commitment authorities			
	Funding Authority	Investment Approval	Commitment Authority
Sponsors	P95 and beyond – DfT held liability for contingency beyond P95 IP 2 (P80 to P95) - Contingency held by TfL	No authority or visibility	No authority or visibility
CRL Board	IP 1 (P80) – CRL Board held contingency, referred to as Board Contingency . Board authority was required in order to release Board Contingency to Programme Contingency for use. The Board has unlimited authority over the release of Programme Contingency .	Unlimited Authority	Unlimited Authority
CCSC	IP 0 (P50) – CCSC had authority over the CRL held P50 contingency CCSC had authority to release Programme Contingency to Delivery Contingency and to Contract Budgets up to a limit of £25 million per event	£10m	£100m
Source of delegated authority	<ul style="list-style-type: none"> • Project Development Agreement • CRL Scheme of Authorities 	<ul style="list-style-type: none"> • CRL Scheme of Authorities, the Scheme of Authorities defines: <i>Investment Authority must be granted before a contract is awarded. Contracts which will give rise to CRL incurring only indirect or overhead costs (indirect expenditure) and transactions which will give rise to land acquisition costs do not require these authorities</i> <i>Commitment Authority as the authority to commit to contract award. For direct expenditure, Commitment Authority can only be granted subject to the grant of Investment Authority. For indirect expenditure, this authority can only be granted subject to the availability of a sufficient Current Control Budget.</i> 	
Comments	Crossrail has exceeded IP2, and Sponsors are in the process of agreeing a revised funding package. Funders and CRL will need to agree a revised framework for management of funding and contingency	The CRL Board may determine that under a new funding settlement, that CRL requires a new Scheme of Authority to reflect the conditions of the settlement.	

Source: Scheme of Authority, Project Documents.

Note: "Unlimited" is the term used in the *Scheme of Authorities* to refer to Board authority. This authority is exercised within certain parameters, for example it is limited by the extent of agreed funding

10.6.3 Revised framework for management of funding and contingency

Our recommendations on the matters to consider in confirming the new framework include:

- The practical challenges which CRL currently faces in being able to identify credible cost estimates and therefore to derive reliable P50, P80 or P95 values for the operation of the existing or a revised

framework. These challenges are likely to continue for some time and hence as an interim measure any plan to define values for contingency to be held at Sponsor and at Board level with the rest at Programme level may require the pre-definition of values other than by reference to CRL declared values for P50, P80 and P95 outcomes and this should be addressed.

- The holding of contingency at a Sponsor level is only effective if Sponsors have in place the following (and therefore related steps will need to be taken to ensure).
 - Sufficient and timely visibility to Sponsors of reliable information on current and expected outturn project performance.
 - Effective oversight for Sponsors including of risks and uncertainties together with planned actions.
 - Appropriate rights of intervention by Sponsors together with a practical ability to intervene on a timely basis when it seems likely that further commitments or actions or the absence of appropriate actions could take AF CDC over the expected project outturn.
- Whether the interests of additional stakeholders will need reflecting in some way (eg GLA, HMT).
- Whether the Investment and Commitment authority levels of the CCSC need revision.

10.7 Risk management processes and reporting

During our review we noted that the risk management process changed in 2017 from a devolved project risk process with risk management and analysis undertaken on each individual project to a more centralised process. The following table sets out the key changes post-2017.

Table 16: Risk management processes and reporting

Risk Management Processes and Reporting		
Risk process	Pre-2017 change	Post-2017 change
Management of project risk registers	Quantitative at project level by project risk managers	Qualitative at project level. Quantitative centrally with a central risk management team
Project level quantitative risk assessment	Project Team	Central risk management team
Programme level quantitative risk assessment	Central risk management team	Central risk management team
Project contingency amounts determined by	Project Manager	Central commercial team
Unresolved trends	Raised in PRISM cost management tool against the individual contracts and their associated cost estimates were automatically included in the risk allowance and AF CDC figures for that contract without consideration of the level of certainty	URT and commercial risks are managed separately
Risk Management tool	ARM was used to capture, record and track all risks across the programme	ARM was shut down in May 2018 and active risks were exported to spreadsheets to be managed centrally at programme level

The Programme Risk Management procedure revision 7 requires the central risk management team to undertake a series of activities including those listed below. We note that the team was substantially demobilised in 2018 when the Active Risk Manager (ARM) tool was shut down, leaving only one to two people in the central risk management team to:

- Ensure that CRL teams use the designated tools to maintain up-to-date risk data which is of suitable quality and is in accordance with the process.
- Ensure records are held to demonstrate risk management practices follow the risk procedure (e.g. records of meetings, approvals).
- Ensure that CRL teams understand their risk management obligations and are actively engaged in the Risk Management Process.
- Liaise with the Head of Programme Risk to ensure continued alignment in approach with requirements.
- Undertake risk workshops as and when required to identify risks across the contracts and highlight risks that may impact the CRL opening of Stages 1-5.
- Support risk reporting requirements.
- Support the delivery of quantitative cost and schedule risk analysis.

10.7.1 Comments

CRL had a risk management process in place that was in line with what we would expect to see on large complex programmes of work of this scale and complexity. However at the start of 2018 it modified the processes to remove the control of risk and contingency management from the projects to the central programme level. At the same time it decommissioned the ARM database where all risks were tracked and stored and downloaded the data on current risks to excel spreadsheets.

The risk management resources were also demobilised leaving only one to two people to manage the central risk processes.

In our experience it is unusual to manage risk through qualitative assessments at project level when the project teams are best placed to quantify risks and assess probability. Whilst it is normal on most projects to expect risk levels to reduce towards the end of the project, in this case the integration of all aspects of the works is the responsibility of CRL, and is one of the largest risk elements of the entire programme.

More detail of our review of risk processes is set out in Appendix 6.

In light of the recently reported delays, the loss of whatever float was included in the CRL programme (at least until a new baseline is established) heightens the risk of consequential delay impacts. Understanding the critical interfaces between contracts and planning mitigating activities to lessen the impact of consequential delay impacts will require a re-assessment of project and programme level risks. We recommend that this be addressed as a matter of urgency and the outputs are taken into account in the updated MOHS, or at least the MOHS is tested to assess the potential impacts of these delays.

11 Commercial reporting and oversight

This section of our report addresses a single element of our Terms of Reference as outlined at section 3 and which for ease of reference is repeated below:

- Reviewing the commercial reporting/tracking and oversight arrangements in place and whether effective reporting to the Crossrail Board and Sponsors has taken place over the last 12 months.

We have first set out below a high level summary of findings, followed by our recommendations for consideration, and then our detailed findings.

11.1 Summary of findings

A summary of the key findings is set out below:

- CRL performance monitoring and reporting has not led to adequate⁶² advance notice being provided of the need to materially change the Stage 3 opening date and the resulting significant cost impact.
- Reporting was neither sufficiently timely nor sufficiently clear as to the impacts and magnitude of the range of probable consequences of the issues within the programme.
- Cost scenarios reported to the Sponsors in the first half of 2018 critically did not take sufficient account of the impact of delays in infrastructure works which had a much more substantial cost impact than the delays addressed in the scenarios.
- Effective reporting of programme status relies inter alia on effective contract management, monitoring and oversight of the supply chain by contractors; of contractors and the supply chain by CRL; and on effective reporting systems and flows of information up through CRL from project and commercial teams, through to management, on to EIC, and then to the Board and thereafter to Sponsors.
- The resultant reporting was neither sufficiently timely nor sufficiently clear as to the impacts and magnitude of the range of probable consequences of the issues within the programme. CRL management explained to us that its understanding of the project costs and timeline as reported through the project management teams and systems was evolving and changing at pace during the first half of 2018. It also explained that there were many challenges to schedule and milestones and that a variety of actions were being taken to address the challenges identified. It is evident that there were formal and informal discussions taking place between CRL and Sponsors around these matters⁶³.
- The fact of formal discussions around these matters is evident, for example, from the minutes of the June 2018 SB which record that Sponsors asked CRL to provide information for the next checkpoint (in effect the July SB) on: confidence in December delivery, alternative options to December, including a delayed opening or a reduced frequency or partial opening. We note that a document entitled “Stages 2-5 Readiness” dated 25 June 2018 and tabled by CRL at the June SB showed the Stage 3 opening date of 9 December as “Green” with no variance against a 9 December 2018 opening date although a significant number of the preceding Stage 3 milestones and activities were clearly shown as red or amber as follows:

⁶² “adequacy” when assessed in the context of the length of the Crossrail programme and the magnitude of changes to forecast time and cost outturn recently announced

Table 17: Stages 2-5 Readiness Milestone / Activities RAG

Milestone / Activity	Green	Amber	Red
Dynamic Testing	4	1	3
Pre-Trial Running	4	2	3
Combined Elizabeth line trials	1	4	0
Passenger Service	5	0	0
LU and RfLI Stations – Staged Completion for familiarisation and Trial Ops	7	1	0
Infrastructure, Trains and Testing	0	2	4
MTR, NR, LU and RFLI readiness	0	4	1

- It is also evident that there was regular reporting each period on forecast cost outturn and timeline inter alia in the CRL Board Reports during 2018⁶⁴ and in P Rep reports⁶⁵. We have based our comments and recommendations, on what is recorded in the papers and documents that we have reviewed and the formal minutes of meetings.
- We also note the extent of delay which CRL had concluded to be relevant as an upper book-end for funding requirement was only based on [REDACTED] delay against the planned Stage 3 opening in December 2018 which assumption, together with not considering the impact of failing to recover delays in infrastructure works, led as a consequence to the conclusion of a £200m to £300m increase in cost above IP2 at P50.
- It is clear from the reporting of CRL and of P Rep that a large volume of work was being undertaken to mitigate delays, re-sequence works and search for alternative approaches to testing and commissioning to maintain the opening date. A feature of the increasing stretch or optimism however was a failure to identify, and / or report on a timely basis, the point at which it became unrealistic to expect all remaining activities to be completed within the diminishing timeframe for planned Stage 3 opening and which should have led to revised expectations as to time and cost outturn being developed and reported.
- More generally, we consider there was insufficient information in CRL Board reports (i) around actual and likely performance of individual contracts to enable an accurate and sufficient understanding of their likely outturn and impact on the programme; and (ii) of useful trend and other analysis to enable an adequate understanding of historic performance against plan in the context of assessing forecast cost and time to completion.
- The reporting of programme level progress was often by reference to cumulative and in month percentages rather than trended historic performance data. Coupled with insufficient reported information about the comparative difficulty / complexity of the activities remaining, and productivity being achieved, this added to the difficulty faced by a reader in trying to assess the likely impact of programme progress on the probability of achieving the Stage 3 planned opening date.

⁶⁴ We note in this regard that the Crossrail Cost Scenario Review report prepared by Jacobs and dated 19 June 2018⁶⁴ stated: “In early March 2018 CRL presented to JST its document entitled AFDCDC Scenarios whereby it proposed two scenarios and developed costs for three options within those scenarios, in order to establish and describe an estimated upper and lower limit of funding requirements (known as the ‘book-ends’). During this meeting CRL stated that it felt the book-ends of the cost projections lay between Scenario A, Range 2 and Scenario B, Range 3 month delay, equating to a £200m to £300m increase in cost above IP2 at P50.”

We note the CRL Board Report for period 4 2018_19 [24 June to 21 July 2018] shared with Sponsors addressed “Are we on time” inter alia as follows:

“Overall delivery is 94.4% complete vs. planned of 96.3%. 0.6% was achieved in the Period against the plan of 0.7%. Work remains ongoing to evaluate the impact of schedule delays to critical path activities on Stage 3. Alternative scenarios have been identified and communicated, with an executive review planned in Period 5. The drive to complete all physical works and handover each element to the IMs in accordance with the agreed stage completion dates remains resolute.”

The same CRL Board Report commented overall: “Steady but vital progress continues to be made across the project, but in order to mitigate further schedule slippage, each contract is working on detailed plans to demonstrate the steps they are taking towards handing over their sites to the IMs. Despite this, significant overall schedule pressures exist across the programme and work remains ongoing at a project level to identify and evaluate the impact of schedule delays on critical path activities ahead of Stage 3. Alternative scenarios have been developed with Executive, Board and Sponsor reviews planned in August and September to discuss the schedule pressures and proposals for a revised delivery strategy. The drive to complete all physical works and handover of each element to the IMs in accordance with agreed stage completion dates remains resolute as this is key in minimising further cost growth.

Overall, the project has now reached 94.4% complete. In the Period, the AFDCDC remained unchanged at £12,810m (£297m above IP2). In the next few weeks, further defined-cost reviews will be held with key contracts in our ongoing review of emerging costs and additional cost increases in light of schedule pressures. These increases are in the process of validation ahead of being reported next Period.”

⁶⁵ The role of P Rep is performed by Jacobs. See Appendix 5 for example relevant extracts from P Rep reports during March to August 2018.

- CRL Board reports contained insufficient amounts of useful trend analysis to enable an adequate understanding of historic performance against plan in the context of assessing forecast cost and time to completion.
- There is a critical and urgent need to enhance the suite of metrics reported on in the CRL Board Reports so as provide enhanced visibility over inter alia productivity (current and assumed going forwards), progress achieved against milestones and overall timeline, programme float, net risks remaining, and AFDCD.

11.2 Recommendations for commercial reporting and oversight

The recommendations in Table 18 are proposed for consideration. These should be considered in the context of related recommendations in other Sections.

Table 18: Reporting and controls recommendations

Commercial reporting and oversight recommendations		
<i>Sponsors to agree timescales for the development of the initial programme by the new CRL CEO and then the development of that programme. Obtain independent assurance of the CRL programme with a deep dive into the estimates for time and cost and providing scenarios based on various scope and other options.</i>		
<i>Sponsors to agree the metrics and analysis required from CRL in their performance reporting, as well as a set of critical milestones to indicate CRL's performance in progressing works to plan. Reporting to include greatly enhanced visibility of productivity and progress against the most complex and highest-risk critical path tasks. Reporting to be transparent, timely, sufficient and assured. Sponsors to provide regular updates to stakeholders based on outputs provided by CRL and P Rep. Escalation to stakeholders to be triggered where reporting identifies delivery performance outside of agreed cost and schedule parameters.</i>		
Owner	Ref	Recommendations for consideration by Sponsors (see section 11 for supporting detail)
Sponsors	11.1	Sponsors to satisfy themselves around the development of the delivery plans with associated estimates of time, cost, risk and assessment of scope adjustments required to open the line as early as possible.
	11.2	Sponsors to agree the metrics and analysis required from CRL in their performance reporting to allow the Sponsors to make their own assessment of whether the progress being achieved is in line with the plan.
	11.3	Sponsors to provide regular reports to the TfL Board, TfL Commissioner and DfT Permanent Secretary reporting on. <ul style="list-style-type: none"> • Programme performance in the context of the agreed, revised funding envelope, forecast cost outturn and programme completion timeline. • Progress against agreed critical completion milestones. • Status of key programme risks and their mitigation. • In the event of further slippage, clarity in respect of delay impacts, including on forecast cost to completion.
	11.4	Escalation to TfL Board and DfT Board and Executive Committee should be triggered where reporting identifies programme delivery performance outside of agreed parameters (these to be defined) in terms of cost and timeline.
	11.5	Agree the timescales for the development of the new programme ⁶⁶ by the new CRL CEO. Once the new programme / detailed baseline is developed the Sponsors to obtain independent assurance through an instructed deep dive review of the programme to validate that it provides a

⁶⁶ We understand that the situation in relation to preparation of a CRL MOHS has changed since our fieldwork was completed, and that the revised CRL MOHS was not issued or shared with Sponsors as expected on 5 December 2018. In the absence of a MOHS, CRL will need to develop a plan to manage the programme that needs to be agreed with Sponsors which sets out the approach to delivering the opening of Stage 3. Sponsors should seek the provision of such a plan as soon as possible from CRL and obtain independent assurance as to its basis and robustness.

Commercial reporting and oversight recommendations

Sponsors to agree timescales for the development of the initial programme by the new CRL CEO and then the development of that programme. Obtain independent assurance of the CRL programme with a deep dive into the estimates for time and cost and providing scenarios based on various scope and other options.

Sponsors to agree the metrics and analysis required from CRL in their performance reporting, as well as a set of critical milestones to indicate CRL's performance in progressing works to plan. Reporting to include greatly enhanced visibility of productivity and progress against the most complex and highest-risk critical path tasks. Reporting to be transparent, timely, sufficient and assured. Sponsors to provide regular updates to stakeholders based on outputs provided by CRL and P Rep. Escalation to stakeholders to be triggered where reporting identifies delivery performance outside of agreed cost and schedule parameters.

Owner	Ref	Recommendations for consideration by Sponsors (see section 11 for supporting detail)
		<p>realistic reflection of the scope of work to complete and that the time allowed is logic driven and the productivity assumptions are realistic and based on agreements with the contractors.</p> <p>The cost estimate to complete the works should be independently reviewed to check that it takes account of the updated programme and is based on assumptions that are aligned with the contract and commercial positions agreed with the contractors. Realistic scenarios should be considered and assured.</p>
CRL	11.6	<p>CRL to re-establish / develop / provide the following.</p> <ul style="list-style-type: none"> • A detailed bottom up schedule⁶⁷ for each contract that is logic linked, based on the known scope to complete the works (including in relation to the stations taking into account the lessons learned from Tottenham Court Road station). Each contract schedule should be progressed by the PMs taking into account change, risk, compensation events and contractor resource levels and productivity. The schedule should include an appropriately assessed time contingency allowance (float). • The schedule should be informed by rates of activity achieved to date and where different rates are used to drive assumptions about the time and cost to go, this should be clearly highlighted in reporting to Sponsors. This should include where assumptions are made about increased resources to be applied by contractors and their supply chain from those recently applied and / or where improvements in productivity are being assumed, and where this is without any specific agreement to that effect with the contractors concerned. • Once there is an agreed robust baseline then the reporting of performance and cost should be measured against the baseline plan to provide the Board and Sponsors with a transparent view on performance at individual contract level and at programme level. Reporting should include current AFC and risk allowance for each significant contract and a clear separate analysis of overall significant programme risks. Reporting of progress should take proper account of the complexity of, and effort likely to be required to complete, each principal remaining activity within each contract such that reporting is a reliable indicator of progress made and productivity likely to be achieved. • There will need to be a clearly defined strategy which enables both effective downward contract management as well as clear upward performance reporting. Contractors should be managed against challenging but achievable targets using a mixture of contractual rights and other measures. Upward reporting to Sponsors should include providing clear visibility of the forecast Stage 3 opening date as per the schedule, the level of remaining float, key critical path activities and risks etc. Sponsors should pay close attention to trends in, and to the level of, reported float in the programme as well as to reported risks to critical path activities. Public reporting of achievable opening dates will need to recognise both what is realistically expected to be achieved and the consequences of potential inconsistencies between public messages and target dates against which contractors are being managed. Where relevant CRL and Sponsors should consider appropriate range rather than point reporting, reflecting the remaining risks in the programme. • At programme level develop an integrated logic linked baseline schedule that takes inputs from each contract to determine the key programme completion dates. The Stage 3 opening date should be allowed to move in line with the schedule logic. • Reporting to the CRL Board and the Sponsors which provides sufficient information on the progress of the individual contracts and the overall impact at programme level.

⁶⁷ We are referring to an appropriate logic driven programme that balances the time to develop versus the time left in the programme.

Commercial reporting and oversight recommendations

Sponsors to agree timescales for the development of the initial programme by the new CRL CEO and then the development of that programme. Obtain independent assurance of the CRL programme with a deep dive into the estimates for time and cost and providing scenarios based on various scope and other options.

Sponsors to agree the metrics and analysis required from CRL in their performance reporting, as well as a set of critical milestones to indicate CRL's performance in progressing works to plan. Reporting to include greatly enhanced visibility of productivity and progress against the most complex and highest-risk critical path tasks. Reporting to be transparent, timely, sufficient and assured. Sponsors to provide regular updates to stakeholders based on outputs provided by CRL and P Rep. Escalation to stakeholders to be triggered where reporting identifies delivery performance outside of agreed cost and schedule parameters.

Owner	Ref	Recommendations for consideration by Sponsors (see section 11 for supporting detail)
		<ul style="list-style-type: none"> Reporting which includes Key Performance Indicators (KPIs) / trend assessments to demonstrate progress achieved compared to the forecast rates of progress to meet planned dates. Where there is a slippage in a key date then CRL should report on the variance to indicate the impact and what mitigation measures will be taken to recover the delay. The recovery of a delay should not be shown in the schedules until it is achieved. The reporting should indicate the unmitigated completion date and CRL's view on the mitigated completion date, including remaining programme float. Reporting against Sponsor Milestones which are agreed and reported directly from the programme schedule.
	11.7	<p>Develop an enhanced suite of metrics for reporting which at a minimum meets pre-defined criteria agreed between Sponsors and CRL and which enables clear visibility of inter alia.</p> <ul style="list-style-type: none"> Current, previous, and predicted future productivity and progress on key contracts and against key activities on each critical path with explanations where there is a significant variance between current and forecast future productivity rates. This should include dependent activities not under CRL direct control. For systems, integration and other relevant activities which are less suited to traditional productivity measures, develop suitable metrics to give equivalent visibility of the critical path activities. Current agreed as well as latest expected TOSD [REDACTED] with expected [REDACTED] rates for each key contract and any significant variances against reported AFCDC – together with the current cost run rate by contract being incurred. Progress against pre-agreed milestones, and a summary of programme float (current, recent, and predicted future levels by milestone and overall). Risks, planned mitigation and remaining key net risks with quantification. Cost by contract, for integration activities and other CRL managed activities, and for indirect costs etc. and the overall AFCDC. <p>The metrics should evolve over time to suit the changing needs of the project as it moves into a more systems and integration dominated phases whilst preserving the ability to provide historic comparatives and trends.</p>
	11.8	<p>Oversight of reporting within CRL to be provided through the 3 lines of defence. CRL to review the effective operation of the first and second lines of defence⁶⁸ and allocate additional resources and enhance processes and procedures as appropriate.</p> <p>Assurance of the quality and timeliness of CRL reporting for Sponsors to be provided by CRL Management validating that, and separately by internal audit testing that, the first two lines of defence are operating appropriately.</p> <p>The CRL Audit and Risk Committee to be responsible for ensuring that the third line of defence, internal audit, has adequately addressed commercial and financial as well as other area risk areas such as health and safety.</p>
<p>Commercial Reporting (see Appendices 8 and 9 for supporting detail)</p>		

⁶⁸ Being the operation of appropriate controls and processes, and of appropriate business as usual checks on the effective operation of those controls and processes.

Commercial reporting and oversight recommendations

Sponsors to agree timescales for the development of the initial programme by the new CRL CEO and then the development of that programme. Obtain independent assurance of the CRL programme with a deep dive into the estimates for time and cost and providing scenarios based on various scope and other options.

Sponsors to agree the metrics and analysis required from CRL in their performance reporting, as well as a set of critical milestones to indicate CRL's performance in progressing works to plan. Reporting to include greatly enhanced visibility of productivity and progress against the most complex and highest-risk critical path tasks. Reporting to be transparent, timely, sufficient and assured. Sponsors to provide regular updates to stakeholders based on outputs provided by CRL and P Rep. Escalation to stakeholders to be triggered where reporting identifies delivery performance outside of agreed cost and schedule parameters.

Owner	Ref	Recommendations for consideration by Sponsors (see section 11 for supporting detail)
CRL	11.9	Guidance should be developed and issued around the application of judgement in determining AFCDC so as to help ensure a sufficient measure of consistency from period to period in the degree of optimism or pessimism which is applied. There should be sufficient clarity in the reporting such that the approach taken in relation to views taken on material subjective matters is apparent to the reader.
	11.10	Guidance should be developed / reinforced to PMs on the information to be considered and approach to be taken by them in reaching their view of the expected outturn on each contract, which should include taking an informed view on Contractor Compensation Events.
	11.11	The reporting of expected contract outturn should be clearer with a single view on each contract used for both Commercial Performance and Funding Adequacy. Where it is concluded that different bases are justified, the reporting should include a clear explanation of the differences and the reasons for them. Where there are significant differences between CRL, PMs and Contractor views, brief explanations of the most material items should be recorded. A consistent level of optimism / pessimism should be applied from period to period in determining the reported CRL view.
	11.12	We recommend for major contracts, the currently quarterly reviews by Programme Director, FD, PCD and CD that address schedule, defined cost and commercial issues are performed on a more regular basis so as to enhance control and quality of reporting. Outputs to include a single consolidated commercial position for each contract enabling the CRL Board and in turn SB to be informed of up to date views of anticipated outturn and key issues on a contract by contract basis.
	11.13	Reporting around the nature and value of identified risks and the resulting amount included in AFCDC should be clearer.
	11.14	Reporting around Contingency should include explaining the level of Contingency concluded to be required each month in respect of identified risks where this differs from the actual contingency held. In so far as is possible the level of Contingency held should be aligned with the view formed of the level concluded to be required which should be calculated using a consistent methodology and agreed level of optimism / pessimism.
	11.15	The NEC3 guidance on Contractor Programme acceptance should be followed and where Contractor programmes are not accepted this should be reported to the CRL Board with details of the potential implications.

11.3 Commercial reporting and tracking

11.3.1 CRL's reporting system

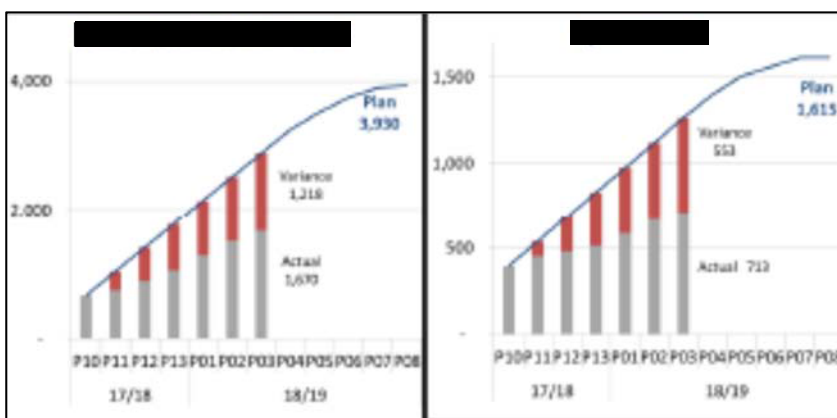
We have set out in Appendix 8 an overview of CRL's reporting processes relevant to the scope of our review. The rest of this section focuses on the principal performance reports provided to the CRL Board and the Sponsors with a view to commenting on the extent to which effective reporting has taken place over the last 12 months and seeks to highlight areas for improvement required to strengthen the programme reporting going forwards.

11.3.2 CRL Board Reports

The CRL Board reports provided to us⁶⁹ included a large amount of commercial information but in our view insufficient clear trended data on physical progress against plan. In our view this missed the opportunity to provide readers with better information to assess the likelihood of achieving the increasingly demanding rates of progress which were building up period by period.

This could have been better addressed by reporting historic as well as current rates of progress against critical metrics and then showing the trending consequence, overlaid where appropriate with clear explanations as to how an assumed accelerated trend would be achieved and whether previous projected accelerations had succeeded or failed. One of the metrics where progress was graphically reported historically against plan in the CRL Board Reports was IRN completion. From the graphs set out in Figure 12 it is clear that the variance was consistently getting wider against plan implying that completion was going to be substantially later than Plan.

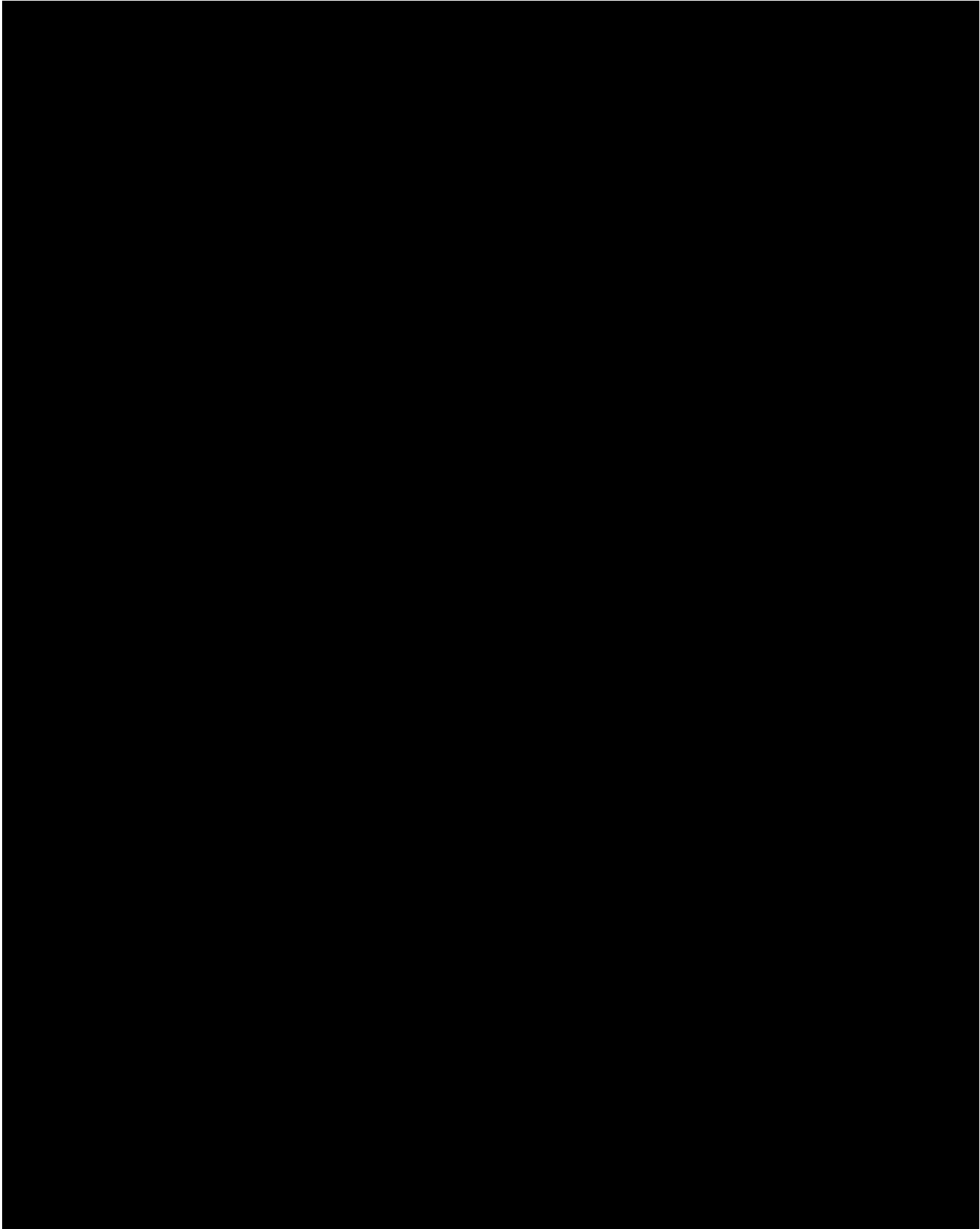
Figure 12: CRL Board report: Phase 2.1 IRN Status



Source: CRL Board Report P03 2018_19

By comparison however the analysis of progress on Stage 3 critical contracts (see Figure 13 and Figure 14) was inter alia set out in the same CRL Board Report in a manner that did not enable visibility of the level of trended performance needed over time against plan, to achieve the timeline. These metrics show the recorded point progress against plan as a percentage and a projection of the completion date visually. It is not clear though from these tables how rates of recent actual progress compare with the rate of progress needed to achieve the assumed dates of completion. Furthermore we have some concerns about the reported spot completed percentages given the amount of time now confirmed as required to complete some of these contracts.

⁶⁹ We were provided with copies of CRL Board Reports covering the 13 periods to Period 4 2018-19 inclusive.



In hindsight and given the volume of work still remaining to be completed, and the now extended timeline to Stage 3 opening, these reported schedule performance percentages appear high. We understand they were drawn from PRISM. For each contract on PRISM there are a set of project key milestones, and each milestone has a weighted value assigned. A milestone completed in the period will claim 100% of its weighted value. PRISM then adds up the weighted value for each milestone across all the contracts up until the reporting period, to arrive at an overall percentage complete figure. This figure is used for the CRL board reports. We note that the weightings will have been based on a judgemental weighting of effort which may or may not be in line with what is now understood to be the effort / hours actually required to execute those activities.

We note that the trend of actual progress being achieved period by period, and that required to hit Stage 3 opening in December 2018, is not clear from this table.

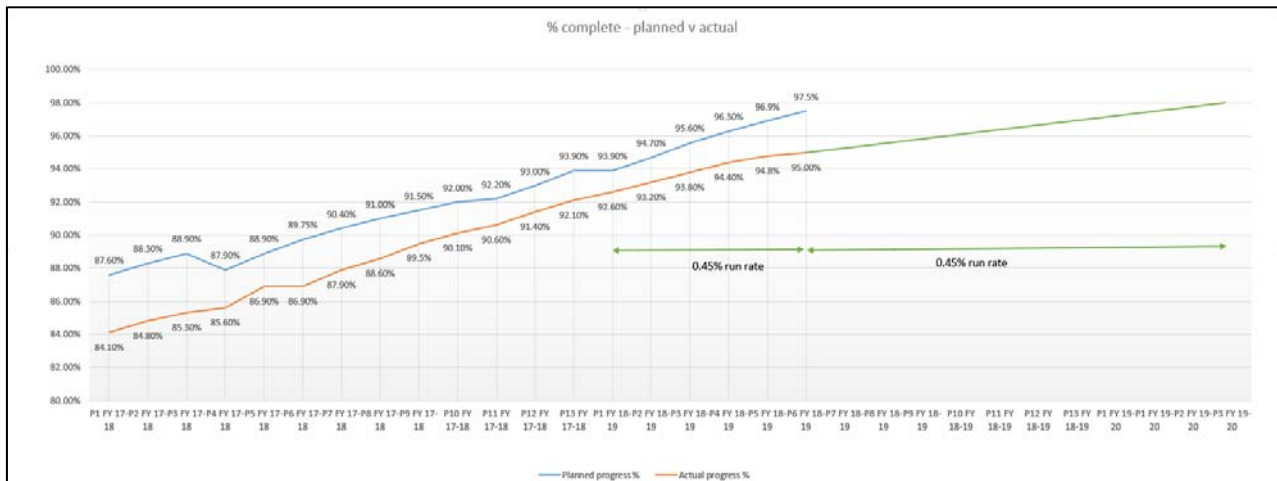
We note the CRL Board reports explain in some detail the issues that result in time pressure on the programmed activities and in some cases describe impacts and mitigation measures on individual contracts, however they do not provide a programme level impact assessment of all contract delays to indicate the impact on the Stage 3 opening date. The reports do state that CRL is working towards delivering mitigation strategies to maintain the completion date.

We have analysed the percentage complete information recorded in each Board report since Period 1 2017-18 which has been provided to us. The data provided in the reports suggests that the overall programme progress has consistently been circa .3 periods behind planned progress through to Period 6 2018_19. The average progress achieved over the period is 0.5% per period, but since Period 1 2018_19 this dropped to 0.45% per period.

The following chart summarises the progress data from the Board reports. We have added a trend line assuming a future progress rate of 0.45% per period, which adds 11 months to Period 6 2018_19 which would indicate a completion date during Period 3 2019-20. It is however important to note that rates of progress in completing the final tail of activities can decrease - particularly if some of the most challenging

aspects remain to be completed and / or there is rework identified during the closing review stages. It is not readily apparent from the data provided in the CRL Board Reports we reviewed, whether the level of difficulty remaining in the tasks to be completed on for example the main station contracts, is similar to, greater or less than that addressed in recent periods. Good reporting regimes develop means of identifying and clearly communicating such matters. For the purposes of illustrating the impact on potential completion dates, we have shown below the consequences of trending the current rate of progress of 0.45% per period.

Figure 15: Reported Progress – Planned and Actual



Source: KPMG analysis based on data drawn from CRL Board Reports

The report does not provide detailed variance analysis as to the specific reasons why the actual progress achieved in the month is less than the planned progress and how this will be recovered. Until the announcement of the delay to the Stage 3 opening date made by CRL at the end of August 2018, CRL was reporting that the Stage 3 completion date would be achieved.

We note that the Period 3 2017_18 report includes a critical path analysis indicating that dynamic testing would start in October 2017 for a period of 9 months⁷⁰. The Period 6 2018_19 report indicates that dynamic testing will commence on 22 October 2018 for a period of 16 weeks⁷¹, which is one year later than indicated in the report 16 periods earlier.

The Board reports provide lots of information and data but do not provide sufficient critical analysis to enable the realistic achievability of the Stage 3 opening date to be fully understood. In our experience of programmes of this scale and complexity we would expect the forecast programme to completion to be progressed against actual contractor progress achieved, taking into account all compensation events that have either been agreed with the contractor or which have been assessed by the PMs. In a logic driven programme the critical path will determine the end date. Delays to works on the critical path will impact the end date. The MOHS available during the course of our fieldwork was not an integrated logic driven programme.

We would expect that the result of the reported delays at contract level to have a cumulative impact at programme level that progressively delays the Stage 3 opening date and that this would be visible to the CRL Board and to the Sponsors. If this had been reported to the CRL Board and to the Sponsors progressively as the delays impacted the end date this would have provided the opportunity to challenge the CRL delivery teams on the mitigation measures being put in place and the likelihood of recovering the delays. It would have also enabled Sponsors to better understand the impact on time and cost of the mounting challenges.

⁷⁰ Page 10 of the CRL Board Report P03 2017_18

⁷¹ Page 7 of the CRL Board Report P06 2018_19

From discussions with various CRL executives (i.e. those in place at the start of our fieldwork) it seems that their approach was to avoid reporting slippage to the Stage 3 opening date whilst putting plans into place to mitigate the delays. It is of course entirely appropriate to target a challenging planned opening date but there is a critical need to report internally the actual position and what is realistically achievable. It seems that over time more and more stretch or optimism became incorporated into the programme through assumptions around shorter activity durations and in some cases parallel running activities to reduce elapsed time but with a consequence that efficiency became more difficult to sustain, float decreased, and time required to complete activities started to exceed the programme time allowed.

It is clear from the reporting of CRL and of P Rep that a large volume of work was being undertaken to mitigate delays, re-sequence works and search for alternative approaches to testing and commissioning to maintain the opening date. A feature of the increasing stretch or optimism however was a failure to identify, and / or report on a timely basis, the point at which it became unrealistic to expect all remaining activities to be completed within the diminishing timeframe for planned Stage 3 opening and which should have led to revised expectations as to time and cost outturn being developed and reported.

This lack of transparency coupled with excessive optimism appears to have contributed to why the CRL Board failed to re-set the forecast timing for the opening of Stage 3 by around nine months until just over three months before the planned opening date⁷².

11.3.3 Commercial reporting - Remedial [REDACTED] n Plans

As requested by Sponsors, we reviewed the robustness of CRL's approach and assumptions used to arrive at their forecast outturn cost of up to £13.8bn. This was set out in RAP 2, was described as a P95 outturn cost and was based on so called '[REDACTED] dates' aligned with a Stage 3 opening date of [REDACTED]. This outturn cost, and all others we refer to in this report, excludes ONW. RAP 2 in turn built upon an earlier Remedial Action Plan issued on 18 September 2018 (RAP 1).

Whilst the forecast outturn cost is described in CRL's RAP 2 as a P95 outturn cost, the calculation is not the product of a detailed P95 risk analysis process nor is that number in our view in line with what we consider to be an outturn cost which has a 95% probability of not being exceeded.

CRL's approach to forecasting outturn cost in RAP 2 essentially comprised a high level top down approach to adjusting the forecast outturn cost as reported at Period 4 2017_18 rather than a detailed bottom up assessment made in conjunction with a detailed completion programme.

In summary therefore the RAP documents whilst pulling together a huge amount of analysis and detail in a relatively short amount of time, were not based on a detailed bottom up analysis and ascribed P50, P80 and P95 to forecast outturns which were not based on a P50 / P80 / P95 process.

11.3.4 Programme level reporting

CRL do not have an integrated logic linked baseline schedule that takes its progress inputs from each of the contracts. This is what we would expect to see on a programme of this scale and complexity. CRL developed a milestone based schedule which is described in the following section.

We understand that in essence the commercial programme level information summarised in the CRL Board Reports essentially comes from a mixture of PRISM, the MOHS, and inputs from the CD and PD (further detail is set out in Appendix 8).

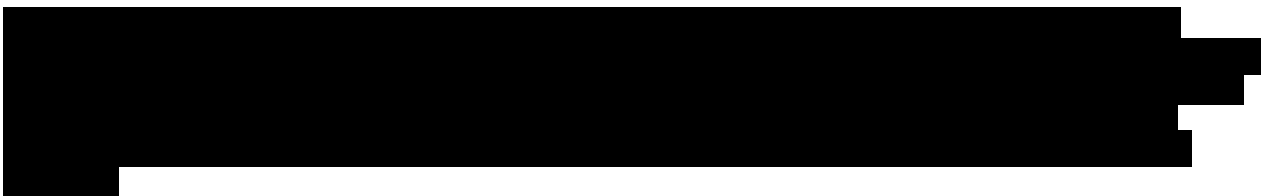
⁷² The date for Stage 3 opening was re-set from December 2018 to autumn 2019 in an announcement on 31 August 2018. In RAP 2 dated 2 October 2018, some 5 weeks later, the date was [REDACTED]. There are currently some uncertainties as to whether this revised date can be achieved and, it is clear that if achieved, there is likely to be a long tail of work remaining thereafter.

11.3.5 MOHS

The reporting at programme level is provided through the MOHS - a milestone based schedule which summarises the individual contract milestones at programme level. It is not a detailed bottom up schedule and it is not logic linked. It shows the key contract milestones but does not record progress.

At the time of completing our fieldwork, CRL was updating the MOHS and had aimed to finalise it for 30 November 2018⁷³. As part of this exercise it started to undertake a detailed assessment of the issues, sequencing, scope undertaken and plan to complete the contracted works at TCR. This will provide an approach for the other, less progressed stations to follow to improve the accuracy of the estimate of time and resources required. This is a logical approach and will need to be implemented at all of the stations as it will validate the scope of work to complete each contract. We understand that the exercise on TCR is not complete but it has highlighted issues that had not previously been recorded (for example learning points in relation to radio cabling). We understand the exercise has focussed on identifying learning points which can be shared with other stations. We have been told that completing the same exercise for all stations could take another couple of months.

The re-assessment of the approach to completion and scope is essential to develop a robust baseline programme to completion. We understand that this might not be available until the second quarter of 2019 although an interim programme is expected to be issued sometime in December 2018 (it was delayed from planned issue to Sponsors on 5 December).



Given the above fluidity in the quality and completeness of the data underpinning the current MOHS, there are inevitable consequent frailties and uncertainties in the resulting reporting by CRL of time to completion and final outturn cost.

11.3.6 Comments and recommendations

Effective performance reporting on large complex programmes relies on a number of critical elements and varies significantly in design from programme to programme. We have noted below some of the underlying features we consider to be important elements of effective programme reporting.

- A robust baseline of total scope, and achievable schedule, cost and risk assessments.
- Appropriate selection of metrics and data for reporting and tracking of performance.
- Reliable base data, which has been subject to good 1st and 2nd lines of defence.
- Appropriately designed reports containing analyses to demonstrate current performance versus the baseline and transparent forecasts of future performance versus the baseline based on the right data.
- A sufficient understanding by the reader of what the reports say and don't say and whether, when and what intervention is required.

⁷³ This was changed to be presented to the CRL Board on 5 December 2018; it was presented but was not approved or issued to Sponsors

12 CRL Board Committees

This section addresses one question in the Terms of Reference:

- Considering the role and performance of the committees of the CRL Board, including its Audit Committee (recently subsumed into the CRL Board).

12.1 Summary of findings

A summary of the key findings arising from the review of the CRL Board Committees are outlined below. These are intentionally high-level, the detail is set out in sections 12.3 – 12.6:

- Trust between Sponsors and the CRL Board has been undermined by reporting which did not sufficiently surface the probable impact of or the magnitude of the emerging programme performance issues soon enough (see section 11 for additional details). The review identified opportunities for enhanced transparency between the CRL Board and Sponsors (see sections 4, 5 and 11 for additional details). This is considered as a requirement to support improved Sponsor oversight.
- The CRL Board continued, until relatively recently, to pursue a pre-planned demobilisation of central resources around a December 2018 Stage 3 opening. This included the disbanding of the CRL Audit Committee and the reallocation of its responsibilities (further details can be found at Section 12.4.3).
- There was a much reduced level of internal audit coverage in 2017_18 and 2018_19, with insufficient coverage in particular in the critical areas of finance and commercial controls.
- Demobilisation reduced central risk oversight and central reporting around commercial and financial risks although CRL considers it did not impact risk management and mitigation at a project level as demobilisation was only focussed on central resources.
- The arrangements for an integrated EIC mean that the majority of investment decisions have not required the involvement of CRL NEDs.
- The exercise of decisions related to remuneration has been performed by the CRL RemCo. The last RemCo meeting was held 8 November 2018, the two prior to this on 26 October 2018 and 24 May 2018. In the period between the 24 May and 26 October RemCo meetings, all except one member (Sir Terry Morgan) of the RemCo left the CRL Board having reached the end of their terms of office as Directors of CRL. Since 8 November 2018 Sir Terry Morgan has resigned from the CRL Board.

12.2 Recommendations

Our recommendations on Board Committees are given in Table 19.

Table 19: CRL Board Committees recommendations

CRL Board Committees recommendations for consideration		
CRL to review the current Board sub committee structure, this to include (re)-establishing the Audit and Risk Committees as a single combined Committee in line with good practice for an organisation such as CRL and the creation of a separate Investment Committee reporting to the CRL Board, distinct from the Executive Committee. The breadth and focus of the internal audit programme and resources should be enhanced. The capabilities and expertise of the CRL Board should be enhanced through the nomination of new Non-Executive Directors.		
Owner	Ref	Recommendations for consideration by Sponsors (see section 12 for supporting detail)
CRL	12.1	<p>CRL to recognise that greater openness and transparency with Sponsors and timely communication of relevant information is required to reflect the changed circumstances of the project.</p> <p>CRL to set out to Sponsors how CRL will cascade enhanced expectations regarding behaviours, transparency, and culture throughout their organisation and maintain this over the rest of the programme so as to support transparent and timely reporting of successes and challenges, avoid optimism bias, and also so as to sustain a strong and positive morale amongst their staff in the face of the current challenges. Regular updates to be provided demonstrating how CRL has satisfied itself that the appropriate culture is being sustained.</p>
	12.2	<p>The bullets below set out detailed recommendations relating to the re-establishment of the Audit Committee and Risk Sub-Committees as a single combined Committee and recommendations relating to Internal Assurance.</p> <ul style="list-style-type: none"> • CRL to establish as soon as possible a CRL Audit and Risk Committee reporting to the CRL Board. The remit of the Audit and Risk Committee should be consistent with standard good practice for an organisation such as Crossrail (e.g. addressing internal controls, financial and commercial controls, project and risk reporting, as well as external audit and internal financial, commercial, technical and health and safety assurance etc.). The frequency of meetings of the Audit and Risk Committee should be considered urgently and be sufficient so as to allow for appropriate attention on risk reporting matters. • The Annual Internal Audit Report should be presented to the CRL Audit and Risk Committee. The Annual Audit Plan should be approved by, and Audit Plan Updates should be provided no less frequently than quarterly to, the CRL Audit and Risk Committee. • The breadth and focus of the internal assurance programme should be broadened so that whilst maintaining the focus on critical technical and health and safety matters there is also sufficient focus on Programme delivery and corporate risks, internal financial and commercial controls and on CRL reporting, reflecting all of this in a renewed Integrated Assurance and Approval Plan (IAAP). • The breadth and nature of resources required and available to deliver the broadened internal assurance programme should be assessed and gaps appropriately addressed. • The Audit and Risk Committee to sponsor implementation of a dedicated corporate risk management procedure with the development of a separate corporate risk register. A CRL risk lead to be appointed who will be in charge of both the project risk and corporate risk management processes. <p>With regard to the central reporting of risk we recommend.</p> <ul style="list-style-type: none"> • Consideration is given to reviewing the sufficiency of the current eight weekly cycle of reporting to EIC and whether this should be shorter. • Risk matters should be reported to the CRL Audit and Risk Committee once re-formed. • CRL's Head of Programme Risk to report to both the EIC and Audit and Risk Committee. • The sufficiency of the resources addressing risk reporting should be reviewed in light of the impact of the implemented demobilisation actions (in line with planned Stage 3 opening in December 2018) and consideration should be given to reinstating risk quantification at project level.
	12.3	<p>Executive and Investment Committee:</p> <p>CRL to separate the Investment Committee from the Executive Committee. The Investment Committee should report to the CRL Board, it should also have a NED majority, and CRL should</p>

CRL Board Committees recommendations for consideration		
CRL to review the current Board sub committee structure, this to include (re)-establishing the Audit and Risk Committees as a single combined Committee in line with good practice for an organisation such as CRL and the creation of a separate Investment committee reporting to the CRL Board, distinct from the Executive Committee. The breadth and focus of the internal audit programme and resources should be enhanced. The capabilities and expertise of the CRL Board should be enhanced through the nomination of new Non-Executive Directors.		
Owner	Ref	Recommendations for consideration by Sponsors (see section 12 for supporting detail)
		consider a requirement for this to be a NED Chaired Committee. The current CRL delegation framework (the "Scheme of Authorities") will require amendment.
	12.4	Health and Safety Committee: The CRL Board to review the decision to disband the Health and Safety Committee ⁷⁴ and consider whether it should be re-established given the status of the programme and revised forecast timelines and whether this would contribute to the maintenance of CRL's successful focus on health and safety matters.
	12.5	Nominations Committee: In the event that Sponsors and CRL decide to retain the CRL RemCo, CRL to formalise consolidation of the RemCo and Nominations Committees.
Both	12.6	Sponsors should work with CRL to enhance the capabilities and expertise of the CRL Board through the nomination of new NEDs with expertise matched to the current and future requirements of the programme. Sponsors should work with the CRL Board to identify and agree candidates with additional expertise in Commercial, Construction, Construction close-out, Railway systems and Network integration. Sponsors and the CRL Chair should give consideration to implications of adding new NEDs to the CRL Board in terms of its size, efficiency and effectiveness.

12.3 CRL Board Committees

A full description of the structure and functions of the CRL Board is given in our *Crossrail Governance Report*. As required in the Terms of Reference, this section of the *Financial and Commercial Report* addresses only the role and performance of the CRL Board committees, which are (or have recently comprised):

- Remuneration Committee
- Audit Committee and oversight of internal assurance;
- Risk Sub-Committee
- Executive and Investment Committee (EIC)
- Health and Safety Committee
- Nominations Committee
- Commercial and Change Sub-Committee.

12.3.1 Current status

Figure 16 shows CRL corporate governance structure and status, as of November 2018. Table 20 provides additional detail on each of the Board Committees and sub-Committees. In December 2017, the EIC

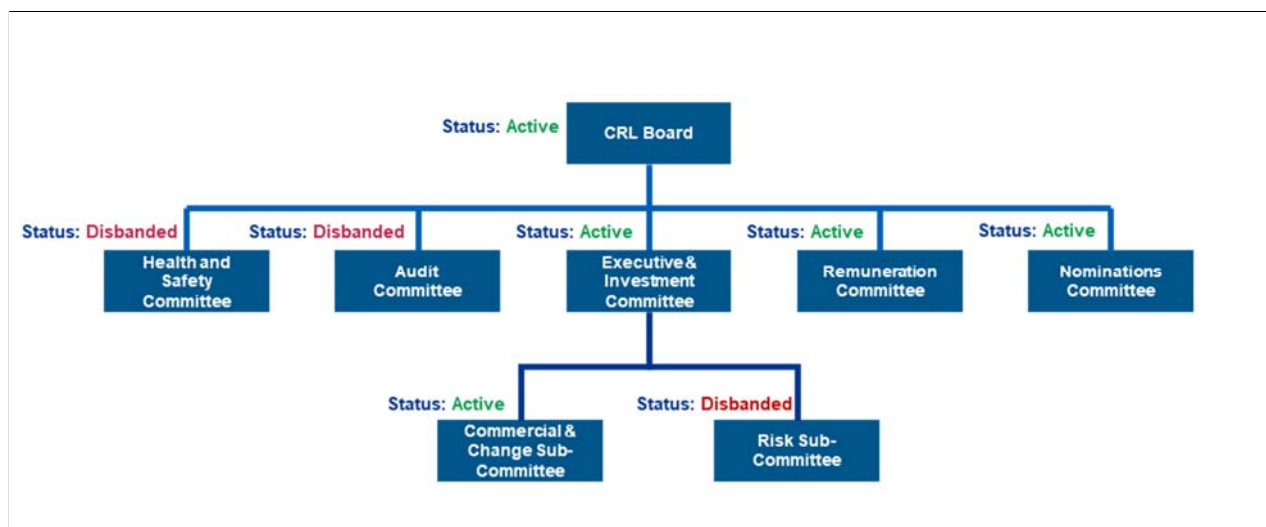
⁷⁴ Recommendation 12.4 is in the context that we have been asked to consider the role of Committees of the Board which included the Health and Safety Committee which we note was recently disbanded. We have not attempted to assess the historical additive impact of that Committee on the Health and Safety record of the Programme nor to distinguish its impact from that of the many other measures in place.

We note SACR 20 states "The focus on effective health and safety performance has been maintained and improved, with some of the best HSPI scores ever achieved on the programme during this SACR period. Crossrail and its contractors continue to promote effective management engagement with personnel at all levels and on all sites."

considered proposals relating to changes to governance and reporting through Crossrail close-out and transition to TfL. The proposals had assumed programme completion in line with the original timeline. There is evidence that some aspects of the proposals presented have been implemented, however, since these actions were taken, CRL has advised Sponsors that the planned Programme timelines would not be achieved and there would be further cost increases beyond the IP2 threshold (the programme’s P95 cost estimate, and the point at which the TfL contingency fund was exhausted). Proposals presented to EIC which have been adopted include the CRL Board:

- Disbanding the Health & Safety Committee, its functions now being incorporated into the CRL Board.
- Disbanding the Audit Committee and the re-allocation of its responsibilities (further details can be found at Section 12.4.3).
- Merging the Nominations and Remuneration Committees. This does not appear to have been formalised but in practice has occurred.

Figure 16: CRL corporate governance status



Source: Terms of Reference for Board Committees, Board Committee Meeting Minutes and KPMG interview programme.

Table 20 summarises the role of each of the CRL Board Committees and sub-Committees. Commentary on each Committee and sub-Committee has been included, these include the recommendations which are summarised in Section 12.2 and supporting considerations which have arisen from a review of documentation and feedback obtained during interviews. As part of this review we did not assess the impact of disbanding various committees. However, we note that for the Audit Committee and Risk Sub-Committees the timing of their disbanding was not appropriate. As regards the disbanding of the Health and Safety Committee, we recommend that in light of the current status of the programme that the CRL Board review the decision taken to disband this committee.

Table 20: CRL Board Committees and sub-Committees summary

Committee and status	Summary	Comments and recommendations
Executive & Investment Committee (EIC) (Active)	CRL operates a combined EIC. This is an Executive only Committee which meets weekly. The EIC is the highest level executive decision making forum. Responsibility for most investment, commitment and contractual approvals has been delegated to the Commercial and Change Sub-Committee (CCSC) chaired by the FD. The EIC retains	Consider the separation of Executive and Investment Committee into separate Committees and incorporation of NEDs on the new Investment Committee There remain some critical commercial decisions to be made and approved including in relation to potential supplemental agreements with certain contractors. NED expertise in constructively challenging Executives should support more

Committee and status	Summary	Comments and recommendations
	<p>visibility of certain decisions, in particular those decisions requiring Board approval.</p>	<p>effective decision making for these remaining decisions.</p> <p>Should the EIC be separated, CRL should review the role and functions of the Executive Committee and the CCSC.</p> <p>Changes to the current delegation structure would necessitate revisions to the current <i>Scheme of Authorities</i>.</p>
<p>Commercial and Change sub-Committee (CCSC) (Active)</p>	<p>The CCSC is a sub-committee of the EIC. The CCSC meets fortnightly. The CCSC is CRL's principal body for financial decision making. The Terms of Reference state "<i>The Sub-committee is the main decision-making body for financial, contractual and commercial matters in connection with delivery of the Crossrail Programme.</i>"</p> <p>The CCSC is chaired by the FD / CFO, and other members include the Commercial Director (CD), Operations Director, Programme Controls Director (PCD), Technical Director, Delivery Director, Company Secretary and Chief of Staff.</p> <p>The authority of the CCSC is set out in the <i>Crossrail Scheme of Authorities</i>. Within the prescribed limits the authority reserved to the CCSC includes:</p> <ul style="list-style-type: none"> • Release of Programme contingency • Pre-Tender Budget Authority • Investment Authority • Category procurement plans • Package procurement plans • Approval of the tender list • Authority to commit to contract award • Settlement of contractual claims and disputes • Settlement of third party claims 	<p>The change control process should be revised⁷⁵ for more significant changes to allow time for Sponsor review to understand what is changing and why it is changing. Should CRL establish separate Executive and Investment Committees, CRL to consider further the changes which may be required to the CCSC.</p> <p>The CCSC reports and makes recommendations to the EIC.</p> <p>The summary sets out the areas delegated to the CCSC as defined in the <i>Scheme of Authorities</i>. The <i>Scheme of Authorities</i> has been amended twice since September 2017. These changes reduced the authorities delegated to the CCSC and required additional oversight by the EIC and Board.</p> <p>Should CRL establish separate Executive and Investment committees, CRL will need to consider the role of the CCSC, its responsibility, authority delegated to it and its reporting lines.</p> <p>In terms of the operation of the CCSC we note:</p> <ul style="list-style-type: none"> • It has authority to release programme contingency to delivery contingency and contract budgets up to a limit of £25m • It is responsible for ensuring contracts and agreements are procured and managed in a manner consistent with CRL's financial constraints and commercial objectives • The Chair is the FD, Deputy Chair is the CD • There is some risk of self-review in that the CD leads the commercial negotiations with the key contractors and is a key member of this sub-committee providing governance and approval on behalf of CRL without any reference back to the Sponsors. <p>We recommend going forwards in light of the challenged position of the Programme that a change control process should be implemented that allows time for Sponsor review to understand what is changing and why it is changing. The criteria for escalating change for review by the Sponsors should be agreed between the Sponsors and CRL. This is addressed in more detail in Section 10.</p>

⁷⁵ Changes should be required to be notified to Sponsors within a finite time period of say 7 days.

Committee and status	Summary	Comments and recommendations
<p>Health & Safety Committee (Disbanded)</p>	<p>The last meeting of the Health and Safety Committee was on 19 July 2018. The full CRL Board now deals with H&S issues directly.</p> <p>We note SACR 20 states “<i>The focus on effective health and safety performance has been maintained and improved, with some of the best HSPI scores ever achieved on the programme during this SACR period. Crossrail and its contractors continue to promote effective management engagement with personnel at all levels and on all sites.</i>”</p> <p>Our recommendation is in the context that we have been asked to consider the role of Committees of the Board which included the Health and Safety Committee which we note was recently disbanded. We have not attempted to assess the historical additive impact of this Committee on the Health and Safety record of the Programme nor to distinguish its impact from that of the many other measures in place.</p>	<p>CRL Board to review its decision to disband the H&S Committee</p> <p>The Board decision to disband the H&S Committee was in line with a plan considered by the EIC in December 2017.</p> <p>In light of the extension to the programme and therefore the remaining work required to complete the programme, the CRL Board should consider whether re-establishing the Health and Safety Committee would contribute to the maintenance of CRL’s focus on health and safety matters.</p>
<p>Audit Committee (Disbanded)</p>	<p>The Audit Committee was disbanded in 2018. A decision was taken at the last meeting of the CRL Audit Committee in June 2018 to send proposals to the CRL Board covering the re-allocation of the CRL Audit Committee’s responsibilities. The CRL Board subsequently (19 July 2018) agreed a re-allocation of the CRL Audit Committee’s responsibilities. Further detail is included at Section 12.4.3.</p>	<p>Re-establish the Audit Committee and Risk Sub-Committee as a single Committee</p> <p>The Board decision to disband the Audit Committee and re-allocate its responsibilities was in line with a plan considered by the EIC in December 2017.</p> <p>The CRL Audit Committee should be re-formed as part of an integrated Audit and Risk Committee with a broader remit appropriate to the balance of risks and uncertainties remaining to be addressed and the volume of programme activity remaining to be completed and in need of assurance.</p> <p><i>See details in Section 12.4 or further information on the Audit Committee</i></p>
<p>Risk Sub-Committee (Disbanded)</p>	<p>The last meeting of the Risk Sub-Committee was on 12 January 2018 and agreed that risk registers and any summary reports should be reviewed at the EIC meeting from March 2018 at eight weekly intervals.</p>	<p>Re-establish the Audit Committee and Risk Sub-Committee as a single Committee</p> <p>The Risk Sub-Committee should be incorporated as part of a re-established Audit and Risk Committee.</p> <p><i>See details in Section 12.6 for further information on the Risk Committee</i></p>
<p>Remuneration Committee (Active)</p>	<p>The RemCo has recently (26 October 2018) updated its Terms of Reference, which coincided with the first meeting of the RemCo since May 2018.</p> <p>In the intervening period former members of the RemCo reached the end of their terms as CRL Directors, and membership of the RemCo has been amended accordingly.</p> <p>Minutes from the RemCo indicated this body met 5 times between November 2017 and May 2018, but did not meet again until October 2018.</p>	<p><i>See details in Governance Report Section 5.7 for further information on the RemCo.</i></p>

Committee and status	Summary	Comments and recommendations
Nominations Committee (Active)	<p>The last meeting of the Nominations Committee was 12 October 2017. This was a joint meeting of the Nominations Committee and RemCo.</p> <p>The Terms of Reference for the Nominations Committee were last amended in Jan 2016, these have not been updated to reflect the changes to the CRL Board.</p>	<p>Consolidation of RemCo and Nominations Committee where Sponsors select to retain the CRL RemCo</p> <p>The Nominations Committee is already operating informally as a joint Committee, twinned with the RemCo. Should Sponsors determine that CRL retain its remuneration responsibilities and therefore a RemCo, the CRL Board should consider formally merging the RemCo and Nominations Committees</p> <p>This would require an update to the Terms of Reference.</p> <p>The recent NED appointments being Sponsor nominees has meant a limited role for the Nominations Committee</p>

Source: Terms of Reference for Board Committees, Board Committee Meeting Minutes and KPMG interview programme.

12.4 Audit Committee and Internal Audit

12.4.1 Internal Audit

The draft 2018/19 integrated internal audit plan was presented to the CRL Audit Committee on 12 March 2018. This showed that 518 days were planned to be expended of which 182 were focussed on reviews described as financial / corporate functions. This compares with the planned 1,669 days in 2017/18. The reason for this substantial reduction in the number of planned days was given as “*reflecting the changing risk profile for Crossrail and the railway moving into operational mode during the year*”. However, with the prolongation of the CRL programme, the number, nature and focus of audits in the plan should be reconsidered, and therefore in turn should the resource requirement.

We reviewed the subjects which the 2018/19 internal audits were planned to address in relation to corporate and financial functions and we requested further information on two which we considered particularly interesting in the context of our scope of work. These were the “Management and close out of commercial contracts” and a proposed internal audit of the demobilisation and transfer of staff to TfL. The scope of these internal audits is set out in Figure 17 and Figure 18.

Figure 17: Scope of proposed internal audit of Management and Close out of commercial contracts

18 xxx	Management and close out of commercial contracts	To review the management and close out of commercial contracts, including the financial calculations made by the Crossrail Finance Team. The purpose will be to include having sufficient information to defend subsequent claims for compensation from contractors.	30
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Source: CRL 2017_18 Internal Audit Plan

Figure 18: Scope of proposed internal audit of Demobilisation and Transfer for Staff to TfL

17 529	Demobilisation and transfer of staff to TfL c/f from 2017/18	A review of the demobilisation process, including readiness and effectiveness of the transfer of any staff from Crossrail to TfL. Review to include any transition plan and ‘hold points’ should the project be behind schedule.	20
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Source: CRL 2017_18 Internal Audit Plan

At the time that we made our enquiries (November 2018) we were advised that neither of these audits had at that stage been completed and that the whole of the 2018/19 internal audit plan had been put on hold.

We note that in past years, auditor resource had been split between TfL Internal Audit and auditors employed directly by the Crossrail Health & Safety and Environment teams. All internal audits for 2018/19 were to be resourced by the TfL Risk and Assurance Directorate.

Review of internal audit plans for CRL since financial year 2016/17 indicate a large number of internal audits although very few finance focused audits had been completed during that time by CRL's Internal Audit (IA) function. We did not find evidence of any cyclical reviews being performed of key financial controls and believe this should be considered.

We obtained a copy of the 2017/18 internal audit plan which for each planned audit included a brief high level scope summary. We reviewed the list for internal audits which addressed risk within their scope. There were, as expected, a significant number in relation to Health and Safety, and also in relation to Environmental matters and Ethical Sourcing but relatively few in the commercial and financial area. The numbers of such audits were as follows:

Table 21: Summary of number of proposed internal audits in 2017/18 addressing risk

Summary of number of proposed internal audits in 2017/18 addressing risk	
Internal Audit	Number
Health & Safety Matters	10
Environmental Matters	13
Ethical Sourcing	7
Commercial / Financial / Other	2

Source: 2017_18 CRL Internal Audit Plan

Two Commercial / Financial planned audits were:

Table 22: Scope of proposed internal audits in 2017-18 of commercial / financial matters

17 508	Master Operational Handover Schedule (MOHS)	A review of the arrangements for monitoring progress against the MOHS. To include a review of the process by which the data to support Board reporting on Safety Critical Paths is generated and collated. Also the Schedule Quantified Risk Assessment (SQRA). The review to include a representative sample of contractor reporting.	IA	14104 Crossrail and supply chain performance	20
17 512	Risk Management and ARM	A review of the role of ARM in the final year of the Crossrail Programme. To include a review of the risk management process to ensure that Crossrail is capturing and monitoring the stage risks appropriately.	IA	14104 Crossrail and supply chain performance	25

Source: CRL 2017_18 Internal Audit Plan (undated) as provided by CRL

We note that in a schedule provided to us containing details of issued internal audit reports, the “Risk Management and ARM⁷⁶” internal audit was not listed.

We would have expected a higher proportion of internal audits addressing areas of commercial and financial risk.

We reviewed a summary provided by CRL of issued internal audits in relation to 2017_18 and identified the following which were relevant to reporting on project progress and on time and cost outturn. We note that the findings were summarised as “Well Controlled – No issues raised”. We recommend that the scope of and breadth of future reviews of such areas should be reconsidered carefully as should the sufficiency of appropriately skilled resource being deployed in the execution of such key reviews. This should enhance the probability of identifying issues of concern.

Table 23: Scope and results of 2017-18 CRL commercial / financial internal audits

17-500 Semi-Annual Construction Report (SACR) reporting process Issued 14/12/2017	A review of the SACR process to ensure that the underlying data is sound. This is to include a review of the Work Breakdown Structure reporting and PRISM. Three contracts will be selected as examples - Whitechapel, Bond Street and the Systemwide main works (C610). No issues were raised during this audit (combined with 17-508).	Well Controlled No issues raised
17-508 Master Operational Handover Schedule (MOHS) Issued 14/12/2017	A review of the arrangements for monitoring progress against the MOHS. To include a review of the process by which the data to support Board reporting on Safety Critical Paths is generated and collated. Also the Schedule Quantified Risk Assessment (SQRA). The review to include a representative sample of contractor reporting. No issues were raised during this audit (combined with 17-500).	Well Controlled No issues raised

Source: Extracted from “Audit Reports issued in 2017-18 (undated) provided by CRL”

We note that internal audit report 17-500 (recorded as combined with 17-508) recorded its scope as being:

“The audit focused on the control environment in relation to the following key risk areas.

- *Resources and governance over reporting cost and schedule within Crossrail.*
- *Compliance with internal procedures for example change control and risk management including their inclusion in regular reports.*
- *Assurance provision over the accuracy and timeliness of data for reporting.*
- *Robustness of progress monitoring of cost and time.*
- *Robustness of programme reporting at different levels of Crossrail, and*
- *Communication and stakeholder management.*

During the audit, a sample of projects currently being undertaken were reviewed in relation to the above scope items to ascertain if controls are being consistently applied at project level. IA attended a selection of management meetings to review how reports are utilised by management to support the SACR and MOHS.”

It is not entirely clear to us from the above or from the remainder of the report exactly how the scope was addressed.

We are surprised at the conclusion that “*processes and controls in place for effective management and reporting of the Crossrail programme budget and schedule are well controlled*”. We consider that the approach used and the skillsets and experience of resources deployed in the internal audit of commercial

⁷⁶ Active Risk Management

management and critical related progress monitoring and reporting processes should be reviewed and enhanced.

We note the following comments in the findings section of the report:

“The use of Crystal as the single source of data ensures that there is data transparency and traceability. The strict timetable used for the reporting cycle ensures that data is timely and the data assurance process ensures accuracy and completeness.

There is appropriate focus on underperforming contractors and the pressures on cost and time in the board report. The current contingency budget is insufficient to cover the P50 risk exposure by £128m and SACR 18 reports a decrease in confidence in meeting the Stage 3 opening from 77% to 71%.

It is essential that sufficient resource is retained both [by] CRL and contractors to ensure that the railway is able to open as planned. There is an audit in the 2018/19 plan that will cover this. We would recommend that the scope is expanded to include a review of contractor resource.”

We would make the following observations on the above findings:

- We note the ‘data assurance process’ is described as ensuring accuracy and completeness but it is unclear to us how this was checked, nor what if any steps were taken to review key aspects of the base data underpinning the schedule for costs and time to go.
- It is not clear whether and if so, how, internal audit was satisfied as to the basis of calculation of the 71% confidence of achieving Stage 3 opening. We note that the subsequent report by P Rep a few months later commented that underpinning assumptions to this calculation were out of date and that they thought the probability was significantly lower (at that time). We also note that SB 87A minutes recorded that JST reported: “The Stage 3 confidence of 71% has limited accuracy given the exclusion of the three most at risk stations and 19 assumptions on ‘red’ items.”
- The internal audit correctly highlighted issues around potential shortfalls in resource although this was one of many issues which needed to be addressed. We note the reference to there being an audit in the 2018_19 internal audit plan which will cover this, however we could only see the proposed internal audits in Figure 17 and Figure 18 above which might have touched on this area, but neither of which were carried out.

We did not see any internal audits addressing the accuracy of the commercial or financial data which was used as the basis for the preparation of the CRL Board Reports, during 2017_18 or 2018_19 although elements of the data used in those reports would have been common to the data which should have been considered in the execution of the above internal audits numbered 17-500 / 17-508.

We also did not see any completed internal audits testing the alignment between the planned pace of demobilisation and the effectiveness of the control environment versus programme tasks still to be managed and performed. This is relevant given our concern that the head office demobilisation continued in line with plans drawn up against a Stage 3 Opening of December 2018 leading to a reduction in resources in certain key areas beyond that required to preserve a sufficient operation of key processes. We understand this is being addressed.

12.4.2 Assurance across the CRL business

The interactions between CRL’s existing lines of defence are not as clearly defined as they should be, in terms of who is being provided with what assurance, to what degree, when, how and by whom.

There is also insufficient clarity that all key areas of risk are being properly addressed through a mixture of business as usual processes and checks and internal assurance.

12.4.3 Audit Committee

The CRL Audit Committee met for the last time in June 2018 and was in effect disbanded in July 2018. Discussion at the CRL Audit Committee at their final meeting on 11 June 2018 led to the finalisation of a proposal approved by the EIC on 11 July 2018 and which was subsequently approved at the CRL Board on 19 July 2018. This included details of proposed future governance arrangements related to Audit Committee matters. These are set out below.

With regard to future arrangements for the oversight of internal assurance we note that the minutes of the 11 June 2018 CRL Audit Committee record that: *“The Committee agreed that there must be a clear distinction between those audits that fall within the TfL remit (i.e. relating to the Elizabeth line) and those relating to CRL (i.e. those relating to delivery of Crossrail). The former should be considered and approved by the TfL Audit and Assurance, and the latter by the CRL Board. The members considered that only a small number of audits would need to be considered by the CRL Board, but agreed that an appropriate process needed to be put in place by CRL to monitor the progress of such audits.*

The meeting further discussed the distinction between the governance delivered by the TfL Audit and Assurance Committee and that provided by the CRL Board. The members considered that it was important that the interface between the two be properly managed to ensure that the appropriate matters were debated in the correct forum. The meeting accepted that in all probability only a small percentage of the governance matters presently considered by the Audit Committee would fall upon the CRL Board to review.”

The 19 July 2018 CRL Board approved the proposals contained in a paper titled *“Future Audit Committee Arrangements”*. It was proposed that arrangements going forwards for managing the matters previously looked after by the CRL Audit Committee in relation to internal audits, would be as shown in Figure 19.

We note it was intended that there would still be meetings between the Head of Internal Audit and the CRL Programme Director on a quarterly basis. We have been advised that such a meeting has taken place at least twice.

Figure 19: Proposed Internal Audit arrangements for remainder of 2018_19

Proposed Arrangements for remainder of financial year 2018/19

<u>Current Arrangements</u>	<u>Proposed Arrangements</u>
<p><u>Annual Internal Audit Annual Report</u></p> <p>(i) Presented by the TfL Director of Risk and Assurance to the CRL Audit Committee at the same meeting as the Annual Report & Accounts.</p>	<p><u>Annual Internal Audit Annual Report</u></p> <p>(i) Presented by the TfL Head of Internal Audit to the CRL Board at the same meeting as the Annual Report & Accounts (June 2019).</p>
<p><u>Approval of Annual Audit Plan</u></p> <p>(i) Reviewed by TfL Director of Risk and Assurance</p> <p>(ii) Reviewed by CRL ExCom.</p> <p>(iii) Approved by CRL Audit Committee</p>	<p><u>Approval of Audits for 2019/20 in March 2019</u></p> <p>(i) Reviewed by TfL Director of Risk and Assurance</p> <p>(ii) Reviewed by CRL ExCom</p> <p>(iii) Those relating to the delivery of Crossrail, Approved by the CRL Board</p> <p>(iv) Those relating to the Elizabeth line, approved by the TfL Audit and Assurance Committee as part of the TfL Integrated Audit Plan.</p>
<p><u>Audit Plan Update</u></p> <p>Presented 3 times per year by the Crossrail Head of Internal Audit to CRL Audit Committee giving formal updates on:</p> <p>(i) Progress on audit plan</p> <p>(ii) Closure of audit findings</p> <p>(iii) Fraud Risk Assurance Group</p> <p>(iv) Crossrail Integrated Assurance Group</p> <p>(v) Auditor Resource</p>	<p><u>Audit Plan Update</u></p> <p>Those relating to the Elizabeth line to be presented 4 times per year (September 2018, December 2018, March 2019 and June 2019) to the TfL Audit and Assurance Committee. This will continue to provide formal updates on:</p> <p>(i) Progress on audit plan</p> <p>(ii) Closure of audit findings</p> <p>Those relating to the delivery of Crossrail to be referred to the CRL Board on a quarterly basis.</p>

Source: CRL Board paper 19/19: "Future Audit Committee Arrangements", tabled at the CRL Board 19 July 2018

We recommend that a CRL Audit and Risk Committee be formed. In addition, the Annual Internal Audit Report should be presented to the CRL Audit and Risk Committee, the Annual Audit Plan should be approved by the Committee, and Audit Plan Updates should be provided no less frequently than quarterly to, the CRL Audit and Risk Committee. We have also recommended that the internal audit programme should be broadened so that whilst maintaining the focus on critical technical and health and safety matters there is also sufficient focus on programme delivery and corporate risks, internal financial and commercial controls and on CRL reporting. We would expect oversight of these areas to fall within the remit of the new CRL Audit and Risk Committee.

12.5 External Audit

It was not part of our scope of work to consider or comment on the statutory audit of CRL and we have not done so.

We were, however, asked to speak with the audit partner from external statutory auditors, EY and to consider any observations he provided which were relevant to our scope of work. We were also asked to have regard in our report to the contents of an extract from a paper tabled to the Audit Committee by EY, dated 8 June 2018 in relation to EY's observations on outturn costs.

During our discussions with the EY audit partner we were told that the issue of expected outturn costs for the programme was only relevant to their audit in so far as considering whether outturn costs were likely to exceed committed funding, in which case it was relevant to going concern considerations. We note that the EY audit partner advised that the statutory accounts for CRL for the year ended 31 March 2018 had not as yet been signed although he expected to sign them shortly.

To contextualise the EY paper dated 8 June 2018 in terms of timing:

- SACR 19 issued in June 2018 referred to an expected P50 AFDCD cost outturn of £12,723m which was said to be £211m over IP2 (that figure (£211m) is referred to in the EY paper below).
- A paper prepared by TfL and dated 20 July 2018 for the Deputy Mayor of Transport and Mayor's Chief of Staff, referred to "CRL and Sponsor view following further scenario testing" as £211m to £315m, and "Jacobs independent assessment - worst case" £400m, and referred to "Sponsors had agreed to co-fund overrun up to £300m".
- On 31 August 2018, CRL served an Adverse Event Notice of a delay in Stage 3 opening and tabled at the Sponsor Board on 3 September 2018 two alternate calculations of a revised AFDCD which were £767m to £823m (P50 to P95) or £728m above IP2.

We note the EY paper which was tabled to the CRL Audit Committee and dated 8 June 2018, stated:

"CRL Management anticipate the risks to materialise at the 50% level and forecast the total final costs to exceed Intervention Point 2 (IP2) by c.£211m.

We have:

- *Performed a sensitivity analysis on future cost outturn by identifying different scenarios and forming our own independent view of total capital spend compared to existing funding agreements.*
- *Assessed the impact of our findings on the going concern of CRL."*

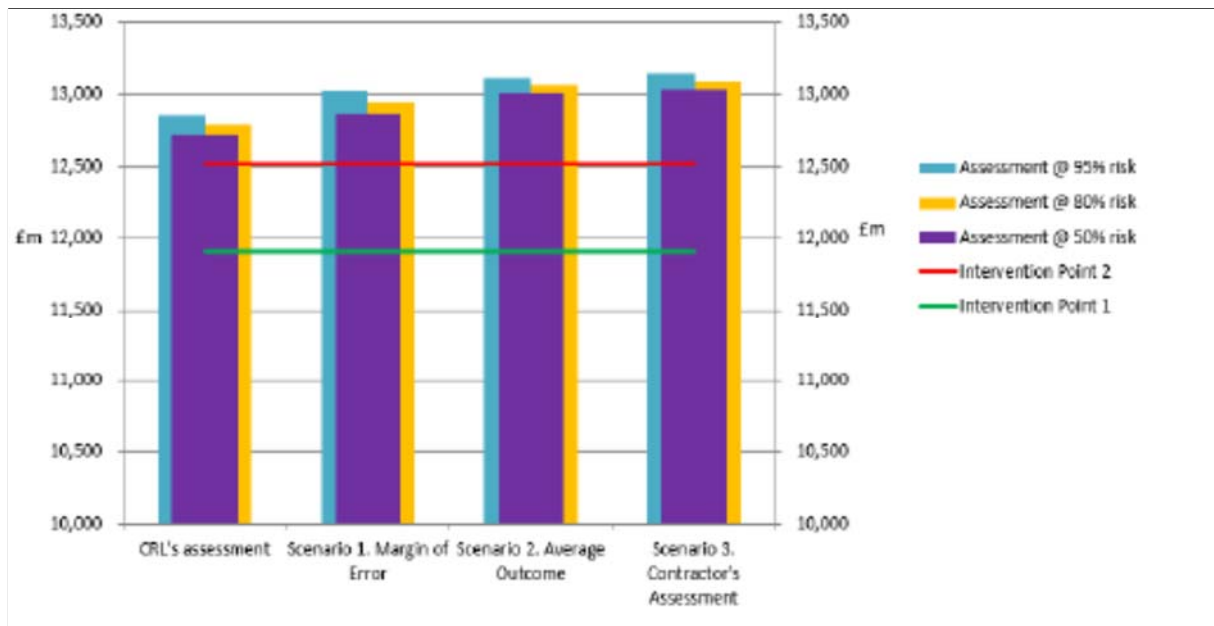
A separate handout tabled by EY stated:

"Set out in the graph below in scenario 1 is the current forecast position for Crossrail. The remaining three scenarios utilise different assumptions with respect to target and forecast cost outcomes. In addition, to avoid an element of double counting, we have adjusted the CRL risk assessment. Please refer to the table below the graph for the assumptions used.

In all of the scenarios presented, the forecast costs at a 50% risk assessment are in excess of intervention point 2. The expected breach of Intervention point 2 ranges from £356.4m under EY's Margin of Error assessment at 50% risk (scenario 1), to £632.0m using the Contractor's view of target price and cost at 95% Risk (scenario 3).

Based on the analysis performed we consider that it is highly likely that the total Crossrail spend will breach intervention point 2."

Figure 20: Anticipated Final Crossrail Direct Cost – EY sensitivity analysis



	CRL's Assessment	Scenario 1	Scenario 3	Scenario 4
Target price	CRL	CRL with a 19.2% margin of error applied	Median of CRL and Contractor	Contractor
Anticipated Final Cost (AFC)*	CRL	CRL with a 19.2% margin of error applied	Median of CRL and Contractor	Contractor
Other	None	None	None	None
Risk adjustment	None	None	15% reduction on CRL	15% reduction on CRL

*The AFC includes the impact of pain/gain adjustments where applicable.
 **The predicted AFC within the graph does not include the Contractor's updated AFC for C610 as a result of the revised programme in order to meet the most recent MOHS dates.

Source: End of extract from EY Paper of 8 June 2018.

We note that this paper in essence explains it applies a 19.2% margin of error to the CRL numbers, and sets out the Contractor position and the median, the latter two scenarios with some adjustment to CRL's position on risk. The EY Audit Partner told us the source of the 19.2% was based on a comparison between actual and expected spend rates.

We note the Minutes of the CRL Audit Committee of 8 June 2018 comment as follows on the above:

"[The EY Audit Partner] then handed round a separate sheet setting out EY's 'Future Outlook'. The members debated the sensitivity analysis of the Anticipated Final Crossrail Direct Costs and in particular 'scenario 3' which was based upon the Contractors' Assessments. [The EY Audit Partner] accepted that this was somewhat more pessimistic than Crossrail's assessment. The Committee considered that 'scenario 3' was an unduly pessimistic prediction..."

The Committee noted the EY Audit Results Report."

12.6 Risk Sub-Committee

We note the central risk team and the Risk Sub-Committee were demobilised in early 2018. The Head of Programme Risk had until this point provided reports to and attended the Audit Committee and Risk Sub-Committee⁷⁷. The final meeting of the Risk Sub-Committee was 12 January 2018 at which the plan for demobilisation of risk was reviewed and the following decisions taken:

“Quantitative Cost Risk Analysis (QCRA):

- In accordance with the 2017/18 Business Plan, the final quarterly QRA was scheduled for March 2018 as part of the SACR19 process;
- Post March 2018, risk reporting would be reviewed periodically and would only focus on the AFCDC (P50); and
- Sponsors were to be formally informed that there was no benefit in continuing to conduct QRA's beyond March 2018

The Sub-Committee agreed that:

- There was no justification for incurring the costs and resources that would be required to conduct another QRA beyond SACR 19; and
- Nikki Gash, Richard Palczynski and Lucy Findlay should prepare a letter notifying Sponsors that beyond March 2018, the QRA modelling exercise would no longer be carried out and only the P50 would be reported. Risk management would continue within the various sectors.

Active Risk Manager (ARM)

The meeting agreed the following actions:

- Shut down of the ARM software was planned for 1 May 2018;
- Closed risks would be archived while active risks would be exported to Microsoft Excel and managed by individuals within the various sectors;
- Central collation and monitoring of the management of these risks was key; and
- Strategic, Programme and Business risks would be the main areas of focus, with a view to streamline these risks between now and May 2018.

The sub-committee agreed that:

- ARM should be shut down on 1 May 2018;
- The format for collating, monitoring and managing active risks using Microsoft Excel and SharePoint should be defined; and
- The individuals within each directorate responsible for managing these risks should be identified, as well as the person who would be responsible for central monitoring and control of the reporting system.

Risk Data and Reporting

- The ARM Metrics Report (usually produced for the Risk Sub-Committee and the Audit Committee) would no longer be produced after the shut down of ARM on 1 May 2018 (the final report would be produced in April 2018);
- The cost and risk sections of the Board Report would be simplified and reduced beyond SACR19; and

⁷⁷ The Head of Programme Risk reported to the PCD (Richard Palczynski) who attended the Risk Sub-Committee. The PCD reported to the Finance Director (Mathew Duncan) who attended the Audit Committee.

- The management and closure of the Strategic and Programme Risk Registers would be managed by the Head of Change, with the intention that the register would no longer be incorporated into the Board Report from Period 1, 2018/19.

Closure of the Risk Sub-Committee

- The Risk Sub-Committee would cease to meet after its meeting on 12 January 2018;
- Risk registers and any summary reports should be reviewed at the ExCom78 meetings from March 2018, at eight weekly intervals (as opposed to the current governance proposal for the reports to be reviewed at ExCom from September 2018);”

We note that at the Audit Committee of 8 June 2018, proposed arrangements in relation to Risk Management reporting going forwards were summarised and compared with those to date, as follows in Figure 21.

Figure 21: Extract from CRL Board Paper regarding Future Audit Committee Arrangements 19 July 2018

Proposed Arrangements for remainder of financial year 2018/19

<u>Current Arrangements</u>	<u>Proposed Arrangements</u>
<p>Risk Management Report</p> <ul style="list-style-type: none"> (i) Risk matters presented to ExCom on an 8 weekly cycle. (ii) Presented to CRL Audit Committee 3 times per year. 	<p>Risk Management Report</p> <ul style="list-style-type: none"> (i) Risk matters presented to ExCom on an 8 weekly cycle. (ii) Risk matters referred to the CRL Board as necessary.

Source: CRL Board Paper 19 July 2018

We recommend:

- Consideration is given to reviewing the sufficiency of an 8 weekly cycle of reporting to EIC and whether this should be shorter
- Risk Matters should resume being reported to the reformed and integrated CRL Audit and Risk Committee
- The sufficiency of the resources addressing risk reporting should be reviewed in light of the impact of the planned demobilisation actions (in line with Stage 3 opening in December 2018)

⁷⁸ The reference to ExCom in the Risk Committee report is a reference to the Executive and Investment Committee referred to as EIC elsewhere in this report.

Appendix 1 Terms of reference

Terms of Reference: Crossrail Financial & Commercial Independent Review

Summary

Following the announcement by Crossrail Limited (CRL) of a delay in opening of the core section, the Crossrail Sponsor representatives, the Department for Transport and Transport for London (DfT and TfL) and the TfL Executive have asked for a review of CRL's assessment of the ongoing funding requirement, cash forecast and commercial and governance arrangements be undertaken by a qualified independent consultancy.

The review will need to consider whether CRL's assessment of future spend forecasts, funding requirement and cash profile form a reliable basis for decision making by TfL and DfT.

Should the consultant conclude that CRL's forecasts cannot materially be relied upon they should identify areas of concern and seek instructions as to whether Sponsors require the development of alternative views of the likely future spend forecasts, funding requirement and cash profile.

Scope

The scope comprises a review of CRL's financial modelling and forecasts for all stages of the opening to determine the extent to which they reflect the true financial position of CRL, along with a review of commercial/contract management and governance, including but not limited to:

Financial Scope and Project Forecast Outturn

Determining whether appropriate and effective financial controls are in place and processes used to produce the forecasts are consistent with good practice and have been subject to appropriate quality checks.

Reviewing the material inputs to those models, to determine if they are well founded on an appropriate assessment of the estimate cost at completion for each remaining contract or activity.

Assessing whether the allowances made in the financial models for risk and uncertainty are reasonable and consistent with the schedule scenarios presented by CRL and the independent (Ranachan) review.

Determining if assumptions and exclusions are appropriate and have been priced as risk, or quantified but excluded from the analysis, or have not been quantified.

Reviewing the assumptions adopted in relation to critical dependencies outside of CRL's control such as the timing of availability of trains for dynamic testing and considering how the risk of a range of related outcomes has been assessed and addressed in CRL's forecast outturn cost and schedule.

Reviewing any material subjective assessments or adjustments that form part of the inputs or modelling and conclude if they are appropriate.

If required, the preparation of alternative forecasts, which reflect the findings and conclusions of the consultant should they differ from CRL's views.

Commercial & Governance Scope

Assess whether appropriate and effective commercial controls are in place.

Assess whether appropriate and effective commercial and contract management processes are in place.

Review commercial reporting/tracking and oversight arrangements in place and whether effective reporting to the Crossrail Board and Sponsors has taken place over the last 12 months.

Considering the role and performance of the committees of the CRL board, including its Audit Committee (recently subsumed into the CRL board);

Make recommendations on any changes to the control or governance environment from the reviews above.

Outputs and timings of the review

The consultant is expected to start work w/c 24 September. Briefing meetings and interviews with CRL staff will be arranged by the Joint Sponsor Team in conjunction with CRL and prioritised.

The consultant will be expected to form initial views for the Crossrail Sponsor Board on 15 October. Following the start of work the Sponsors and the consultant will agree the extent of work possible during that period and in turn the extent of progress and form of reporting thereon that will be possible and appropriate for those meetings.

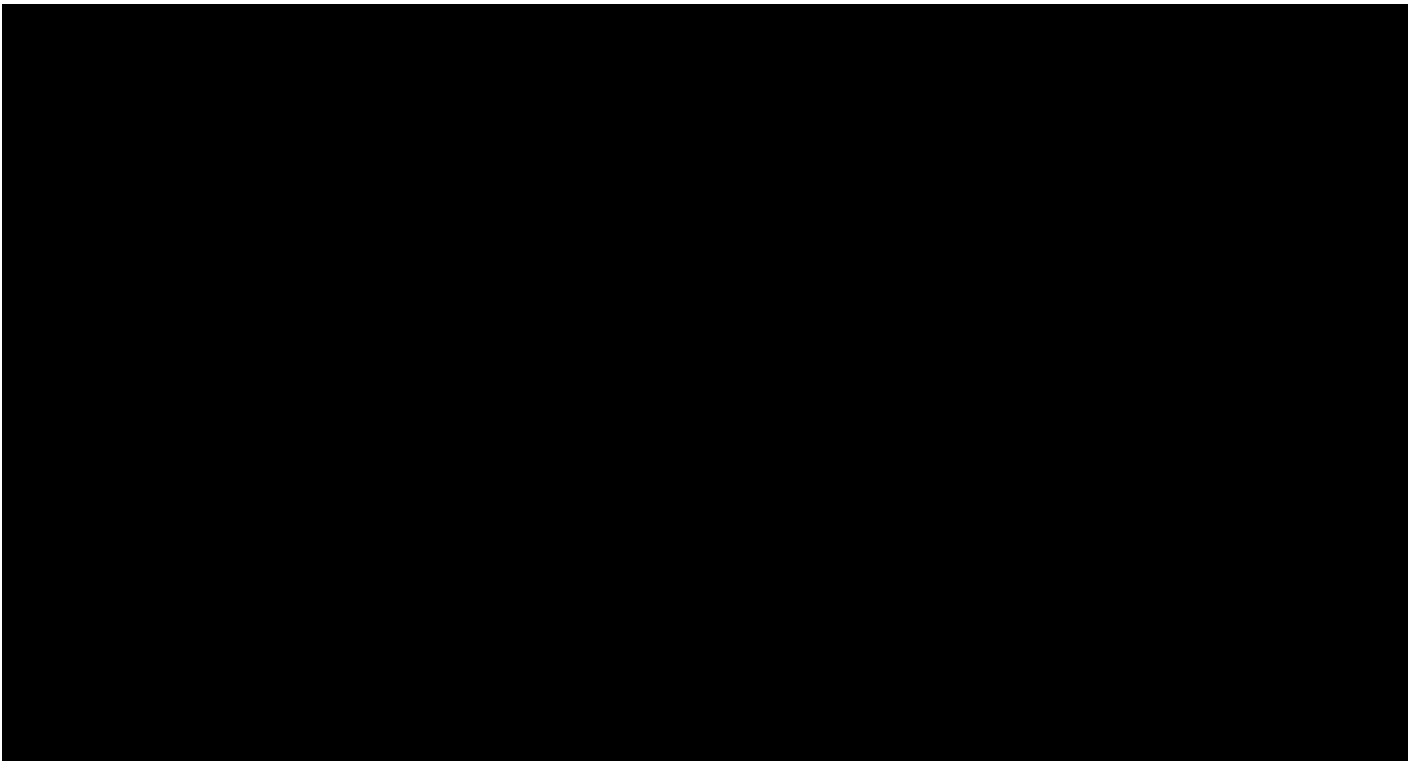
Sponsors and the consultant will agree the timing for the submission of the report and detail of its contents.

Appendix 2 Programme review

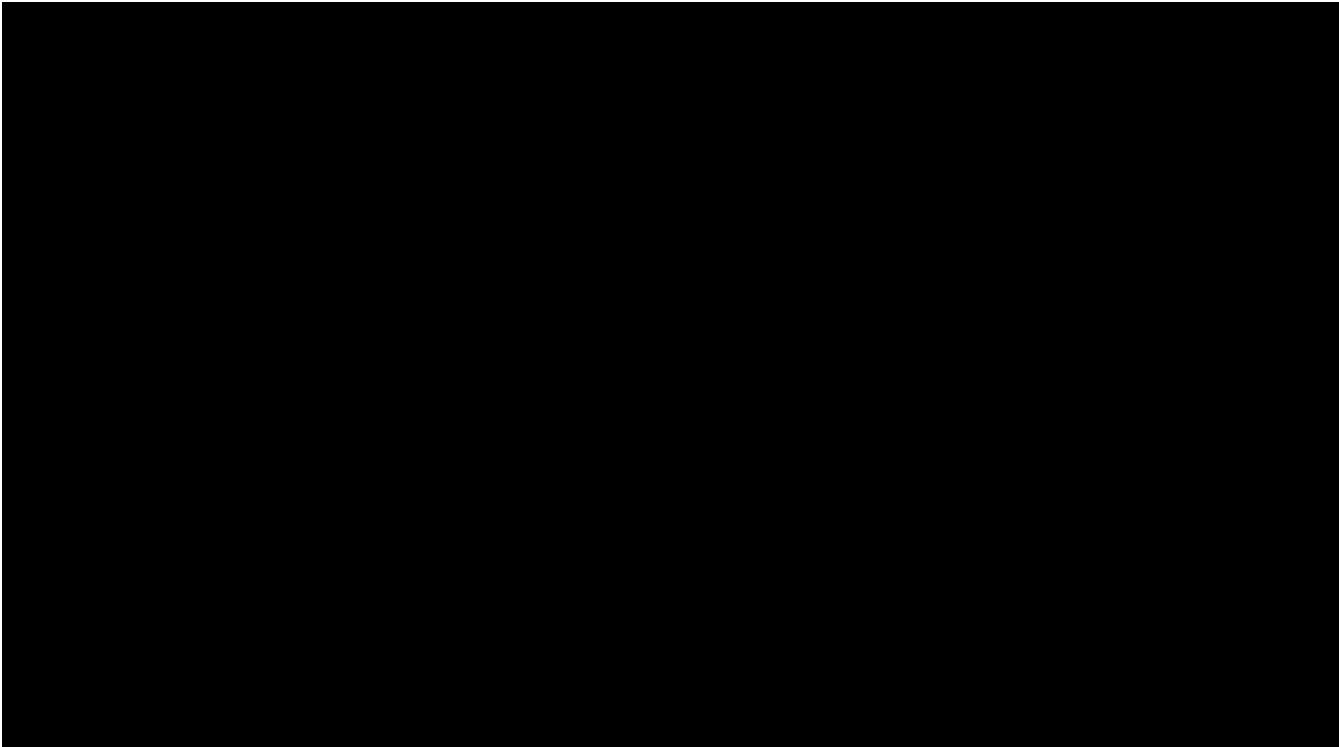
Stage 3 schedule overview

The diagram in Figure 22 gives an overview of the Crossrail programme based on the RAP 2 timeline and shows the critical drivers and risks to the programme. We identified the two critical drivers to be the readiness of the rolling stock (trains) and routeway. The key schedule risks are:

- procurement
- managing the interfaces across the contracts
- contractors' capability due to resource constraints
- performance/productivity of the tier one contractors
- a catastrophic event such as a fire occurring during the dynamic testing.



We reviewed the programmes for the 13 principal live contracts. [REDACTED]

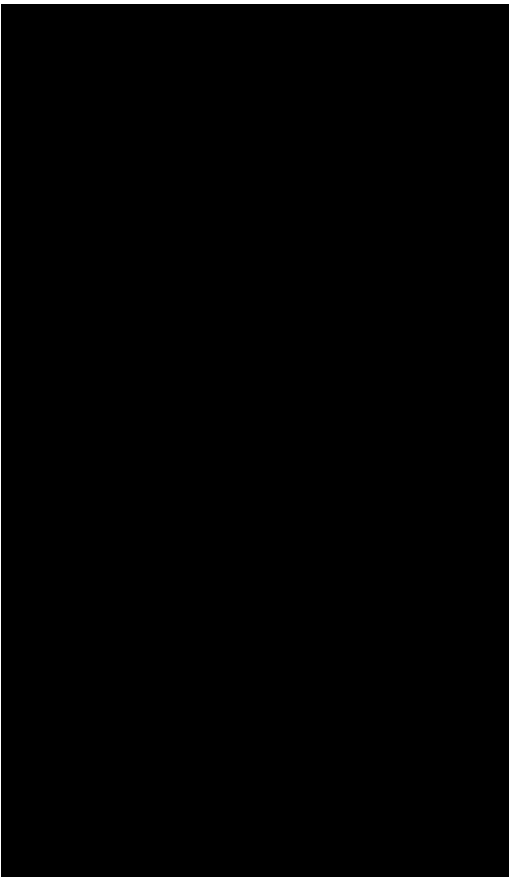


Summary of Rannachan report findings

The findings of the Rannachan report conclude that the RAP 1 Stage 3 opening date of [redacted] is unachievable. The author proposes a programme with a revised Stage 3 opening in [redacted]. A summary of the report findings is detailed in the table below.

Table 25: Rannachan report key findings

Activities	View
Routeway	<ul style="list-style-type: none"> Low confidence that the routeway would be finished by 21 October 2018.
Bombardier & Siemens train software testing	<ul style="list-style-type: none"> Low confidence that the trains will achieve the full testing criteria by 21 October 2018.
Dynamic testing (DT)	<ul style="list-style-type: none"> Did not believe the four pass, four week (16 weeks) strategy for DT testing is appropriate nor sufficient. Recommended addition of a fifth four week pass.
Stations	<ul style="list-style-type: none"> Stations not on the critical path however there is still a lot of work to complete on a number of the stations [redacted]. Staged completion dates appeared too optimistic leaving significant amount of work and testing to be finished off.
Trial running	<ul style="list-style-type: none"> Agrees with duration allowed for activity in MOHS.
Trial operations	<ul style="list-style-type: none"> Agrees with the duration allowed for this activity in the MOHS.
Critical path	<ul style="list-style-type: none"> Identifies two high level critical path to DT as: <ul style="list-style-type: none"> routeway train software



Summary of Boss report findings

Boss identified the challenges and uncertainty around the dynamic testing programme and suggested an approach that would build the trains' reliability. The key findings of this report are summarised in the table below.

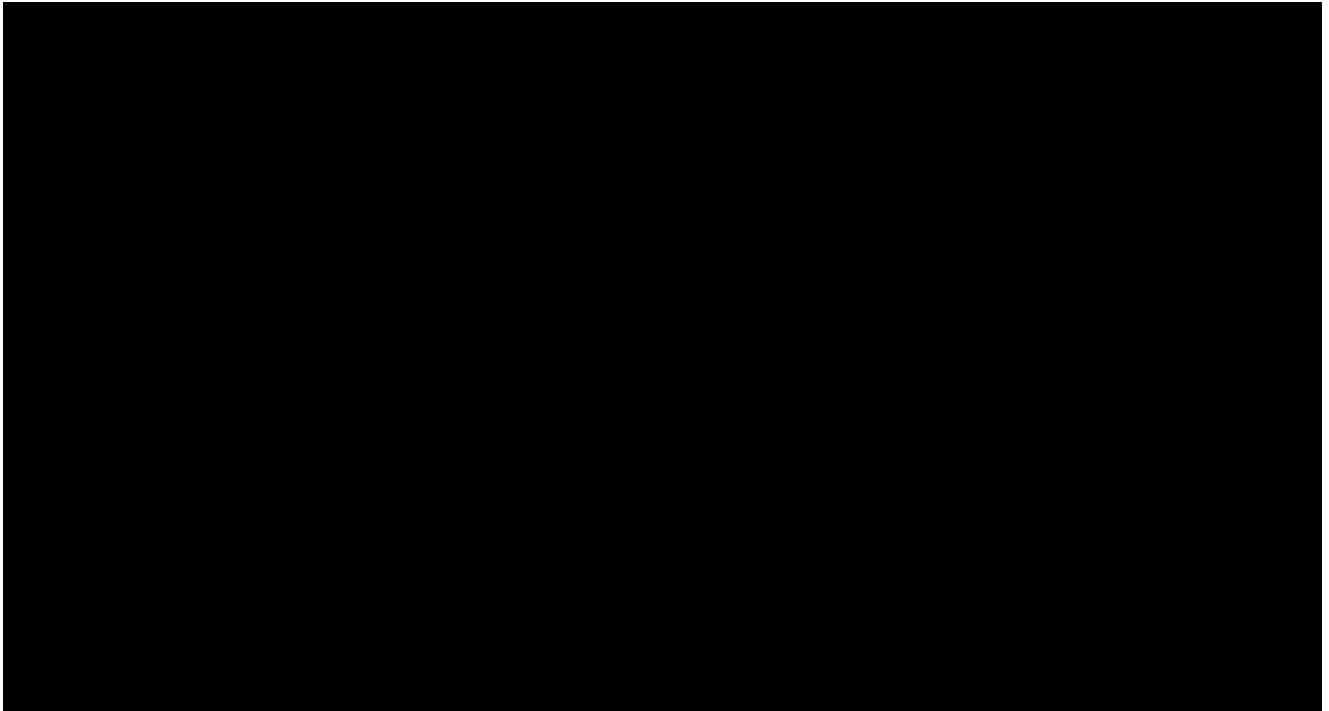
Table 26: Boss report key findings

Activities	View
Routeway	<ul style="list-style-type: none"> Supports the approach that the routeway be cleared as soon as possible to start DT and completion of the routeway installations to be completed during engineering hours or at the weekend.
Bombardier & Siemens train software testing	<ul style="list-style-type: none"> Suggests that the successful completion of all 29 train CBTC tests at Melton should not be defined as a prerequisite for commencement of testing in COS.
Dynamic testing (DT)	<ul style="list-style-type: none"> Proposes that DT be started gradually as soon as possible in order to build reliability growth. Feels there does not appear to be a credible plan for delivering DT as the four test cycle is questionable.
Stations	<ul style="list-style-type: none"> There are many stations reaching completion at the same time which would make the SCADA and other C660 works more challenging.
Trial running	<ul style="list-style-type: none"> Asserts that the duration of five weeks allowed for trial running is realistic but preparations for test scripts need to be accelerated.
Trial operations	<ul style="list-style-type: none"> Agrees with the duration allowed for trial operations.
Critical path	<ul style="list-style-type: none"> Identifies two high level critical path to DT as: <ul style="list-style-type: none"> - routeway - train software

RAP 2 contract key dates

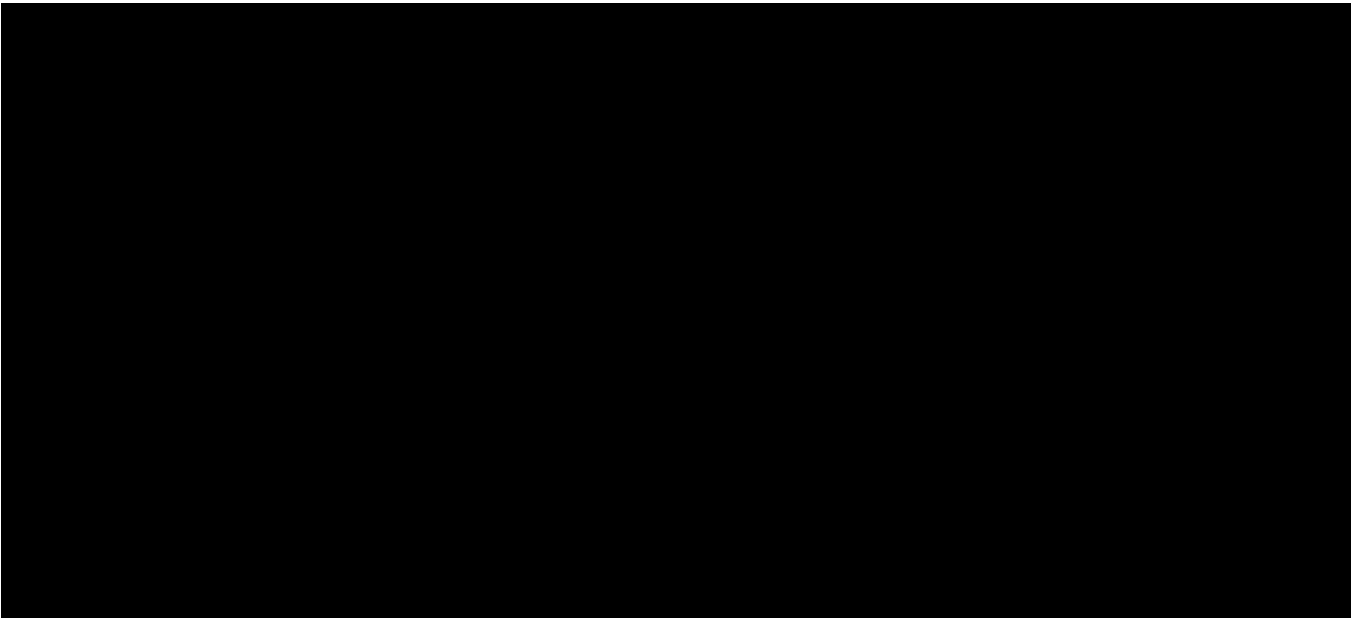
RAP 2 provided further breakdown on the contract key dates by specifying [REDACTED] dates for the TOSD, staged completion and NEC handover as shown in the table below. The [REDACTED]

[REDACTED]

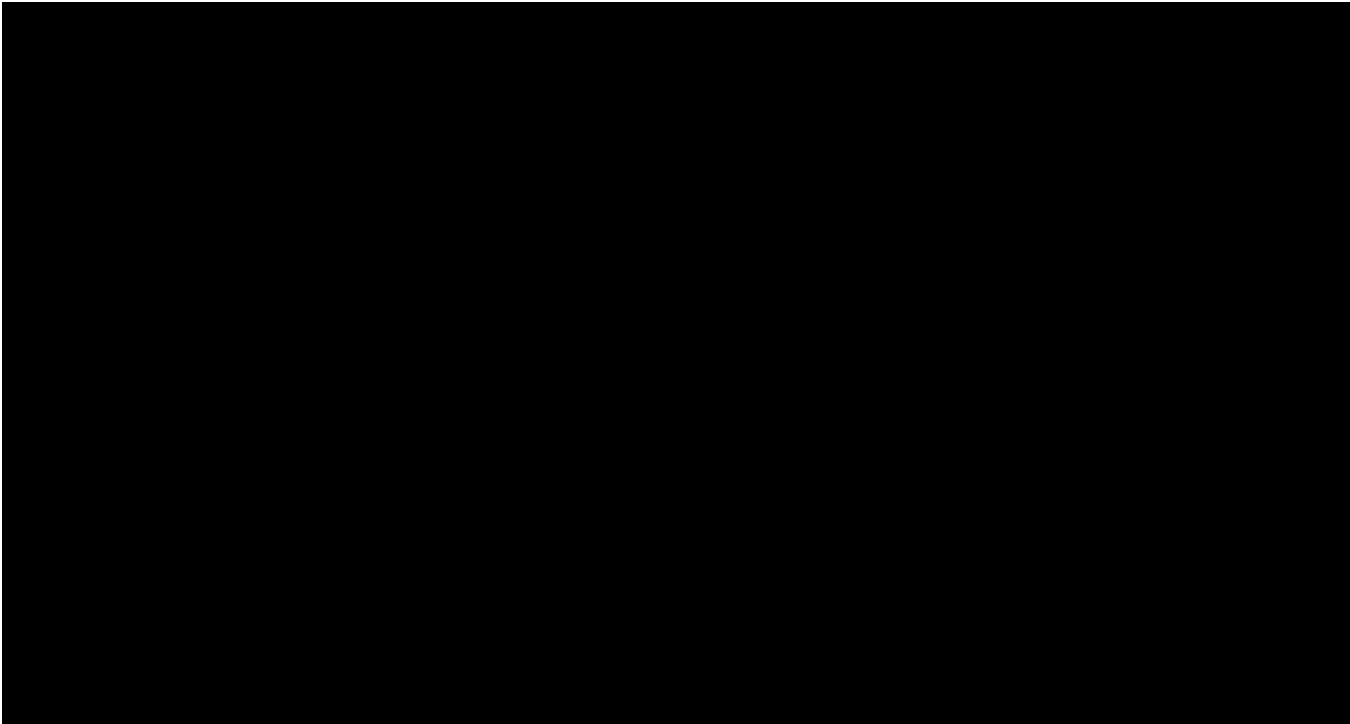


RAP comparison with Rannachan, Boss programme

We compared the schedules from the RAP 1 and the RAP 2 [redacted] dates programme, with the proposed schedules from the Rannachan and the Boss reports, which is shown in the Figure below. We observed that the duration for the dynamic testing proposed in the Rannachan and the Boss reports is longer than the duration allowed for in the RAP programmes. We also observed that the Stage 3 opening date in the RAP 2 coincides with the Stage 3 opening date in the Rannachan proposed programme.

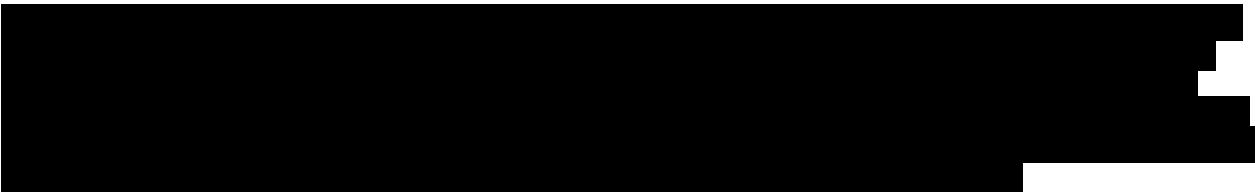


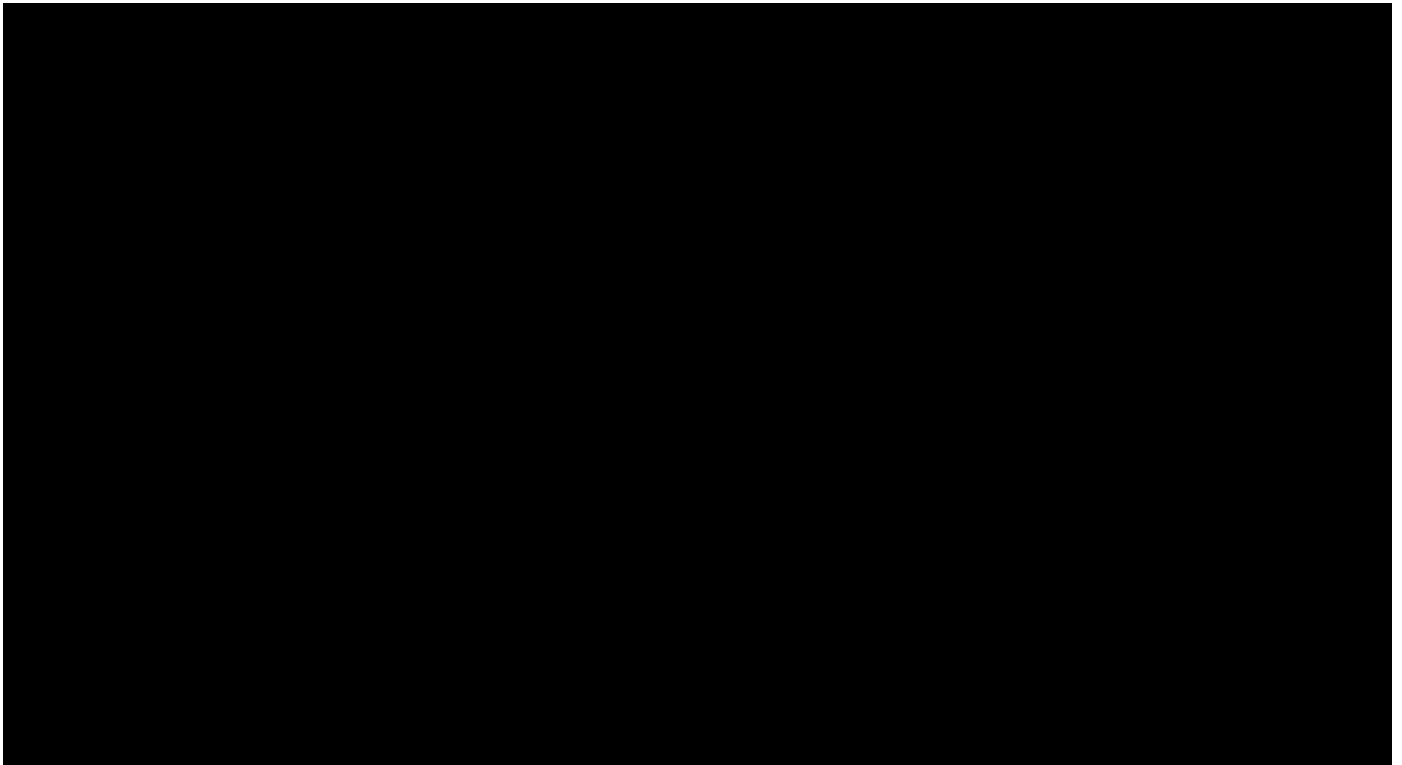
The findings from our review of RAP 1 showed that none of the recommendations in the Rannachan and the Boss reports had been incorporated into the RAP 1 schedule. A variance analysis on the contract key dates for the principal live contracts shows the schedule impact from addressing some of the reports' recommendations. For the station contracts, there is an average increase of seven weeks in the schedule duration to achieve TOSD. [redacted]



CRL project managers' views

We interviewed the CRL project managers to gain their views on the RAP 2 schedule and contract key dates. The findings are shown in the table below.





Appendix 3 Cost review

Summary of RAP1 Cost Estimate

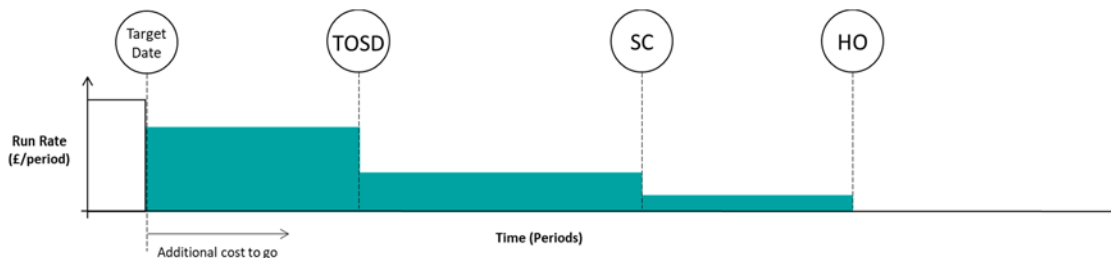
The RAP 1 cost estimate is calculated as an addition to the P4 2018-19 AFDCD value. The estimate is calculated by applying an expenditure per period (run rate) over an extended schedule duration (expressed as a number of periods) to give a total cost increase due to delay. The cost for each key live contract is summed to provide an overall project cost increase.

The cost estimate uses three different run rates for the periods up to three key dates:

- TOSD – the date the main contractor demobilises its main on site resources (when the main installation works are completed)
- Stage Completion (SC) – the date the assets are taken over by the IM
- NEC Handover (HO) – the date when all documentation is complete.

The run rate reduces after TOSD and again after SC, and the contract costs end at HO.

Figure 25: Illustration of RAP 1 calculation



RAP 1 presents three schedule scenarios (see schedule section 4), two of which are costed:

- Schedule scenario 2, which represents the point estimate
- Schedule scenario 3, which represents the P50 risk estimate

Two sets of key dates are used, one for each scenario.

Assumptions

The RAP 1 estimate excludes costs that we would expect to be included by CRL or risks which should be managed by CRL. These include:

Risks that should be owned by CRL and accounted for in its estimate:

- [REDACTED] routeway installation not sufficiently complete to allow 5/2 dynamic testing to commence before the end of November 2018
- Further slippage in station, shaft and portal (SS&P) programmes, including TOSD dates
- Delays to GSM-R and stations radio programme
- Additional [REDACTED] SCADA and radio testing resources
- Phased completion of [REDACTED] asset installation by stations in advance of the TOSD dates and support the revised strategic programme
- No upturn in completion of Installation Release Notes (IRNs)
- Tier 1 contractors fail to deliver the necessary safety evidence in time to obtain safety approval.
- Lack of availability of signalling testing resources

- Insufficient time to undertake trial operations (i.e. late handover to the IM)
- Risks that should be managed by CRL as integrator, with appropriate costed mitigation plans in place:
 - Safety Integrity Level (SIL) 4 issues are found during dynamic testing
 - Rolling stock not ready to commence 5/2 dynamic testing
 - Additional passes required to complete dynamic testing
 - Not permitted to commence trial operations with some [REDACTED] communications work incomplete ('non critical' communications)
 - Further possessions required by NR to undertake fringe works (Westbourne Park and Pudding Mill Lane)
 - Readiness of IMs (LU, RfL & MTRC).
 - Train and integrated systems fail to perform reliably and fail to meet the Sponsors' Requirements.

Summary of RAP 1 cost estimate

The RAP 1 CP2 cost estimate summarised in Table 30 is based on:

- A point estimate assuming schedule CRL scenario 2 (detailed in section 2).
- An assessment of the cost impact if the schedule incurs delays, shifting from schedule scenario 2 to schedule scenario 3
- No provision for delays beyond schedule scenario 3 are included
- The preliminary TOSD dates represent the completion of construction works and the significant demobilisation of resource. There is some cost allowed for the risk of potential overruns, quantified as P80 and P95 risk values.
- The RAP 1 P95 estimate gives a £525 million cost increase above the P4 2018-19 AFDCDC (£12,810M), resulting in an overall increase of £823 million above IP2 for a 10 period delay to the opening of Stage 3 (an average of around £82m per period).

Table 30: Summary of RAP 1 cost estimate

Item	Cost £M	Start dynamic testing	Commence trial running	Stage 3 open	RAP 1 ref/ comments
IP1 Intervention Point	11,912				
Contingent Funding	600				Page 13
IP2 Intervention Point	12,512	26/02/18	05/07/18	09/12/18	
IP2 Budget	12,512				
Forecast cost increase P4 2018_19	298				
AFDCDC at P4 18/19	12,810				page 10
RAP 1					
Increase for Point estimate	268				Scenario 2 (page 9)
AFDCDC (Point estimate)	13,078	05/11/18	30/04/19	15/07/19	+ 8 periods vs original schedule
Risk (P50)	201				Risk of delay scenario 2 to scenario 3, page 9
Risk (P50-P80)	30				
Risk (P80-P95)	26				
RAP 1 AFDCDC incl. risk (P95)	13,335	04/12/18	31/05/19	31/08/19	+ 10 periods vs original schedule

Comments on RAP 1

The RAP 1 assumes the P4 2018-19 AF CDC is a reasonable starting point for a P50 cost estimate.

The RAP 1 cost estimate assumes a lower cost run rate for the extension of the programme than the current run rate of around £120 million per period:

The RAP 1 point estimate adds £565 million to the IP2 budget for a shift of the whole programme by eight periods (although some contracts are delayed by more than this). If an eight period delay were to occur at the current run rate it would result in a cost increase of £960 million

The RAP 1 P95 cost estimate adds £258 million for an additional two period delay (including risk), giving an overall cost increase of £823 million above IP2 for an overall programme shift of ten periods. However, the cost of a ten period delay at the current overall run rate would be £1,200 million.

The RAP 1 cost estimate excludes several risks which are the responsibility of CRL and, hence, it did not provide a comprehensive assessment of the costs and risks up to Stage 3 completion. In particular, we would expect CRL to have accounted for the following risks, which are the responsibility of CRL to manage:

- Delays to the [REDACTED] routeway installation
- Slippages in SS&P programmes
- Delays to GSM-R and stations radio programme
- Additional [REDACTED] SCADA and radio testing resources
- Phased completion of [REDACTED] asset installation by stations
- Delays in IRNs
- Tier 1 contractor failure to deliver safety evidence on time
- Lack of availability of signalling testing resources
- Late handovers to the IM

Overall, it appears likely that RAP 1 significantly underestimates the cost to complete the programme.

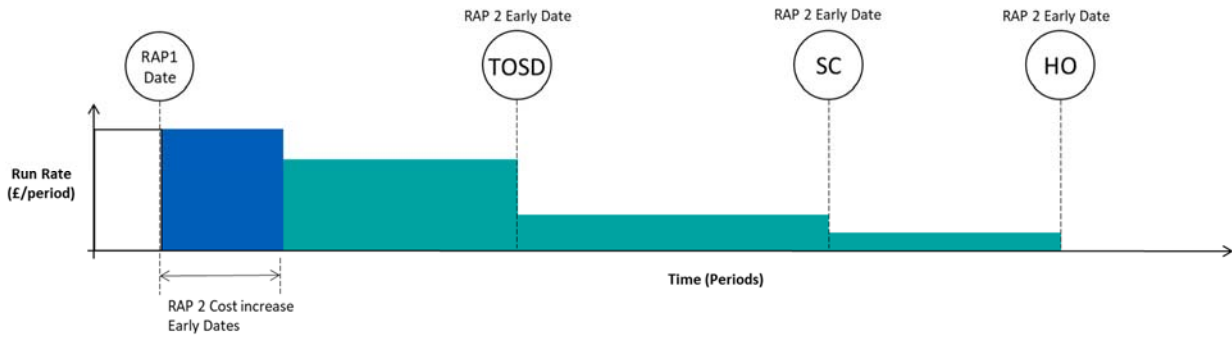
Summary of RAP2 cost estimate

The RAP 2 estimate is calculated as an addition to the RAP 1 estimate and follows a similar methodology to RAP 1 based on cost run rates and key dates.

RAP 2 considers two schedule cases:

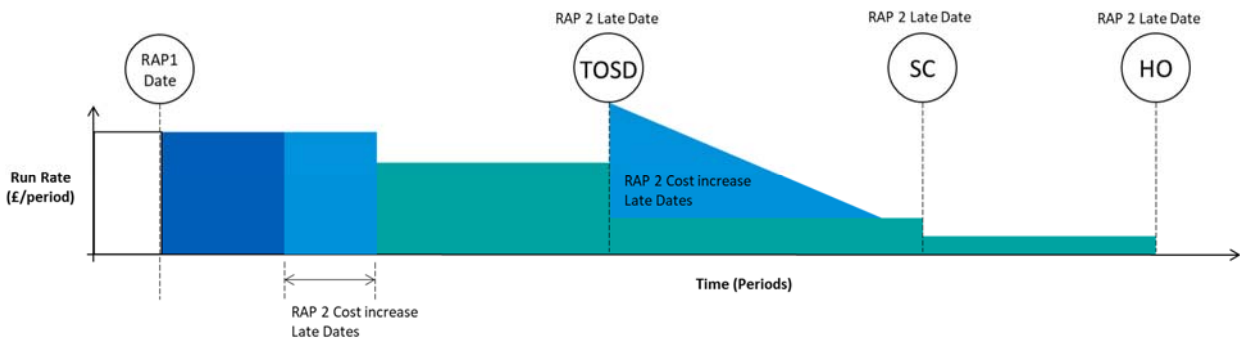
- [REDACTED]
- [REDACTED]
- [REDACTED]

Figure 26: Illustration of RAP 2 [redacted] dates calculation



The [redacted] date value is calculated in a similar manner but also includes an additional ramp down period (graduated rate reduction) allowing for a gradual demobilisation of resources after the TOSD date.

Figure 27: Illustration of RAP 2 [redacted] dates calculation



The RAP 2 estimate is not consistent with the assumptions in RAP 1 as different run rates appear to have been used. However the run rates used up to the TOSD date appear to be broadly in line with current levels of expenditure.

Table 31: Summary of RAP 2 Estimate

Item	Cost £M	Start dynamic testing	Commence Trial Running	Stage 3 Open	RAP 2 ref/Comments
RAP 1 AFCDC incl. Risk (P95)	13,335				See RAP 1
Increase for [redacted]	162				Programme shifted to [redacted]
AFCDC for [redacted]	13,497	19/12/18	15/07/19	15/10/19	
Increase for [redacted]	180				
AFCDC for [redacted]	13,677	06/01/19	31/08/19	31/12/19	Proposed CRL budget
Additional risk (P50)	58				QRA for additional risks excluded from CRL estimate
Additional risk (P50-P80)	42				
Additional risk (P80-P95)	54				
RAP 2 AFCDC [redacted] + Additional risks (P95)	13,831	not stated	not stated	not stated	Budget for consideration by Sponsors

Comments on RAP 2

The estimate is based on an assessment of the cost increases beyond RAP 1 for ten stations, shafts and portals contracts, and seven other contracts.

The RAP 2 estimate assumes that the P4 2018-19 AFCD and RAP 1 estimates form a sound basis for building a revised total cost estimate (as opposed to for example taking COWD and compiling a fresh estimate of costs to go).

The RAP 2 cost estimate assumes higher cost run rates than RAP 1 for the extension of the programme:

- The RAP 2 [REDACTED] dates point estimate adds £162 million (excluding risk) to the RAP 1 budget for a shift of the Stage 3 opening date from [REDACTED]
- The RAP 2 [REDACTED] dates cost estimate adds £180 million (excluding risk) for [REDACTED], giving an overall point cost [REDACTED] increase of £342 million for a five month shift of the programme beyond RAP 1. However, the cost of a [REDACTED] at the current full run rate ([REDACTED]) be around £650 million.
- RAP 2 also includes an additional £154 million of risk for 'additional risks' excluded from the cost estimate and schedule. When this is added to the point estimate it gives an overall cost increase of £496 million above RAP 1. RAP 2 does not indicate the overall additional time delay expected to arise as a result of these 'additional risks' materialising.

Several of the additional risks are the responsibility of CRL and should be included in the base RAP 2 cost estimate. Hence, the RAP2 estimate did not provide a comprehensive assessment of the costs and risks up to Stage 3 completion. In particular, we would expect CRL to have accounted for the following risks, which are the responsibility of CRL to manage:

- incomplete works, ([REDACTED] not ready), which should be the responsibility of CRL and its contractors
- defects, which should be the responsibility of the contractor
- Health and Safety, which should be the responsibility of CRL and its contractors
- resource availability, which should be the responsibility of CRL and its contractors
- Testing, Commissioning and Handover, including document production, which should be the responsibility of CRL and its contractors
- contractor insolvency, which is a general programme risk.

There are some dynamic testing risks related mainly to the commissioning of the rolling stock and which include the risk of a SIL4 issue occurring. It may be possible to operate the railway until such an issue is resolved, as it is likely to relate to an unusual/highly specific set of circumstances that, potentially, could be avoided through operational measures. While dynamic testing risks could be excluded from the CRL scope on the basis that these risks are not under the full control of CRL, CRL's rolling stock/infrastructure integration role means they could still reasonably be included within the CRL scope.

There are four catastrophic risks within the additional risk register which Sponsors need to be aware of, but would not normally be allowed for within the programme schedule or budget. These risks include:

- A fundamental failure of systems design philosophy, which would call into question the core systems design that is a CRL responsibility. However, the chance of 'building the wrong project' appears to have a remote likelihood and if it were to materialise the costs could not be funded from within the programme.
- Industrial action by MTR which would be an issue for RfL to manage and is not considered to be significant.
- A serious fire, which should be allowed for by the infrastructure owner/manager, as for existing TfL infrastructure. CRL should be required to execute mitigation measures and adequate insurance arrangements during the construction period.

Illustrative Scenario Analysis

We undertook an analysis through the application of illustrative scenarios using three date cases and two run rate cases creating six different scenarios, for each of which a cost to complete was calculated. Other contracts were accounted for by a pro-rata adjustment based on the analysis of the 13 contracts and indirect costs.

Key Dates

The three date cases assumed were:

- The PM View, representing a more up to date view than RAP 2. This was based on dates provided by the Project Managers based on their understanding of current progress and productivity levels.
- [REDACTED]²
- Additional delays beyond the [REDACTED] dates representing the additional risks identified in RAP2

Run Rates

The run rate cases assumed were:

- Run rate stepping down after TOSD and SC points, as assumed by CRL
- Run rates not stepping down at TOSD and instead running to SC, representing a more pessimistic view

We met with the PMs to understand contract specific issues concerning the applicability of historic run rates for forecasting costs to complete. In our analysis of each contract we adopted either the 6-month average historic cost run rate, or where the PM had used a higher rate in his/her own assessment, we used that rate. We used the adopted run rate up to the TOSD date [REDACTED] after TOSD to a lower level appropriate for achieving the SC date. After SC, and until the Handover (contractual completion) date, we assumed a further [REDACTED] to a level rate based on resource levels anticipated by the PMs.

For the [REDACTED] contract, applying the full run rate to the SC date was not considered to be a realistic case, as TOSD has to occur when 5/2 dynamic testing commences and, hence, in this case the 6 month average rate was applied for an additional 2 months rather than assuming that rate continues right up to SC.

For [REDACTED] no TOSD date applies. Hence, in all scenarios for these contracts the 6 period average run rate was applied up to SC.

As SC comprises handover to the infrastructure manager, we assumed that this would be the latest date for the start of the ramp down of tier one contractor demobilisation in order to achieve SC.

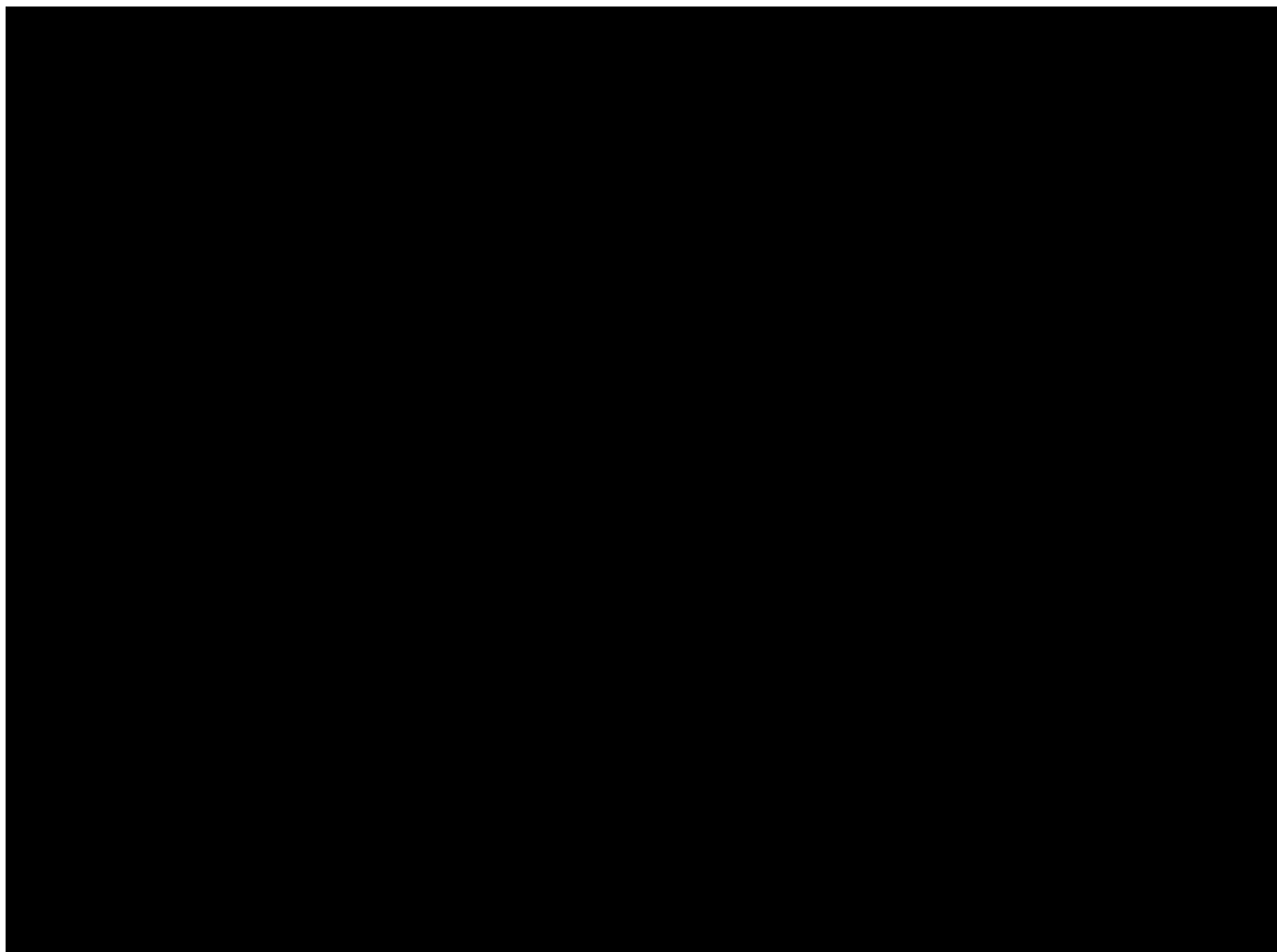
Summary of RAP 1 and 2 cost estimates

In order to be able to compare the RAP cost estimate at contract level with the results from the scenario analysis, which includes delay risk, the RAP costs needed to be recast to allocate the centrally held programme risk across the individual contracts and indirect costs. We allocated the risk in the following way:

- The RAP 1 cost estimate allocates the centrally held programme risk (£95.3m) across the contracts through Unresolved Trends (URT) and Allocated Risk. The URTs are reported against each contract and represent changes which have not been formally approved and incorporated into the contract price. The balance of the programme risks were allocated to individual contracts and indirect costs by CRL as Allocated Risk. We followed the risk allocation defined by CRL when making our comparisons

- RAP 2 includes no additional programme risk, but separately identifies 'Additional Risks' with a P95 value of £154 million. We allocated this risk value across the contracts based on the type, description and likelihood of the risks as described in the risk register.

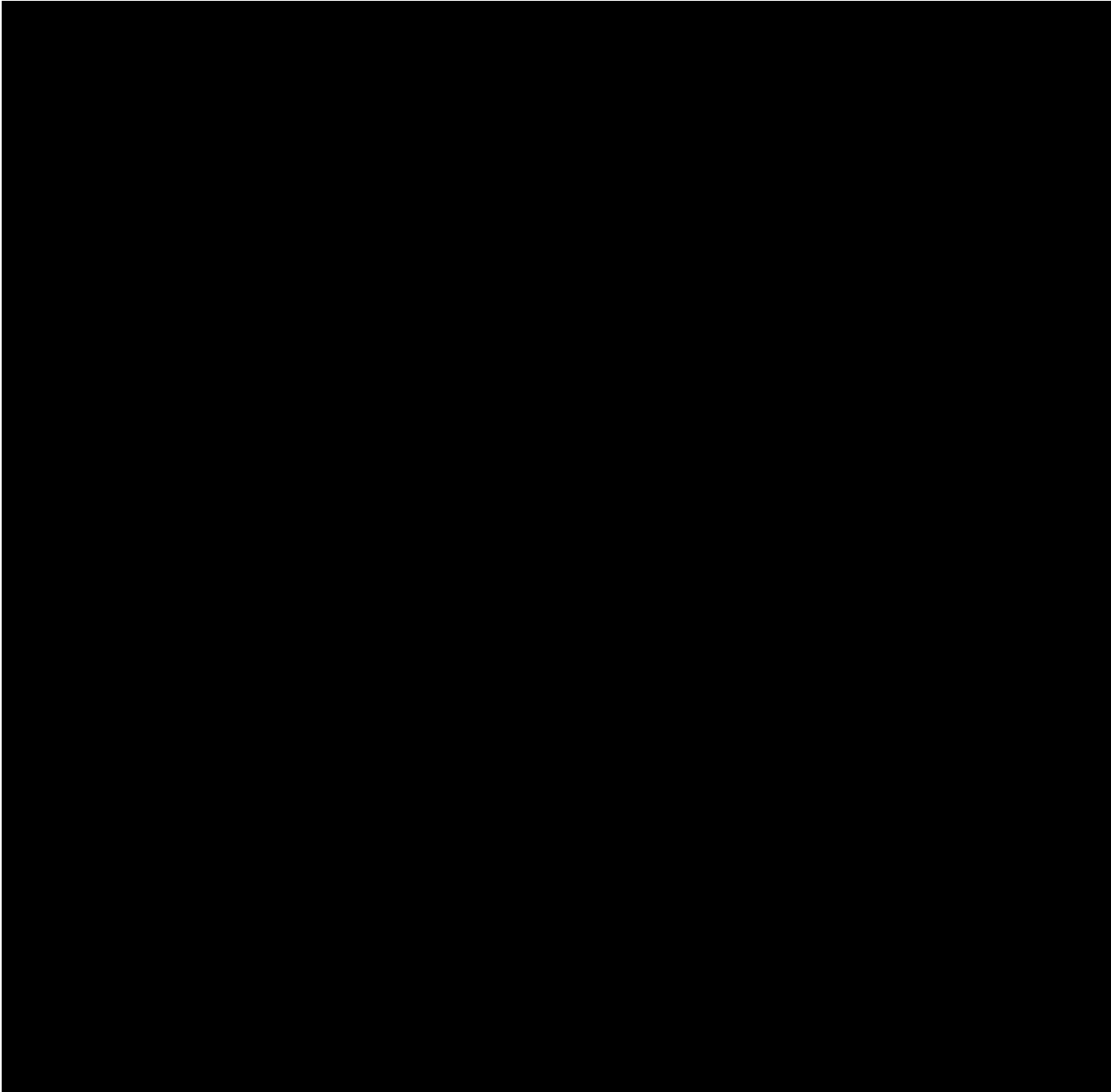
The analysis gave an equivalent RAP2 cost for each contract as shown in Table 32.



Scenario Analysis Results

Table 33 summarises the total cost to go and Table 34 total costs calculated for each contract for each illustrative scenario. Scenario 1 gives a total cost broadly in line with the RAP 2 P95 value, whereas scenarios 2 and 3 show increases of between £209 million (16%) and £311 million (25%). Scenarios 4, 5 and 6 (based on demobilisation being delayed until SC) show increases of £247 million (20%) to £656 million (52%).

Not all contracts will follow the same scenario, as different scenarios could occur on separate contracts. However, there is some interdependency between contracts, particularly between the stations and systemwide contracts such as Communications and Controls, which means that several contracts could follow a single scenario.



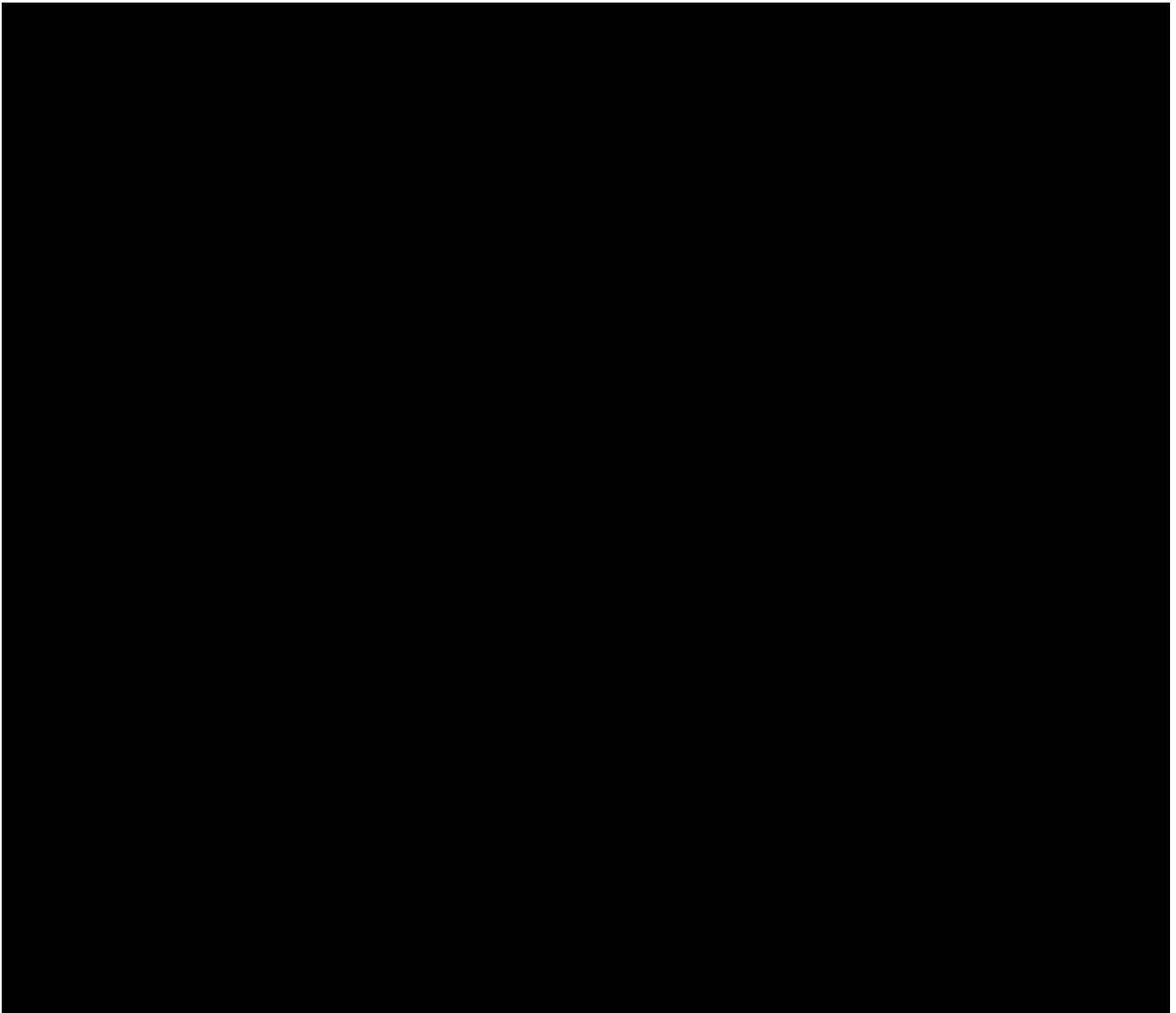


Figure 28 compares the RAP2 P95 values to the scenario results:

- The ranges of values derived from the scenario assessment are illustrated by the blue (scenarios 1-3) and purple (scenarios 4-6) bars
- The RAP2 P95 values are shown by the solid line.

The scenarios reveal that the costs to go for [REDACTED] Contracts show the greatest potential increases compared to RAP2. This result is driven by the impact of [REDACTED] SC dates combined with delayed demobilisation under scenarios 4, 5 and 6. Each scenario needs to be considered in aggregate rather than on an individual contract by contract basis as we are in effect assuming for each scenario that a variety of additional costs and different delays will impact each contract and cost category. The overall effect will, on average, equate to the result of applying the same scenario to all contracts and cost categories.

The outturn costs could be lower or higher than shown, dependent in part upon the extent to which the right steps are promptly and effectively taken to re-set certain aspects of the Programme and its management and oversight, and in part upon the occurrence of future unknown events and challenges which could cause greater delay and additional cost than has been assumed.

Modelling of Additional Risks

The RAP 2 additional risks register comprises 20 risks which are not allowed for in the RAP2 cost estimate or the [REDACTED] dates. CRL suggests that Sponsors consider these additional risks when applying for additional funding. The additional risks are, in effect, exclusions from the RAP 2 cost estimate and can be grouped into three categories:

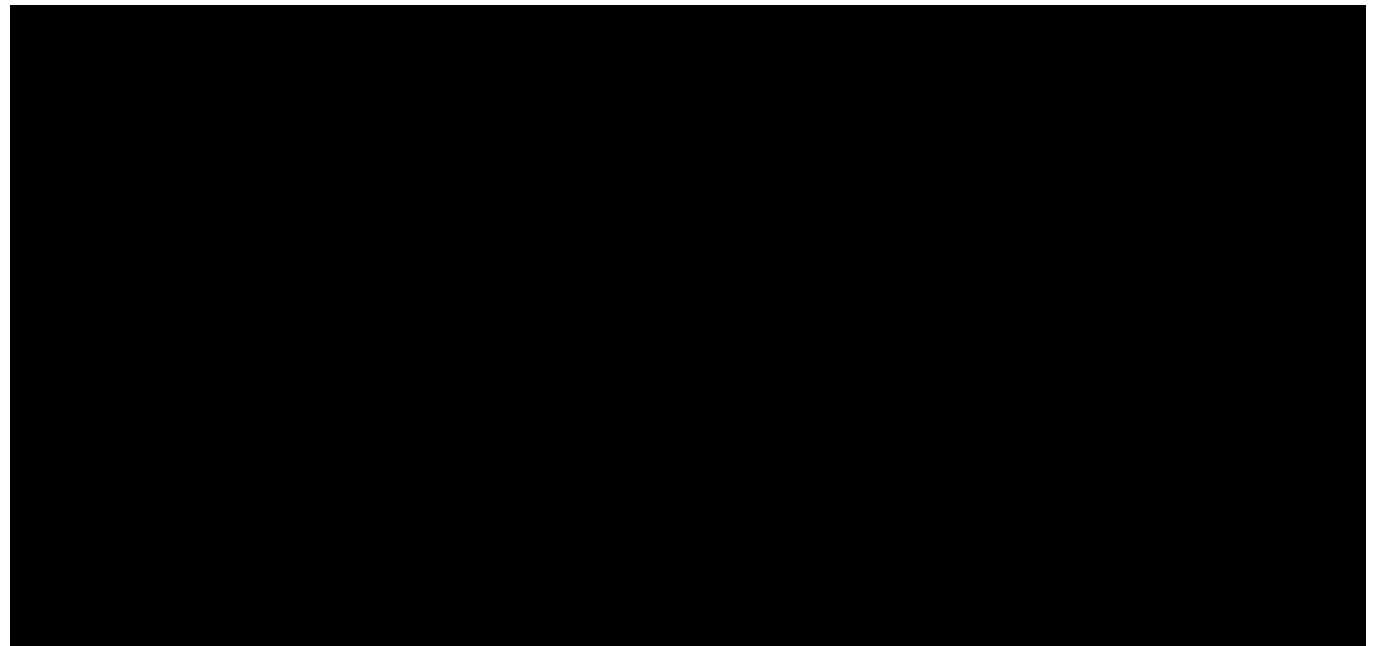
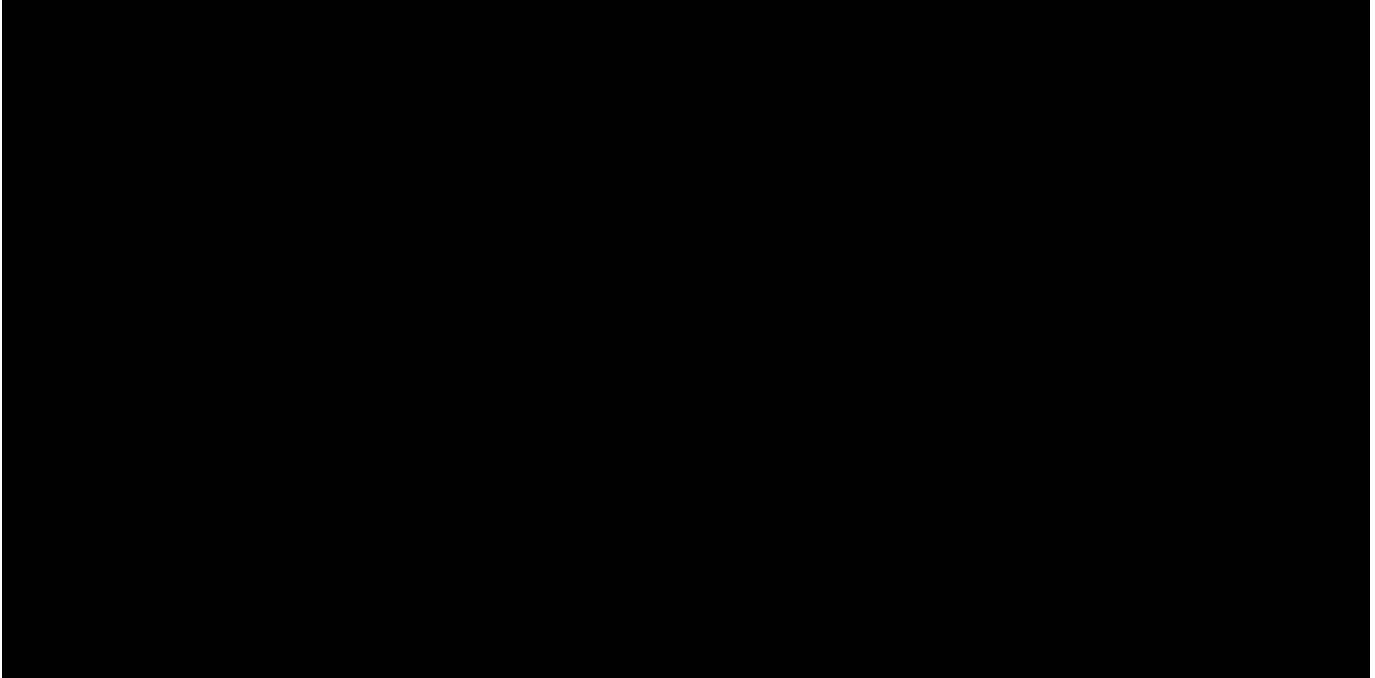
- Infrastructure Completion – 11 risks relating to works within CRL control that would not normally be excluded from the programme budget
- Dynamic testing (commissioning of rolling stock) – 5 risks relating to works outside CRL budget, relating to the commissioning of the rolling stock and signalling which have a high time impact but low infrastructure cost impact
- Catastrophic Risks – 4 risks outside CRL control. Sponsors need to be aware of these risks, but they would not normally be allowed for within the programme schedule or budget.

The Infrastructure Completion risks should be owned by CRL and be allowed for within the RAP 2 estimate. Illustrative scenarios 3 and 6 incorporate the following delays to the RAP 2 [REDACTED] dates representing these additional risks, based on the risk descriptions, probabilities and impacts provided by CRL:

- Routeway: [REDACTED]
- Signalling / Rolling Stock commissioning: [REDACTED]

- Stations: [REDACTED]
- Communications: [REDACTED]

These additional delays are illustrated below.

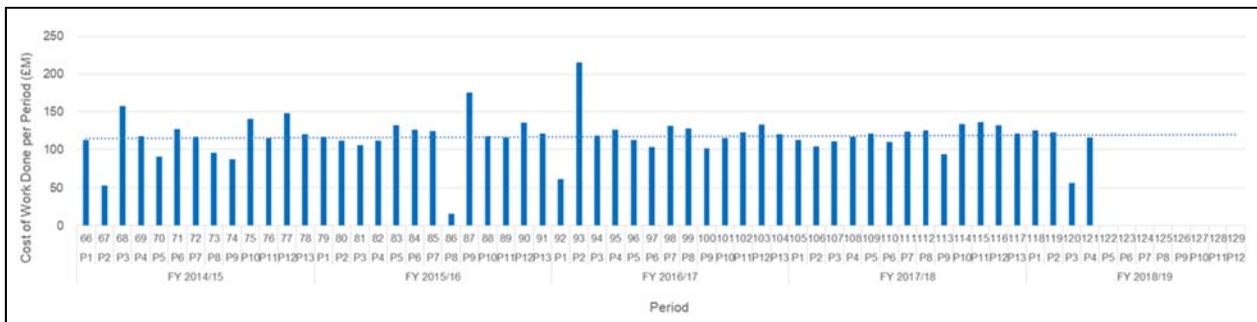


Sense check of scenario analysis results

To provide a sense check of the results of our scenario analysis, we undertook a high level assessment of the cost of the delays to the programme. A simple way to assess the cost of delay is to consider the duration of the delay, when the delays occurred and the expenditure rate at that time. Figure 31 shows the periodic cost of work done over the last four years, which has averaged [REDACTED] per period. The current spend rate is around [REDACTED] per period and the forecast spend rate remains at around that level at least until the end of 2018. As the expenditure rate has been reasonably uniform over a long

period, the exact timing of when the delay arose does not need to be known to provide a reasonable assessment of the cost of the delays to date.

Figure 31: Periodic spend rate over the last four years



The Stage 3 completion [redacted] It is reasonable to assume that this [redacted] is due to events which have already occurred, as the current timeline for the final year up to Stage 3 opening is similar to the original plan. Assuming the activities and run rate profile in the final year remain broadly as originally planned and the cost run rate only starts to ramp down in the final year as the works are completed, the cost of the delays to date can be estimated based on the historic costs [redacted]

As the annual spend rate has been consistent over the last four years, the average cost run rate multiplied by the delay period provides a good indication of the cost of the delay to date. Assuming an expenditure rate of around [redacted]. Adding this to the IP2 value of £12.5 billion (assumed previously by CRL as a reasonable total cost to complete on time⁷⁹) gives a total cost after [redacted] £14.1 billion. This is equivalent to our illustrative scenario 2 which is based on the RAP 2 [redacted] dates. If an additional delay of 1 period were added due to the additional risks at stations, which is broadly equivalent to scenario 3 the cost would increase by around £0.1 billion to £14.2 billion at the full cost run rate.

The results of this simple assessment are compared with the RAP 2 values and scenario 2 and scenario 3 (RAP2 [redacted] dates + Additional risks) in Table 35 below.

Table 35 Comparison of simple assessment with RAP 2 and Scenario results

Remedial Action Plan	£bn	Scenario Analysis	£bn	Simple Analysis	£bn
IP2	12.51			IP2	12.51
Cost increases to P4 2018_19	0.30				
RAP 1 cost increase	0.53				
RAP 2 cost increase	0.34			one year delay cost	1.56
[redacted]	13.68	Scenario 2	14.04	Total	14.07
RAP 2 additional delay risks	0.15			additional delay	0.12
Total incl. additional risks	13.83	Scenario 3	14.14	Total incl. additional delay	14.19

The results of this simple assessment for a [redacted], representing the RAP 2 [redacted] dates, are comparable to illustrative scenario 2 and around £0.4 billion greater than the RAP2 value. When additional delay risks are included, the simple analysis is similar to illustrative scenario 3 (around £0.05 billion higher at £14.19bn) and £0.36 billion higher than RAP 2.

⁷⁹ i.e. to complete Stage 3 opening by December 2018

However, as there is more work to be completed in the final year than originally planned, because some stations and other contracts will not be completed before the start of trial running as originally assumed, we expect further cost increases above the cost of the simple calculation of the [REDACTED]. Such increases would move the outturn cost nearer to illustrative scenarios 4, 5 and 6.

This simple assessment shows that the scenario 2 analysis provides a result consistent with a [REDACTED] [REDACTED] to the programme represented by the RAP 2 [REDACTED] dates.

Appendix 4 Assumptions, exclusions and risks

In order to identify and consider the risks excluded from the RAP timeline and cost estimates, we summarised and then compared the reported schedule assumptions, risks and costing assumptions included in RAP 1 and 2 by grouping them into the following categories:

- Dynamic testing
- Rolling stock
- Infrastructure
- Network Rail (NR)
- Operations
- Revenue
- Catastrophic

The results of our review are shown in Table 36 below.

Table 36: Assessment of assumptions and risks included in RAP1 and RAP 2

Type	RAP	Schedule Assumption	Risk	Cost assumption	Excluded ?	Quantified?	Reasonable?	Comments
Dynamic testing	1	ii. 5/2 dynamic testing will only commence once the "entry criteria" are fulfilled. Note the readiness review for the start of dynamic testing is being independently assessed at the request of the CRL Board	i. Train and train software does not provide the necessary functionality or stability to commence 5/2 dynamic testing or trial running.	Trains will be available for the start of dynamic testing on 5 February 2019 with the necessary level of reliability and appropriate software as set out in the CP2 schedule presentation	Excluded	Unquantified	Reasonable ⁸⁰	The dynamic testing programme is uncertain. CRL should have mitigation plans in place for such an eventuality A prudent approach would be to allow some float in the dynamic testing programme, given the uncertainty of this activity The start of 5/2 dynamic testing is also dependent on the readiness of the Routeway infrastructure.
	2			No specific risk has been allowed for any further delays in the provision of an homologated train although there may be some overlap with other combined risks. CRL has assumed that there is a reliable and integrated train by the start of dynamic testing.	Excluded	Unquantified	Not reasonable	

⁸⁰ Reasonable because this is a risk which RfL should be bearing, and in any event delay would at least in the short-term assist CRL to complete tunnel infrastructure works

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Type	RAP	Schedule Assumption	Risk	Cost assumption	Excluded ?	Quantified?	Reasonable?	Comments
	1	iii. Four months/four passes is sufficient to complete dynamic testing	ii. Sub-optimal integration of train and signalling systems leads to further 'Passes' being required to complete dynamic testing and pass durations are insufficient.	Risk allowance has been made for a 5th software pass	Excluded	Quantified	Reasonable ⁸¹	The RAP 2 schedule includes additional time for dynamic testing
	1		iv. [REDACTED] fails to complete necessary routeway installation to support commencement of 5/2 dynamic testing before the end of November 2018.	A new ROGS exemption for dynamic testing is granted to C610. This has been applied for from the ORR and approval is expected	Excluded	Unquantified	Not reasonable	The [REDACTED] contract is a CRL responsibility. The start of 5/2 dynamic testing is dependent on handover from [REDACTED] (which could occur before all [REDACTED] works are completed). Premature commencement of 5/2 dynamic testing will prolong the [REDACTED] completion works
Rolling stock	1 / 2			[REDACTED]	Excluded	Unquantified	Reasonable ⁸²	Rolling stock costs are not included within the CRL budget
Infrastructure	1		v. Further slippage in station, shaft and portal (SS&P) programmes (including TOSD dates).		Excluded	Unquantified	Not reasonable	This is not a risk, it is a consequence of other risks materialising
	1		x. GSM-R and stations radio programme is further delayed.		Excluded	Unquantified	Not reasonable	This is not a risk, it is a consequence of other risks materialising
	1	v. Additional SCADA and radio testing resources are secured from the market to support the programme	vii. Sufficient [REDACTED] resources are not secured to support Phase 3 testing.	Risk allowance has been made for signalling and communication resources which may be required to deliver full functionality for Stages 3, 4 & 5 after Stage 3 opening.	Included	Quantified	Reasonable	It is CRL's responsibility to plan and manage these works. CRL has to make sufficient allowance in the schedule to accommodate a shortfall in resources
	1		xi. There are insufficient signalling testing resources available for critical roles.					

⁸¹ Reasonable as additional allowance was made in cost assumptions although judgemental whether this is going to be sufficient

⁸² Whilst reasonable to exclude from the capital costs, it is possible that a non-capex cost could be incurred

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Financial and Commercial matters

Type	RAP	Schedule Assumption	Risk	Cost assumption	Excluded ?	Quantified?	Reasonable?	Comments
	1	vii. There is a significant upturn in completion of Installation Release Notes (IRNs) across the programme.	vi. IRNs are not completed in time to support [REDACTED] SCADA and radio programmes. viii. Tier 1 contractors may not deliver all necessary safety evidence in time to obtain safety approval. ix. Delay in provision of required documentation (asset data, operation and maintenance manuals, IRNs, training plans etc.) impacts the completion programme including training. Due to lack of coordination between SS&Ps and C6xx and/or the testing duration for Phase 3 integration testing is insufficient and delays the handover process to the infrastructure managers (IM).		Excluded	Unquantified	Not reasonable	It is CRL's responsibility to plan and manage the works. The timeline should take due account of the rate of completion of IRNs
	1			No allowance has been made for the findings of the independent schedule review report although an estimate has been provided (£125m at P95)				Superseded by RAP 2 which states that the [REDACTED] dates take account of the independent schedule reviews
	1	vi. Phased completion of [REDACTED] asset installation by stations is completed in advance of the TOSD dates and supports the revised strategic programme		Stage 3 testing will be prioritised over Stages 4 & 5	Included	Unquantified	Reasonable	It appears unlikely that [REDACTED] works will be completed in advance of the TOSD dates at every station.

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Type	RAP	Schedule Assumption	Risk	Cost assumption	Excluded ?	Quantified?	Reasonable?	Comments
	1	iv. Staged Completion and Trial Operations can commence with some [redacted] communications work incomplete ('non critical' communications)		Testing and Commissioning (T&C) personnel will be able to operate under live electrical supply lines (OLE). This item is currently under review as working under live wires is not supported by some parties on safety grounds	Excluded	Unquantified	Not Reasonable	It appears likely that the [redacted] works will be prioritised to focus on completing essential systems prior to Stage 3 opening, with the remainder of systems to be completed at a later date
	1			RfL will undertake the completion of the temporary services removal. This is planned to be undertaken during the assurance period at the end of dynamic testing. It has been agreed in principle with RfL	Included	Unquantified	Reasonable	This is only necessary due to the late completion of the works
NR	1		iii. Further possessions are required with NR to undertake required fringe works (Westbourne Park and Pudding Mill Lane) and subsequent approvals by NR are not achieved.	NR will make possessions available to suit the Crossrail schedule particularly at transitions	Excluded	Unquantified	Not reasonable	CRL assumes NR will provide possessions to suit the completion programme. This may not be possible, and is a risk to the programme. Some allowance for missed possessions should be included
	1 / 2			Stage 3 will be able to open outside normal timetable changes. RfL has confirmed this is acceptable	Included	Unquantified	Reasonable	The opening of rail services outside of normal timetable changes must be agreed with RfL and NR.
Operations	1		xii. There is insufficient time to undertake Trial Operations activities.		Excluded	Unquantified	Not reasonable	This is not a risk, it is a consequence of other risks materialising
			xiii. Readiness of IMs – LU, RfL & MTRC.		Excluded	Unquantified	Reasonable	IM readiness is an operator risk
			xiv. Train and integrated systems fail to perform reliably and fail to meet the Sponsors Requirements.		Excluded	Unquantified	Reasonable	Train performance is a BT / TfL risk. Whilst it is reasonable not to include an amount in the capital cost, CRL should have taken steps to satisfy itself that the train and integrated systems will perform to the required standard within the timeline assumed in the schedule. If

Independent review of Crossrail
Financial and Commercial matters

Type	RAP	Schedule Assumption	Risk	Cost assumption	Excluded ?	Quantified?	Reasonable?	Comments
								this fails to happen then there could be cost and time consequences for CRL as well as the suppliers.
Revenue	1 / 2			Oversite Development (OSD) income is unaffected and there are no costs from developers	Excluded	Unquantified	Reasonable	OSD income is not included within the CRL budget
				No cost is included for TfL revenue impact	Excluded	Unquantified	Reasonable	TfL revenue is not included within the CRL budget.
Catastrophic	1	i. No Safety Integrity Level (SIL) 4 issues are found during dynamic testing (impact could be a four month duration to resolve)		The effect of a fundamental failure of the system design philosophy is excluded including a SIL 4 issue	Excluded	Unquantified	Reasonable	This is considered to be a low probability risk outside CRL control. However, CRL should have mitigation plans in place for such an eventuality. Depending on the nature, it may be possible to operate the railway until such an issue is resolved, as it is likely to relate to an unusual / highly specific set of circumstances, which potentially could be avoided through operational measures
				The effect of catastrophic low probability / high impact events is excluded	Excluded	Unquantified	Reasonable	These are low probability/high impact risks outside CRL control. However, CRL should have mitigation plans in place for such risks
				As these are low probability items the amount included following the Additional QRA is relatively low and it should be noted that should an event of this type occur there would be a much greater cost than included in the risk. CRL has not included for any other low probability/high impact/force majeure type events.	Excluded	Unquantified	Reasonable	Serious fire.
Major contractor insolvency.								
Train crash/derailment during the testing phases.								

Included = CRL estimate makes this assumption and costs are included
Excluded = CRL has not made allowance for this risk and the cost estimate excludes this item
Quantified = included in cost estimate
Unquantified = not included in cost estimate

Appendix 5 Details of 'Scenario 3' Sponsor cash flow analysis

The Sponsor analysis required us to estimate a time profile for the additional P95 costs/ Additional QRA at P95 (set out on page 2 of RAP 2 in Tables 1.1 and 1.2). We profiled the additional £138m (i.e. £152m less the erroneous £14m already included in Model) pro-rata to the Model's periodic direct cost assumptions from P1 19_20 onwards. This is based on the implicit CRL assumption in RAP 2 that the additional P95 versus P50 cost and QRA arises after 31 March 2019 (as CRL's stated 31 March 2019 SFA cash position aligns to the P50 Model, which implies that the additional P95 costs and QRA arise after that date).

We have also assumed that this £138m is only allocated to direct costs, and therefore no part relates to indirect costs or any other costs. Alternative assumptions would affect the timing of Sponsor funding requirements because, for example, indirect costs have different working capital assumptions.

The analysis maintains CRL's Model working capital assumptions (i.e. a two period lag between direct costs being incurred and the subsequent cash payments, with 50% of indirect cost-related cash payments occurring in the period in which the cost is incurred, and the other 50% two periods later).

The outputs of this high level assessment of scenario 3 costs on potential Sponsor funding requirements are summarised as follows:

Table 37: Analysis of 'Scenario 3' additional Sponsor funding requirements in £m

	At P6 2018-19	By P13 2018-19	By completion	Additional to agreed £300m
Model SFA closing balance – (P50 costs/additional P50 QRA ^(a))	157	(652)	(1,180)	(880)
Difference between P50 and P95 costs/ additional QRA at P95, per RAP 2	-	-	(138)	(138)
Est. SFA closing balance at P95 cost/ additional QRA at P95	157	(652)	(1,318)	(1,018)
Scenario 3 additional Sponsor funding over RAP 2 P95	-	(73)	(312)	(312)
Estimated Scenario 3 SFA closing balance	157	(725)	(1,630)	(1,330)

Note (a) includes the additional £14m erroneous QRA figure.

Appendix 6 Review of financial controls – findings

We addressed financial control under the headings People, Processes, Financial reporting and Assurance, as detailed in Table 38.

Table 38: Review of financial controls

Areas	Findings	Comments
People	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]

Areas	Findings	Comments
	[REDACTED]	[REDACTED]
	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	
	[REDACTED]	
	[REDACTED]	
Financial reporting	[REDACTED]	[REDACTED]

Areas	Findings	Comments
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	
	[REDACTED]	
	[REDACTED]	
	[REDACTED]	
	[REDACTED]	
	[REDACTED]	[REDACTED]
	[REDACTED]	[REDACTED]
	[REDACTED]	
	[REDACTED]	
	[REDACTED]	

Areas	Findings	Comments
	<p>would no longer be available at sites after 14 December</p> <p>[Redacted]</p>	
[Redacted]	<p>[Redacted]</p>	<p>[Redacted]</p>
	<p>[Redacted]</p>	
	<p>[Redacted]</p>	
	<p>[Redacted]</p>	

Areas	Findings	Comments
	[REDACTED]	
	[REDACTED]	[REDACTED]
	[REDACTED]	

Appendix 7 Risk management within RAP 1 and RAP 2

CRL's overall approach

The business-as-usual risk management process conducted by CRL is comprised of the quarterly risk analysis managed at programme level, as well as the Unresolved Trend (URT) process which is managed at project level and is ongoing. The URT process informs the quarterly risk allocation at programme level, and the quarterly risk process informs the programme AFCDC each period.

At period 5, RAP 1 was developed to estimate the cost to complete Stage 3 of the programme over and above the period 4 AFCDC. RAP 2 was subsequently released with additions over and above the period 4 AFCDC and RAP 1, to align with updated schedule information. In an effort to relate the business-as-usual risk process to the RAP process, the programme level risk analyses conducted in Period 6 and Period 7 were then made to reflect the risk position developed in RAP 1 and RAP 2.

The risk analyses undertaken at RAP 1 and RAP 2 were conducted by the CRL management team and were presented in terms of risk allocations at a P50, P80 and P95 position. These analyses quantified known risks and detailed several exclusions and assumptions made. Further, RAP 1 also included a small amount for general contingency, allocated for uncertainty. Risks identified in RAP 1 were separated into schedule risk and 'other' commercial risk, which were modelled using Monte Carlo simulations. Contingency was also included within the risk sums without modelling. Risks identified in RAP 2 included schedule and commercial risks which were excluded from RAP 1, as well as several high-impact, low-probability risks. These were analysed together and modelled using a Monte Carlo simulation.

RAP 1 risk analysis

In RAP 1, P50, P80 and P95 figures for schedule risk, commercial risk and contingencies respectively were added together, to produce the final risk allocations at RAP 1. A total of £257 million of risk was identified at P95 comprising £188 million for schedule risk, £46 million for commercial risk, and £23 million for contingencies.

It should be noted that it is not correct to add together separate P50, P80 and P95 figures, and that this does not produce appropriate P50, P80 and P95 total figures.

RAP 1 schedule risk analysis

The schedule risk analysis captured the risk of prolongation within each of 17 key contracts, as well as indirect costs, past the dates assumed for calculating the relevant point estimates. RAP 1 was presented such that the point estimate was the cost of achieving schedule scenario 2, while the allocated risk was the additional funding required should the programme be prolonged to schedule scenario 3.

In calculating the schedule risk, the expenditure run rates for each key contract were multiplied by worst case, most likely and best case risk durations (in months) to produce worst case, most likely and best case impact costs per contract. These were then assigned probabilities and modelled using a Monte Carlo simulation to produce single P50, P80 and P95 risk values for the sum of the key contract and indirect costs. We reviewed each of the three principal factors in the schedule risk analysis: the run rates used, the risk durations defined, and the probabilities assigned.

Run rates

We observed that some of the run rates used in the schedule risk analysis, specifically those used to calculate the impact costs of prolongation of construction completion, have been reduced by about 50% when compared to the run rates used in the point estimate. This resulted in a reduction of the impact costs which were modelled.

This reduction was the result of an assumption made by the CRL management team who considered it unlikely that all construction activity on a given contract would be equally affected should the risk period for that contract materialise. It was assumed more likely that specific issues affecting individual trades and subcontractors would cause the delay. Therefore, a decision was made to use half the run rate in quantifying the impact costs for these risk durations.

Risk duration

The costing sheet used to calculate the point estimate in RAP 1 shows a target date and a risk date for several milestones within each key contract, which were collected from discussions with the stations delivery director and the signalling/communications delivery director. For station, shaft and portal contracts these milestones include: construction work completion, phase 3 testing, and NEC completion; and for systemwide contracts these include: completion of installation, dynamic testing, trial running/trial operations and NEC completion. The variance between the target date and the risk dates for construction work completion/completion of installation ranges from 0 to 3.3 periods, and the variance between the target date and the risk date for NEC completion ranges from 0 to 5.4 periods, with the exception of contract C660 for which this variance is 16.3 periods.

It is unclear how the risk dates correlate to the risk durations defined in the schedule risk analysis. We were told that the 'most likely' risk durations are derived from the risk dates in the RAP 1 costing sheet. These dates are then modelled by the CRL commercial team, with input from the risk team, to derive the worst case and best case durations (see below). However, we observed that for some contracts, the variance between the target date and risk date did not align with the 'most likely' risk durations used in the QRA. In one example, the variation between the target date and risk date for the phase 3 testing milestone on contract [REDACTED] was 3.9 periods, however the 'most likely' risk duration used in the schedule QRA was 1 month. In a second example, the variation between the NEC completion target date and risk date for contract [REDACTED] was 3.3 periods, however the 'most likely' risk duration used in the schedule QRA was 2 months.

It was noted that the CRL commercial team's knowledge of the individual contracts, together with their experience working with major projects in the past, was used to model the schedule risks whilst remaining true to the risk dates provided by the delivery teams. This suggests that the CRL management team have applied their own interpretation to the risk dates provided by the delivery teams, in some cases.

Further, we have observed that for some contracts, some risk dates have not been accounted for at all in the schedule QRA. As an example, for contract [REDACTED] the variance between the risk date and target date for construction completion is 2.2 periods, and for NEC completion the variance is 4 periods. While there is a risk item in the QRA for [REDACTED] construction completion prolongation, there is no risk item included for prolongation to the NEC completion date.

Probability

The probabilities assigned to each risk vary between 50% and 90%, with the majority assigned a probability of 75%. These have been initially determined by the CRL estimating team at programme level, and reviewed by the CRL commercial team prior to finalisation, though there is no specific documentation to support how they have been determined.

RAP 1 other risk analysis

The 'other' risk analysis captured known commercial risks associated with contractual settlements and claims, prolongation risks associated with non-key contracts, as well as other non-prolongation risks. Each of these were assigned a low, medium and high impact value and a probability, then modelled using a Monte Carlo simulation to produce single P50, P80 and P95 risk values.

The probabilities of these risks range from 50% – 100%. We would expect those risks assigned a probability of 100% to be included in the base budget estimate rather than be included as risks, because they are costs which are known will occur. However, CRL management has assigned Low values of £0 million to these risks, implying that there may be no associated costs should these risks materialise. It is unclear what these risks entail; the listed descriptions are [REDACTED].

RAP 1 contingencies

The contingencies section of the 'other' risk analysis was comprised of three contingency items: [REDACTED], £5 million for legal agreements, and an amount allocated for a general contingency allowance, which was presented as £10 million at P50, £13 million at P80 and £15 million at P95. These amounts were not modelled to produce P50, P80 and P95 figures, but rather were estimated by the CRL management team.

RAP 2 Additional QRA

In RAP 2, £154 million of risk was identified at P95, and presented as an optional 'Additional QRA' for Sponsor consideration separately from the point estimate. The value of the additional risks has been assessed by CRL through a Quantified Risk Analysis (QRA), giving a P50 value of £58m and P95 post-mitigated value of £154m. The additional risks register identifies delay impacts for most of the risks, which are used as the basis for assessing the cost impact, but a time risk analysis has not been provided.

The cost impacts are assessed as single point values, rather than a three point estimate as would be expected.

RAP 2 includes an additional risks register made up of 20 risks which are not allowed for in the CRL RAP2 cost estimate and [REDACTED] dates. CRL suggests that Sponsors consider these additional risks when applying for additional funding. In effect, the additional risks are exclusions from the CRL cost estimate. However, it appears that most of these risks should be allowed for by CRL within its budget and be managed by CRL.

The register included: commercial or schedule risks which were excluded from RAP 1; specific issues which emerged as the MOHS programme was developed between RAP 1 and RAP 2, largely concerned with system integration readiness and dynamic testing; as well as several high-impact, low-probability risks.

The register is made up of 20 risks, which broadly align to three categories:

Infrastructure: 11 risks relate to issues with infrastructure completion such as defects, health and safety, testing and handover, and contractor insolvency. These have assigned cost impacts ranging from £3 million to £400 million and assigned probabilities ranging from 0.01% to 30%. These risks principally relate to works within CRL control and / or which can be managed by CRL and which should be included within the CRL cost and schedule and allowed for in the RAP.

Dynamic testing: 5 risks relate to systems and dynamic testing. They relate mainly to the commissioning of the rolling stock and cover software risks and NR possession risk. These have assigned cost impacts ranging from £1 million to £80 million and with probabilities ranging from 20% to 25%. These risks are largely outside the control of CRL. They could delay the Stage 3 opening by up to 6 months, but would have a low cost impact on CRL and, as CRL is responsible for integrating the rolling stock and infrastructure, could reasonably be included within the CRL budget. The delay or cost impact has not been evaluated in detail by CRL and these risks should be reassessed to provide a more detailed assessment of both time and cost risk.

Catastrophic: 4 risks relate to catastrophic incidents, such as a serious fire or a train derailment. These have assigned cost impacts ranging from £1 million to £400 million and assigned probabilities from 0.01% to 1%. Catastrophic incidents are matters for which CRL should not make an allowance and which would not usually be included with the programme budget or schedule but sponsors should be aware of. These risks should be excluded from the analysis and CRL budget.

The risks were then modelled together using a Monte Carlo simulation. As currently modelled, the costs allocated for low-probability, high-impact risks are much lower than the costs that would be incurred should any of these unique risks materialise, as noted in the RAP narrative. These types of risks appear in both the Infrastructure and Catastrophic risk categories.

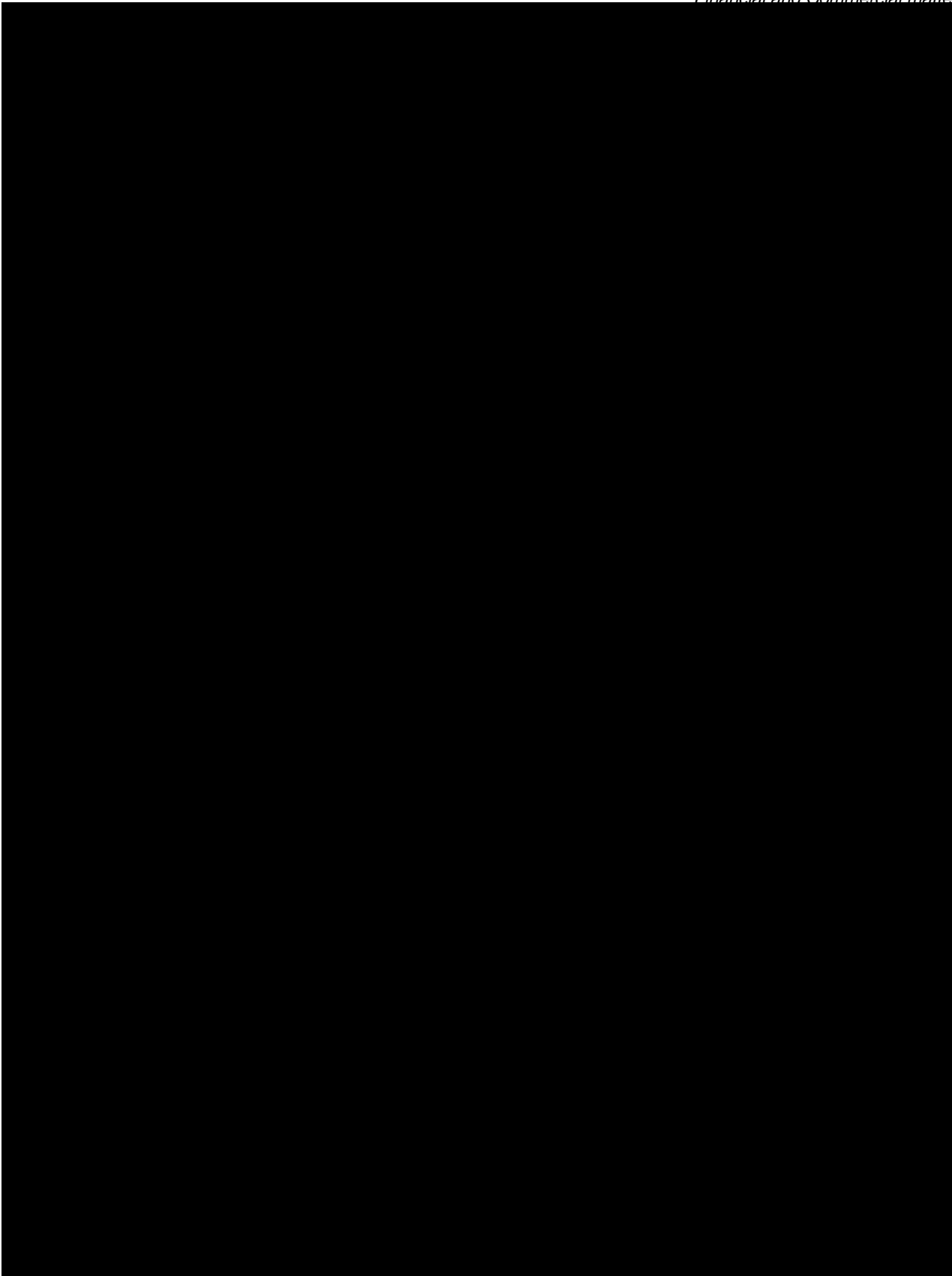
Per CRL management, the high-impact, low-probability risks were included at specific request by the joint sponsors in their review of the original RAP. While the use of a Monte Carlo simulation is a reasonable approach for modelling risk generally, we would expect the high-impact, low-probability risks to be excluded from the simulation and presented separately, as ranges of schedule and cost impact, rather than as point estimates with probabilities.

The additional risks should be reassessed to exclude the catastrophic risks and include an updated assessment of the other risks, including three point estimates of time and cost impact.

The RAP budget should then be updated to include the reassessment of the additional risks.

Infrastructure completion risks

There are 11 risks associated with the completion of the Infrastructure, with an expected total value of £11m (calculated in the RAP by multiplying the described probability by the Most Likely impact).



The above risks would not normally be excluded from the programme, as CRL should have measures in place to manage / mitigate these risks, which include:

- Incomplete works, (█████ not ready) - which should be the responsibility of CRL and its contractors
- Defects, which should be the responsibility of the contractor

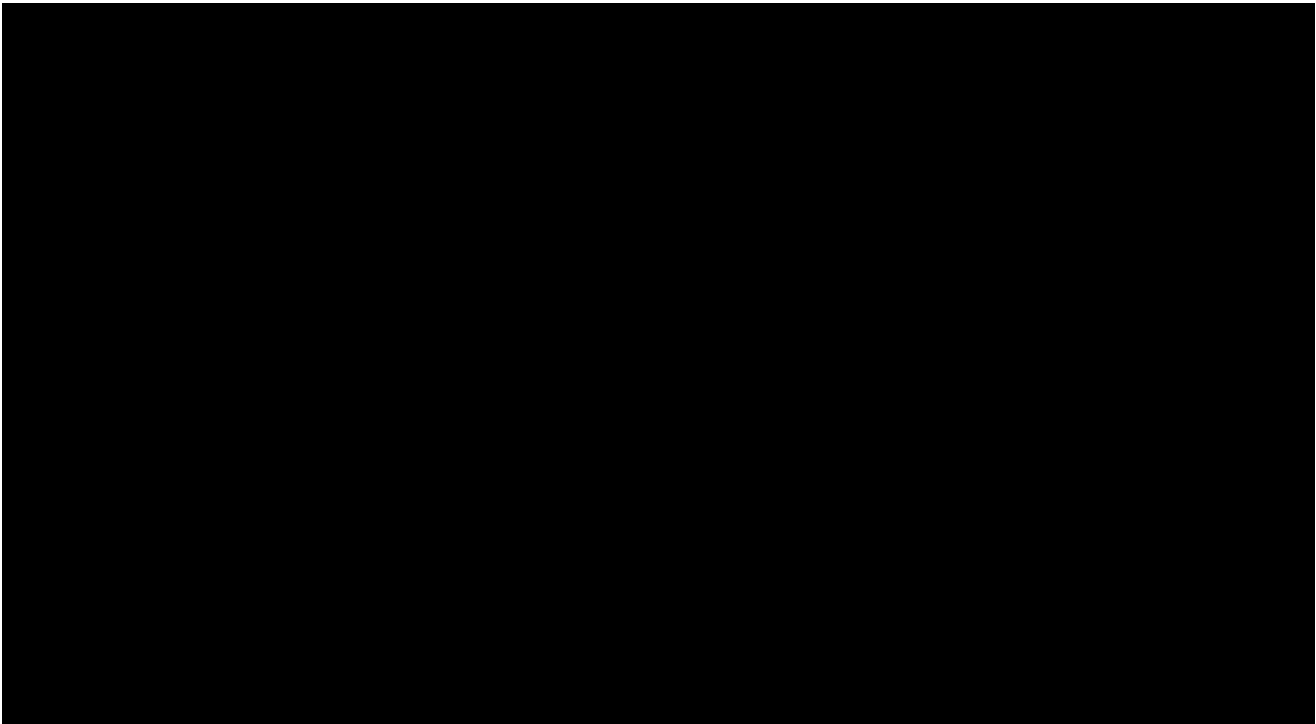
- Health and Safety, which should be the responsibility of CRL and its contractors
- Resource availability, which should be the responsibility of CRL and its contractors
- Testing, Commissioning and Handover, including document production – which should be the responsibility of CRL and its contractors
- Contractor insolvency, which is a general programme risk

While the causes of a few of these risks are outside the control of CRL (risks 10, 11 and 16), they would not normally be excluded from the programme.

There are two infrastructure completion risks assigned with extremely low probability: [REDACTED]
[REDACTED] The probabilities appear unrealistically low and cost impacts too high for such risks.

Dynamic testing

There are five risks associated with 5/2 dynamic testing, with a total expected value of [REDACTED] The Dynamic Testing risks relate to activities which are largely outside the direct control of CRL.



The above risks relate mainly to the commissioning of the rolling stock and cover the following areas:

- Software risks (4 no.), trains and signal software development
- NR possessions (1 no.).

The assessed cost impact of delays of [REDACTED] per month appears high, given the estimated run rates for signalling and CRL indirect costs of around [REDACTED] and [REDACTED] per month respectively, resulting in a much lower cost impact of around [REDACTED] per month.

Of more importance is the potential delay to Stage 3 opening and the consequential impact on revenues.

The average delay impact of this set of risks is around 4 months, based on the values provided. There are three risks with a delay impact of between 3 and 6 months, each with a probability of 20% or greater. This implies that one of those risks is likely to occur, resulting in an additional delay of up to 6 months. However,

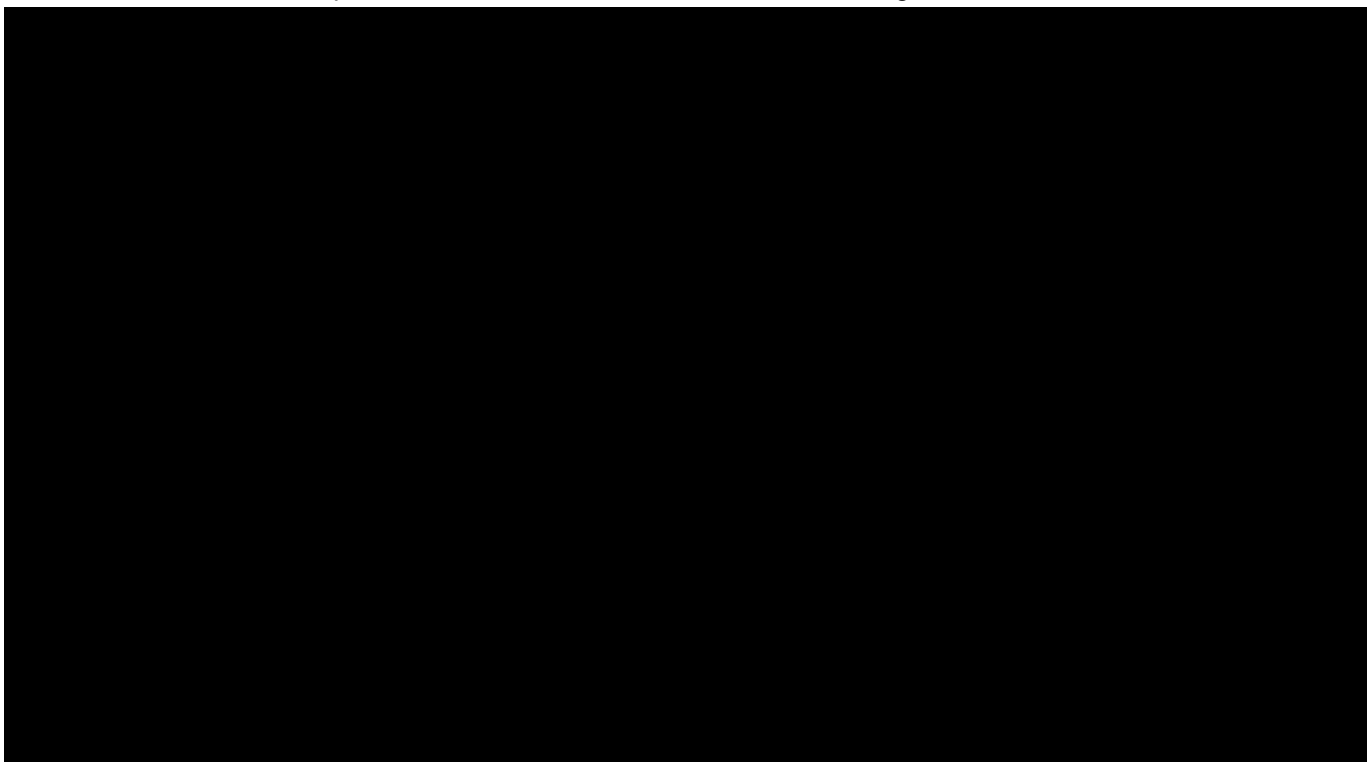
the duration of the delay due to such risks is highly uncertain and a more detailed assessment is required to provide a meaningful assessment of the potential delays, including three point estimates of time impact.

The risk of a SIL4 risk occurring is given a 25% probability, which appears relatively high, and the delay impact needs to be more clearly understood. Depending on its nature, it may be concluded that it is possible to operate the railway from before such an issue is resolved, as it is likely to relate to an unusual / highly specific set of circumstances, which potentially could be avoided through operational measures.

While the above risks could potentially be excluded from the CRL scope on the basis that these risks are not under the full control of CRL, CRL's rolling stock / infrastructure integration role means they could still reasonably be included within the CRL scope.

Catastrophic / Excluded Risks

There are four catastrophic / excluded risks within the additional risk register:



Sponsors need to be aware of these risks, but they would not normally be allowed for within the programme schedule or budget.

The probabilities assigned to these risks, particularly the fire risk, result in little cost being included in the P50, P80 or P95 risk values, meaning in effect they are simply exclusions from the CRL cost estimate.

A fundamental failure of systems design philosophy () would call into question the core systems design, which is a CRL responsibility. However, the chance of 'building the wrong project' appears to have a remote likelihood and if it were to materialise the costs could not be funded from within the programme.

Industrial action by MTR is an issue for RfL. This risk is not considered to be significant

The risk of a serious fire () should be allowed for by the infrastructure owner, as for existing TfL infrastructure, with CRL required to provide mitigation measures and insurance. The values shown in the RAP are of course stated to be post-mitigation measures.

Other risks

Finally we note that the QRA Additional Risk summary in the RAP Update details some 27 risks with zero attributed value where the ascribed reasons for zero value are as follows:

- Cover [redacted] dates 6
- Covered in above risk 1
- Unable to price 1
- Not considered a valid risk 1
- Risk duplicated in [] 1
- Risk managed 4
- Risk managed at senior interface 1
- Covered in other risks 1
- Retain as a clarification. Excluded 3
- Note 3
- Included in update 1
- Risk covered in current QRA (Programme unallocated) 1
- Covered in item [] 1
- Covered in “Other Commercial Risks” 1
- Excluded 1

The five items described as Excluded, Unable to Price, or Retain as a clarification – Excluded, are as follows:

Table 42: Excluded risks

Risk	Description
Political environment	[redacted]
Force majeure	[redacted]
Train entry criteria	[redacted]
Stage 3 opening	[redacted]
OSD income	[redacted]

Appendix 8 Commercial reporting

Approach

In this appendix we have reviewed the Commercial Reporting of key contracts, as covered in the CRL Board Reports.

Recommendations

Recommendations arising from our work are as follows:

- Guidance should be developed and issued around the application of judgement in determining AFCDC so as to help ensure a sufficient measure of consistency from period to period in the degree of optimism or pessimism which is applied. There should be sufficient clarity in the reporting such that the approach taken in relation to views taken on material subjective matters is apparent to the reader
- Guidance should be developed / reinforced to PMs on the information to be considered and approach to be taken by them in reaching their view of the expected outturn on each contract, which should include [REDACTED]
- The reporting of expected contract outturn should be clearer with a single view on each contract used for both Commercial Performance and Funding Adequacy. Where it is concluded that different bases are justified, the reporting should include a clear explanation of the differences and the reasons for them. Where there are significant differences between CRL, PM and Contractor views, brief explanations of the most material items should be recorded. A consistent level of optimism / pessimism should be applied from period to period in determining the reported CRL view
- Reporting around the nature and value of identified risks and the resulting amount included in AFCDC should be clearer
- Reporting around contingency should include explaining the level of contingency concluded to be required each month in respect of identified risks where this differs from the actual contingency held. In so far as is possible the level of contingency held should be aligned with the view formed of the level required, which should be calculated using a consistent methodology and agreed level of optimism / pessimism
- [REDACTED]

Detailed findings

We have reviewed the portions of recent CRL Board reports⁸³ which focus on programme schedule and cost performance. The three sections which contain the most critical information relevant to these matters are:

- Cash Forecast and Funding Adequacy
- Commercial Performance
- Current Position – Schedule

We have traced the key reported figures in each of these sections to their source documents and actions. The source data flows from the tier one contractors through to the CRL project site team and CRL central project controls team as shown in Figure 32.

For most reported figures, there are direct sources of data which can be traced and evidenced, and most are calculated in a consistent manner or pulled directly from the PRISM system. However, one key reported figure, the AFCDC associated with each contract, does not have a clear evidenced source. Several different sets of source data are considered, including URTs which originate from the project site teams as well as the PM view and Contractor view of forecasted defined costs. A 'New AFC' for each project is then

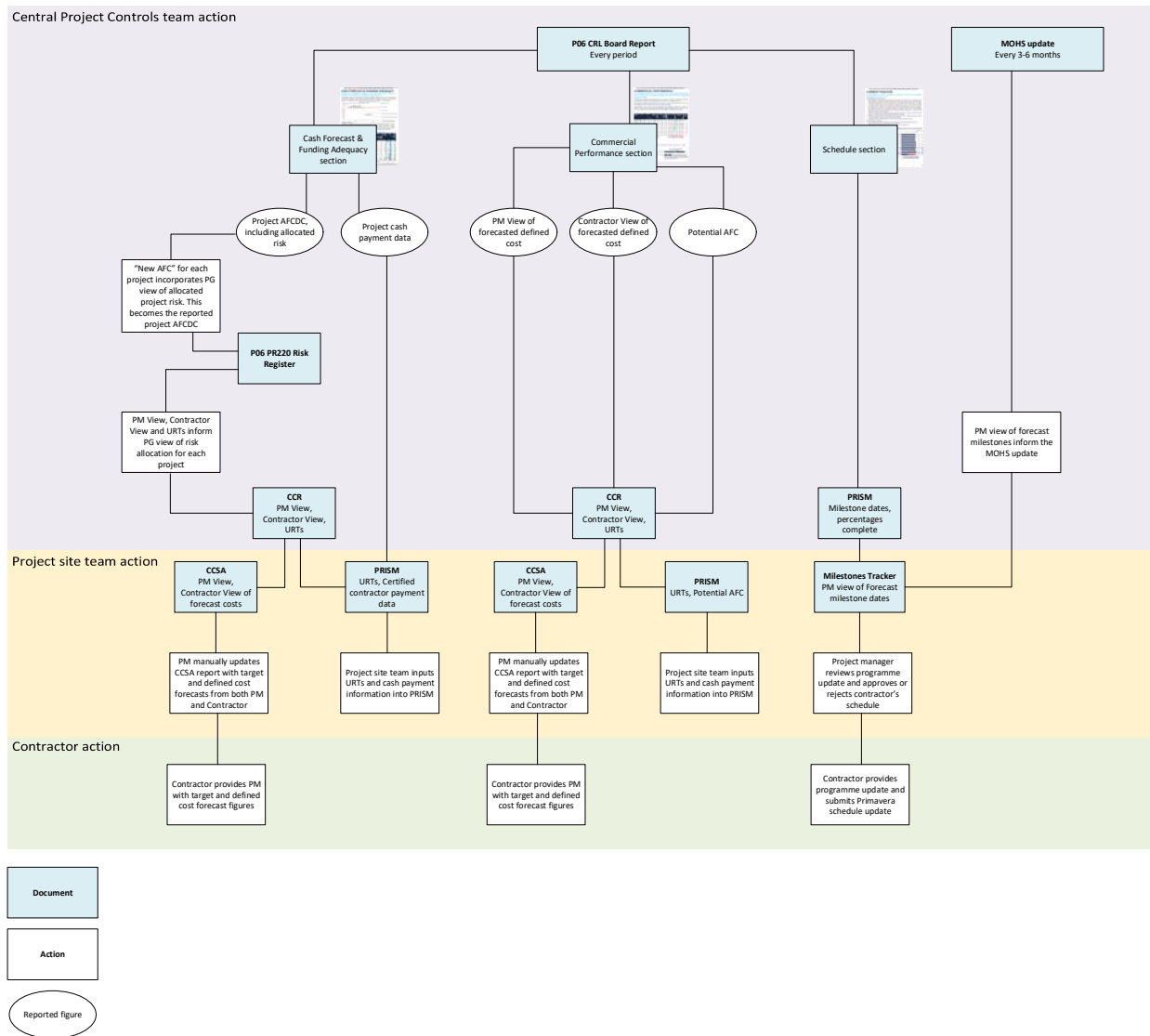
⁸³ Periods 05 and 06 2018_19

determined by the CRL central project controls team and the Commercial Director using these data sources and the application of judgement. This 'New AFC', as shown in Figure 32, becomes the reported project AFDCD.

Unlike other reported figures, it is more difficult to assess whether project AFDCD figures have been determined in a consistent manner from period to period as we did not find written documentation to evidence how these figures were calculated and how the various data sources have been considered.

It was unclear to us, therefore, how consistency was maintained in what was reported as project AFDCD from period to period. We recommend going forwards that this be addressed in order to enable trends in likely outturn cost to be better understood.

Figure 32: CRL commercial reporting process flow, based on P06 CRL board report

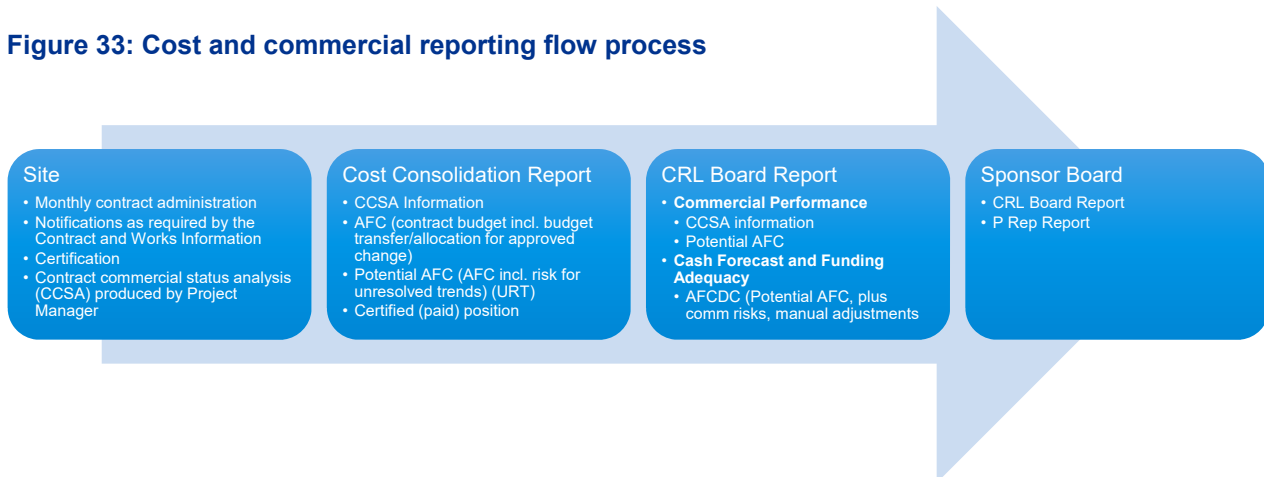


Cost and commercial reporting

We reviewed the commercial reporting process and identified various levels of data consolidation, concluding in the Sponsor Board report, separated into two key sections:

- Commercial Performance
- Cash Forecast and Funding Adequacy

Figure 33: Cost and commercial reporting flow process



Commercial performance

The CCSA report is prepared by the PM for each contract and includes both current and forecast target and cost statements:

- Target position is based on the tendered contract price adjusted for: accepted change, notified change pending acceptance of contractor quotation, notified change pending project manager assessment, notified change pending decision in principle, rejected change, withdrawn change, changes associated with other contract mechanisms (such as price adjustment factor for inflation).
- Cost position is based on the cost incurred to date adjusted for: potential disallowed cost (taken or to be evidenced), fee percentage, and forecast cost associated with risk.
- Adjustments are made for other issues such as damages and incentives which are not classed as part of the Price for Work Done to Date

The target and cost positions are reported by the PMs based on both the PMs' and the contractors' contractual status including assessments of both current and forecast positions. Comparison with forecast target is relevant to the determination of the final cost outturn to the extent of any expected pain / gain amounts. For the avoidance of doubt, the CCSA is not used to calculate the AFDCG; it is used as part of informing overall CRL risk allowances.

We noted that within the CCSA documents (we reviewed a number) there is a hidden tab which details both the PMs' and their understanding of the contractors' respective positions on Contract Dates (both current and forecast) including Completion, Sectional Completion, Key Dates and Bonus Milestones. It appears that the information in these documents has not been updated and does not flow through to the reporting we reviewed. In another tab the PM can provide an independent view based on their experience and expertise on contentious matters relating to contractual entitlement and assessment. This seems to be the PM's negotiating position on target. It was not apparent that such information had been considered within the commercial performance section of the reporting.

Cash forecast and funding adequacy

The cash forecast and funding adequacy is determined by a variety of blends of the AFC:

- **AFC** The summation of initial agreed budgets of all contracts, inclusive of agreed budget changes (arrived at by the CCSC)
- **Potential AFC** as above, with the addition of 'potential' budget changes associated with all URTs
- **AFDC** as above, with the addition of all CRL risk as well as technical, land and property, utility and NR financing costs.

We note that the two tables 'Cash Forecast and Funding Adequacy' and 'Commercial Performance' which appear on consecutive pages⁸⁴ in this important section of the CRL Board Report cannot be easily reconciled by the reader. This is evident from the subtotals highlighted and detail set out within Figure 34 below.



[Redacted] We note that at this time, risk registers were qualitative rather than quantitative and that the CRL CD took an overall view on the risk value he considered appropriate to take. The analysis set out in the Board Report makes it difficult to see what the considered PM's position would have been, and what key judgements have been made in arriving at the different central view.

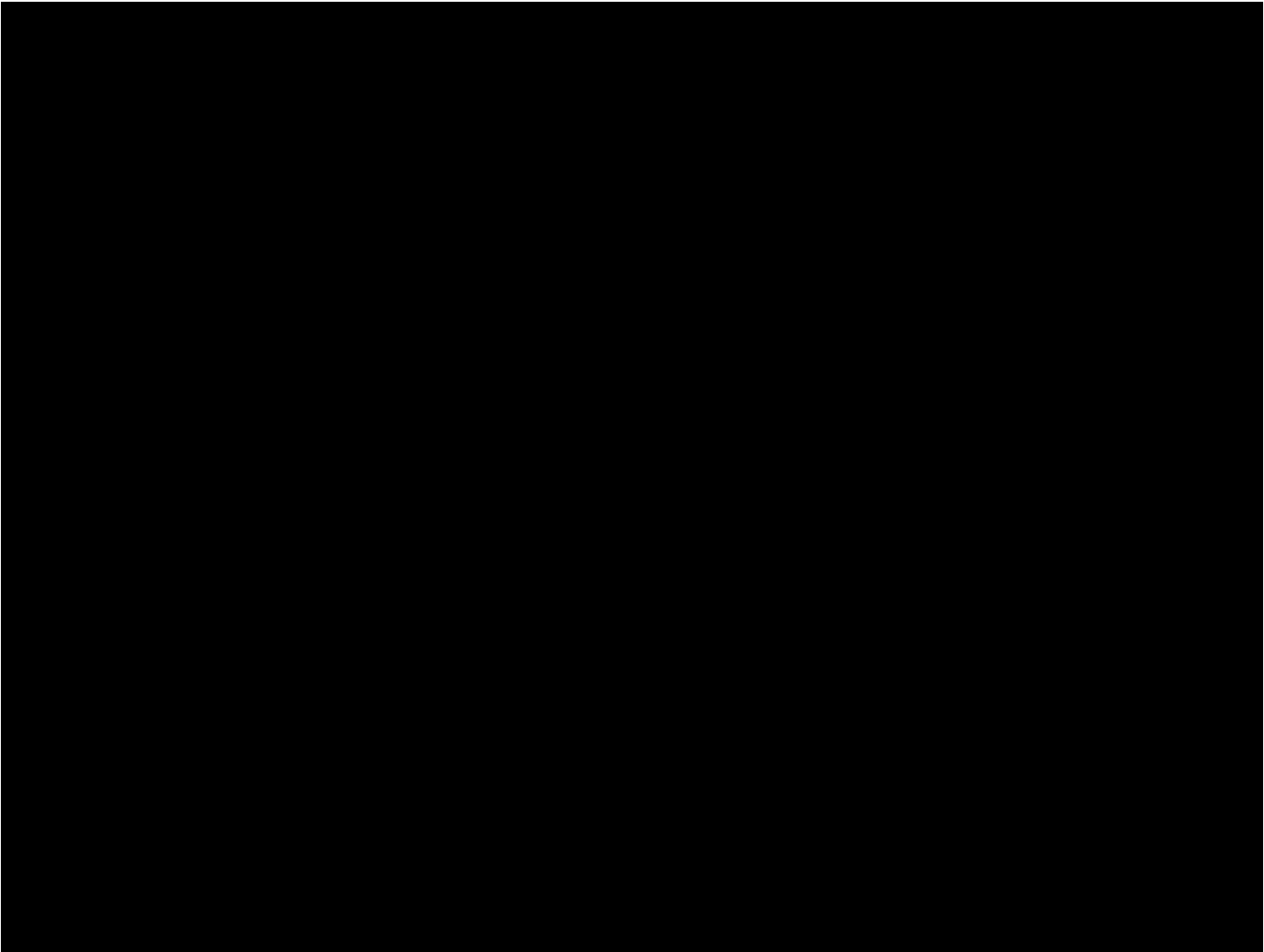
Figure 34 indicates that the £12,810m stated as the total AFDC at P05 2018_19, [Redacted]

CRL stated that the P06 AFDC figures were meant to reflect the RAP 1 cost position, which was done by increasing the risk associated with specific key contracts. In moving from P05 to P06 following RAP 1, the AFDC increased from £12,810m to £13,293m. The CRL Board report explains the increase of £483m is primarily due to an increase in cost and schedule risk. Where CRL believed the RAP figures did not adequately cover all the risk on a given contract as of P06, it has forecasted a higher AFC for the contract than would be suggested by RAP 1. Hence, the increase in AFDC in P06 is slightly higher than the increase in AFDC per RAP 1.

We note the P06 CRL Board Report states that the £84m of Contingency held is insufficient to cover the £574m of risk exposure.

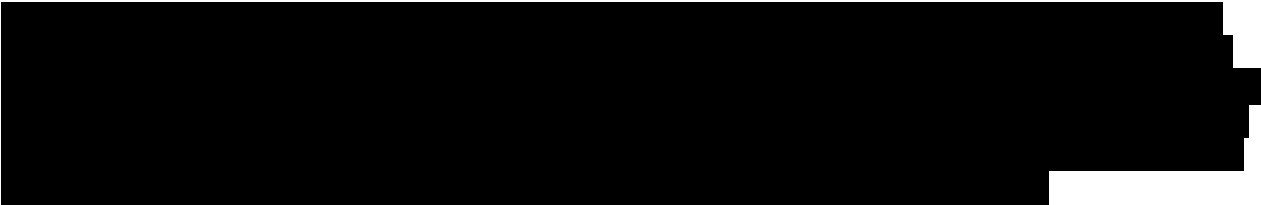
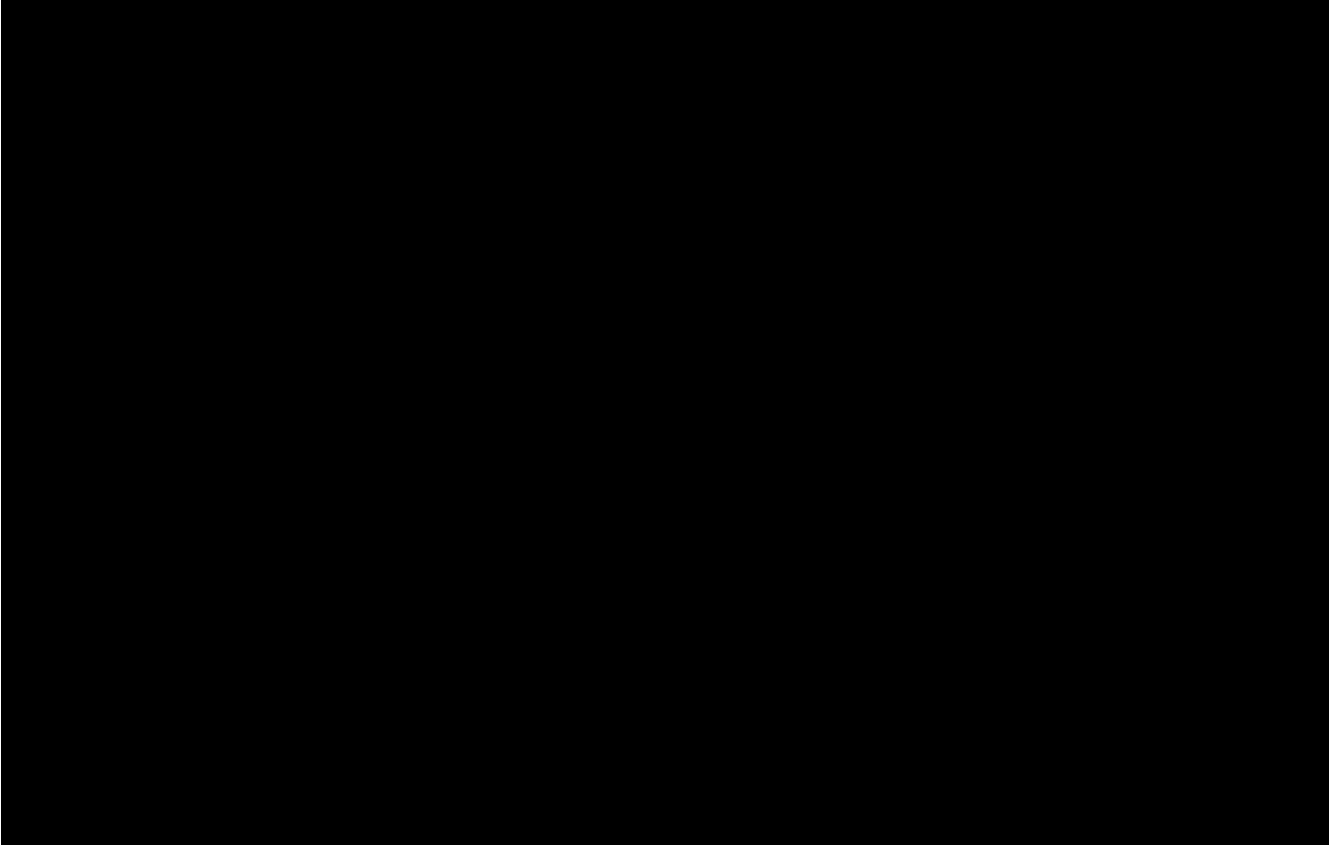
We also note that the P06 CRL Board report states that the majority of the £574m risk total (£530m) is Programme risk not allocated to projects. However, the CRL Programme unallocated risk register and PR220 risk register for P06 suggests the opposite is true, showing £467m of the £574m risk total is associated with specific contracts, and split into cost risk and schedule risk.

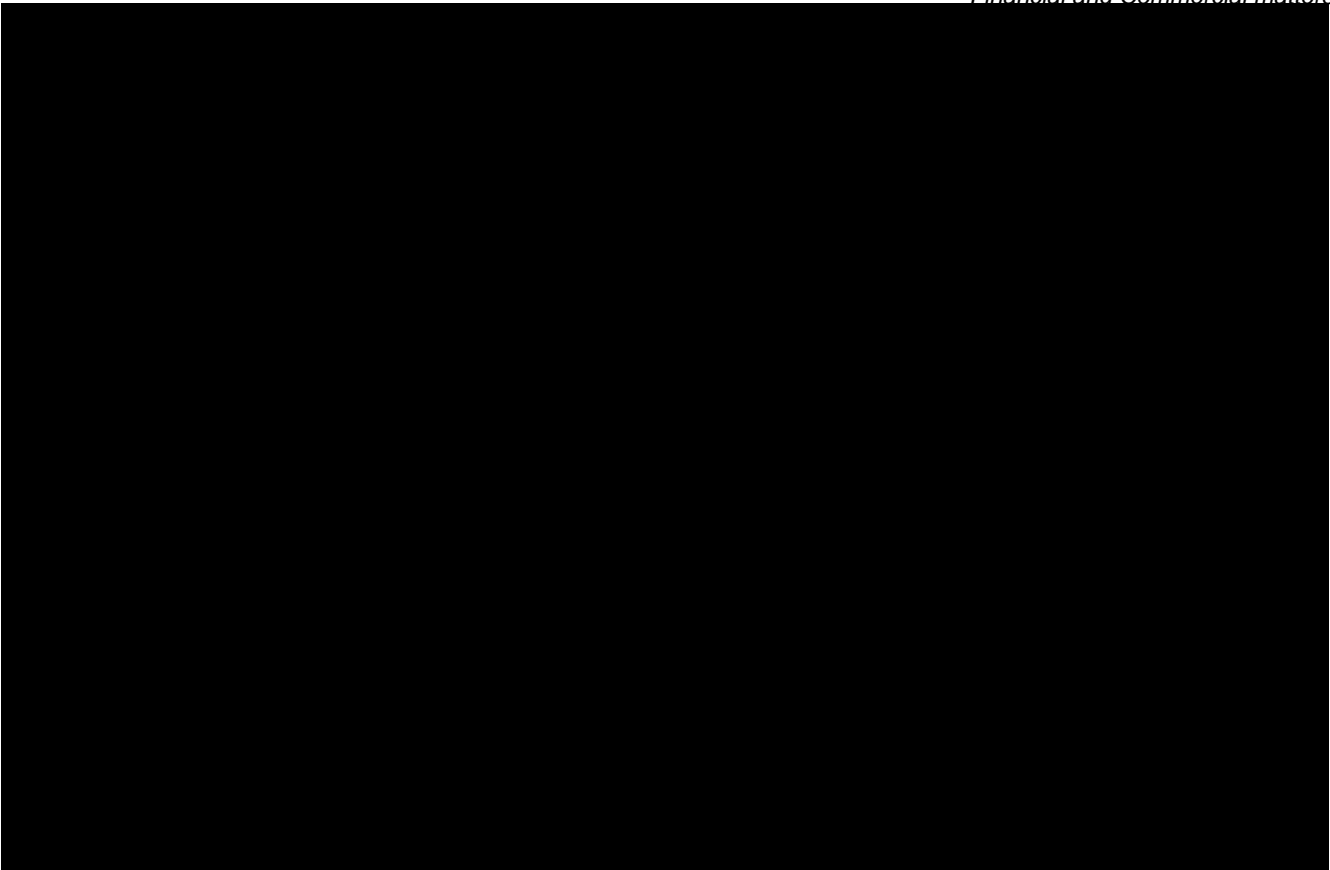
⁸⁴ Pages 14 and 15 of Period 05 CRL Board Report 2018_19



We note that it is not particularly easy to understand the level of optimism or pessimism taken on the individual contracts and whether a consistent approach has been taken period to period.

A view of the commercial risk means that, of the key contracts indicated in Figure 35, only [redacted] of the [redacted]





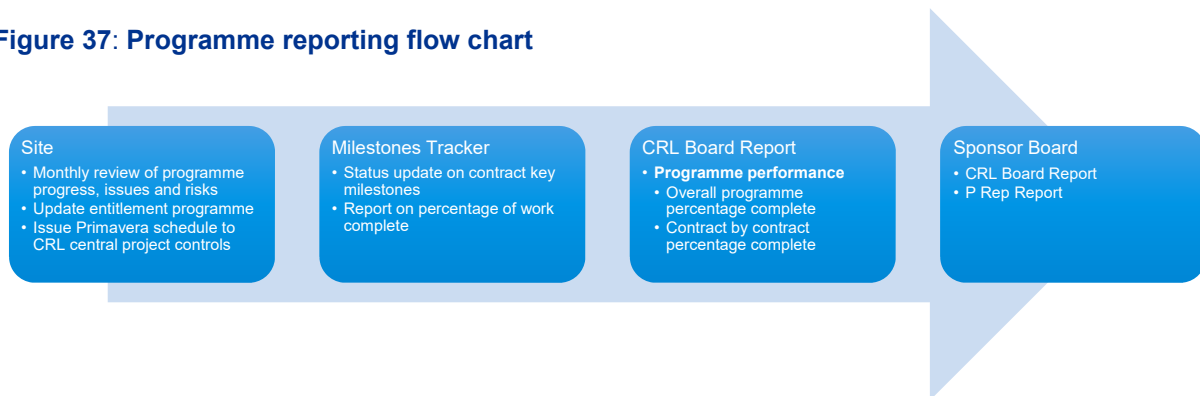
Programme reporting

There are two layers of updates that take place during the progress review cycle:

- Updating the programme schedule
- Updating the milestone tracker.

Figure 37 shows the programme update and reporting flow process from site to the CRL Board level.

Figure 37: Programme reporting flow chart



Updating the programme schedule

The contractor prepares its updated entitlement programme at the start of the progress review cycle for the PM's review and approval. The PM submits the latest Primavera schedule to CRL central project controls team who retain a copy on the CRL Primavera planning software. The project manager reviews the programme and then accepts or rejects the schedule in line with the NEC3 non-acceptance criteria and notifies the contractor.



In accordance with clause 31.3 of the NEC3 Engineering and Construction contract, the PM should either accept or notify the contractor of his or her reasons for not accepting the programme within two weeks of the contractor submitting a programme for acceptance. Permitted reasons for not accepting a programme are:

- The contractor's plans which it shows are not practicable
- It does not show the information which the contract requires
- It does not represent the contractor's plans realistically, or
- It does not comply with the Works Information.

When reviewing one of the contracts ([REDACTED]), we learnt that the PM's main reason for not accepting the programme was because the contractor's planned completion date was shown to be later than the PM's view of the completion date. Not accepting the contractor's programme on this basis is not in accordance with the clause above. We would expect the PM to work collaboratively with the contractor to agree an acceptable programme prior to the formal submission of the programme for acceptance. In the event that the contractor continuously fails to provide an acceptable programme to the PM, this should be escalated and flagged in the monthly board reports as a major risk item.

We also found that the PMs do not maintain an up-to-date programme to record where the contractor's programme has not been accepted. While programme maintenance by the PM is not a strict requirement for the contract management, it is considered best practice within the guidance included in the NEC Managing Reality book, and a necessity to retain the Employer's right to levy delay damages and make PM's assessments for compensation events.

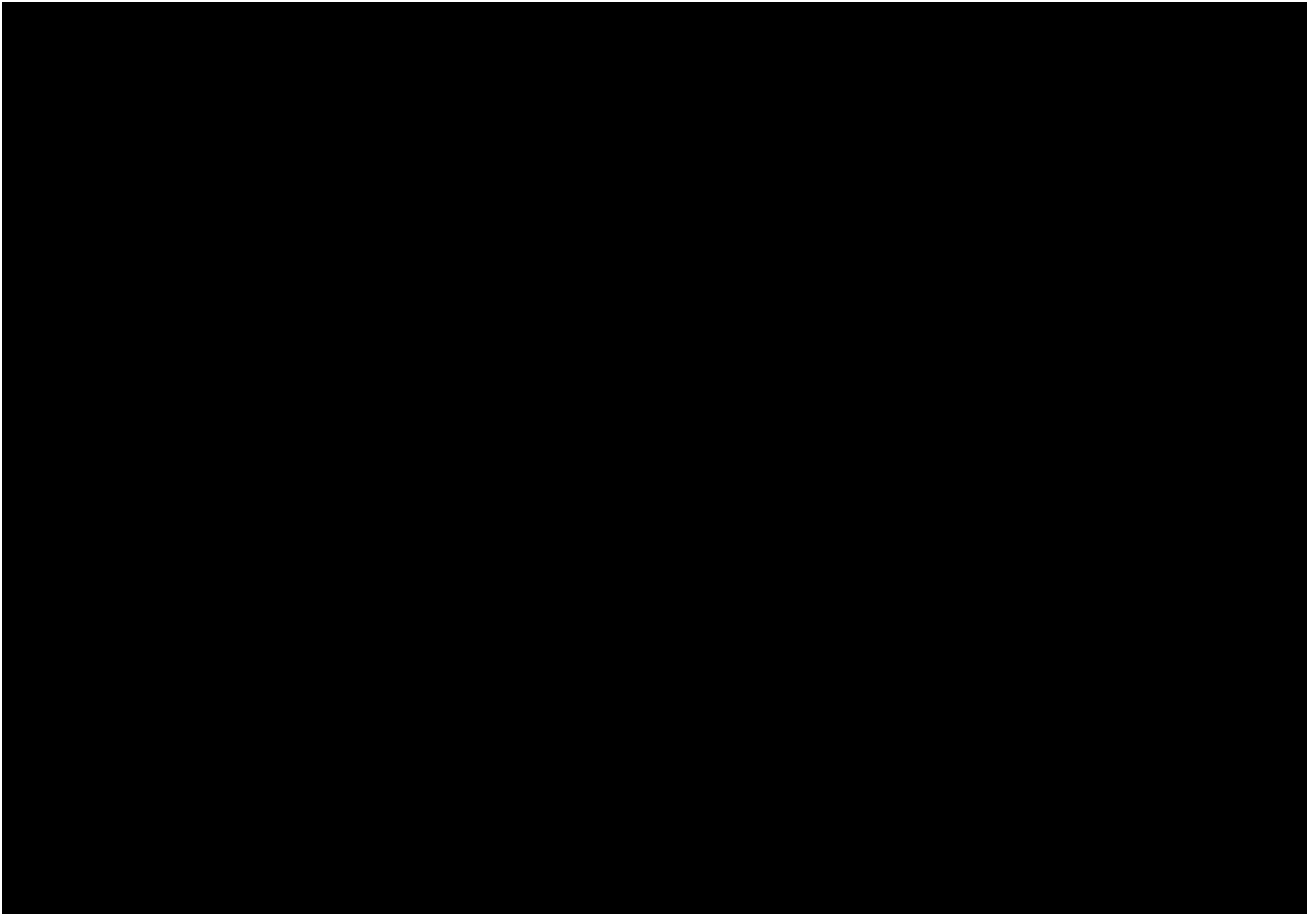
Updating the milestones tracker

Following the programme review with the contractor, the PM updates the milestones tracker based on his / her view of progress. The milestone tracker comprises a list of predefined milestones for each contract. These were defined by the PMs at the start of the contract and represent the steps involved in completing the work scope.

The milestones set will vary from contract to contract due to the differences in complexity. Each milestone has a planned date, weighted value, forecast date and percentage complete value. The planned date is the set baseline date and is used for performance monitoring. The planned date is reset each time CRL re-baselines its programme. The current baseline was set around the time of the latest MOHS approval.

The weighted value is determined by the PM to quantify the amount of work and resource effort associated with achieving the milestone. The forecast date shows the current date the PM is forecasting to complete the work to deliver the milestone. This date is reviewed and may be revised during the progress review cycle. The percentage complete value is updated each period by the PM to show the actual percentage of work completed to date towards achieving the milestone. The milestone can claim a 100 percent once the PM confirms with the contractor that all the works relating to the milestone have been completed.

The milestone structure for each contract is set up in the CRL PRISM cost management software and is updated by the central project controls team during the progress review cycle using the information provided in the updated milestones tracker. Central project controls run a number of reports off PRISM; one involves a PRISM calculation to arrive at an overall percentage of work completed for the individual contracts. This information is reported in the 'CURRENT POSITION' section of the Board report in the table shown in Figure 38.



Another PRISM report that rolls up the percentages of work complete across all the contracts' milestones is generated to calculate the percentage of work complete on the overall programme. This is reported in the 'ARE WE ON TIME?' section of the Board report shown in Figure 39.

Figure 39: CRL Board Report P6 2018-19 page 17

3. ARE WE ON TIME?

Overall delivery is 95.0% complete vs. planned of 97.5%. 0.2% was achieved in the Period against the plan of 0.6%. In the Period, work was ongoing in regard to the additional detailed analysis around the revised Stage 3 strategy necessary in order to deliver a new Master Operational Handover Schedule in October 2018.

While it is common practice to use a milestone based method to assess and report on programme performance, judgement is required to assess the effort required to complete each activity and if this is misjudged then the percentage reported as complete will be impacted. Poor estimation of effort required to complete remaining activities can also impact thinking around the achievability of planned completion dates. We have not attempted to review how activity effort assumptions were determined.

We note that re-baselining has occurred a number of times. Whilst this has its advantages, it can create the illusion of being on or nearly on target where reporting is only against the new and not also the original baseline.

CRL was reporting in Period 6 2018-19 that the programme was slightly behind schedule but on track to achieve the Stage 3 opening in December 2018. Reporting against an earlier baseline would have shown a wider gap between the planned percentage complete and the actual percentage complete, highlighting the more significant increase in productivity required as compared with historical rates achieved, if CRL was to meet the December 2018 Stage 3 opening date. Alternatively had there been more and clearer reporting of productivity trend information in the CRL Board reports (actual to date and forecast to achieve Stage 3 opening) this issue would have been more readily apparent.

Appendix 9 Commercial controls

Compensation Events

In accordance with the Contract Administration Manual the PM should determine both the principle and valuation of compensation events in a progressive and timely and efficient manner.

[REDACTED]

[REDACTED]

[REDACTED]

In such instances the PM is able to determine that the event is too uncertain to forecast reasonably and state assumptions for the Contractor to provide a quotation (direct and time related cost).

In the event a PM's assumption is incorrect, it can later be amended by a further compensation event adjusting the respective add or omission.

We have been made aware that the supplemental agreements previously signed were required as the contractors were due compensation events with significant time and cost associated.

[REDACTED]

[REDACTED]

Assessing the contractors' programmes

[REDACTED]

In accordance with clause 31.3 of the NEC3 Engineering and Construction contract, within 2 weeks of the Contractor submitting a programme for acceptance the PM is required to either accept or reject the programme based on four defined contract criteria: :

- The contractor's plans are not practicable
- It does not show the information which this contract requires
- It does not represent the contractor's plan realistically, or
- It does not comply with the Works Information.

[REDACTED]

[REDACTED]

[REDACTED]

It is generally better to have a programme in place which needs adjustment than for the project to go a significant length of time with no accepted programme. If a contractor's programme must be rejected on the basis of it not being 'reasonable' or 'practical', the rejection should be justified and supported with reasons as to why.

Without an accepted programme on a project, the assessment of compensation events becomes significantly more unwieldy and less accurate. In assessing the 'effect of the event on the last accepted programme' the project team may be adjusting for the event against a programme several months out of date.

Project Manager's authority

The contract administration manual details '*whilst the parties to the contract are the Contractor and the Employer the majority of client duties under the CRL NEC3 contract fall to the Project Manager to undertake*'. As such '*the Project Manager is obliged to act in accordance with the instructions of, and in the interests of, the Employer so as to secure completion of the works in an economical and efficient manner subject to the duty to act impartially in relation to the assessment and certification of matters of contractual entitlement*'.

[REDACTED]

[REDACTED]

[REDACTED]

It is important that PMs assess compensation events in accordance with the contract where they do not accept the Contractor's quotation. This approach should be adopted on all contracts regardless of any planned settlement agreements to formalise the commercial position.

Contract review process

Reporting regime from contract level:

- There is a cut-off point each period when the project teams are required to enter their unresolved trends into PRISM and prepare their CCSA reports
- The individual projects are reviewed by the delivery directors and the contract AFCs are reported to the PDB
- The central cost team review trends and the other reports
- URTs are reviewed every 2 weeks at the CCSC
- The overall programme is reviewed each period at the PDB which is chaired by the Programme Director with attendance from other members of the CRL executive
- Every quarter the major contracts are reviewed in detail by Programme Director, FD, PCD and CD addressing schedule, defined cost and commercial issues (direct cost review)
- The AFCDC is finalised for the CRL Board report at a meeting including the CEO, Finance Director, PCD and Commercial Director
- The Board Report is then issued and key points presented at the CRL Board meeting
- The P Rep team produce their report in parallel but hitherto⁸⁵ have not attended the CRL Board meeting
- The JST Board report is finalised after the CRL Board meeting.

The monthly reported data lacks clarity and key risks/red flags are not clearly shown in the Board report. It is not possible to review the contract AFC and risk allowances for each contract as there is no detailed breakdown of the AFCDC as well as the total risk of the project.

The actions from the defined cost reviews are not formally recorded.

We were informed that each quarter there is a direct cost review undertaken by the Commercial Director where the PMs present their current AFC including assumptions on schedule and risk items. Following these meetings the Commercial Director updates the commercial risk register (P220) based on his adjustments to the contract AFC and the inclusion of risk allowances.

Within the CRL Board report for Period 06 2018_19 there is a table⁸⁶ showing the Contractors with the highest 'cash-to-go' position. This includes a breakdown of the AFCDC figure (£13,293m) including the AFCs for the 13 key contracts that align to the CCSA reports and a balancing figure of £8,794m.

There is no detailed breakdown presented of the balancing figure.

⁸⁵ We were advised by P Rep that they have not attended CRL Board meetings.

⁸⁶ Page 14, Period 06 CRL Board Report 2018_19

Appendix 10 Risk management processes

The summaries below of the processes prior to 2017 and the current processes are based upon information and explanations provided by employees of CRL, and supplemented by information learnt during our fieldwork.

Risk management prior to 2017

Prior to March 2017, the primary differences in the risk management process were as follows:

Risk registers were managed at project level with project contingency amounts determined by PMs. Contingency funding for specific project risk items would either come from project contingency or sector contingency depending on the nature of the risk item.

As Unresolved Trends (URTs) were raised against contracts in PRISM, their associated cost estimates were automatically included in the risk allowance and AFCDC figures for that contract, without consideration for the level of certainty of the URTs.

Risk management was conducted using ARM, Crossrail's risk management system. ARM was shut down in May 2018 and active risks were exported to Microsoft Excel to be managed by individuals at programme level, i.e. through the programme unallocated risk register and the commercial risk register.

URTs. Prior to March 2017, URTs which were raised against a contract in PRISM were automatically included in the risk allowance and AFCDC figures for that contract, without consideration for the level of certainty of the URTs. As a result, draft URTs often impacted project AFCDC figures unnecessarily, before the project team had adequate information to estimate accurately the cost of the trend, and manual manipulation was required to exclude draft URTs. To resolve this issue, the process has since been amended in that project URTs and commercial risk are managed separately. The current process is detailed further in the following section.

ARM. ARM was a risk database configured to record the most up-to-date risk data on a project, and was the source of risk reporting. The Central Risk Team managed risk registers in ARM on behalf of all CRL projects.

March 2017 amendments. In March 2017 CRL's risk management approach was amended as follows:

- Centralisation of risk management team
- Project level risk management to emphasize pre- and post-mitigation positions and risk mitigation actions
- Project teams to provide qualitative risk registers to the central risk team to facilitate programme-level QRA
- Programme-level QRA completed periodically, to allow modelling against funding Intervention Points
- No further QRA is carried out at project or sector level

Central risk team. In accordance with the Programme Risk Management procedure, revision 7, there is a central risk team who undertake the following activities. This team was significantly demobilised in 2018, in alignment with the shutdown of the ARM system. The central risk team activities described are to:

- Seek to ensure that CRL teams use the designated tools to maintain up-to-date risk data which is of suitable quality and is in accordance with the process. The central risk team activities described are to:
- Seek to ensure records are held to demonstrate risk management practices follow the risk procedure (e.g. records of meetings, approvals).
- Seek to ensure that CRL teams understand their risk management obligations and are actively engaged in the Risk Management Process.

- Liaise with the Head of Programme Risk to ensure continued alignment in approach with requirements.
- Undertake risk workshops as and when required to identify risks across the contracts and highlight risks that may impact the CRL Opening Stages 1-5.
- Support risk reporting requirements.
- Support the delivery of quantitative cost and schedule risk analysis.

Current risk management process

In summarising the current risk management process we have focused on relevant aspects of CRL's approach to commercial risk management in relation to the programme.

URT Process

A URT may be one of three types of trends:

- Scope or change that the PM has instructed or will instruct the contractor to implement, which will likely become a compensation event
- Scope or change that the contractor has notified the PM of, using an early warning notice, which will likely become a compensation event
- An update of the anticipated final cost as determined by the PM, which may be based on any matter, such as a change of programme or productivity.

URTs are held within the PRISM system; they are grouped by project but raised against specific contracts within the project, one of which being the main NEC contract. PMs enter URTs into PRISM once they become aware that the cost will materialise, though they may not know what the extent of the cost will be. True project risks, which may or may not materialise and require mitigation, do not appear as URTs. The changes made to the risk management process in 2017 included the decision to move to a subjective assessment of project risks, as project scope at that point was reasonably well defined.

As new trends are raised by the site teams, they are added to the URT total for a project. As these unresolved trends are resolved, they are removed from the URT total for the project. Those that are formally approved as compensation events are added to the contract AFC. Thus, the URT metric provides a snapshot in time of the potential trends on a project, rather than a cumulative value.

The timeline of a new URT is as follows. When a new URT is raised by the project site team, it may be initially entered into the PRISM system as a Draft URT with an order of magnitude value. Once the site team has collected enough information to estimate accurately the cost of the trend, it will turn the draft URT into an official URT in the system. The time elapsed between a draft and final URT can vary from 1 week to 1 year, and this function is under project site team control. The CRL management team keeps an Aged Trend Report to monitor URTs which remain in draft form for several periods. Once a URT reaches official status, those with a value of £250,000 and under are typically approved by the relevant delivery director within four weeks. If the value of a URT is between £250,000 and £10 million, it must go to the CCSC for approval and if the value is over £10 million, it must go to the CRL Board for approval. These approvals may take an additional 2-4 weeks. Further, as a part of CCSC meetings occurring every two weeks, the CCSC receives a list of unapproved URTs over £3 million in value on each project. Those that appear on the list as new URTs are flagged to allow the Head of Trends to review.

The URT total for a project is considered by the Commercial Manager and the risk team when determining the level of commercial risk allocated to the project in a given period. Though the URT total for a project previously fed into a project's risk and AFCDC figures automatically, these metrics are now considered separately. The commercial risk allocated to a project as a part of the quarterly risk analysis is intended to cover the value of relevant URTs.

Quarterly Risk Analysis, Programme Unallocated Risk

Each row in the Programme Unallocated Risk Register is a priced element of risk and details:

- The QRA ID
- Description/impact of the risk
- Directorate, director and owner of the risk
- Details regarding risk consequences and modelling notes
- Minimum, most likely, and maximum cost
- Distribution type
- Current period's True Expected Value (TEV), previous period's TEV, and the change between periods.

The TEV assigned to each risk is a weighted average calculation, based on the risk's potential cost and probability, though it is not a simple multiplication of the two factors. TEV values for each risk are added together to produce the total risk figure for the programme.

Quarterly Risk Analysis – Commercial and Project-Level Risk

In previous periods, total URT cost across the programme was allocated to an individual row in the Programme Unallocated Risk Register, labelled PR1001 (outturn cost). This line item has now been eliminated, and instead URTs are considered by the Commercial Director and risk team when determining risk values in items PR220a and PR220b.

The PR220 risk register details for each key contract:

- Net risk allocated to the contract per the previous period
- Contract AFC in the current period, per the Cost Consolidation Report (CCR)
- Total URT value, per the CCR
- Potential AFC, per the CCR
- 'New AFC' for the contract
- Additional risk allocated to the contract in the current period, defined as the gap between the Contract AFC and the New AFC
- Total commercial risk allocated to the contract, defined as the additional risk per the current period plus any residual net risk from the previous period.

The majority of the commercial risks defined in a given period are derived from the exposure between the Contract AFC of a project and the New AFC forecasted for the contract. This is the basis for the majority of the general risk allowance at programme level. The commercial risk allocated for each contract is divided into a schedule risk allowance and a cost risk allowance, which make up risk items PR220a and PR220b, respectively.

Determination of the New AFC for each project is preceded by a face-to-face review of to-date and forecasted defined costs on the project (Defined Cost Review), which takes place between the Project Director, Commercial Director, Risk Manager, and principal members of the project site team. Within this review, the costs to date, cost forecast, key project risks and commercial position are studied to inform both the commercial risk position and the CCSA report for the end of the period. Ideally, an agreement is reached between the project site team and the CRL management team on an accurate defined cost forecast for the project, though this is not always the case.

The New AFC is then determined by the Commercial Director with consideration for the total URTs raised on a project, as well as the exposure between the Contract AFC, the PM's view of the AFC and the Contractor's view of the AFC.

We have observed that in Period 6 2018_19, of the 26 contracts for which a 'New AFC' has been determined, seven fall below the PM's view of AFC for that contract, seven fall above the Contractor's view of AFC for that contract, and five fall between the PM view and the Contractor view. In every case, the Contractor's view was higher than the PM's view. For seven projects there was no PM view or Contractor view available.

When asked, the CRL management team stated there is no written documentation or calculations to detail how the New AFC is developed, nor detailing which potential costs within the PM's view or Contractor's view have been excluded and the justification for these exclusions. We also have been told that the project site teams are not aware of these New AFC figures nor the risk allowance allocated to their projects.

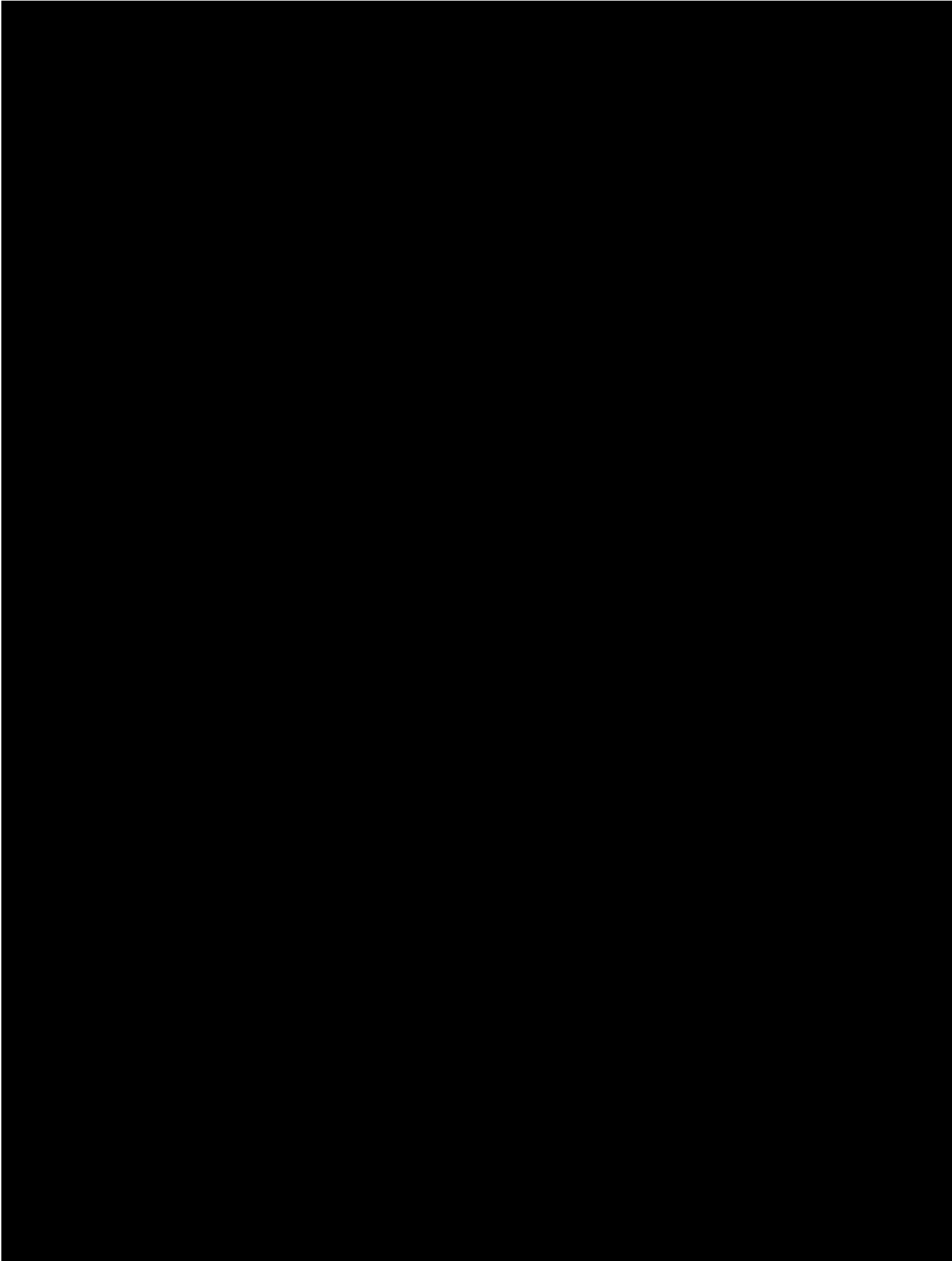
Though a comprehensive review of the PR220 risk item is conducted once a quarter, to align with update of the Programme Unallocated Risk Register, we were told a strategic review of the PR220 item occurs each period in between to identify specific issues that may significantly affect the risk item.

Contingency management

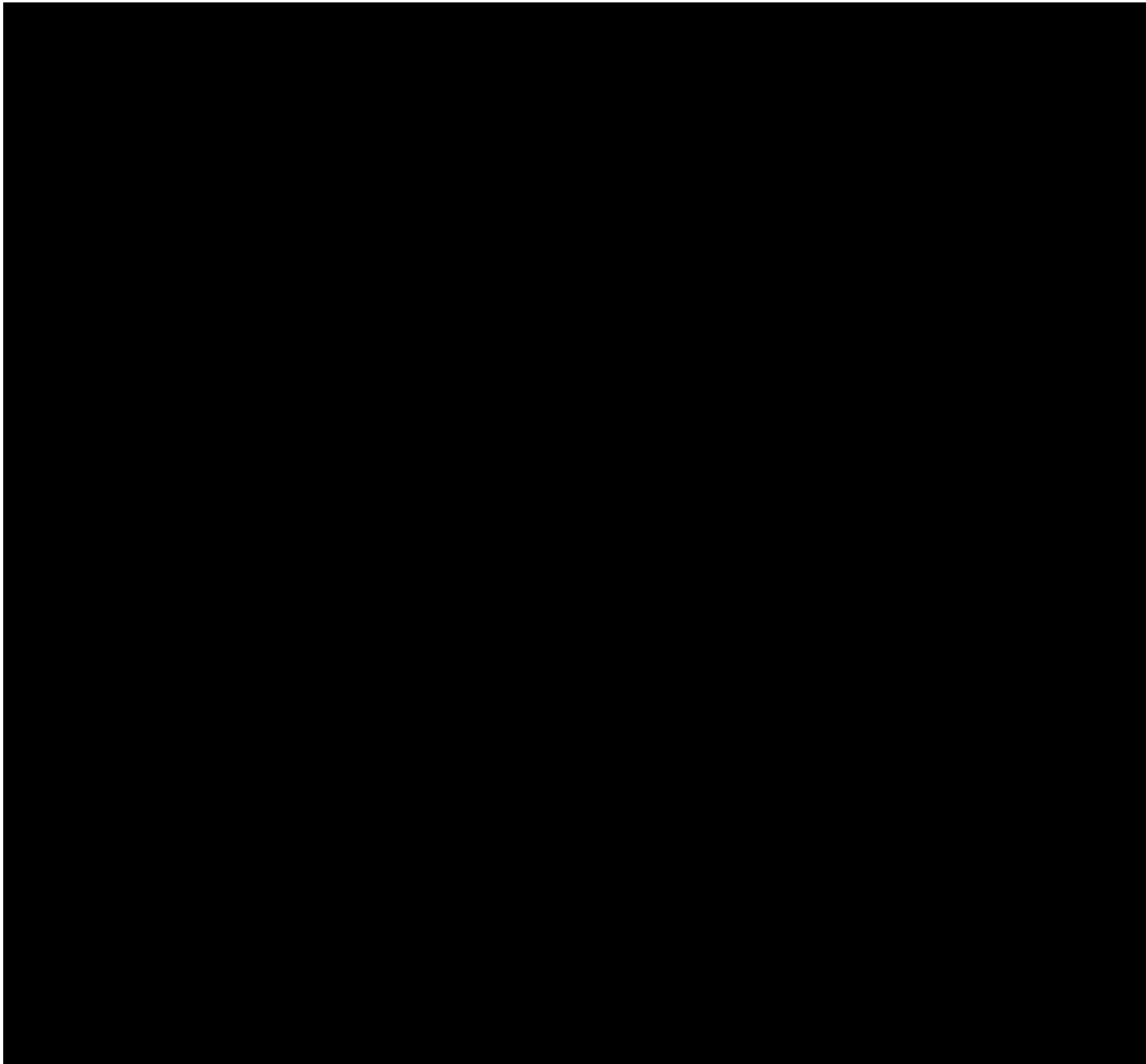
In the event the full requested amount in RAP 2 was to be funded, including the Additional QRA amount, the CRL management team had proposed dividing this sum into budget and contingency. Once the final MOHS is published, bottom-up forecasts will be built for each project, and verified and agreed with the site teams. These forecasts will serve as the updated Contract AFCs and, if CRL management's above proposal is followed, the sum of the forecasts will determine how much of the requested funding between the Early dates figure and the Late dates figure will be allocated as programme budget. The balance of funding beyond this budget, up to the full amount requested in RAP 2, would be allocated as contingency.

Further to CRL management's proposed approach, contingency would be split into Board contingency and programme unallocated risk contingency, held by the CRL team. Further, the Additional QRA figure requested in RAP 2 would be help separately from the primary requested funding.

Of course, the amount now requested is greater than RAP 2.



Major Change Event



Appendix 12 Financial Model Assumption and Logic Queries

Table 43: Financial Model and logic queries

CUFI	Worksheet	Address	R2_CIM v405_CP2+ Scenario v02.xlsm (all sheets)	Label	Query Type	Comment	Client Response	Fin	Applies to
R1_638	Nominal	\$L\$175	=IF(\$C175=\$C\$173,'1Q07'!L175*INDEX('Data set'!L\$814:L\$822,\$A175),'1Q07'!L175*INDEX('Data set'!L\$800:L\$808,\$A175))	Crossrail Central indexation	Assumption Query	For Crossrail Central only, if the line item is marked as 'TPI' in column C, then the indexation will be based on the Tender Price Indexation values rather than the 'Inflation index - for escalation' values as used for all other inflation calculations in this sheet.	This is confirmed to work as intended.	5	Entire row
R1_644	Nominal	\$L\$581	=1Q07'!L581*INDEX('Data set'!L\$800:L\$808,\$A581)*Rec!\$N\$19	Contingency - row 4	Assumption Query	This contingency line applies the 'On Network' factor from row 19 of the Rec sheet. This is not clear from the structure.	This is confirmed to work as intended. This functionality relates to the historic RP4 Baseline scenarios.	6	Entire row
R1_687	Nominal	\$L\$735	=SUMIF(Nominal!\$B\$107:\$B\$570,\$G735,Nominal!L\$107:L\$570)+SUMIF(Nominal!\$B\$11:\$B\$79,\$G735,Nominal!L\$11:L\$79)+SUMIF(\$B\$100,\$G735,L\$100)	Costs by Asset Type	Assumption Query	The Network Rail costs (in section 4 of this sheet) are excluded from this calculation. This also applies to the 'Costs by Sector Type' calculations starting in row 757.	Confirmed as correct. This section summarises the costs included in the Delivery Point Estimate (section 1, 3 and 8); Indirect Costs (section 2); and Land & Property Capex (section 5). The Land & Property Capex commitment line reflects the cost profile rather than actual cash payments.	7	Entire row
R1_697	Nominal	\$L\$746	=SUMIF(Nominal!\$B\$584:\$B\$655,\$G746,Nominal!L\$584:L\$655)	Project risk by asset type £m	Logic Query	<p>This formula does not all the rows from the Contingency & Risk section - rows 656:687 are missing which is not clear in the labelling of this section.</p> <p>2. The Contingency values in rows 577:581 are also omitted, which is not clear in this section.</p> <p>These points also apply to the 'Project Risk by Sector Type' calculations in rows 776:784.</p>	<p>1. The Project Risk sum omits rows 656:687 intentionally because these rows contain Sector Risk. This structure exists in the model because in the past CRL managed and reported risk at 3 levels: Project, Sector and Programme.</p> <p>2. The structure in rows 577:581 relates to contingency in historic scenarios and are not relevant to the calculation of AFDC.</p>	8	Nominal!\$757:\$765, Nominal!\$776:\$784
R1_721	Nominal	\$L\$772	=NR Financing!L11	NR financing charge	Assumption Query	The NR financing charge appears only in the Costs by Sector Type and not the Costs by Asset Type section.	This is confirmed. The Costs by Asset Type section summarises the Delivery Point Estimate, Indirects and Land & Property costs.	9	Entire row

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CUFI	Worksheet	Address	R2_CIM v405_CP2+ Scenario v02.xlsm (all sheets)	Label	Query Type	Comment	Client Response	Fin	Applies to
R1_773	NR Financing	\$J\$20	=J19/(1+(J19/2))	Annual CRL applied finance charge	Assumption Query	This adjustment uses the ORR's headline rate (4.31%) and adjusts down to the allowed rate of return using an undocumented methodology.	This section is used to keep a record of how the NR financing charge was calculated in the historic RP4 baseline scenarios and reflects the methodology used at that point in time. This does not impact the calculation of the current AFCDC.	12	Entire row
R1_783	NR Financing	\$L\$30	=AND((L4>=\$J\$18),(L5<=\$J\$17))*(L2=Periods)*L24*L28	RAB Indexation (RP4 NR Financing Charge)	Assumption Query	This is applied to the 13th period's opening balance annually on the 13th period. This means that any periodic amortisation within that year has no indexation applied.	This is correct. This reflects the calculation of the financing charges in the historic RP4 baseline scenario and has been maintained in the model for comparison purposes.	13	Entire Row
R1_784	NR Financing	\$L\$31	=IF(L26=0,0,-SUM(L28:L30)/L26)	Amortisation of RAB	Assumption Query	1. The RAB is built up from 1 April 2009 until 10 December 2018. 2. The amortisation starts on completion of the RAB. 2. The opening balance and any indexation is amortised on a straight-line basis over the remaining periods. This means that the amortisation will be constant within a year but will increase on every 13th period.	This is correct. This reflects the calculation of the RAB in the historic RP4 baseline scenario and has been maintained in the model to allow comparison with the Current scenarios.	14	Entire Row
R1_788	NR Financing	\$L\$34	=IF((L4<=\$J\$16)*(L5>=\$J\$16),(AVERAGE(L28,L32))*(\$J\$20/Periods)*((\$J\$16-L4+1)/(L5-L4+1)),(L4>=\$J\$15)*(L5<=\$J\$16)*(AVERAGE(L28,L32))*(\$J\$20/Periods))	NR financing charge, RP4	Assumption Query	This is calculated by applying the 'Annual CRL applied finance charge' rate to the average of the opening and closing balances of the RAB, pro-rated (on a simple basis rather than de-compounded) for the number of days in that period.	This is correct. This reflects the calculation of the financing charges in the historic RP4 baseline scenario and has been maintained in the model for comparison purposes.	15	Entire Row
R1_789	NR Financing	\$L\$35	=IF(AND(L4<\$J\$16,L5>\$J\$16),L22* ((\$J\$16-L4+1)/(L5-L4+1)),(L4>=\$J\$15)*(L4<=\$J\$16)*L22)	Nominal ONW Opex (masked)	Assumption Query	1. If the 'Completion of RAB' is on a period start date then a full period is included. 2. This is pro-rated for the number of days in the period for the period in which the 'Commencement of RAB' occurs.	This is correct. This reflects the calculation of the financing charges in the historic RP4 baseline scenario and has been maintained in the model for comparison purposes.	16	Entire Row

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CUFI	Worksheet	Address	R2_CIM v405_CP2+ Scenario v02.xlsm (all sheets)	Label	Query Type	Comment	Client Response	Fin	Applies to
R1_797	NR Financing	\$J\$47	=(J46+1)^(1/Periods)-1	Periodic real finance charge	Assumption Query	This is calculated by decomposing the annual figure.	This is confirmed. The "Periodic Rate of Return" means, in respect of each Railway Period: (Regulatory Rate of Return + 1)^(1/13) - 1	17	Entire Row
R1_798	NR Financing	\$J\$48	=Scenario Manager!F68	Financing change start date	Assumption Query	This is the 'End of cash funding the ONW'.	Confirmed.	18	Entire Row
R1_808	NR Financing	\$L\$59	=Current Inputs!L734	NR expenditure*	Assumption Query	This is the 'Network Rail AFC (P80)'.	Confirmed.	19	Entire Row
R1_809	NR Financing	\$L\$60	=MAX(0,IF(L2=Scenario Manager!F\$70,L58*L54,0))*(L59<>0)	RPI of RAB, Revised NR financing Charge	Assumption Query	The 'Opening RAB' is indexed by RPI in the first period of every year.	Confirmed - the Cumulative NR costs are adjusted for RAB RPI on 1 April of each year.	20	Entire Row
R1_810	NR Financing	\$L\$61	=-MAX('Current Inputs!L721,0)	CRL funded	Assumption Query	This is the positive figures from 'NR interim cash funding'. A similar comment also applies to the 'NR repayments to CRL' which uses the negative figures from 'NR interim cash funding'.	Confirmed. This reflects payments from CRL to NR under the CRL Interim Funding Payments Agreement. This agreement effectively allowed for a suspension of the calculation of financing charges for as long as CRL funded the NR On Network Works. The negative figures from 'NR interim cash funding' reflect repayments from NR to CRL.	21	Entire Row
R1_812	NR Financing	\$L\$63	=IF(K63<\$J\$49,MIN(\$J\$49,SUM(L58:L62)),J\$49)	Closing RAB	Assumption Query	This balance can be positive or negative but is limited to £2,300m by the 'DfT Intervention Amount'.	Confirmed.	22	Entire Row
R1_815	NR Financing	\$L\$65	=IF(AND(L\$5>=\$J48,L\$5<=\$J45),L63*\$J47*L52,0)+L\$85	NR Financing Charge	Assumption Query	For periods between 'Financing change start date' and 'Completion of RAB' the 'Periodic real finance charge' is applied to the 'Closing RAB' for the '% of period charge applicable' and then the 'Pre IFA NR Financing charges' added.	Confirmed.	23	Entire Row
R1_816	NR Financing	\$L\$66	=L65+K66	ACWP	Assumption Query	This is the cumulative 'NR financing charge'.	Confirmed.	24	Entire Row

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CUFI	Worksheet	Address	R2_CIM v405_CP2+ Scenario v02.xlsm (all sheets)	Label	Query Type	Comment	Client Response	Fin	Applies to
R1_821	NR Financing	\$L\$76	=(L70-L72)*(L74-K74)	Historic NR financing charge reported	Assumption Query	For those periods which are within the 'Cost to Date flag' but not the 'SACR period', this is the movement in 'ACWP reported to date (Board Report/PRISM)'.	This is correct. The reason for this is to ensure that the NR financing charge reflected in historic periods in the model aligns with that reported in CRL's Board reports. The 'ACWP reported' is hardcoded for reference because the NR Programme Costs which is provided by NR and drives the calculation of the NR financing charge in the model has been subject to revisions in the past. The model is structured so as to allow the total financing charge to be calculated based on NR's latest cost profile but at the same time preserving the integrity of the historic data.	26	Entire Row
R1_822	NR Financing	\$L\$77	=(L71+L72)*L65	Forecast	Assumption Query	For 'Forecast flag' or 'SACR period' periods this is the 'NR financing charge'.	Confirmed.	27	Entire Row
R1_824	NR Financing	\$FG\$78	=FG66-SUM(FD77:FG77,FD74)	SACR period true-up	Assumption Query	In the period ending 8 December 2018 only, this true-up is applied to the past 4 periods 'Historic NR financing charge reported' and 'Forecast'.	This adjustment is to align the cumulative reported NR financing charge with the NR financing charge calculated in the model (row 65).	28	8 December 2018 only
R1_827	NR Financing	\$L\$81	=K81+L79	Cumulative (ACWP)	Assumption Query	This is the cumulative 'NR financing charge'.	Confirmed.	29	Entire Row
R1_1399	AFCDC-AFC	\$L\$18	=SUM('1Q07'!L577:L580)*NOT('Scenario Manager'!\$F\$86)+('1Q07'!L688+INDEX('1Q07'!L\$690:L\$692,'Scenario Manager'!\$F\$60))*Scenario Manager'!\$F\$59))*Scenario Manager'!\$F\$86	Total risk exposure (1Q07)	Assumption Query	The 'NR Contingency' is not linked through to the calculation of 'Total risk exposure' in this formula, clarify the rationale.	The NR Contingency does not link through to the calculation of 'Total risk exposure' because the NR On Network Works is not part of the AFCDC. The NR Contingency links through to the £2,300m On-Network Works total (included in the AFC but not the AFCDC) in row 31 of the AFCDC-AFC tab.	30	Entire row

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CUFI	Worksheet	Address	R2_CIM v405_CP2+ Scenario v02.xlsm (all sheets)	Label	Query Type	Comment	Client Response	Fin	Applies to
R1_747	Tax	\$L\$24	=(L43*L22)+(L44*L21*\$J\$11)	Land & Property - VAT Payable	Assumption Query	This includes: 1. all of the 'Actual VAT Payable' from the SFA sheet is included within this Land & Property section. all of the Actual VAT is assigned to the L&P VAT, rather than being split between L&P and non-L&P VAT. Please confirm whether this is as intended. 2. VAT of 20% is applicable to the Land & Property costs. 3. there is a time lag of 1 month between VAT payable and VAT receivable.	1. Confirmed - this is the actual VAT paid on Land & Property payments only.) 2. This is correct. 3. This is correct.	36	Entire row
R1_838	Periods	\$L\$8	=SUMIF(Nominal!\$E\$11:\$E\$570,Control!\$I78, Nominal!L\$11:L\$570)	Delivery Point Estimate	Assumption Query	By using the 'Area' or Sector codes, this Delivery Point Estimate is effectively the sum of the Third Parties, London Underground and Crossrail Central items from the nominal sheet.	This is correct.	38	Periods!\$8:\$29
R1_881	Periods	\$L\$63	=(L119*SUM(L36-Nominal!L33-Nominal!L727))+(1-L119)*(-L104+SUM(L36-Nominal!L33-Nominal!L727)*(1-Scenario Manager!\$F\$96))	Add Indirects cash payments	Assumption Query	During the accruals and cash profile timeline (as per the flags on row 199), the 'Accruals (Indirect) % of spend in Period' is not applied.	This is correct.	39	Entire row
R1_892	Periods	\$L\$75	=-SUM(Nominal!L11:L17)	Less CWG commitment	Logic Query	The CWG commitment links directly to the first 7 lines of the Third Party costs section on the Nominal sheet. If the input data was to be amended or re-ordered, this row may not sum the intended items. This also applies to other 'Commitment' items in this section which are directly linked to specific rows.	Noted. With the exception of new rows occasionally needing to be added to reflect new contracts in the '8. Crossrail Central' section, the structure of the model is relatively stable and there is no intention to change the structure of the Nominal sheet.	40	Periods!\$73:\$82

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CUFI	Worksheet	Address	R2_CIM v405_CP2+ Scenario v02.xlsm (all sheets)	Label	Query Type	Comment	Client Response	Fin	Applies to
R1_914	Periods	\$L\$98	=SUM(L17,L44,L75,L73,L76,L77)**Scenario Manager!\$F\$93	Accruals for Period	Assumption Query	Accruals for the period are the sum of 'Total Deliver Point Estimate' and 'Total CRL Risk Exposure', less the sum of Traction Power Commitment, CWG Commitment, Reading train commitment and Direct Cost Provision commitment.	This is correct - these items are not included in the accrual figure for direct costs (Delivery Point Estimate + Risk) because they have separate cash forecast assumptions, whereas a 2 period lag is applied to the rest of the direct costs to forecast cash paid. For example, the timing of cash payments for the Reading train is shown in row 67.	43	Entire row
R1_932	Periods	\$L\$115	=L109-L113	Programme risk exposure	Assumption Query	Programme risk exposure is calculated by deducting the CRL Board risk from the Total Programme risk exposure.	This is confirmed - Total Programme Risk exposure includes £3.6m of Board risks which are disclosed separately in this section.	44	Entire row
R1_1610	Periods	\$L\$72	=Nominal!L723	Other cash movements	Assumption Query	This row is linked to the 'SoS funding' line on the Nominal sheet.	This is confirmed - other cash movements reflects the 'SoS grant for Rolling stock funding'.	47	
R1_541	1Q07	\$L\$577	=IF('Data set'!\$J577=Control!\$I\$44,'Data set'!L577,'Data set'!L577/INDEX('Data set'!L\$772:L\$780,\$A577))*Rec!\$N\$10	Contingency & Risk	Assumption Query	There is a risk factor applied at the end of this calculation, which is not clear from the structure of the model. NB the factor is not applied to the NR Contingency.	This reflects functionality that was used to calculate the contingency in the historic RP4 baseline scenarios at (P50, P80 and P95) and has been maintained in the model. These risk factors have no impact on the Current (P50, P80 and P95) scenarios.	48	'1Q07'!\$577:\$580
R1_1355	SFA	\$L\$106	=MAX(0,L103/Periods*AVERAGE(L99,L88))	Calculated Interest based on cash and cost profiles	Assumption Query	This interest calculation (not being used under the current model settings), does not reference the Actual interest in row 9.	This is intended. This row calculates interest based on the alternative SFA forecast in '4. SFA Balance - cost and cash profiles' which assumes no time lag between costs incurred and cash paid and is just maintained in the model for comparison purposes.	52	Entire row
R1_1402	AFDCD-AFC	\$L\$20	=SUM(Nominal!L11:L22,Nominal!L47,Nominal!L80,Nominal!L100,Nominal!L142,Nominal!L169,Nominal!L571)-L16	Point estimate Escalation	Assumption Query	This 'Point estimate Escalation' is the indexation applied to the costs under items 1-3 and 5-8 from the 1Q07 sheet to the Nominal sheet.	This is confirmed - this is the indexation applied i.e. the difference between the 1Q07 sheet and the Nominal sheet.	53	Entire row

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CUFI	Worksheet	Address	R2_CIM v405_CP2+ Scenario v02.xlsm (all sheets)	Label	Query Type	Comment	Client Response	Fin	Applies to
R1_142 6	AFDCD-AFC	\$L\$44	=SUM(L42:L43,L40)	IP0 Adjustment	Assumption Query	<p>1. The IP0 adjustment is spread over the months in proportion to the CRL amounts for the period.</p> <p>2. The IP1 adjustment is a reversal of the IP0 adjustment.</p>	<p>1. The IP0 adjustment of £240m is an adjustment to the total IP0 amount and has no pre-defined time phasing. In this section, because the other items that make up the Intervention Points have been time phased, an attempt has been made to spread the IP0 adjustment in proportion to the CRL Programme Risk phasing. This has no impact on the AFDCD or cash forecasts in the model.</p> <p>2. Confirmed. IP1 is equal to IP0 with the £240m IP0 adjustment added back.</p>	63	'AFDCD-AFC!\$44:\$44', 'AFDCD-AFC!\$A\$48', 'AFDCD-AFC!\$48:\$48
R1_150 3	Rec	\$K\$26	=SUM(Nominal!K11:K16)	CWG commitment profile incl contingency	Assumption Query	CWG commitment profile incl contingency for the selected model scenario is based on total nominal third party costs for contracts CW01 to CW06. Please confirm that this is intended.	This is correct.	68	
111	Current Inputs	\$K\$577		Contingency	Assumption Query	This contingency risk section has been greyed out such that it is not to be used under the Current Inputs scenario, but can be used under the RP4 scenario.	This is correct, this contingency risk section (row 577-582) is only relevant for the RP4 scenario.	75	Entire row
319	Rec	\$K\$36	=IF(LEFT(K31,3)="RP4",0,INDEX(Nominal!\$K\$690:\$K\$692,MATCH(\$K\$31,'Scenario Manager!\$K\$11:\$M\$11,0)))	Programme Risk	Assumption Query	If the active scenario is one of the RP4 scenarios, then no Programme Risk is calculated.	This is correct.	77	Entire row

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