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# PROGRAMME CONTROL

## Quantitative Risk Assessment Procedure

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## 1 Purpose

The purpose of this procedure is to set out how Quantitative Risk Assessment (QRA) will be undertaken on Crossrail. It represents a quality plan for achieving Crossrail risk management objectives. It is written to accord with:

- Crossrail Risk Management Plan Ref 1
- Crossrail Risk Management Procedure Ref 2
- Change Control and Budget Management procedure Ref 3
- Cost Management and Forecasting procedure Ref 4
- Programme Controls Glossary of Terms Ref 5
- Project QRA Template Ref A

## 2 Scope

This procedure defines an approach for quantifying risks to Crossrail costs throughout the Project and up to handover. Risks and uncertainties will be assessed either negative (i.e. threats) or positive (i.e. opportunities) outcomes.

This procedure addresses the quantification of risks caused by the many functional, organisational and physical interfaces with other Crossrail work packages.

This procedure applies to Project, Area and Functional teams, and describes the Programme Level assessment. It also explains how the QRA at Project and Area levels combines with the Programme Level assessment to inform the overall Crossrail risk profile.

This procedure does neither cover Crossrail's approach to schedule risk analysis nor Opportunity Management.

## 3 Key Definitions

**Correlation:** Two input distributions are correlated when their samples are related (i.e. the value sampled for one distribution affects the values sampled for the others)

**Risk:** An uncertain event or set of circumstances that, should it occur, will affect the project's objectives. Risks could have negative effects (threats) or positive effects (opportunities).

**Opportunity:** A Direct Cost saving although some risk reduction opportunities (where a significant change in strategy will reduce risk exposure) are being pursued. Opportunities can originate from a number of places and may only benefit one project or a number of projects.

An Opportunity is not:

- An action to mitigate a risk
- A de-scoping of work required to be carried out for the completion of Crossrail
- A balance mechanism for an increase in risk

**Probability:** Refers to an estimate of the likelihood of the risk occurring

**Point estimates:** Refers to the estimate of the effect of the risk on key business output variables

**Uncertainty:** Refers to possible errors in cost, revenue, and schedule predictions owing to lack of information

## 4 Objectives

Crossrail is committed to the use of the quantitative assessment of both cost and schedule risk as part of its integrated risk management approach. QRA provides the following benefits to risk management:

1. Allows the assessment of combined effects of risks, which allows the prioritisation; selection and execution of treatment plans that support the project objectives of delivery on time and on budget;
2. Provides metrics which can allow prioritisation of risk management activity and support decision making e.g. when utilised as part of a scenario analysis;
3. Informs the selection of economic and efficient mitigation actions;
4. Informs affordability to Cost Management and Change Control process;
5. Provides a more detailed understanding of the risks themselves and assurance to stakeholders on best value for money.

QRA should, therefore:

- Support project delivery, with Accountable Managers responsible for assessments;
- Be integrated with planning and cost management processes;
- Take account of both uncertainty and risk;
- Used to inform project affordability;
- Be integrated with risk management processes, utilising risk information held in ARM;
- Be documented in a QRA report; and
- Be subject to peer review.

## 5 Accountabilities and Responsibilities

In accordance with Crossrail Risk Management Plan (Ref **Error! Reference source not found.**) and Procedure (Ref **Error! Reference source not found.**), ultimate responsibility for delivering the risk management obligations, set out in the Risk Management Policy and Strategy, is placed with the Chief Executive and the senior management team. The Head of Risk Management is responsible for developing a suitable risk management framework to enable this.

Accountable Managers are required to take part in this process and are accountable for the numbers contained within.

The Head of Risk Management will develop and implement the QRA process. The Senior Risk Analyst, Risk Managers and Risk Analysts are responsible for carrying out QRAs with Accountable Managers. QRAs should be carried out involving the project team including Business Manager, Engineer Manager and Cost Engineer. A RACI chart is included in Appendix A.

Crossrail carries out QRA at Project, Area and Programme Levels with accountability as shown below:

Deliverable	Accountable Manager
Project QRA	Project Manager
Area QRA	Area Director

Programme QRA	Programme Director
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## 6 Principles

### 6.1 Forecast vs Budget

The forecasting of cost is maintained independently of budget and/or authority. Cost forecasts are intended to provide a realistic assessment of the outturn cost of the scope in question, including an assessment of uncertainty and risk.

Contingency is that part of the Budget which is identified to manage risk and the impacts of risk. In Crossrail, Budgets are generally set below Forecasts as shown below.

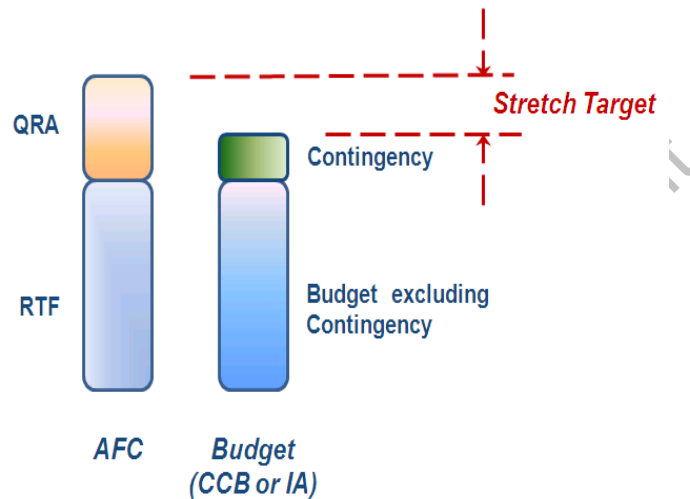


Figure 1: AFC versus Budget

### 6.2 Risk Forecast

Anticipated Final Cost (AFC) is defined as having two distinct elements: Resolved Trend Forecast (RTF) plus Risk Forecast, as shown in Figure 2. Please see Cost Management and Forecasting procedure (Ref 4)

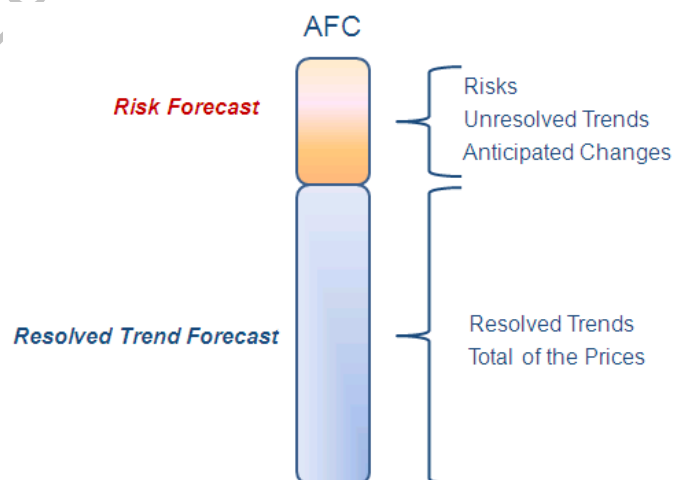


Figure 2: AFC = Resolved Trend Forecast plus Risk Forecast

AFCs are calculated at Project, Area and Programme levels.

### 6.3 Trends

Crossrail captures the impact of events which may change the Contract, Project, Area, or Programme costs through the raising and resolving of Trends.

Figure 3 shows the relationship between risks, trends and issues.

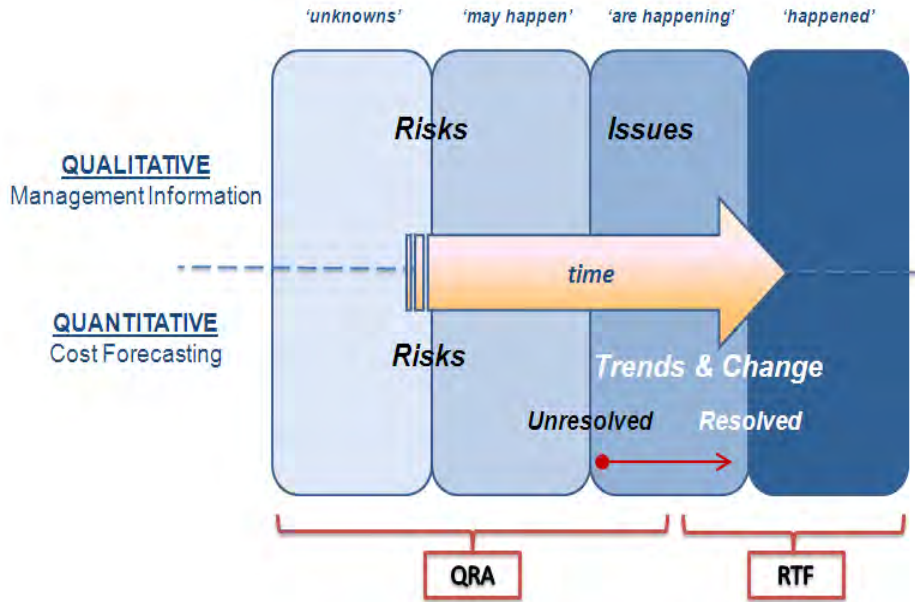


Figure 3: Risks Relationship with Trends, Issues and Change

Trends are raised initially with 'Unresolved' status to allow teams to work to mitigate their impact. Once the impact is known, the status of the trend is set to 'Resolved' and the item is effectively treated as cost.

The forecast of known costs is therefore termed 'Resolved Trend Forecast' (RTF).

Trends with Unresolved status are included in the Risk Forecast. It is important to reconcile the list of unresolved trends with the assessment of risk to ensure no double counting.

As work progress and trends are resolved into the RTF, it is important to deduct these values from the Risk Forecast. An understanding of the trends process and the specific trends raised against each contract is critical in producing a robust and detailed QRA.

### 6.4 Risk Allocation

Risks are managed by the party best placed to manage them. Funding for risk impacts should reflect the allocation shown below, which allocates responsibility for managing categories of risk to the appropriate parts of the Crossrail organisation.

Contractor	Project	Area	Programme	Board	Sponsor
<p>Contractor owned risks as defined in the contract for example:</p> <ul style="list-style-type: none"> <li>• Contractor and supply chain performance</li> <li>• Production rates</li> <li>• Change to material and subcontractor prices</li> <li>• Impact on local stakeholders</li> <li>• Construction quality</li> <li>• Contract/ site management</li> <li>• Delivery in accordance with approved schedule</li> <li>• Contract specific risks</li> <li>• Contractor design change, no change to contract price</li> </ul>	<p>Any risk not allocated to any other party for example: General delivery risk, not covered below</p> <ul style="list-style-type: none"> <li>• Commercial adjustments for liquidated damages, bonds etc., which impact the ECC. Not to include pain / gain adjustments which are not to be Trended. Normally only used at contract completion.</li> <li>• Interface between Contracts within Project</li> <li>• Failure to provide timely and accurate information to the Contractor</li> <li>• Late design not supporting the construction schedule</li> <li>• Interface with third parties at project level</li> <li>• Delivery in accordance with Master Control Schedule</li> <li>• Inter-contract scope omission (intra-project)</li> <li>• Consequences of OCI (including design activities to support OCI)</li> <li>• Unforeseen site conditions</li> <li>• Delayed access caused by RfL, LO, DLR.</li> <li>• Delayed delivery by RfL, LO, DLR or RSD contractor.</li> <li>• Delayed / impaired access by LU</li> <li>• Delayed delivery by LU</li> <li>• Delayed / impaired access by NR</li> <li>• Delayed delivery by NR</li> <li>• Delayed by interfacing contractor</li> <li>• Change/ delay to SPS contract caused by Systemwide contract</li> <li>• Change/ delay to Systemwide contract caused by SPS contract</li> </ul>	<p>Interface between Projects within Area including schedule, design and site management interfaces*</p> <ul style="list-style-type: none"> <li>• Inter-project / Inter Area scope omission*</li> <li>• Interface between Areas*</li> <li>• Design change to facilitate delivery*</li> </ul> <p>* See also INTA A2A Systemwide Construction Guidance</p>	<ul style="list-style-type: none"> <li>• Catastrophic events connected to our works</li> <li>• Failure to secure global approvals from Industry Partners for design or asset acceptance</li> <li>• Rolling Stock and Depot procurement</li> <li>• Failure to obtain timely decisions from CRL Board or Sponsors</li> <li>• Failure to provide property and access</li> <li>• Failure to procure Tier 1 contractors</li> <li>• Financial assumptions and indirect costs</li> <li>• Programme instructed schedule change</li> <li>• Impacts of OSD changes upon FDC design, and/or delivery budgets</li> <li>• 'Extra-ordinary' delivery risks not included within Projects (e.g. Significant ground condition impacts, asbestos, logistics etc.)</li> <li>• Design Development : Design Activities</li> <li>• Construction impact of design including:                             <ul style="list-style-type: none"> <li>- Design development pre IFC issue</li> <li>- Inaccuracies /incompleteness /inadequacy of design</li> <li>- CAT III checking</li> </ul> </li> <li>• Programme level change resulting from external party actions</li> <li>• OSD Indirect Budget - Impacts of OverSite development changes upon FDC design, and/or delivery budgets</li> </ul>	<ul style="list-style-type: none"> <li>• Catastrophic events not connected to our works</li> <li>• Failure of CRL Executive</li> <li>• Strategic relationships with Government, Sponsors, stakeholders and partners</li> <li>• Cost overrun in excess of all other funded contingency</li> <li>• Unfunded Sponsor changes e.g. Plumstead sidings (or unfunded Material Events)</li> <li>• Board instructed scope change</li> <li>• Further categories of risks as agreed</li> </ul>	<ul style="list-style-type: none"> <li>• Change in scope or execution originated by sponsors</li> <li>• Material Event (i.e. Change in law, excess inflation)</li> <li>• Failure of CRL or Industry Partners</li> <li>• Railway service performance</li> <li>• Operations procurements</li> <li>• Force majeure</li> </ul>

Table 1: Risk Allocation

This allocation is in line with the Change Control and Budget Management procedure CR-XRL-Z9-GPD-CR001-50003, (Ref 3). Other interface guidance will, however, be developed and addressed as required.

## 7 QRA Procedure

### 7.1 QRA Structure

All Project and Area QRAs will be completed according to a standard format (Project QRA Template Ref A) in order to ensure completeness and consistency, see Appendix B.

All QRAs will be made at Forecast i.e. post mitigations. All risk response measures should be examined in depth to confirm their feasibility and risk control potential, relative to cost, before being accepted.

#### Estimating Tolerance / Uncertainty

Estimating tolerance is the uncertainty in the quantities and rates which have been used to generate the cost estimates, and is to be included for each contract in the QRA. The uncertainty ranges should be determined by the Accountable Managers and their teams producing the estimates and applied to remaining expenditure only.

#### QRA Modelled Risks

The QRA process attempts to quantify the effect on cost from risks – both opportunities and threats. The cost of risk impacts should be estimated by project estimating personnel and take into account all existing management actions / controls included in plans and estimates, any further cost of mitigation or fall-back plans, and insurance recovery.

Each risk should be identified against a risk within ARM. Where possible the probability and impact of the risk should align with the risk information within ARM. Cross-reference with the Crossrail Assumptions Register should be made where applicable.

#### Schedule risk assessment

Modelled risks should include direct costs (contractor staff and plant) associated with the risk event in question.

Costs associated with overall schedule prolongation and recovery of schedule impacts should be made at the Contract/ Project level as appropriate.

This overall assessment should allow for the fact that multiple risk impacts may happen in parallel. Where possible the assessment should be based on a Quantified Schedule Risk Assessment (QSRA).

#### Exclusions and Assumptions

All material Exclusions and Assumptions should be recorded as part of the Programme QRA.

#### 7.1.1 QRA Modelling

Inputs into QRA model are risk and uncertainties identified at risk workshops and risk interviews. The point estimates (e.g. minimum, most likely and maximum cost values), assuming the risk occurs, will be made relative to the baseline cost plan(s).

At programme level, an assessment of schedule prolongation should be informed by a separate Quantitative Schedule Risk Assessment (QSRA) exercise, based on Master Control Schedule.

Probability of occurrence should be modelled using Binomial distribution. Cost impacts should be modelled depending on to the nature of each risk, as an advisory guidance highly uncertain risks should be modelled by either Uniform or Triangular distributions whilst highly disruptive risks should be modelled by Pert distribution. Cost uncertainties should be modelled by Uniform distribution only.

The cost risk exposure should be modelled and analysed with @Risk for Excel, using Monte-Carlo modelling technique, to provide a range of potential outcomes. The number of iterations (e.g.5000) will be selected with reference to the number of inputs being modelled and hence the number necessary to reach a stable result.

#### Modelling considerations

The following modelling notes are to be considered in the QRA;

- Risks should be quantified excluding commercial adjustments;
- Consideration should be given to the project schedule and emphasis should be made on the timely retirement of risks.
- Recovery of any costs through insurance will be reported in the individual assessments (net impact only modelled);
- All impacts to be forecast exposures (include the effect of currently planned and costed mitigations);
- Impacts costed at outturn prices (i.e. including appropriate levels of inflation);
- CRL indirect costs are not included, unless specified gaps or omissions in the current budget/ plan;
- Design/ Redesign costs are to be accounted for.



7.1.2 QRA Process- Activities

The figure below maps the QRA activities and responsibilities for more guidance.

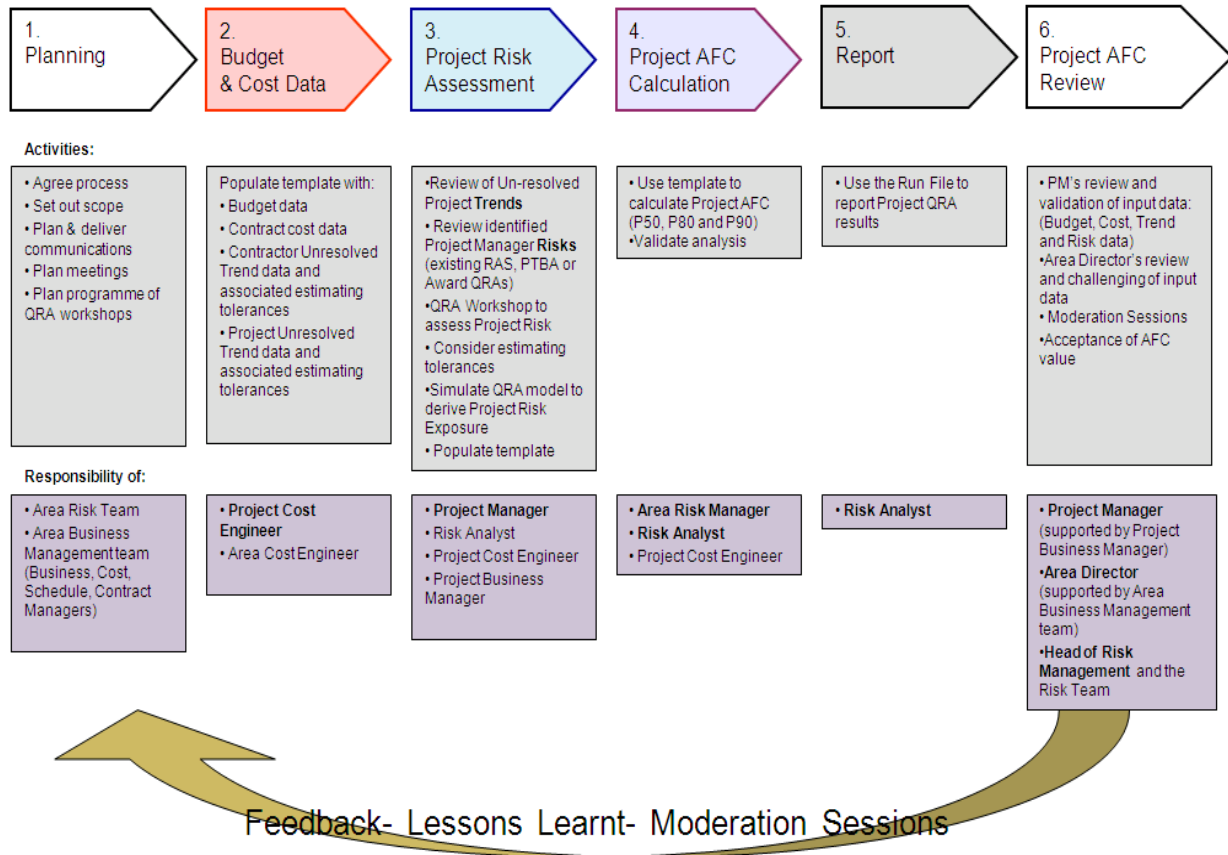


Figure 4: QRA Process Activities and Responsibilities

7.1.3 QRA Reporting

For each quarterly cost QRA, as recorded in Crossrail Risk Management Plan Ref **Error! Reference source not found.**, a report should be produced to include:

- Description of the scope to which the assessment relates;
- The key statistical results ( e.g. P5, P50, P80, P95, Mean and Standard Deviation)
- Cumulative distribution curves for the overall cost of works as well as curves for components as required;
- Description of the key risks/ dominant contributors to the project QRA;
- A register of the risks considered and modelled during analysis.

7.2 QRA Review

QRA outputs at all levels should be reviewed with the Accountable Manager. Prior to this review a quality check needs to be undertaken by the Area Risk Manager, or an independent Risk Manager/ Analyst. Refer to Appendix C for the Quality Check Guidance.

Inputs and outputs from the Project QRAs should be reviewed by the Area Director prior to submission of outputs into the cost management system. Outputs from the Project & Area QRAs should be reviewed by the Delivery Director prior to inclusion of risk exposures in the cost management system for period cost report in.

Moderation sessions should be held every quarter and chaired by the Head of Risk Management to ensure consistency in the QRA process is achieved.

Outputs from the Programme QRA should be reviewed and challenged by the Executives and senior management prior to reporting to the Board and Executive Committee.

### **7.3 Time spreading of risk exposure**

There are two fundamental approaches to time spreading of risk. They are: a) commitment/ expiry and b) expenditure.

Commitment/ expiry refers to the point at which funds will be committed against a particular risk, whilst expiry refers to the expiry date of the same particular risk i.e. when will this risk cease to be represented in the QRA.

Expenditure reflects the time when the impact of a particular risk is felt, in other words when will the money be spent.

*e.g. Approval of the design by the IM could result in additional systems scope being required and additional capital cost being incurred. Whilst this risk would expire and fund committed at the end of the Design Approval activity; the spend will not be recognised until the systems fit out phase some time later.*

The Crossrail cost management systems and Investment Model reports on the basis of Expenditure.

For Projects and Areas, Risk managers should review the profile of risk expenditure with the Business Manager and Cost Engineer taking into account all available information, and this profile should be entered into the cost management system.

In deriving a Risk Expenditure Profile, the following considerations should be made:

- 1) Many risks result in delay to the spend already planned so freeing up the funding which is already available;
- 2) There is often a limit to how quickly resources can be mobilised and hence how much can be spent in any given period;
- 3) Delivery teams are incentivised to deliver to their short term spend forecasts (typically 3 periods). Therefore, spend is likely to tend to these forecasts with additional costs being felt outside that time frame
- 4) Typically planned works will be optimised to achieve the maximum output in the minimum time. Unplanned works – like asbestos removal – will not be optimised. It is likely therefore that the cost of works delayed could be greater than the cost of unplanned works that delay them. Hence the risked forecast could be lower than the planned forecast
- 5) Examples of risks which will not result in delay could be fines or other costs which are incurred away from the delivery activity or costs that are incurred in order to maintain the schedule such as relocation of residents in temporary accommodation away from the works.

### **7.4 Deliverables**

At Project and Area level, the QRA documents will be produced each quarter, as shown in Figure 5; P50 Risk recorded in the cost management system as profile and to be updated periodically for movement in trends and refreshed quarterly by carrying out QRA.

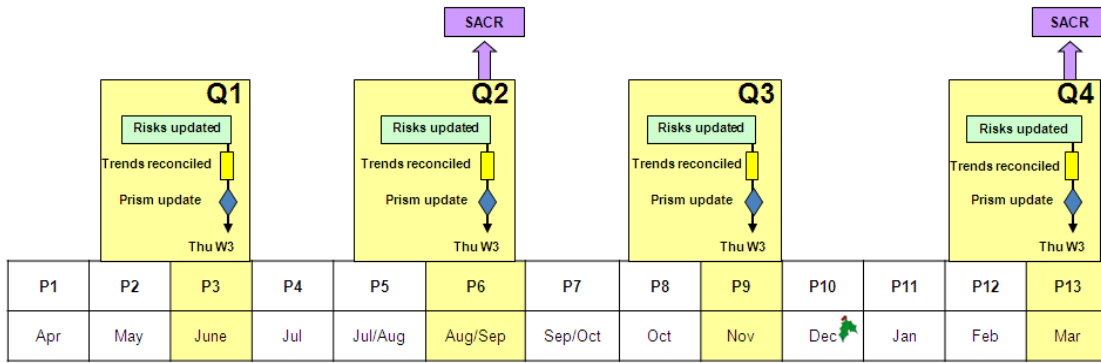


Figure 5: QRA Plan

## 8 Programme QRA

Project and Area P50s will be reported to the cost management system every quarter.

The output ranges from this Project and Area QRAs will be combined with the assessment of Programme Risk within the Crossrail Risk Model (CRM) in order to calculate the overall Crossrail AFC, as shown in Figure 6 below.

The Programme Risk Assessment will be carried out in accordance with the principles outlined above. A number of additional considerations will apply.

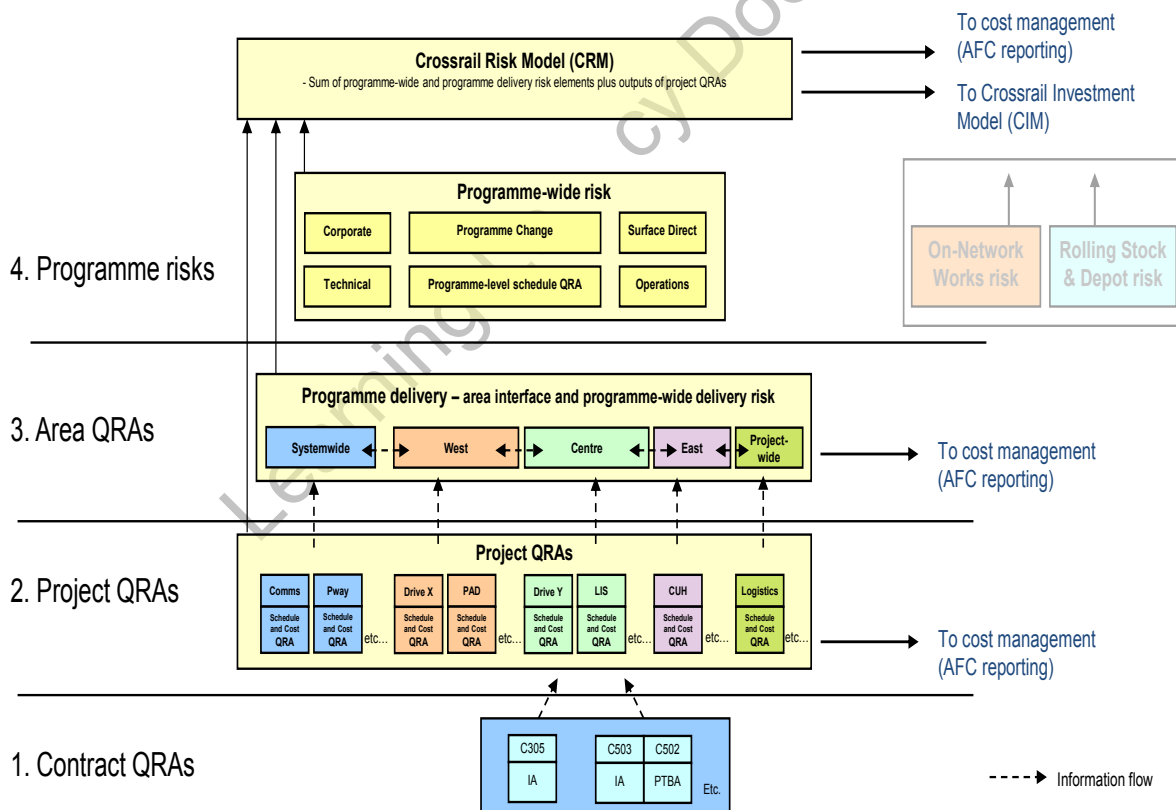


Figure 6: Crossrail Risk Model

At Programme level, the QRA & Time Profiling outputs will be produced each quarter; P50, P80, P95 recorded in Investment Model as profile. Updated periodically for movements in trends and refreshed quarterly by carrying out QRA.

## **8.1 Programme Risk Profiling**

The P50 programme risk profile, stepped in time, informs the Time Phased Data (TPD) for the Crossrail project. The risk phasing is based on when risk impact costs would be incurred. Exposure timeframe implementation periods are defined in accordance with the Project phases as in Build, Fit out and Testing. This Profile is used in the Crossrail Investment Model to inform the capital expenditure over the Project execution period. The profiling assumes the calculated risk profile will be delayed by 3 months, but keeps the end date as planned.

## **8.2 Correlation**

Correlation will be added within the Crossrail Risk Model in order to take account of systemic factors driving performance.

Correlation is added at a number of levels

- Projects correlated with Projects;
- Areas correlated with Areas;
- Selected programme risks have been correlated with the Projects.

Wherever correlation is used, this should be supported by a rationale which may be based on one or more of the following factors:

1. A logical relationship which exists between two (or more) variables, such as Area to Area interface, project to project interface & Area scope interface;
2. Common external factors that could affect two or many variables at the same time, such as railway integration & technical system risks impacting on individual projects;
3. Modelling interdependencies such as M&E design immaturity versus Civil design maturity, price of contracts at award stage and the volume of RFIs impacting on various projects;

Confidence testing will also be used to help determine whether observed correlations are real. This will involve adjusting the coefficient values used until a reasonable correlation of the outputs is achieved.

## **9 Bias**

Quantitative assessments are prone to systemic biases due to optimism tendencies, commercial behaviours and conflict of interests. A few steps are recommended to combat biases in QRA:

- Overcoming subjectivity by inviting discipline leads, i.e. Business Manager, Contract Admin, Design Lead, Field Engineer and Cost Engineer to the QRA workshops.
- Identifying three scenarios for each risk and recording the assumption behind these scenarios in the modelling notes section
- Peer review QRA inputs and outputs across Projects within the Area
- Moderation of QRA inputs and outputs across the Areas to ensure consistency.
- Discussing changes in AFC and emerging risks in the Area Directorate Report meeting
- Periodic Crossrail AFCDC review and adjustment
- Quarterly Programme Risk Reviews by the Executive Senior Management

## 10 Interface with the cost process and periodic adjustment

QRA interface with the cost process is via unresolved and resolved trends. Trends can be raised with quantification of impact for multiple contracts across multiple Areas. This will allow the initiator of the trend to capture all impacts of the change against a single trend. Unresolved trends will be included within the AFC at Project, Area and Programme levels, as they will form part of the overall Risk Forecast. As Trends are resolved, this should be reflected through adjustment to the risk forecast, as shown in Figure 7. These adjustments are done on a periodic basis at Project, Area and Programme levels.

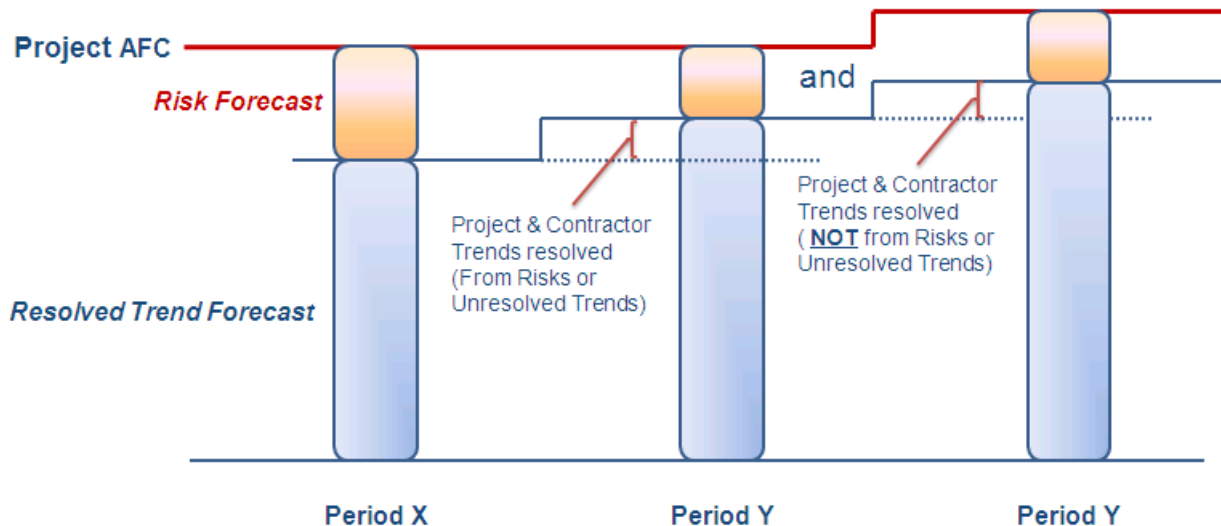


Figure 7: Periodic Project Risk Forecast adjustment

This interface is governed by the trend category; see section 6.1 in Change Control and Budget Management procedure CR-XRL-Z9-GPD-CR001-50003, Ref 3. The funding for each of the trend categories is aligned with the risk allocation, explained in Sub-Section 6.4 of this document.

## 11 Other QRA Activities

Other Quantitative Assessments may be required from time to time, for example to support significant investment decisions.

Where these bespoke risk models may be required, these should:

- Follow the principles outlined above;
- Be developed in line with Crossrail's guidance on good spreadsheet practice; and
- Be subject to the same process of peer review outlined in section 7.2 above.

## 12 Systems and Tools

Crossrail will use the Active Risk Management System (ARM), @Risk Software, the PRISM cost management database software, the standard format (Project QRA Template Ref A) in order to ensure completeness and consistency. Access to these systems and tools will be given to all members in the risk management team.

### 13 Glossary

The following glossary terms are used in this procedure & they are in line with the Programme Controls Glossary of Terms Ref 5.

Acronym	Term	Definition
AFC	Anticipated Final Cost	The accountable manager's current best view of the final cost at completion of the works. (Note: the PDA has a specific definition of the AFC for reporting under the PDA)
AFC	Anticipated Final Cost: Programme Level	The aggregate of Project and Area level AFCs + Risk at Programme level + third party and indirect costs (all at outturn value, i.e. including inflation).
AFDC	Anticipated Final Crossrail Direct Cost	The AFC of all works funded by Crossrail (Note: the PDA has a specific definition of the AFDC for reporting under the PDA)
	Change from Programme Baseline	Accepted change from the Programme Baseline scope, quality, cost and schedule, which will be reflected within the Current Control Budget
	Initial Total of the Prices	Tendered total of the prices at Award
CCB	Current Control Budget	The Baseline Budget and subsequent amendments reflecting approved change proposals, investment authorities and budget transfers. The Project CCB is the sum of the contract CCBs + Project Contingency. Prior to Contract Award, the CCB is the Original Baseline Budget plus approved changes including transfers. Post Contract Award, the CCB is reset to the Investment Authority that includes the contractor (target) contract price and permitted allowances and contractor risk.
	Contingency	A budget (at Board, Programme, Project and Area level) which is set aside specifically to cover the cost of change and/or risk including unforeseen events, to be allocated and expended in accordance with the governance procedure against a defined scope.
	Change	A Crossrail Programme Controls term for accepted change to a previously agreed Project scope, quality, cost or schedule baseline.
IA	Investment Authority	Authorised limit of expenditure (via the IA process) for a contract, project and area, which is available to commit external direct costs; required before a contract can be awarded.
ICE	Implemented Compensation Event	An acceptance by the Project Manager of the Contractor's quotation for the change in Works.
	Issue	A currently occurring event that is already impacting the achievement of Project Objectives (Critical Issues are those requiring immediate management attention/action and are reported as priorities)

QRA	Quantitative Risk Assessment	Method of calculating exposure to cost and/or time risk using quantitative modelling techniques
	Resolved Trend	Trend for which an impact has been authorised allowing AFC to be adjusted
RTF	Resolved Trend Forecast	The sum of the Initial Total of the Prices + Resolved Trends
	Risk Forecast	Impact of currently identified risks upon AFC; includes Unresolved Trends, excludes Resolved Trends
	Scope	Definition of the work necessary to meet the programme requirements
	Scope Change	A change from the programme baseline scope, resulting from a change in programme requirements
	Total of the Prices	Tendered Total of the Prices + Implemented Compensation Events (All at outturn value, i.e. including inflation)
	Trend	Potential event causing deviation from an agreed project scope, quality, cost or schedule baseline, which is logged as a trend via the cost management system

Learning Le cy Document

**14 Reference Documents (Mandatory)**

Ref:	Document Title	Document Number:
1.	Crossrail Risk Management Plan	CR-XRL-Z9-GPR-CR001-00014
2.	Crossrail Risk Management Procedure	CR-XRL-Z9-GPR-CR001-00009
3.	Change Control and Budget Management procedure	CR-XRL-Z9-GPD-CR001-50003 (V06)
4.	Cost Management and Forecasting procedure	CR-XRL-Z9-GPR-CR001-00010
5.	Programme Controls Glossary of Terms	CR-XRL-Z3-MDA-CR001-50019

**15 Standard Forms / Templates (Mandatory)**

Ref:	Document Title	Document Number:
A.	Project QRA Template	
B.		



## 16 Appendices

### APPENDIX A: Crossrail QRA RACI

**R = Responsible for undertaking the activity**

**A = Accountable for activity success**

**C = Consulted during implementation**

**I = Informed of outcomes**

\* Engineers, Planners, etc.

Activity	Risk Manager or Analyst	Cost Engineer	Subject Matter Experts*	Project Business Manager	Project Manager	Area Director	Programme Risk Function	Head of Risk Management	Programme Cost Function
Developing and implementing the QRA process	R	C		C	C	C	C	A	C
Contract Cost Forecast and Current Control Budget (CCB) data from the cost management system, - including Contractor Owned Risk in CCB - Monday week 3 of QRA period	I	R		A				C	
Unresolved Trend data from the cost management system - determination of cost uncertainty and probability of occurrence - Monday week 3 of QRA period	I	R	C	A	C			C	
Risk identification, quantification and modelling: - Contractor, Project, Area and Programme risks related to the Project	R	C	C	C	A	I		C	
Reporting QRA results and risks modelled	R	I	I	I	A	I	I	C	I
Update of Project Risk Forecast in the cost management system post QRA					A		C	C	R
Profiling of Risk Forecast over time in the cost management system	C	R	C	A				C	
Interim Period Adjustments - Adjust Risk Forecast with individual Trend adjustments (ensuring no duplication with Area or Programme risk)	C	R		C	A	I		C	

APPENDIX B: Project QRA Template

The screenshot displays a complex spreadsheet template for Quantitative Risk Assessment (QRA). It is organized into several horizontal sections, each representing a different risk category or assessment step. The sections include:

- 1. Planning:** The top section, containing project details and initial risk parameters.
- 2. Budget & Cost Data:** A table for inputting budget and cost-related data.
- 3. Contractor Risk:** A table for assessing risks associated with contractors, with a blue highlight on a specific cell.
- 4. Project Risk:** A table for assessing overall project risks, with a purple highlight on a specific cell.
- 5. Project AFC Calculation:** A table for calculating the Project Affected Cost (AFC).
- 6. Project AFC Review:** The final review section.

On the right side of the spreadsheet, a vertical flow diagram illustrates the six-step process, with each step represented by a colored arrow pointing downwards, corresponding to the sections of the spreadsheet.

## APPENDIX C: Guidance on Quality Review

### All costs are in £k.

#### Guidance on RiskTemplate Project QRA Quality Review

##### 1. Contract Budget and Forecast Data.

Check that all costs are in £k.

##### 2. Results

Do not amend the RiskTemplate\_Project QRA as Results values, s-curves and tornado are generated at the completion of the Simulation.

- Check that the following @Risk Simulation Settings are used:
  - from General tab: When Simulation is not running = Static Values, and 'True' Expected Value
  - from view tab: Automatically Generate Reports at End of Simulation
  - from sampling tab: Sampling Type to be Latin Hypercube

##### 3. Inputs - Contractor Risk (Gross)

###### Unresolved Contractor Trends

- Check if these cells for each Contract read the sum from the respective Contract URT Tab and that the cell in Contract URT Tab reads the total Unresolved Contractor Trends for that particular Contract.

###### Contractor risk

- Check the scenarios for modelling Estimating uncertainty / tolerance & Schedule Risk Exposure due to Contractor Risk in each Contract Risks Tab are correctly calculated.
- Check if the cells in each Contract Risks Tab read the correct sum for each contract and that the cell in Contract Risk reads the total Contractor Risks for that particular Contract.
- Review risks Identified as Contractor Contingency Source in ARM.
- Ensure cost impact of risk is expected to be within the contract / target price, i.e. no compensation event if occurs – affects pain/gain share.
- Ensure Contractor Risks covers: production rates, market conditions, supply chain problems, damage to works or 3rd party assets, etc. (anything not identified as a Compensation Event or Employer Risk in the contract). This may be determined by contract specific QRA - examples of ARM extract, IA QRA and previous Project QRA formats.

##### 4. Inputs - Project Risk and Uncertainty

###### Unresolved Project Trends

Check if this cell reads the sum from the Project URT Tab and that the cell in Project URT Tab reads the total of Project Unresolved Trends.

###### Project Risk

- Check if the distribution noted in this section is the one intended to model the scenarios identified in this QRA.

- Ensure cost impact of risks that are expected to be funded from the Project contingency via compensation event
- Ensure modelling notes determined by the Cost Engineer, Project Manager and subject matter experts are recorded.
- Check if the Project P50 is read in Section 3 under P50 Proj Risk Forecast (to the cost management system).
- Ensure Tornado formulas are included for each Project Risk
- Ensure project risks have individual ARM ID/ ID (for ID - suggested format Project Number - sequential number, e.g. P101-001, P101-002, etc.)
- When used: Ensure the Project Risk Tab is fully reflected in the Project Risk Section 4 in Project QRA Template Tab.

#### **1. Inputs - Area Risk relevant to the Project**

##### Unresolved Area Trends

- Check if this cell reads the sum of the Area URT and that the cell in Area URT tab reads the total Area Unresolved Trends.
- Check alignment with the latest Change Control Procedure for definitions of Project, Area and Programme funded items.

##### Area Risk

- Check if the distribution noted in this section is the one intended to model the scenarios identified in this QRA.
- Ensure the cost impact of risks are those expected to be funded from the Project contingency via compensation event
- Ensure modelling notes determined by the Cost Engineer, Project Manager and subject matter experts are recorded.
- Check if the Area P50 is read in Section 3 under Indicative Area Risk Forecast.
- When used: Ensure the Area Risk Tab is fully reflected in the Area Risk Section 5 in Project QRA Template Tab.

#### **6. Inputs - Programme Risk relevant to the Project**

As for Area inputs, but Programme contingency exposure items