



# Crossrail cost to complete: Cost and commercial management

# 1 Introduction

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In August 2018, Crossrail Ltd (CRL) announced that the programme to open the Elizabeth line would not be delivered on the original estimated timeline and that the opening of the Central Operating Section (COS) by December 2018 was not achievable. It was also made public that the original estimated budget would be insufficient and that additional funding was required to complete the programme. In late 2018, the Department for Transport announced that the central section funding would be increased to £14.9bn, a £2.15bn increase on the previous limit of funding, enabling the programme to continue with the works.

The delays led to the need to develop a new delivery strategy that could take the programme to completion. In the first half of 2019, after several months of intense planning, Crossrail announced a revised opening window reflecting the Earliest Opening Programme (EOP). The plan was to bring the central section of the line into Revenue Service as early as possible between December 2020 and March 2021, opening all stations except Whitechapel and Bond Street, which would not be complete by this date. This strategy introduced the concept of staged configurations to allow progressive completion of key testing activities. A bottom-up schedule was developed to reflect this logic called the Delivery Control Schedule (DCS 1.0).



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By the start of 2020, it became evident that the timescales outlined in DCS 1.0 were not achievable, mainly because of the volume of testing, commissioning and assurance activities required to complete the programme, and the productivity levels that could be achieved in completing this work. In March 2020, the COVID-19 pandemic caused the programme to undertake a 'Safe Stop' when the national lockdown was introduced. Work resumed in the second half of April for 'niche works' – critical works that could be delivered with small teams working under social distancing rules – but Crossrail used this pause to improve its plan to deliver the remaining works. This brought further resilience to the programme that would ultimately deliver the opening of the COS.



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In August 2020, a revised strategy was completed: the new plan was to bring into Revenue Service the central section, this time only excluding Bond Street, in the first half of 2022 and to complete integration of the full end-to-end railway by mid-2023. This new strategy was underpinned by an updated Delivery Control Schedule (DCS 1.1) and supported by a thorough cost and risk modelling process.

This process concluded that additional funding of up to £1.1bn was required, a value that remained valid until the end of the programme. At the time of writing, the P50 forecasted cost was £104m lower than the £1.1bn headline, and the reduction trend was expected to continue as risks and provisions were retired, due to successful delivery and commercial close-out.

This revised DCS 1.1 and the associated cost estimate supported the funding negotiations that led to an additional injection of £825m funding at the end of 2020, and £98.5m in autumn 2022, taking total CRL funding to £15,887m.

This paper explains the methodology used to determine a robust cost estimate for DCS 1.1 and the measures implemented in the closing stages of the programme to maintain control, provide agile decision making and support final close-out.

# 2 Implementing cost controls

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Following the announcement that the programme would be delayed and would not achieve the planned opening date at the end of 2018, CRL went through a strategic planning phase that included not just the development of a revised delivery plan, but also the reinstatement of the organisation required to support the completion of the programme. This remobilisation process included the Commercial, Cost and Risk Management functions that had been largely demobilised during 2018.

At the start of 2019, there was no consistent structure for the reporting of cost forecasts from projects and a lack of risk assessments resulted in significant uncertainties associated with the potential final outturn cost of the programme. Systems used to manage cost and risk either were fully discontinued or became less relevant for control activities. All these factors resulted in the recognition that these fundamental control processes needed to be reinstated.

To address this, a cross-functional team led by the Commercial and Finance teams was created to reinstate comprehensive and consistent cost management of the programme, which was at the time spending in excess of £80m per period. In addition, the team conducted estimation activities to understand how much the programme's final cost would be. This exercise included the full reinstatement of risk management activities, cost modelling and commercial planning and, working closely with the other control functions, was responsible for providing the cost estimates (Deterministic, P50 and P80) that supported strategy developments and funding negotiations.

There were a number of challenges to providing a robust and comprehensive cost and risk estimate.

- The programme was under significant external scrutiny and an enhanced level of reporting and governance.
- There were competing priorities for the control functions to support day-to-day delivery of works and inform the EOP revised strategy and baselined plan.
- The capability, processes and tools were still being reinstated.

From the point at which the delay to the opening of the programme was announced in August 2018 until the publication of DCS 1.1, Crossrail went through a learning process that led to an increased understanding of the scope and integration required to complete, providing a better view of the challenges ahead and problems that needed to be resolved.

Throughout 2019 and the first half of 2020, a number of issues emerged that resulted in more work needing to be done to complete the programme. Problems with emerging scope, productivity and progress of assurance activities were adding further pressure to the schedule and cost.

The need to produce reliable estimates, in an agile methodology, that were aligned to the different updates of the Crossrail schedule on a periodic basis led to the development of an integrated cost and risk estimating model.



# 3 Modelling Crossrail's final cost

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In order to bring consistency and clarity to the estimation of the Anticipated Final Cost (AFC), the Finance team developed a central cost model that could be used to inform the programme estimate, and to validate the project cost plans that were developed with individual project teams.

The model was built considering multiple factors that could impact the AFC, producing a set of overlays that were applied to each contract. Key variables included in the model are listed below.

- Programme key milestones (Trial Running, Trial Operations, Revenue Service, etc.)
- Key milestones or dates for each individual station (completion of Stages 1, 2 and 3 when applicable, handover, contract completion)
- Commercial structure of major contracts (settled sum and cost-reimbursable components)
- Crossrail workforce plan (Indirects)
- Central reserves (identified scope gaps, COVID-19-specific mitigations, management reserves, etc.)
- P50 and P80 Quantitative Cost Risk Assessment (QCRA)

The estimating methodology was applied periodically in the programme from the EOP, development of DCS 1.0 in August 2019 to DCS 1.1 in August 2020, allowing the review and validation of the cost and risk model outcomes. This process was key for the early-programme strategic planning phase, providing reliable cost information for the different decision-making processes in the programme. The model was also utilised to support ad-hoc scenario analysis providing meaningful and timely estimates.

This modelling approach provided schedule, cost and risk alignment to the programme; all estimates produced were aligned to assumptions included in the control schedule. A set of periodic instructions (dubbed as 'Riding Orders') were implemented collaboratively between the Controls, Finance and Commercial teams, and issued to projects to ensure that the bottom-up estimates were based on a common set of assumptions that made the programme modelling process robust and reliable.

To gain confidence in the outcomes of the model, a series of internal and external independent reviews were performed, including a set of third-party expert 'red and black' reviews, in which the black review was focused on cost and commercial position.

# 4 Setting an achievable baseline

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In the first half of 2019, the EOP requirements were to produce an evidence-based strategy to bring the railway into Revenue Service as soon as possible in a safe, assurable and reliable way. The strategic planning helped Crossrail recognise the challenges associated with systems interfaces, signalling updates and asset configurations. The bottom-up schedule that reflected the EOP top-down strategic planning was called DCS 1.0.

The planned handover of shafts and portals provided an opportunity to test the assumptions built into DCS 1.0, and highlighted a number of issues with productivity and the complexity of the tasks.

Adherence to DCS 1.0 rapidly became a challenge, with the programme achieving on average 33% of planned activities each period. Complex interfaces between different projects and systems at this stage of the programme were creating challenges, impacting planned delivery dates and associated costs.

An improved level of scrutiny of the activities required to test, assure, commission and hand over each asset and the railway as a whole was implemented, including the creation of a number of configuration states. This provided a better understanding of the overall programme and associated challenges, and plans were developed to increase maturity and confidence in the strategy.

In March 2020, the COVID-19 pandemic hit the programme, a controlled Safe Stop was instructed and all activities were stopped. This provided a key opportunity for Crossrail to reassess and plan the upcoming milestones, reducing its associated risks. Productivity levels before the Safe Stop were low, overall workforce in the programme was around 4,000 full-time equivalents and progressive demobilisation was a challenge.

The Safe Stop allowed the programme to focus on assurance activities; working from home arrangements were implemented that helped to focus the efforts on the production of required assurance documentation.

In mid-April 2020, a 'niche work' approach was taken, mobilising small teams back to complete specific activities with high impact on the critical path of the programme, while complying with social distancing rules.

A COVID-19 Recovery Strategy was developed that incorporated specific interventions to support the remaining works. Key components of this recovery strategy included bench agreements with the supply chain to allow identified critical resources to remain available for the programme as Safe Stop and niche working arrangements were implemented, and the introduction of construction blockades, with a significant positive impact on productivity.

The schedule implications of this recovery strategy were incorporated into a revised DCS and an update produced called DCS 1.1.

This was the key turning point for cost management in the programme, as DCS 1.1 and the aligned cost estimate provided a robust strategy to achieve completion, incorporating all lessons learned from DCS 1.0 in areas such as remaining physical works, the amount of testing and assurance required, and revised productivity assumptions.

# 5 Developing a robust cost estimate

The DCS 1.1 AFC estimate provided a range for the potential final cost of the programme, including a P80 upper band that forecasted that up to £1.1bn of additional funding would be required. This estimate remained valid for subsequent DCS updates (DCS 1.2 and 1.3) throughout the remaining duration of the programme and supported the negotiations of funding agreements with the sponsors.

The key building blocks of the estimate were:

- base cost (cost estimates submitted by project teams for deterministic schedules)
- management reserves/overlays
- project and programme risk (including prolongation)

The 'cost to go' comprised significant levels of management reserves and risks for a programme in its closing stages (comprising approximately 53% of cost to go), which represented the historic experience of the programme to date and recognised the challenges that were ahead. Risk and provisions were estimated utilising an evidence-based approach, including detailed assessment of potential commercial issues for each of the main contracts, scope gap analysis and potential additional COVID-19 pandemic impacts (for example, the potential additional impact of social distancing measures). The programme team benefited from the significant level of consideration and supporting analysis that was put into producing the final DCS 1.1 estimate.

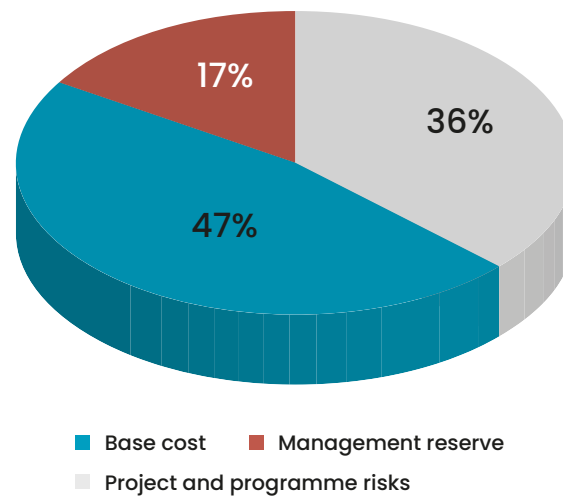


Figure 1 P80 DCS 1.1 cost-to-go building blocks

The DCS 1.1 AFC estimate was subject to internal and external assurance reviews. Detailed analyses of the methodology utilised and outputs produced were performed to increase the confidence on it. Internal assurance reviews led by senior executive members of the programme, project representative reviews and sponsor-instructed independent reviews were done as part of the validation process.

The AFC estimate was produced considering:

- alignment between cost, risk and schedule via implementation of programme overlays based on project-specific periodic run rates
- supply chain estimates
- provision for issues managed at programme level (i.e. COVID-19-specific mitigations, scope gap, commercial allowances, etc.)

In parallel, and as the delivery strategy was developed, a restructured governance cycle and meeting cadence was introduced across the programme, including three levels of review at the project, programme and senior executive levels before reporting to the Crossrail Board or Transport for London (TfL) Elizabeth Line Delivery Group (ELD; from last quarter 2020). This increased transparency and allowed detailed challenge of the management information and the development of interventions when required.

This revised cadence was key to programme delivery and provided a strong platform for cost and risk management activities.





# 6 Reinstatement of risk management

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Reinstatement of risk management was a key recommendation of a third-party independent report on Crossrail in January 2019.

In early 2019, risk management capability was reintroduced into the Finance function. The primary objective of this intervention was to work with project teams to understand the levels of uncertainty and risk remaining on the main stations and railway system projects, and to include allowances for the potential impact of these risks in the cost forecasts.

A process was introduced to support project teams in the active identification, assessment and mitigation of threats to schedule and cost, and to periodically conduct QCRA to inform reporting of projects AFC.

In addition to this, a series of programme-wide cost and schedule risk assessments were conducted to support the development of the EOP and the following DCS updates, in order to inform the likely range of outturn cost and confidence in delivering the programme within agreed funding limits.

Schedule risk analysis conducted on the delivery plan informed decision making around the prioritisation and phasing of key activities – particularly sequencing and overlap of station commissioning – to mitigate the impact of uncertainty and risk on key milestones. The risk review process was embedded on the periodic reporting cadence of the programme and the outcomes were included as key inputs to the cost and schedule review process.

The reinstated risk management process included the identification of a set of key programme-level risks to ensure full visibility of the main threats to the programme at each stage of delivery. Ownership of each of these key programme-level risks was allocated to the Crossrail Executive to allow their management and mitigate the potential impact.

Additionally, an exercise was conducted to identify and map the enterprise risks held by Crossrail and its partner organisations. This exercise informed discussions on transition of the railway and key capabilities within the programme team required in the operational organisation.

# 7 Managing the programme AFC

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Following the development of the DCS 1.1 AFC estimate, a strong and consistent cost and risk management process was implemented. This process was supported by the restructured periodic cadence and was fundamental to ensure the estimated forecast of up to £1.1bn remained valid until completion of the programme, including DCS 1.2 and DCS 1.3.

The cost and risk management process was embedded in the periodic review cycle and included key steps to allow the identification, review and management of emerging cost pressures reported by projects. These pressures were assessed against identified management reserves or risk provisions, providing stability to the programme AFC and allowing the programme to periodically evaluate the remaining risk exposures and associated cost implications.

The collaborative approach between the programme and projects – particularly (but not exclusively) regarding cost, commercial and risk areas – led to further strengthening of the cost management activities. Channels of communication were implemented, and challenges were addressed and resolved with a problem-solving approach. This increased the transparency of the reported information and generated a dynamic and agile environment critical for management activities.

A revised AFC baseline was set across the programme based on the DCS 1.1 estimate and projects were measured against it. Deviations were reviewed and challenged on a periodic basis, and project managers were accountable for the correct control and management of this revised baseline.

A cost-control culture was embedded in the organisation: from executive members to project teams, the whole programme was focused on managing the AFC. An enhanced and agile change control process was implemented ensuring that all required changes to the baseline were reviewed by all involved parties.

This revised change process included the development and implementation of a new change form, which was critical for the success of the process. The form required approval from relevant areas in the programme and included detail about the following main aspects for the change to be approved: cost and schedule impact, change overview, commercial implications, options analysis, benefits and operator/maintainer implications.

The change process also benefited from the change in programme governance when the programme moved into TfL and began to report directly to the ELDG, led by the TfL Commissioner. This move facilitated a rapid decision-making process, allowing the programme to raise and resolve changes within an average of 10 days.

## 7.1 Quantitative risk assessment

The programme team maintained a comprehensive risk management process across the delivery and supporting functions. This included periodic review of risks facing each project team, focusing on the key threats to cost and schedule.

All projects managed risks relating to their objectives and maintained their own risk registers with support from a specialist team of risk managers. On a periodic basis, each project presented an updated QCRA that formed part of the project AFC and was scrutinised in the periodic review. In this review, cost impacts were analysed, mitigation actions were challenged, and any wider implications to other projects and the programme were identified. Schedule risks were included in the programme-wide QSRA (Quantitative Schedule Risk Assessment).

The key functions – including Technical, Assurance and Operations – also maintained active risk registers supported by the central risk team. The scope of these registers was those risks outside of the projects' control or those best managed at programme level. Functional risk management performance was a key focus of the periodic review process and these risks informed a programme-level QCRA, which formed part of the programme AFC.

Based on risk information provided by project and functional teams, the central Risk team produced a periodic QSRA that assessed the confidence level of achieving key programme milestones and informed an assessment of potential prolongation costs. In addition, this assessment indicated the key risks to be managed at each stage of the programme and informed the critical areas requiring intervention by the programme leadership team.

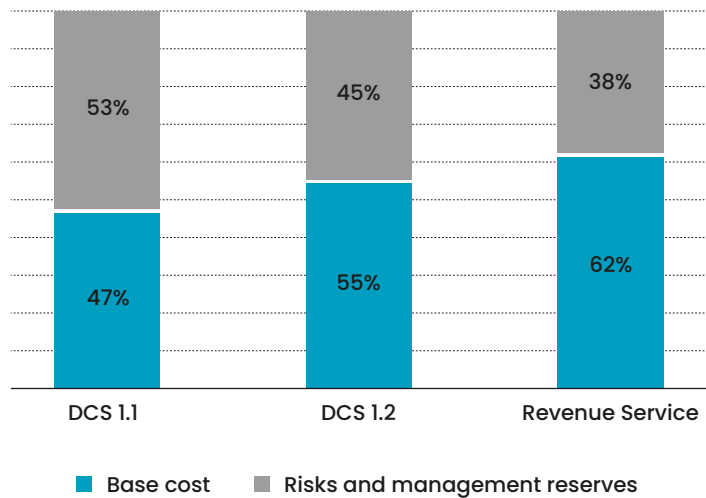
Following the creation of a robust baseline at DCS 1.1, the pace of the programme increased with good progress being made on a number of fronts. This resulted in a significant volume of movement in the risks being faced, both in terms of risks impacting and being mitigated. The periodic update of the risk profile proved to be a dynamic activity that required good communication and integration between the Cost and Risk Management teams.

Programme risks and provisions were centrally controlled, and the revised change control process was utilised to allow projects to draw down from them, ensuring detailed review and challenge of all suggested changes.

### **Example: Management of programme risks – impacts of social distancing during the pandemic**

DCS 1.1 was produced in summer 2020 and made a number of assumptions about the social distancing requirement and the impacts on contractor productivity. All projects were instructed to exclude risks associated with the uncertain outlook once that initial period had expired. As the rules continued to be updated through the remainder of 2020 and into 2021, all impacts related to social distancing and the impact on productivity were managed centrally as a programme risk, avoiding double counts and providing transparency regarding the cost and risk implications.

The evolution of the cost to go, from when DCS 1.1 was developed to Revenue Service, provide a view of how risks and management reserve were controlled. As issues materialised or were mitigated, provisions were either transferred into base cost or released, changing the proportions between the cost to go components.



**Figure 2** Evolution of P80 cost-to-go building blocks



# 8 Key governance meetings

A three-stage periodic review cycle before reporting to the CRL Board or, subsequently, to the ELDG was implemented in the programme.

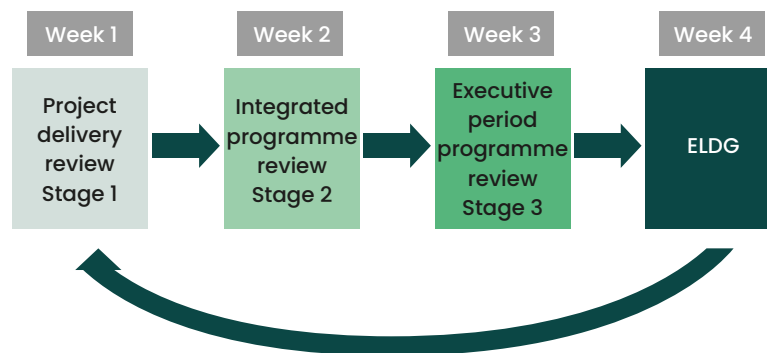


Figure 3 Periodic review cycle from the second half of 2020

Relevant and timely information was reported from projects to programme and programme to executive level to support the baseline management activities.

This review process ensured information was reviewed within four weeks of the period cut-off, starting in week 1 with project reviews at contract level, followed by consolidated project and programme review in week 2, CRL executives signing off period performance and overall schedule and AFC position in week 3, then presentation to the Board or subsequently the ELDG.

## 8.1 Stage 1: project delivery reviews

Project managers reported the performance of each individual key project in each period to programme level. This included safety, delivery successes, issues, schedule and projects AFC.

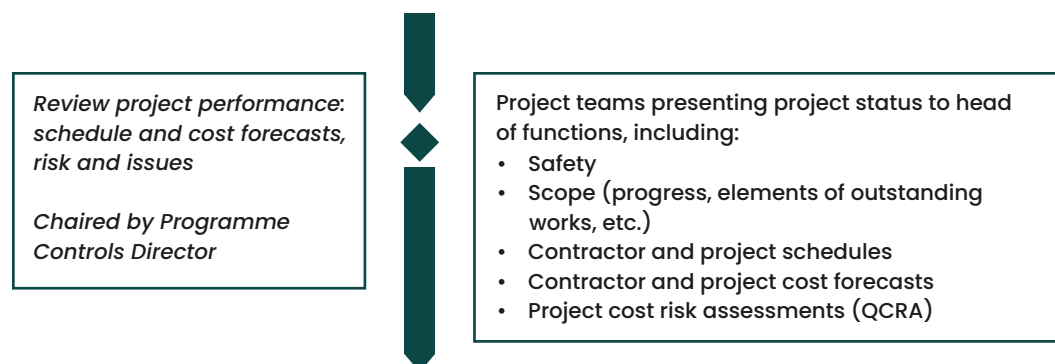


Figure 4 Project delivery review

Following project delivery review, the programme Cost and Risk Management teams performed a set of activities to integrate and assess the impact of reported project positions. These activities included the following:

- analysis of projects' cost movements, including approved changes and forecasted increases
- identification of cost movements and associated offset from management reserves or risk provisions
- updating the programme schedule and cost risk assessment (QSRA/QCRA)
- consolidation of the programme AFC position
- identifying strategies to address residual cost movements

## 8.2 Stage 2: integrated programme review

Integrated programme information was presented by sector delivery directors or senior project managers to the Chief Programme Officer and Chief Financial Officer (CFO).

The Finance and Programme Control functions also reported consolidated period positions.

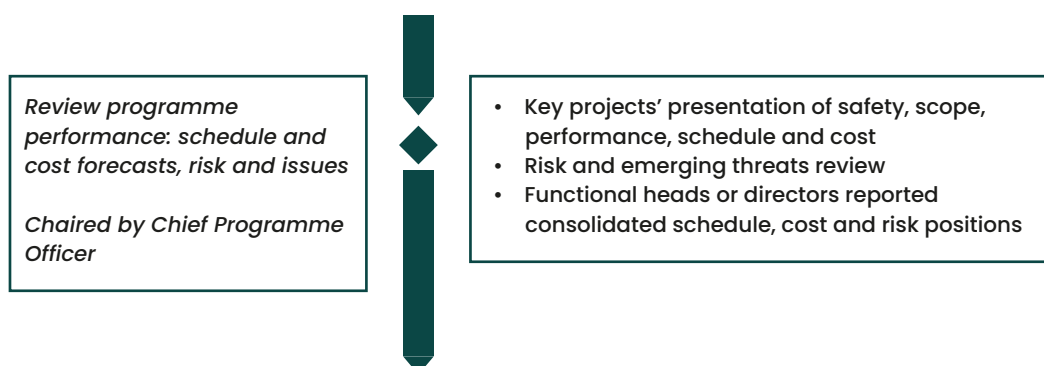


Figure 5 Integrated programme review

Integrated programme review provided further focus on cost and risk management activities, allowed the early identification of risks and emerging threats, and supported the development of programme interventions to mitigate their impacts.

It was a key forum to ensure the timely and direct reporting of period performance to the Chief Programme Officer, increasing transparency and incentivising a forward-looking approach to management activities.

- How have we performed in the period?
- How does this performance impact our plans?
- Are cost, risk and schedule aligned?
- Are we reporting a consistent view of the programme?
- What needs to be done to ensure we continue on track to deliver our key milestones?
- What are our risks and emerging threats?
- What are we going to do to mitigate them?
- Are management interventions needed?
- Who will deal with issues and when (accountability)?

### 8.3 Stage 3: Executive periodic programme review

The Executive periodic programme review was in place until Revenue Service and was then replaced by a programme finance review chaired by the CFO.



Figure 6 Executive periodic programme review

The periodic cadence was built to ensure that the senior management team on the programme was receiving accurate information in time to allow challenge and interventions. This dynamism and transparency was fundamental to support robust cost management and control activities. The whole programme, from projects all the way up to the Executive team, was aware of and actively managing the challenges that were emerging.

The final step on the periodic cadence was the presentation of the consolidated programme position to TfL's Elizabeth Line Delivery Group (ELDG), which replaced the Crossrail Board in the last quarter of 2020 and provided a new governance framework for the programme.

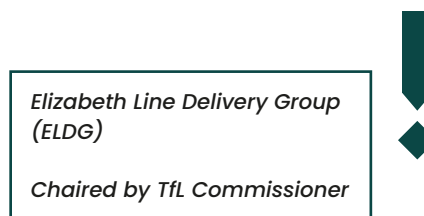


Figure 7 Presentation to the ELDG

# 9 Internal assurance reviews, enhanced control

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Off-cycle internal assurance reviews were performed to provide further scrutiny and challenge to projects' AFC. The reviews were led by the Finance and Commercial teams and covered the following areas:

- Alignment to schedule
- Alignment to supply chain estimates
- Estimating methodology
- Resource levels
- Commercial issues
- Emerging risks and pressures
- Accruals

Reviews were performed utilising a collaborative approach; the aim was to increase confidence in the reported numbers. Identified issues were addressed and mitigation plans developed between project and programme teams.

Workshops with a focus on cost to go were also implemented to support cost reduction activities. Led by the CFO, detailed reviews of all cost to go components were performed and opportunities identified. Actions to materialise these opportunities were agreed between executive members and project teams, and reductions in project forecasted costs were reported as these opportunities crystallised.





# 10 Workforce planning and management cost control (Indirects)

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Following remobilisation in early 2019, it was critical for the programme to ensure that the appropriate capabilities to support the delivery of the remaining activities could be secured. Crossrail resources and related costs were managed as one 'major contract', and reported in the management information materials as 'Crossrail Indirects'. These included staff (resources) and non-staff (IT, office space, insurance, audits, etc.) costs.

As the nature of the work being undertaken focused on client-led activities such as testing, commissioning, assurance and handover, the proportion of indirect versus direct spend increased.

Crossrail Indirects rapidly became a critical area of the programme and interventions were developed not just to secure the required resources, but also to manage an evolving and significant component of the programme AFC.

By the end of 2019, cost to go of Indirects represented approximately 20% of the total base cost (before risk and management reserves), a percentage that increased to more than 25% after the DCS 1.1 estimate was developed.

In addition, there was a clear relationship between evolving schedules and required extensions to people's end dates, which generated significant movement of resources planned to undergo demobilisation. There was a strong need to stabilise cost movements of Indirects to ensure that:

- the cost of Indirects was optimised and the best viable option utilised to fill positions
- individuals knew the plan and had as much certainty as possible of expected demobilisation dates
- there was increased certainty of the cost of Indirects
- uncertainty on remaining durations was appropriately managed and provisioned for

To achieve these, two processes were put in place.

- Costs of Indirects were baselined after each DCS update or at a key stage of the programme. A workforce plan was produced, underpinned by key milestones linked to capabilities and resources, to ensure that all requirements were covered. Updating the baseline in this way reduced the number of ad-hoc extensions and increased the stability of Indirects costs. This also enabled the programme to communicate expected end dates to the teams and individuals involved.
- A review panel was chaired by Crossrail's CEO, to review all resource requirements and challenge extensions. Responsible directors had to provide detailed justifications for any movement, explaining not just the change to dates but also the best mechanism to get the resources required, factoring in technical capabilities, cost and the urgency of the request. The panel included representation from the different delivery and operations areas of the programme, Finance and Human Resources.

The implementation of these interventions had a positive impact on the management of Indirects, reducing uncertainty regarding people's end dates and stabilising cost pressure.

# 11 Commercial strategy and its impact on the programme

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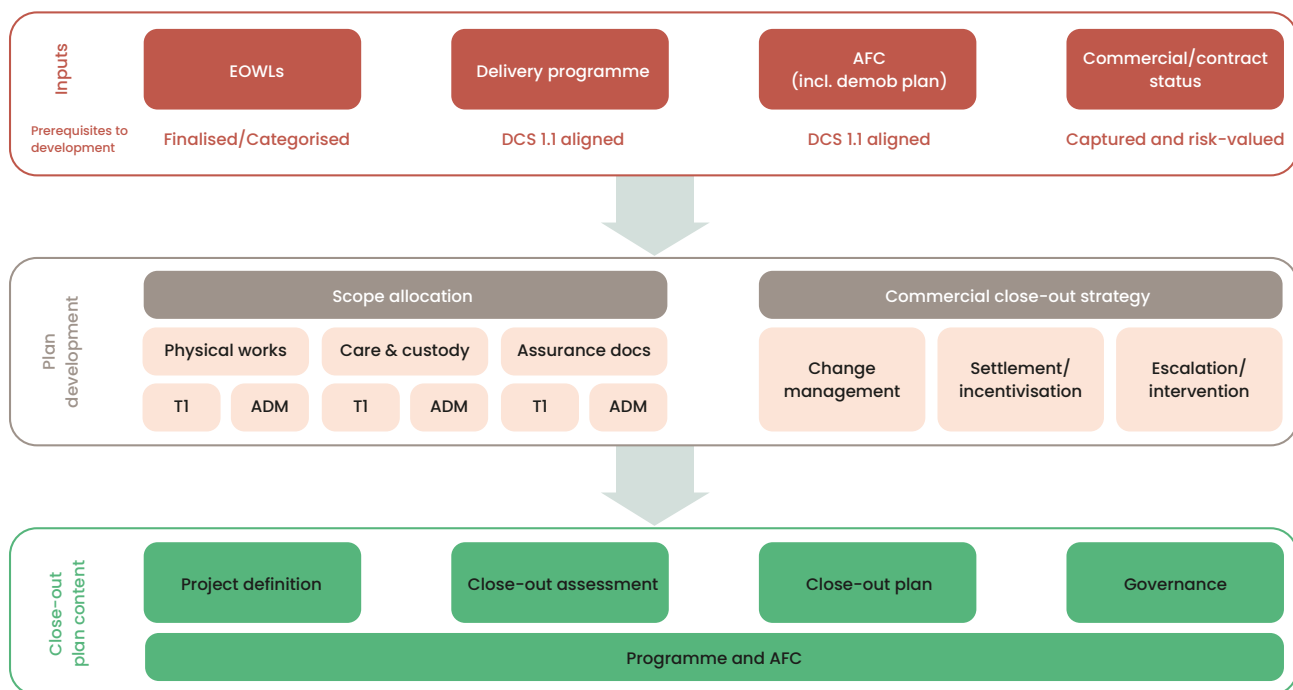
As Crossrail emerged from the strategic planning phase in the second half of 2020 and DCS 1.1 was completed, it was clear that a robust and structured commercial strategy was needed to support the final completion of the programme. Existing commercial arrangements were not designed to incentivise final completion and demobilisation of Tier 1 contractors from the site. The combination of settled-sum milestones plus reimbursable cost did not provide the programme with enough tools to support required delivery activities, and was generating the prolongation of high periodic costs (run rates).

Up until this point, Crossrail had tried different commercial mechanisms to incentivise the supply chain to work in an integrated way towards the delivery of key milestones to unlock final completion. Common incentives were implemented under the name of the Common Incentives Framework but did not provide the desired outcome.

Crossrail recognised that due to the level of completion and complexity of the remaining works, the integration risk should be owned by the programme. This led to the implementation of a non-contractual environment with suppliers to integrate the remaining activities from a technical and schedule perspective. Two teams, led by Crossrail, were created: Plateau 1 was responsible for the integration of routeway and systems, and Plateau 2 for station commissioning. This was a key decision that simplified the relationship with the supply chain and supported the completion of remaining activities.

Following the successful implementation of the Plateau teams, a commercial strategy was developed with a focus on completion of the remaining works, demobilisation and final account/contract completion of all major contracts.

The strategy included the introduction of an Alternative Delivery Model (ADM) for scope where more effective and efficient ways of delivery could be identified (i.e. utilising existing TfL teams as a delivery mechanism), and provided a path for final completion and site demobilisation of Tier 1 contractors. This strategy was underpinned by DCS 1.1 and the associated cost estimate, and was used to incentivise the delivery of key milestones relevant to the programme in the integrated schedule.



**Figure 8** Commercial strategy structure

The commercial strategy included a detailed analysis of the different aspects of the projects. A plan was developed for each major Tier 1 contract that was used to analyse the required interventions to ensure successful implementation. The plan included the following.

- *Project definition:* Overview of the status of the scope, commercial, schedule, risks and performance of the different projects. These provided the data and baseline against which the close-out structures and mechanisms were selected.
- *Close-out assessment:* Review of best close-out mechanism for each individual major contract, including measures of incentive and budgets.
- *Close-out plan:* Definition of the proposed scope delivery model, any required contract changes, benefits, programme certainty, delivery assurance and supplier positioning.
- *Governance:* Lists of the required approvals to implement the various aspects of the close-out plan, including targeted dates for presentation of papers.
- *Close-out programme:* Milestone schedule of the engagements, interventions, meetings, change papers and negotiations required to deliver the project close-out.
- *Opportunities:* Details of any other potential areas of betterment across the AFC or programme that could be driven by the project team beyond the finalisation of the project close-out plan, including key actions and owners for the opportunities.

To ensure the effective implementation of this strategy, three enabling mechanisms were identified.

## 11.1 Micro-incentivisation of contractors to achieve key programme dates

Specific incentives were agreed with Tier 1 contractors to support the achievement of key programme milestones for specific projects.

Bespoke incentives for each project were developed and assessed against programme-level provisions to ensure they were not generating additional cost pressures. This provided the programme with a mechanism to drive Tier 1 contractor performance and demobilisation from the site.

## 11.2 Demobilisation of Tier 1 contractors

Demobilisation of the supply chain from the site was critical to support programme cost control. Prolonged periodic run rates were building pressure on the programme's estimated AFC and mitigations were needed to avoid further cost escalation.

Several interventions aiming to demobilise Tier 1 contractors were made, but limited success was achieved. This was driven by:

- the continued identification of new scope
- required work as the result of assurance/quality issues
- historic commercial agreements in place that did not incentivise demobilisation
- the absence of a clear path to overcome close-out issues such as residual works completion (documentation and physical works)

The implementation of an Alternative Delivery Model for residual works plus the introduction of the previously mentioned micro-incentives provided the right platform, which supported demobilisation of Tier 1 contractors. Target dates for completion of 'must' works to be delivered by the supply chain were defined and projects measured against them.

All target demobilisation dates were achieved within the negotiated ranges and station Tier 1 contractors were successfully demobilised as planned.

### 11.3 Final account and contract completion

Thirty-six main Tier 1 contractors were identified in the programme including those involved in tunnelling, stations, shafts, portals, power, signalling, communications and control, and track contracts.

Strong management capabilities within the Commercial team were fundamental to drive success in this area. Bringing in the right skills for the close-out phase of the programme was essential to the achievement of the expected outcomes.

The Crossrail Employers' Completion Process (ECP), and the management of it, was also crucial in driving success with the final close-out of the programme. A detailed list of activities with progress indicators against each of them was used to drive completion of each of the main contracts.

Supported by the commercial close-out strategy and final account agreements at the time of writing, the programme has achieved commercial close-out for 22 of the main Tier 1 contracts and 11 are in the defects period or have ECP signed off.



# 12 Conclusions and lessons learned

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After remobilising in early 2019, Crossrail experienced a series of delays and emerging issues that resulted in increases to the estimated outturn cost. The implementation of a robust cost and risk estimation and management process was fundamental to support the final phase of the programme.

In this paper, we have described the main interventions implemented by the programme to regain control over the AFC and how the close-out commercial strategy supported this process.

Although some of the challenges faced by this programme were no doubt specific to Crossrail, there are a number of conclusions that are relevant for the closing stages of any major programme.

The main lessons learned are summarised below. These have been classified into four themes that underpin the cost, risk and commercial management processes in the programme.

- Controls
- Governance
- Supply chain
- Culture

## 12.1 Controls

The controls environment that is implemented in the closing stages of a major programme such as Crossrail needs to take the following into account:

- The complex nature of activities involved in testing, commissioning, assurance and handover.
- The reducing involvement of all parties in discrete, independent activities and increasing involvement in integrated activities that support key programme milestones.
- The nature and extent of supply chain organisations that remain in place to deliver these activities.
- The risk of reducing levels of resources in management and control roles within the client organisation, and streamlining of the systems that have been in place through the volume delivery phase.

As a result, the key learnings are:

### *1. Implement an integrated programme cost and risk model*

An integrated model of cost and risk, to inform strategic decisions made by management and support 'what if' or ad-hoc scenario planning, is fundamental to ensure full visibility of implications. This needs to be managed at programme level and integrated with the programme schedule.

The model needs to include 'bottom-up' project estimates and allow the assessment and challenge of forecasts based on specific cost drivers.

Crossrail benefited from a cost model that considered each main contract's specific commercial structure, allowing the integration and inclusion of management overlays to ensure alignment with programme strategies.

Figure 9 provides an example of output for one specific project. The model allowed the review and analysis of emerging cost, the impact of overlays and project-specific risks. It also included key dates to ensure that forecasts were aligned with them.

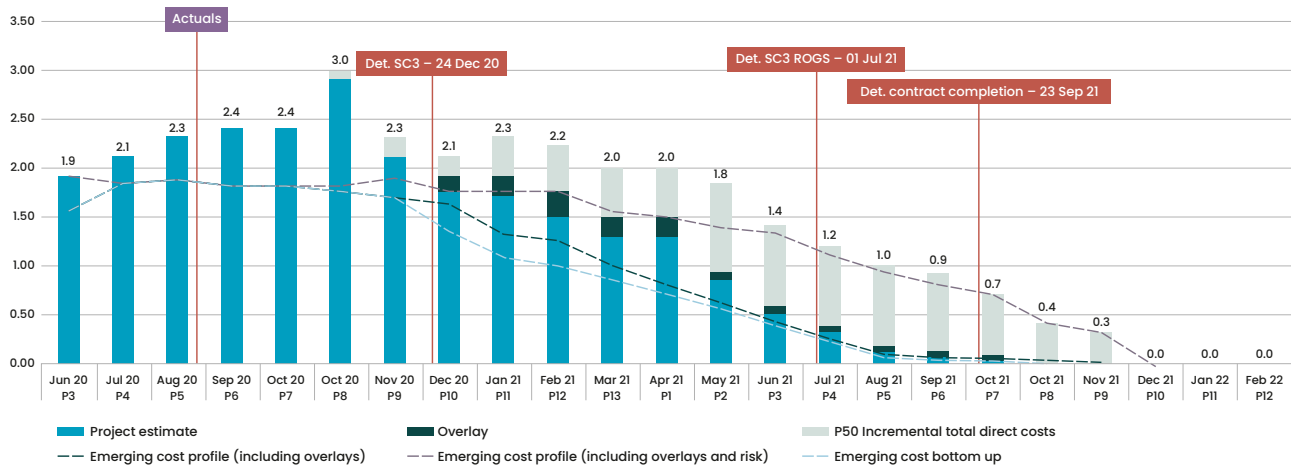


Figure 9 Example cost-to-go model output

2. Schedule, cost and risk alignment should support the periodic decision-making process

This was fundamental to keep the programme AFC under control. Assessment against defined milestones and the risks associated with them provided a strong basis for cost-estimating and management activities. This resulted in tight control of the forecasted cost.

3. Align projects with programme-level assumptions

To minimise the risk of different assumptions being applied by different parts of the organisation, information should cascade down to projects in a consistent and clear way.

When Crossrail was going through intense strategic planning, common key assumptions at project level were fundamental to ensure reported information was consistent and reliable. Crossrail implemented periodic 'Riding Instructions' to provide clarity to projects regarding programme assumptions and key milestone dates.

Standardising reported data at project level was critical to allow integration of information at programme level and support the implementation of enhanced governance.

4. Utilise the risk management process to support decision making

Integrate risk into programme cost and schedule control processes, perform periodic risk assessments and quantify emerging risks.

Actively manage the project and programme risks, and develop and implement mitigation plans and interventions to minimise exposure. Ensuring that provisions (time and cost) are included in project costs and schedules is key.

#### *5. Cost control of Indirects must always be a priority*

As a programme reaches its closing stages, the proportion of management (i.e. Indirects) costs versus delivery (i.e. Directs) costs necessarily increases. It is important that a clear workforce planning process and associated cost controls are put in place from an early stage. For a long time, Indirects in Crossrail were one of the largest 'projects' in terms of cost to go.

The capabilities required to deliver each phase of the programme should be assessed to ensure alignment between resources and strategies.

## **12.2 Governance**

Governance needs to recognise the increased scrutiny on a major programme in the closing stages, especially if – like Crossrail – the programme is experiencing cost and schedule pressures. There is a need for efficient reporting to enable the timely flow of management information and agile decision making that can respond to emerging issues.

As a result, the key learnings are:

#### *1. Implement a rapid decision-making process for change control to reduce the risk of taking decisions based on non-relevant information*

When Crossrail implemented the revised change control process and transitioned into TfL governance, changes were resolved (approved or rejected) very quickly. This allowed the programme to have relevant and up-to-date management information, which was fundamental to ensure agile decisions were made to unlock issues and progress towards final completion.

#### *2. Ensure robust and structured cadence to review management information*

Projects should be accountable for reported data, and periodic reviews should be held to explain progress and deviations from plans.

Schedule, cost and risk should be at the heart of the periodic reviews, information should flow from project to programme levels and an integrated view should be analysed periodically, allowing interventions if required. Timely and accurate data is fundamental.

## **12.3 Supply chain**

Commercial strategy in the closing stages has very specific objectives: to incentivise the delivery of remaining activities, agree final account positions with suppliers and other partners, and finalise the programme's financial position. However, to achieve this on a programme of this scale and complexity, the commercial strategy needs to acknowledge the motivations and drivers of the supply chain, and the increased levels of integration and collaboration required to complete the programme.



As a result, the key learnings are:

*1. Commercial strategy should ensure the programme remains in control of its own destiny*

Removing leverages too early could result in cost escalation and poor performance.

Close-out strategies should incentivise the demobilisation of Tier 1 contractors, providing tools and mechanisms for it to happen. At the end of major programmes, emerging scope, testing and assurance activities will result in 'client-driven' changes to contracts that will undermine the programme's ability to drive completion.

*2. Utilise the benefits of micro-incentives in the close-out stage*

Bespoke incentives, developed to drive the supply chain to deliver results, based on what is relevant for the programme at each stage is a powerful tool that can be used to improve performance.

The implementation of targeted incentives associated with key milestones for the programme was fundamental to support the final completion and demobilisation of the main Tier 1 contractors. Micro-incentives allowed projects to be in control of their own destiny, and this resulted in an increased rate of milestone achievement.

*3. Drive the contracts close-out process from early stages in the programme*

All contracts need to be closed at some point, and the programme should ensure any commercial issues are managed in a timely manner and cost verified based on defined cost in the contract.

Look for indicators of potential issues and implement interventions in a timely manner. Accruals, cash flow, purchase orders, resource rates can indicate incubating problems; do not omit them – it is better to act and resolve.

*4. Implement a structured ECP*

A structured process to support final completion of each major contract is fundamental to ensure a clean close-out process. Key indicators against each element should be set to allow progress measurement. This will provide full visibility regarding the status of each project and will enable project-programme collaboration.

*5. Engage with supply chain senior leaders*

The supply chain needs to be informed of and aligned with the programme strategy. This is especially important in the latter phases of a project with significant systems integration to be delivered.

Rebuilding and enhancing engagement was fundamental in the final stage of the programme, opening fluid communication channels, enabling collaboration and supporting the delivery of common objectives to achieve final completion.

## 12.4 Culture

The closing stages of a major programme are characterised by a number of competing pressures to deliver the outcomes and benefits, often against significant challenges and under intense scrutiny.

From the perspective of cost and risk management, it is important that the culture of the organisation supports continued focus on transparency and collaboration.

As a result, the key learnings are:

*1. Use internal and external (independent) assurance reviews to gain confidence in methodology, and outcomes of cost and risk information*

Assurance reviews provide the space and time to reflect on the processes and results of periodic information. They should be taken as an opportunity for improvement, and work should be done in a collaborative and transparent way to take the most out of each of them.

The Crossrail AFC was constantly under scrutiny; external independent assurance reviews helped the programme to provide confidence to key stakeholders, while internal reviews helped to build trust between teams, drive cost efficiencies and improve the quality of the data.

*2. In programmes under stress, relationships are key to improve the outcomes*

The collaborative approach taken by Crossrail to face its challenges was fundamental to its building of an achievable AFC estimate.

The commitment of projects to report realistic and transparent data helped the programme with the assessment of exposures. Pressures were reported as they emerged, allowing interventions or mitigations to be implemented. The open channels of communication allowed the programme to anticipate potential cost pressures and build in the baseline provisions required to manage them.

This was also supported by key strategic organisational changes: the Commercial team reporting line was changed to the CFO, while the Commercial Director and Commercial team remained embedded with the delivery teams. This shared-ownership model was a key part of the alignment achieved and fundamental to the implementation of interventions that proved critical to enabling final completion (for example, the implementation of an Alternative Delivery Model).