Department for Transport

TAG UNIT A1.2

Scheme Costs

July 2017

Department for Transport

Transport Analysis Guidance (TAG)

https://www.gov.uk/transport-analysis-guidance-webtag

This TAG Unit is guidance for the **APPRAISAL PRACTITIONER**

This TAG Unit is part of the family **A1 – COST BENEFIT ANALYSIS**

Technical queries and comments on this TAG Unit should be referred to:

Transport Appraisal and Strategic Modelling (TASM) Division
Department for Transport
Zone 2/25 Great Minster House
33 Horseferry Road
London
SW1P 4DR
tasm@dft.gsi.gov.uk

Contents

1 Introduction

1.1.1 This TAG unit builds on the guidance on principles of cost-benefit analysis in transport appraisal in TAG Unit A1.1 – Cost-Benefit Analysis and provides specific guidance on how scheme costs should be estimated and reported. It should be noted that this guidance is intended to be applied to the treatment of costs in the Economic case; the development of cost estimates in the Financial case may and will frequently will differ in both presentation and substance.

1.1.2 Estimation of the costs of transport schemes is important for decisions on scheme funding and is a crucial part of the scheme appraisal process. Unrealistic cost estimates that subsequently rise will adversely affect the robustness of the assessment of affordability and value for money of a scheme. There are three main elements of a scheme cost estimate that need to be estimated and reported in scheme appraisals:

- the base cost[1] (section 2)– the basic costs of a scheme before allowing for risks, though these should incorporate realistic assumptions of changes in real costs over time, e.g. cost increases or reductions relative to the rate of general inflation;
- adjustment for risk sections 3-3.4)– which should cover all the risks that can be identified, the majority of which then need to be assessed and quantified through a Quantified Risk Assessment (QRA. This forms the risk-adjusted cost estimate;
- and adjustment for optimism bias (section 3.4.2)– to reflect the well-established and continuing systematic bias for estimated scheme costs and delivery times to be too low and too short, respectively, and results in the risk and optimism bias-adjusted cost estimate.

1.1.3 Theories on cost overruns suggest that there are several means by which optimism bias could be caused, including the psychological tendency for humans and organisations to favour optimism, the economic rationale of advancing projects in which organisations have interests, and the strategic behaviour of stakeholders involved in the planning and decision-making processes. As these causes are likely to affect the objectivity of the risk assessment as well as the base cost estimate, it is likely the QRA will be systematically underestimated. The size of the optimism bias adjustment, therefore, may differ depending on the completeness and robustness of the risk assessment, which itself depend upon the stage of development of a project.

1.1.4 QRAs do not remove the need to make an adjustment for optimism bias. Both are examples of reference class forecasting. Bottom-up QRA refers to project specific cost items and well quantified risks, while top-down optimism bias concerns more general cost uplifts. The two elements are complements rather than substitutes with the relevant significance of each being determined by how well specific risk and probabilities can be estimated. As projects advance through their stages and scheme promoters improve their cost estimation and risk analysis methodologies, through experience and feedback loops, the ability to assign greater weight to bottom up elements will increase. However even when risks are well identified there will remain a residual requirement for a top-down uplift.

1.1.5 The three cost elements outlined above will apply to a given set of objectives, scope, and stage of development of a scheme. A significant change in the objectives/scope of a project will require new base costs, risk assessment and optimism bias adjustment. A change of this magnitude would probably trigger a full reappraisal of the project.

1.1.6 Appendix A provides a worked example illustrating the methodology outlined in each part of this section of the guidance.

[1] The term base costs may have different meanings elsewhere. In this guidance we refer to these as being the basic costs of a scheme formed in a given price base year, which include realistic assumptions about real cost increases between the price base year and the years in which costs are incurred. The base costs do not include any adjustments for risk and optimism bias.

2 Base costs

2.1.1 Base costs are the first component of a scheme cost estimate. The base cost represents the basic costs of the scheme made up of investment (or capital), maintenance and operating costs, for a given price base.

2.2 Real cost changes over time

2.2.1 Base cost estimates should use realistic assumptions about real cost changes, e.g. cost increases above or below inflation measured by the GDP deflator. Analysts should consider current and forecast inflation from industry sources appropriate for their scheme and clearly present the assumptions and sources of evidence used. A strong justification would be expected for any assumption of zero real cost inflation.

2.2.2 When forming base costs in a given price base year, different components of cost should be adjusted by a real cost increase relevant to that particular component. For example, some cost components may be priced in foreign currencies, with a material impact on cost trends. More detail on converting nominal prices to real prices is given in TAG Unit A1.1 and the worked example in Appendix A.

2.2.3 Analysts may feel that it is appropriate to make allowance for the risk of costs increasing above inflation in their Quantified Risk Assessment. More detail is given in section 3.2.

2.3 Investment costs

2.3.1 Investment costs (often referred to as capital costs) should be distinguished from operating costs. Table 1 on the next page, lists the potential main components of investment costs: construction; land and property; preparation and administration; and traffic-related maintenance costs.

2.3.2 Construction costs should include fees for project management, procurement, design, legal and third party costs. Land and property costs should include the implicit costs of any resource that is acquired without financial payment such as 'land gift', including that from a local authority. Transport & Work Act Order (TWAO) application costs and the costs associated with obtaining statutory approvals should also be included in the investment costs. All costs borne by the private sector should include non-recoverable indirect taxation (e.g. landfill costs, fuel duty and so on).

2.3.3 Only the costs which will be incurred subsequent to the economic appraisal and the decision to go ahead should be considered. 'Sunk' costs, which represent expenditure incurred prior to the scheme appraisal and which cannot be retrieved, should not be included. The costs of land or property purchased prior to an appraisal should be treated as sunk costs, unless the purchase costs could be recovered by the re-sale of the land or property if the scheme were not to go ahead. These should be based on current market values and not those incurred at the time of their acquisition.

2.3.4 Investment costs should include estimates of traffic-related maintenance and renewal costs. Investment in new transport infrastructure may provide savings in replacing or maintaining existing infrastructure. These avoided renewals can be treated as a maintenance cost saving in the 'with scheme' case

Table 1 Examples of Investment Costs Components			
Base Investment Costs	**Roads**	**Railways**	**Public Transport**
Construction Costs	i) Main works contract (including preliminaries, structures, road works general, earthworks, main carriageway, interchanges, side roads, signs, etc.). ii) Ancillary work contracts (including provision of maintenance compounds, lighting, motorway communications, landscaping, noise insulation, etc) iii) Work by other authorities (including Network Rail, local authorities` works, statutory undertakers` works) iv) On site Supervision and Testing	Stations, Route Infrastructure Enabling and Advance Works, Communications, Rolling Stock, Track, Power and Signalling or Passenger facilities. Possession costs for train operators.	For Buses: Providing or upgrading vehicle fleet, New System of Ticketing and Passenger Information, New Stops and shelters, Bus Priority Measures on the highway and passenger information
Land and Property Costs	Acquisition cost, Legal transaction costs, Property management costs, Compensation etc.		
Preparation and Administration Costs	Project Management, Consulting engineers` fees, agent authorities fees, actual costs of pursuing alternative routes (if any) in the early stages of the scheme, Design costs, Public Consultation, Public Inquiry, gaining statutory powers or other licences and consents, compensation, the cost of any surveys carried out during scheme preparation, the costs associated with obtaining statutory orders, and on site Supervision and Testing	Generally as for roads. e.g. the costs associated with obtaining statutory orders	Generally as for roads. e.g. the costs associated with obtaining statutory orders
Traffic-related maintenance costs	e.g. non-routine reconstruction, resurfacing, surface dressing attributable to the investment (such traffic-related costs may be applicable to rail and public transport schemes, as well as highways investments).		

2.4 Operating costs

2.4.1 The appraisal should include realistic and comprehensive operating cost estimates, identifying the main components. All operating cost estimates should include an assessment of real growth over time.

2.4.2 It is important to note the distinction between operating costs incurred by transport providers, referred to here, and vehicle operating costs incurred by transport users which are discussed in TAG Unit A1.3 – User and Provider Impacts.

2.4.3 Operating costs may be incurred by private or public sector providers and are recorded in different places in the standard Departmental tables, i.e. Transport Economic Efficiency (TEE) and Public Accounts (PA) tables. Further detail as to how information on costs should be recorded in the appraisal documentation can be found in section 4 of this TAG unit. Examples of operating costs are provided in Table 2.

Table 2 Examples of Operating Costs Components			
Element of Base Cost	**Roads**	**Railways**	**Public Transport**
Operating Costs	Routine and non-traffic related maintenance costs (e.g. drainage, street lighting, fencing, grass cutting, repainting lines etc)	Train and station operating costs (e.g. payroll, fuel and traction and track access and station lease charges). Train leasing charges- which normally includes light and heavy maintenance of rolling stock.	Buses: Enforcement of bus lane Maintenance of stops; Fuel; Payroll.

2.4.4 Staff costs should include allowances for holidays, sickness, shift working, training and overtime. Note that wage rates may increase faster than general inflation. Additional costs may include management costs for park and ride sites and rates for premises used as depots. Where possible, advice should be sought from relevant operators or operating costs from similar existing systems should be used as a reference before adjustments are made for real cost changes.

2.4.5 For public transport schemes it is expected that a whole life cost appraisal is used to establish the total cost of ownership, i.e. the total cost of delivering, operating and maintaining a project. The total cost of ownership will depend on the quality required over the life of the scheme, constant or increasing patronage, service frequency, and the trade-off between maintenance and renewal. Schemes where the project life can be determined from the limited life of its component assets, i.e. with a finite life, will have a planned or contracted life. TAG Unit A1.1 provides guidance on how the residual values should be included for projects with finite lives.

2.4.6 Bus-based schemes may include operating costs falling to the highway authority owing to use of the road network, (e.g. maintenance of bus lane) although, in general, any effects would be expected to be marginal.

2.4.7 Costs per km per year for non-traffic-related maintenance costs of additional infrastructure are given in Table 9/1 of the COBA User Manual, (DfT, 2006).

2.5 Forecasting operating, maintenance and renewal costs

2.5.1 Operating and maintenance costs must be forecast for the whole of the appraisal period. In forecasting future operating, maintenance and renewal costs, analysts should consider:

- the impact of increasing usage or patronage; and
- the potential for cost increases in excess of general inflation.

2.5.2 To gauge the profile of operating and maintenance costs over time it is recommended that estimates should be prepared for three separate forecast years (although this may vary with project type). Analysts will need to use their judgement to choose the number and timing of years to be considered. TAG data book table A5.3.1 may be helpful in forecasting real increases in average earnings for staff-related costs. Interpolation and extrapolation should then be used to cover the whole appraisal period. TAG Unit A1.1 provides further information on the appraisal period.

2.5.3 Detailed analysis for later periods is unlikely to be feasible or worthwhile. However, analysts should take care to ensure that their work is as robust as possible, and based on available evidence. Analysts would be expected to draw on advice on the likely and most appropriate maintenance and renewal regimes to be adopted from experts in this field (scheme design / asset management), with assumptions of costs then appropriately reflecting their guidance. All assumptions and supporting evidence should be fully documented and submitted to the Department.

2.5.4 Projects with long lives may have additional elements of major structural maintenance and/or renewal within the appraisal period. For example, road pavements and drainage may require renewal, as may rail track and rolling stock. Wherever possible, the timing, cost and duration of these major elements of cost should be estimated explicitly. Where this is not possible, these costs may be included in annual maintenance rates, though care must be taken to avoid underestimation.

2.5.5 The need for periodic major maintenance and renewal means that the maintenance costs profile over time is likely to be 'spiky' whereas the operating costs profile is more likely to be fairly constant over time. The appraisal should also include the impact of delays arising from major maintenance or renewal and more detail is given in TAG Unit A1.3.

3 Treatment of cost risk and uncertainty

3.1.1 Risk in the context of this unit refers to identifiable factors that may impact on scheme costs, leading to over- or under-spends. Such risks should be identified and quantified in a Quantified Risk Assessment (QRA) to produce a risk-adjusted cost estimate. This is required for all transport projects with a base cost greater than £5m in 2010 prices, and is encouraged for smaller schemes.

3.1.2 An uncertainty adjustment, based on a top-down view of the risk profile as opposed to individual risk elements, may also be included (on top of the base cost and QRA estimate) to account for further unquantifiable risks in place of standard OB rates. This is only recommended where there is robust evidence on which to base these adjustments. Risks associated with patronage or benefits should be dealt with by sensitivity or scenario testing around the central case. Guidance on handling uncertainty in forecasting is provided in TAG Unit M4.

3.1.3 Risk assessment should be proportionate to the size and the stage of development of the project. The time and resources devoted to quantifying risks should relate to how many risks have to be analysed; how difficult that is to do; and the materiality of these risks. Promoters should draw upon professional advice and reference class forecasting when attempting to identify those risks that have been shown to have the most significant impact on scheme costs in the past. The level of detail required may need to be discussed with the Department. As a minimum the Department expects the impact of delays and above anticipated cost increases to be included in the risk assessment.

3.1.4 Reference class forecasting is a method of predicting the outcome of a planned action based on actual outcomes in a reference class of similar actions to that being forecast. The development of the theories behind reference class forecasting helped Daniel Kahneman win the Nobel Prize in Economics. Kahneman found that, people tend to underestimate the costs, completion times, and risks of planned actions through insufficient consideration of distributional information about outcomes of similar schemes that have already been completed. The Department encourage organisations to systematically collect forecast and outturn cost data at each project milestone to form reference classes for cost risk forecasting.

3.1.5 The risk assessment provides a snapshot of the risks at a particular stage of development and should be kept under review throughout the scheme's development. It is particularly important that the risk assessment reflects the best available evidence and is included in the appraisal at the time it is submitted to the Department as part of a bid for funding.

3.1.6 There also exists "a demonstrated systematic, tendency for project appraisers to be overly optimistic" [HMT Green Book, 2003, p.29]. Therefore, as well as adjusting for identified, quantified risks, risk-adjusted scheme costs should be adjusted to take account of this 'optimism bias'.

3.1.7 The Office for Government Commerce (OGC) expects Gateway Reviews to be carried out on all government projects. These reviews will seek evidence that risks have been properly considered before the project can move on to the next stage.

3.2 Quantified Risk Assessment

3.2.1 A Quantified Risk Assessment (QRA) allows an expected value (defined as the average of all possible outcomes, taking account of the different probabilities of those outcomes occurring) of the cost of the scheme to be calculated. This expected value should form the 'risk-adjusted cost estimate'. The QRA follows a four-step process:

- Risk Identification;
- Assessing the Impacts of Risk;
- Estimating the Likelihood of the Impacts of Risk; and
- Deriving the overall distribution and expected value of Risk for the scheme.

All 4 steps are susceptible to bias, as well as errors, and large schemes should consider having fully independent reviews carried out of their QRAs.

Step 1: Risk Identification

3.2.2 Promoters should construct a comprehensive Risk Register listing any identified risks that are likely to affect the delivery and operation of the scheme and present this in the business case. The risk register should list the results of the analysis and evaluation of the identified risks and should be updated and reviewed continuously throughout the scheme development process. Annex 4 of The Green Book [HM Treasury, 2003] provides further information. Table 3 highlights examples of the main types of risk likely to be encountered in a project. Not all of these will be relevant in the context of estimating scheme costs.

3.2.3 Evidence suggests that risks associated with scheme delays and cost inflation are particularly important. These risks should be included in the Risk Register and appropriate consideration should be given to the combined risk of both delays and cost rises above those assumed in the base costs. The risk of impacts associated with climate change on transport infrastructure being greater or less than has been assumed in the base cost estimate should also be considered. This could have important implications for the maintenance profile of costs for a scheme.

3.2.4 The risks associated with changes in scheme design should be identified and recorded in the risk register. However, the risk of making significant design changes, possibly relating to a significant change in scope - where scope is defined as the specified output/objectives of the scheme - should be mitigated prior to submitting the business case to the Department. If any unforeseen, significant changes in scope then do occur, the project should be subject to a full reappraisal, including reconsideration of rejected alternatives.

3.2.5 The risk register also needs to identify who owns the identified risk. For example some risks may be transferable through insurance or financial instruments. In all cases, the risk register should indicate where risks have been successfully transferred. Where a risk has been transferred, the promoter should ensure that it is fully transferred; provide evidence to the Department; and include any premiums paid as part of the transfer in the base cost.

Table 3 Examples of Project Risk

Policy Risk	Legislative risk	The risk that changes in legislation increase costs. This can be sub-divided into general risks such as changes in corporate tax rates and specific ones which may change the relative costs and benefits of different procurement routes.
	Policy risk	The risk of changes of policy direction not involving legislation.
Risk on delivering the asset	Construction risk	The risk that the construction of the physical assets is not completed on time, to budget and to specification. The risk of inflation differing from assumed inflation rates, particularly for any schemes where construction is not expected to start until some years in advance.
	Planning risk	The risk that the implementation of a project fails to adhere to the terms of planning permission, or that detailed planning cannot be obtained, or, if obtained, can only be implemented at costs greater than in the original budget.
	Residual value risk	The risk relating to the uncertainty of the value of physical assets at the end of the contract.
Risk on operating the asset	Operational risk	The risk that operating costs vary from budget, that performance standards slip or that the service cannot be provided.
	Inflation risk	The risk that actual inflation differs from assumed inflation rates.
	Maintenance risk	The risk that the costs of keeping the assets in good condition vary from budget.
Risks on demand and revenue	Demand risk	The risk that demands for the service do not match the levels planned, projected or assumed. As the demand for a service may be (partially) controllable by the government, the risk to the public sector may be less than that perceived by the private sector.
	Design risk	The risk that the design cannot deliver the services at the required performance or quality standards
	Availability risk	The risk that the quantum of the service provided is less than required under the contract.
	Volume risk	The risk that actual usage of the service varies from the level forecast.
	Technology risk	The risk that changes in technology result in services being provided using non optimal technology.

Source: HM Treasury (2003).

3.2.6 To identify the main areas of risk and who owns them it can be useful to organise workshops or 'brain-storming' sessions. These should involve experienced people like managers of the project, financial and economic advisers, designers, operators and maintainers of the existing infrastructure (where there is some), engineering and insurance professionals, professional negotiators, actuaries, and lawyers.

3.2.7 It may be useful to engage specialist consultants who have relevant expertise in facilitating risk identification exercises. However, the engagement of specialist consultants does not eliminate the need for substantial involvement of the project management team. The value of the input by specialist consultants will depend on the quality of the briefings they receive from client team members who better understand the project specific risks.

3.2.8 One source of risk is from ‘catastrophe risk’, such as major wars or natural disasters. Such events would be so devastating that all returns from policies, programmes or projects could be eliminated or at least radically and unpredictably altered. Catastrophe risk is one of the factors making up the discount rate [HMT Green Book, 2003] so it is not necessary to identify such risks as part of the risk assessment.

Step 2: Assessing the Impacts of Risk to Determine Possible Outcomes

3.2.9 Having identified risks in step 1, the next step is to assess the impact of each risk, or combination of risks, should they be realised, in terms of the cost outcomes of the risk. This should be primarily

through evidence from similar schemes and / or modelled sensitivity analysis. The range of outcomes should consider both the upper and lower extremes of the possible range, taking into account any reasonable constraints.

3.2.10 The best methods for quantifying the impact of risk will depend upon the information sources available. The best approach is to use empirical evidence from similar schemes whenever it is available, and empirical evidence should be gathered when possible. When it is not, common-sense approximations should be used. , rather than aiming for unrealistic or spurious levels of accuracy. What this means in practice depends on the nature of the risk. The objective is always to obtain an unbiased estimate of the impacts of the risk on the costs of the scheme.

3.2.11 When assessing the consequences of any risk, analysis should not be restricted to only the direct effects but should be extended to ensure all knock-on effects are included. This requires care, as there could be interaction between different risk events. Some risks will affect the costs of either the construction or operation of the project. For example if a plot of land is not available on time, the possible knock-on effects could include:

- costs associated with looking at alternative sites;
- lost management time as a result of litigation/seeking Compulsory Purchase Orders;
- inability to meet contractual commitments; and
- increased input costs resulting from cost increases during scheme delay.

Step 3: Estimating the Likelihood of the Outcomes Occurring

3.2.12 Having identified a broad range of risks and used a systematic approach to assess the potential range of cost outcomes, it is necessary to assess the likelihood of occurrence for each of the possible outcomes.

3.2.13 As with assessing the impacts of risk, it is important that the predicted likelihood of an outcome occurring should be based on experience of past events, taking account of any foreseeable changes or developments, rather than arbitrary estimates. Organisations are encouraged to compile databases of past schemes' cost data including details of the reasons for any cost changes. When available, these could be useful in reaching conclusions as to the likely occurrence of different risks.

3.2.14 Estimating probabilities is not an exact science and inevitably assumptions have to be made. There is nothing wrong with this, but it is important that the assumptions in the assessment are reasonable and fully documented, as they are open to question when submitted to the Department.

Step 4: Deriving the Probability Distribution for the Costs of the Scheme

3.2.15 A QRA allows a probability distribution around the costs of the scheme to be derived and enables the expected risk-adjusted cost estimate to be obtained. This expected outcome, also known as the 'mean' or 'unbiased' outcome is the weighted average of all potential outcomes and associated probabilities.

3.2.16 Depending on the level of robust evidence available, it may be acceptable to allow for uncertainty on top of the risk analysis to account for additional risk that cannot be quantified. This should be based on a top-down view of the overall risk profile as opposed to individual elements of the risk register and may be positive or negative. It is expected that any uncertainty element will reduce as the project planning matures. In cases where a sufficiently robust top-down uncertainty adjustment cannot be applied, standard OB rates must be used instead.

3.2.17 The identified risk assessment and uncertainty analysis (if conducted) will together form the (risk-adjusted) mean estimate of the cost of the scheme, and it is to this that optimism bias will be

applied. Operating costs and capital costs should all be based on expected values of the cost of the scheme.

3.2.18 Many risks are linked or correlated, i.e. if one risk occurs another risk is likely to occur. Modelling these relationships is easier with appropriate software, e.g. using Monte Carlo simulation to establish the range of costs. Cost risk relating to time delays is often significant and Monte Carlo simulation can also take account of this.

3.2.19 Several methods can be employed to derive the probability that the total project cost (the sum of all the activities considered in the QRA) will not exceed a particular value. The graph on the left in Figure 1 shows the standard probability distribution. This can provide useful information to derive the cumulative probability distribution or S curve (shown to the right). This gives the probability of the scheme cost estimate being less than or equal to any specified value.

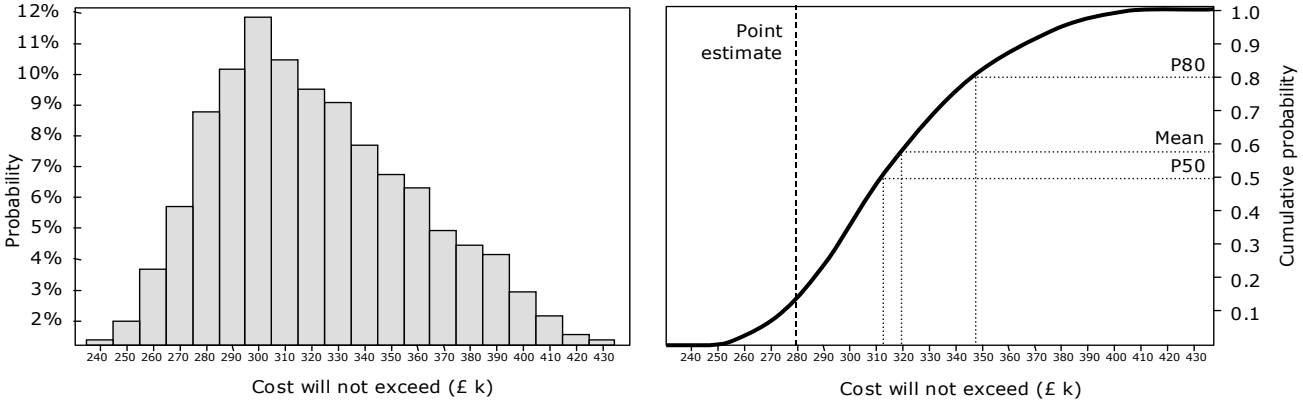

Figure 1 Example Probability Distribution for the costs of a Scheme

3.2.20 The cumulative probability distribution shows the probability of cost overrun associated with different risk-adjusted cost estimates. For instance, the P50 value is the budget estimate associated with 50% probability that the project will be delivered within budget and the P80 estimate represents an 80% likelihood that the project will be delivered within a budget. The mean, or expected, value is the weighted average of all outcomes and probabilities.

3.2.21 In the example above, the P50 estimate is £312k, the P80 is £348k and the expected value (the weighted average of all outcomes and probabilities) is £320k, between the P50 and P80 estimate. It is possible to infer the probability that the scheme is delivered to the base cost. In the case represented above, the base cost point estimate £280k. The cumulative probability distribution shows that there is only a 12% probability that the scheme stays within this base case cost estimate.

3.2.22 For smaller schemes, quantifying the impact of scheme risks can be made easier by banding the risks into a smaller number of categories according to their impact. For example, negligible, slight, severe, catastrophic etc. The amount of time and resources that are devoted to quantifying risks should relate to their likely materiality. It may be acceptable to assess the probability of any one outcome occurring using a simple four-point scale, expanded to more levels if appropriate. This scale would use, at a minimum, very unlikely, moderately unlikely, likely or most likely, where the most likely outcome would normally be the central forecast value. This method (along with the assessment of impacts) can be used to inform 'expected' risk allowances to apply on smaller schemes. However, the exact requirements need to be discussed with the Department on a case-by-case basis.

3.2.23 The P(mean), which tends to be higher than the P50 due to the positive (right-tailed) skew of a typical cost distribution, is the level to which the optimism bias adjustment should be applied. This is to ensure the systematic tendency for project appraisers to be overly optimistic in estimating both costs and risks is accounted for in the appraisal

3.2.24 As outlined by iUK and HMT Green Book supplementary guidance on financial cost estimates, the QRA exercise may also be used to inform the setting of realistic budget contingencies. Each level of contingency may be held at different organisational levels with the appropriate governance arrangements to incentivise cost efficiency. For instance, in the example above the P(mean) could be the contingency at the project level while the P80 could be the contingency at the portfolio level. This use of contingency should be restricted to financial or accounting purposes. Optimism bias uplifts are only required for the economic case.

3.3 Responding to risk

3.3.1 In addition to deriving the risk-adjusted cost estimate and in line with the Green Book [HMT, 2003], promoters should prepare risk mitigation plans and provide evidence of a systematic approach to responding to risks. Broadly speaking, responding to risks will involve some combination of tolerating, treating or transferring the risk; or terminating the activity giving rise to the risk.

3.3.2 There are two alternative reasons why risks should be tolerated: either the cost of taking any action exceeds the potential benefit gained; or there are no alternative courses of action available.

3.3.3 The purpose of treating risks is to affect the impact and / or the likelihood of the risk, while continuing with the activity giving rise to the risk. There are a variety of actions that can be taken to treat risks. The Orange Book (HM Treasury, 2013) defines four different types of control:

- Preventive Controls - to limit the likelihood of an adverse risk occurring;
- Corrective Controls - to minimise the impact of adverse outcomes;
- Directive Controls - to ensure that a particular outcome is achieved; and
- Detective Controls - to identify adverse outcomes once realised to minimise their impact.

3.3.4 Any actions taken to treat risks should be proportional to the risks they are designed to control. Every action has an associated cost and it is important that the action offers value for money in relation to the risk that it is controlling.

3.3.5 Transferring risk can be seen as a form of treating risks. For example, insurance, the conventional approach to transferring risk, can be regarded as a form of corrective control as it facilitates financial recovery against the realisation of a risk.

3.3.6 Ultimately some risks will only be treatable or containable to acceptable levels by terminating particular activities. This option is particularly important if it becomes clear that undertaking certain activities jeopardises the value for money of the scheme as a whole.

3.3.7 Table 4 provides a possible set of options to include in a risk mitigation plan.

3.3.8 The key objective of responses to risk is ultimately to reduce the risk-adjusted costs of the scheme. It is important that the implications of decisions taken to respond to risks are factored into both the estimates of base costs and the risk assessment that are submitted to the Department. Therefore, the process of risk assessment and establishing an estimation of costs accounting for risk needs to be undertaken for both pre and post-risk mitigation situations.

Table 4 Options that could be included in a risk mitigation plan	
Option	**Reason**
Active risk mitigation	Identify risks in advance and plan to reduce or eliminate resulting adverse effects; include process to monitor risks; decision making supported by framework of risk analysis
Early consultation	Helps to identify relevant stakeholders and risk mitigation
Avoidance of irreversible decisions	Through understanding causes of delay, through further investigation and improved reliability of project plan
Pilot studies	Acquire more information on risk affecting projects with many unknowns
Design flexibility	Designs adaptable to future changes are less adversely affected by risk than design suited to only one outcome.
Precautionary principle	Precautionary action required to mitigate severe risks
Procurement/ contractual	Risk contractually transferred to other parties
Make less use of leading edge technology	Complex untried technologies tends to have greater levels of uncertainty and risk
Reinstate or develop different options	Alternative options may be considered if current options are found to be more risky than initially thought
Abandon proposals	Proposal may be so risky that it is worth abandoning due to adverse risk

Source: HM Treasury (2011)

3.4 Further information on managing and assessing risk

3.4.1 Further detailed guidance on performing a risk assessment is Annex 4 of The Green Book [HM Treasury, 2003] and Supplementary Green Book guidance on financial cost estimates of infrastructure projects and the treatment of uncertainty and risk [HM Treasury & Infrastructure UK, 2013]. The Orange Book [HM Treasury, 2004] provides broader guidance on the principles of risk management that are valid and applicable across all modes. More specific information on risk analysis in railways can be found in TAG Unit A5.3 – Rail Appraisal.

3.4.2 Most risks will be common to a scheme regardless of the procurement route and provisional decisions on the acceptability of major schemes are often taken prior to detailed consideration of the procurement route. The Department expects to see a full assessment of risk for all schemes, irrespective of which procurement route may eventually be chosen. Where there are major risks, promoters will have to demonstrate that such risks are understood and can be actively managed within the public sector or transferred at an appropriate cost to the private sector. The costs should reflect the procurement strategy for the project for example Design and Build (D&B), Design, Build, Finance and Manage (DBFM), Private Finance Initiative (PFI). If a firm strategy does not exist, then the costs should come with a statement on the procurement route assumed for the purposes of the appraisal.

3.5 Optimism Bias

3.5.1 Optimism bias is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters. Theories on cost overruns suggest there are several means by which optimism bias could be caused, including the psychological tendency for humans and organisations to favour optimism, the economic rationale of advancing projects in which organisations have interests in, and the strategic behaviour of stakeholders involved in the planning and decision-making processes.

3.5.2 The Green Book [HMT,2003] suggests that appraisers should make explicit, empirically based adjustments to the estimates of a project's costs, benefits, and duration.. The guidance in this section focuses upon making adjustments to costs and draws on evidence from the studies summarised in Table 5. Demand and benefit optimism bias should be examined using sensitivity tests (see TAG Unit M4 – Forecasting and Uncertainty and TAG Units for Appraisal Practitioners).

3.5.3 This optimism bias guidance is only applicable to the economic case. The function of optimism bias adjustments is to confirm that the economic case remains robust if historically observed cost overrun were to be repeated and are most applicable when the cost estimate is immature, i.e. when there are significant elements of the project that are not defined or understood, and/or when there is evidence that the QRA is systematically underestimating costs. The P values produced by the QRA, such as the Pmean and P80, are more appropriate in establishing 'contingencies' at the relevant project and portfolio levels within the financial case. Supplementary Green Book guidance on financial cost estimates of infrastructure projects and the treatment of uncertainty and risk, produced in conjunction with Infrastructure UK, outlines how best to estimate and communicate costs in the financial case.

Table 5 Summary of Recent Studies on Optimism Bias

	Major Determinants of Optimism Bias	Main Features of the study
Mott MacDonald (2002)	Unforeseen cost overrun due to errors or omissions	Sample consists of 50 major public sector projects costing over £40m (not specifically related to transport infrastructure) from 1982 to 2002.
Flyvbjerg et al. (2002, 2004)	Intentional underestimation of costs due to different motivational factors.	Sample consists of 258 projects located in 20 countries across 5 continents of which 70% located in Europe and specifically related to transport infrastructure projects. No information on projects from 1998.
Infrastructure Risk Group (2013)	Underestimation of costs to secure project approval; difficult fund release processes encouraging excessive contingencies; and requirements to return unused risk monies before completion discouraging mitigation.	Six major cost estimation case studies, including Highways England, Crossrail and Heathrow Airport and views from risk analysts / managers from major infrastructural organisations.
AECOM (2015)	Not in scope.	Sample of 8 Highways England major projects that opened from 2012-14; examination of cost forecasts over time and comparison to outturn cost.
De Reyck et al. (2015)	Cost forecast maturity; project type – enhancement riskier than renewals; and the degree of complexity, i.e. interfaces and parties involved.	Large sample (2050 projects) of Network Rail projects of varying types, sizes and complexity from 2009-2014.

3.5.4 The Department requires a 4 step approach to the adjustment for investment costs optimism bias:

- Step 1: Determine the nature of the project
- Step 2: Identify the stage of scheme development
- Step 3: Apply the recommended uplift factors to the risk adjusted transport cost estimate
- Step 4: Provide sensitivity analysis around the central estimate

Step 1: Determine the Nature of the Project

3.5.5 The first step involves categorising the nature of the project according to the typology given in Table 6. Flyvbjerg et al (2004) concluded that within each of the categories identified, the risk of investment cost overruns can be treated as statistically similar.

Table 6 Project Categories	
Category	**Types of projects**
Rail	Metro, Light rail, Guided buses on tracks, Conventional rail, High speed rail
Fixed links	Bridges and Tunnels
Building projects	Stations and Terminal buildings
IT projects	IT system development

Source: Flyvbjerg (2004)

Step 2: Identify the Stage of Scheme Development

3.5.6 The Department has identified three main stages in the life of a transport project for which default uplift values have been provided, as illustrated in Table 7 below. The stages should be seen as indicative of the quality of risk assessment and cost estimate typical of schemes at the different stages of scheme development.

Table 7 Stage of scheme development according to scheme category			
Category	**Stage 1**	**Stage 2**	**Stage 3**
Local Authority and Public Transport Schemes	Strategic Outline Business Case	Outline Business Case	Full Business Case
Highways England Schemes	PCF Options Phase	Order Publication/ Works Commitment	Construction Preparation
Railways	Grip Stage 1: Project Definition	Grip Stage 3: Option Selection	Grip Stage 5: Design Development

Step 3: Apply the Recommended Uplift Factors to the Risk Adjusted Costs

3.5.7 Obtain the recommended uplift (appropriate to the category and stage of development) given in Table 8 and apply to the risk-adjusted scheme cost estimate.

Table 8 Recommended optimism bias uplifts for different projects at different stages of the life of a transport project

Category	Types of projects	Stage 1	Stage 2	Stage 3
Roads	Motorway, Trunk roads, Local roads, Bicycle facilities, Pedestrian facilities, Park and ride, Bus lane schemes, Guided buses on wheels	44%**	15%	3%**
Light rail	Metro, Light rail, Guided buses on tracks	66%**	40%	6%**
Conventional rail[2]	Network rail enhancement projects	64%*	18%*	4%*
Fixed links	Bridges and Tunnels	66%**	23%	6%**
Building projects	Stations and Terminal buildings	51%**	-	4%**
IT projects	IT system development	200%**	-	10%**

Sources: Flyvbjerg (2004), UCL (2015)* and Mott MacDonald (2002)**

3.5.8 As a project develops, the Department expects the scheme cost estimate to be refined based on better quality data and greater definition of project elements. As project-specific risks become better understood, quantified and valued, it should be possible to better capture the factors that contribute to optimism bias within the risk management process, leading to 'cost maturity'. Therefore, as risk analysis improves as a scheme develops, it is expected that the analysis feeding into the quantified risk assessment will become more certain, reducing the reliance on optimism bias uplifts as reflected in the uplifts above. The allowance for optimism bias should be largest at the initial stage of the life of a transport project (e.g. Strategic Outline Business Case); to decrease in a more detailed business case (e.g. Outline Business Case); and smallest in the presence of a fully detailed business case (e.g. Full Business Case).

3.5.9 The Department expects promoters to apply uplifts at other stages of scheme development as well as those identified. For rail schemes, TAG unit A5.3 gives a more detailed breakdown of uplifts by GRIP stage, whereas for other categories, evidence is not available to specify uplifts for other stages of scheme development. Therefore analysts should base the uplift to use on the stage of scheme development relative to those defined in Table 7 and Table 8.

3.5.10 With sufficient evidence, analysts can use uplifts that deviate from those in Table 8 based on the stage of development; quality of risk assessment; and the extent of optimism bias mitigation. In cases where the risk assessment can draw on an extensive reference class database of similar schemes; accounts for unquantifiable risks through a top-down uncertainty adjustment; and is complemented by governance arrangements, such as verification of cost estimates by independent experts, robust and comprehensive cost estimation can potentially reduce the optimism bias adjustment. The Highways England's Project Control Framework is an example where this has been effectively applied. Equally however, if the scheme or elements of the scheme are particularly novel, it might be appropriate to use uplifts in excess of those presented in Table 8. In general, the Department does not expect to see uplifts used that are below those given for the next stage of scheme development in Table 8 without justifiable evidence (e.g. for a road scheme at Stage 1, the Department would not expect an uplift below 15%).

[2] See TAG unit A5.3 for more detailed guidance on optimism bias assumptions for conventional rail projects

3.5.11 The business case should contain evidence to support the level of optimism bias, as ultimately the Department will decide upon the uplift to apply for the purposes of making funding decisions, in consultation with the promoter.

3.5.12 In cases where departmental bodies or agencies have released specific guidance on optimism bias for particular types of transport schemes (e.g. local transport, railways and HE schemes), promoters are invited to refer to these more detailed documents.

3.5.13 Where a project includes significant elements of the different project types identified above, it might be considered a combined project, with the differing elements representing sub-projects. The relative size of each sub-project should be determined and the appropriate uplifts should be identified and applied to that part of the project. After this has been done, the adjusted costs for each sub-project should be aggregated to establish the total cost for the overall project.

Step 4: Perform Sensitivity Analysis

3.5.14 The fourth step requires sensitivity analysis around the uplift used. It is important to examine the impact of a range of other possible levels of optimism bias on the cost estimates reported in the TEE and PA tables. Sensitivity analysis should be performed at every stage of the life of the project.

3.5.15 There is currently insufficient evidence available for the Department to recommend any specific optimism bias uplifts for operating costs**.** Despite the lack of strong evidence, the Department expects scheme promoters to consider the sensitivity of their scheme's business case to changes in operating costs from those that have been forecast. Scheme promoters will be expected to justify the level of optimism bias applied to operating costs, and similarly justify a decision not to apply any uplift to operating costs.

4 Preparing and reporting scheme costs in the PA and TEE tables

Preparation of scheme costs

4.1.1 All cost estimates should include adjustments for risk and optimism bias and should be reported in millions of pounds in real prices (in the Department's base year specified in TAG Data Book table User Parameters); in the market price unit of account (both public and private sector providers perceive costs in the factor cost unit of account so all costs should be converted using the indirect tax adjustment factor in TAG Data Book table A1.3.1 – Values of time per person); and in net present values (discounted to the Department's base year using the schedule of discount rates in TAG Data Book table A1.1.1).

4.1.2 Analysts should document these key steps using the format in the cost pro-forma. Use of the Department's TUBA software is recommended and, where TUBA is used, the risk- and optimism bias-adjusted costs should form the inputs to the software as TUBA will convert the costs to market prices and re-base and discount them to the Department's price base year. Where TUBA is not used, more information on these adjustments is given in TAG Unit A1.1; a worked example is given in Appendix A; and the steps should be documented in the cost pro-forma format.

4.1.3 Section 2 of this TAG Unit provides guidance on the factors that should be included in investment and operating costs. The following paragraphs describe how these costs should be reported, depending on whether they fall on public or private sector providers. All costs should be attributed to the relevant mode.

Public sector provider impacts

4.1.4 Investment and operating costs incurred by a public sector provider should be recorded as positive values in the appropriate rows of the Public Accounts (PA) table, which summarises the financial impact of the scheme on public sector budgets. This is split by the impact on the budget for transport (the 'Broad Transport Budget') and wider public finances, such as indirect tax revenues.

The cost of 'land gift' by a Local Authority should be included in the 'Investment Costs' row under 'Local Government Funding'.

4.1.5 Costs to public sector providers might typically include provision and maintenance of roads and car parks; highway maintenance costs arising from bus schemes; the costs of providing, maintaining and enforcing bus priority measures, stops and shelters that fall to the highway authority or PTE; and the costs of investing in rail track and signals.

Private sector provider impacts

4.1.6 Investment and operating costs incurred by a private sector provider should always be recorded as negative values in the appropriate row of the 'Private sector provider impacts' section of the Transport Economic Efficiency (TEE) table.

4.1.7 Private sector provider costs might typically include investment in bus fleets or ticketing and information systems; investment in rail rolling stock or passenger facilities; and the costs of operating bus and rail services.

Transfers between public and private sector bodies

4.1.8 It is important that all costs are correctly allocated and the PA and TEE tables allow for accounting of transfers between public and private sector providers.

4.1.9 The value of 'land gift' by a private sector provider and hypothecated developer contributions should be included in the investment costs recorded under the public sector provider in the PA table. The value of the 'land gift' or contribution should also be recorded as a negative value in both the 'Developer and Other Contributions' row of the PA table (to offset the cost recorded to the public sector provider) and the 'Developer contributions' row of TEE table (to register the cost to the private sector provider/developer).

4.1.10 Similarly, if private sector costs are met, in part or in full, by a grant or subsidy from the public sector, the full cost to the private sector provider should be recorded as a negative value in the TEE table and the value of the grant or subsidy should be included as a positive value in the appropriate rows of both the TEE and PA tables. This includes counting European Restructuring and Development Funds (ERDF) or equivalent grants.

4.1.11 TAG Unit A1.1 – Cost-Benefit Analysis provides guidance on how costs reported alongside other elements covered by the appraisal in the Analysis of Monetised Costs and Benefits (AMCB) table and Appraisal Summary Table (AST).

5 References

Department for Transport (2006): QUADRO manual

http://webarchive.nationalarchives.gov.uk/20120925153031/http://www.dft.gov.uk/publications/quadro-4-manual/

Department for Transport (2006): COBA User Manual

https://www.gov.uk/government/publications/coba-11-user-manual

De Reyck, B., Grushka-Cockayne, Y., Fragkos, I., Harrison, J., Read, D. & Bartlett, M. (2015) Optimism Bias Study

EC Harris (2006): Review of Optimism Bias for Highways Agency

HMT (2011) Appraisal and Evaluation in Central Government

H.M Treasury: Treasury Taskforce, (1999) How to Construct a Public Sector Comparator Technical Note 5

H.M. Treasury (2013): The Orange Book, Management of Risk- Principles and Concepts

H.M. Treasury (2004): Quantitative Assessment User Guide

H.M. Treasury & Infrastructure UK (2013): Early Financial Cost Estimates of Infrastructure Programmes and Projects and the Treatment of Uncertainty and Risk

H.M Treasury (2004): The Green Book Supplementary Guidance on Optimism Bias (available at: https://www.gov.uk/government/publications/green-book-supplementary-guidance-optimism-bias)

Flyvbjerg, B. (2004): Procedures for Dealing with Optimism Bias in Transport Planning

Flyvbjerg, B., Holm, M.K., Buhl, S.L. (2005): How (In)accurate Are Demand Forecasts in Public Works Projects? The case of transportation (Journal of American Planning Association, Spring 2005, Vol 71, No.2)

Infrastructure Risk Group (2013): Managing Cost Risk & Uncertainty in Infrastructure Projects

Mott MacDonald (July 2002): Review of Large Public Procurement in the UK

Network Rail (June 2005): Project Management Principles of risk management

6 Document Provenance

6.1.1 This TAG Unit forms part of the restructured WebTAG guidance on the estimation and reporting of scheme costs that was previously in TAG Units:

- 3.5.1 – The Public Accounts sub-objective; and
- 3.5.9 – The Treatment of Costs.

6.1.2 This TAG Unit also covers elements of guidance previously included in TAG Unit 3.9.2 – MSA Cost Benefit Analysis on cost estimation.

6.1.3 In November 2014 this TAG Unit was updated to provide guidance on how Network Rail costs should be treated and reported in appraisal following the decision to reclassify Network Rail as a Central Government body; and to align the GRIP stages equivalent to Stages 1, 2 and 3 in Table 7 with those given in TAG Unit A5.3 – Rail Appraisal.

6.1.4 In December 2016 this TAG Unit was updated to provide clarification on the use of quantified risk assessments and optimism bias uplifts in economic appraisal, and provide revised optimism bias uplifts for rail schemes by GRIP stage.

Appendix A– Scheme cost worked example

A.1.1 This appendix provides a worked example of the steps required to produce costs for inclusion in appraisal for a hypothetical Local Authority road scheme at a stage of development equivalent to Conditional Approval. The hypothetical appraisal is being undertaken in 2014 and the scheme opening year is 2018.

A.1.2 The example follows the process described in section 2:

- deriving a base cost estimate;
- adjustment for risk and optimism bias;
- re-basing the price base to the Department's base year;
- discounting to the Department's base year; and
- converting to the market prices unit of account.

A.2 Base cost estimate

A.2.1 A1 provides an initial estimate of the investment costs in 2014 prices but taking no account of real increases in construction costs. For simplicity it is assumed there are no traffic-related maintenance costs post-opening.

Table A1 Components of Investment Costs (£million)

Calendar Year	Construction Costs	Land Costs	Other Costs	Total
2016	7.9	5	1.5	14.4
2017	6.7	0	2.5	9.2

A.2.2 Base costs should be estimated separately for investment and operating costs in a given price base, taking account of real increases in costs. Therefore the first step is to incorporate real cost increases. General inflation is assumed to be 2.5% per year, while construction costs are forecast to increase by 3% until 2016 and 5% in 2017. Therefore the base investment costs, including real cost increases, can be calculated by: **In 2016** - £14.4m (initial estimate) x (1.03/1.025)^2 (the real cost adjustment) = £14.54m

- the contribution of real cost increases is £0.14m (£14.54m - £14.4m)
- **In 2017** - £9.2m (initial estimate) x (1.03/1.025)^2 x (1.05/1.025)^1 (the real cost adjustment) = £9.52m
- the contribution of real cost increases is £0.32m (£9.52m - £9.2m)

A.2.3 Table A2 illustrates the estimation of the profile of base costs, including investment and operating costs. Operating costs are essentially due to non-traffic related maintenance costs and are realised with a frequency of approximately 10 years starting from 2028. For simplicity it has been assumed that no adjustments are required to operating costs for increases in costs above the general rate across the economy.

Table A2 Base Cost Scheme Profile (£million, 2014 prices)						
Calendar Year	**Cost excluding real cost increases**		**Contribution due to real cost increases**		**Cost inc. real cost increases (Base Cost)**	
	Investment	Operating	Investment	Operating	Investment	Operating
2016	14.4	0	0.14		14.54	
2017	9.2	0	0.32		9.52	
2027	0	2.0		0		2.0
2037	0	2.0		0		2.0
2047	0	5.0		0		5.0
2057	0	2.0		0		2.0
2067	0	2.0		0		2.0
2077	0	5.0		0		5.0
TOTAL					**24.06**	**18.0**

A.2.4 The base cost estimate for the scheme is the sum of the base investment cost (£24.06m) and operating cost (£18.0m), £42.06m. This cost estimate should be used for appraisal purposes only and not as the basis for funding bids.

A.3 Adjusting for risk and optimism bias

A.3.1 Table A3 shows the P(mean) risk contribution, which is the weighted average of all outcomes and probabilities, calculated from the QRA of scheme investment and operating costs and how it should be added to the base cost to produce a risk-adjusted cost estimate of £43.8m.

Table A3 Risk-Adjusted Base Cost (£m, 2014 prices)						
Calendar Year	**Cost inc. real cost increases (Base Cost)**		**Quantified risk contribution QRA P(mean)**		**Risk adjusted cost using QRA P(mean)**	
	Investment	Operating	Investment	Operating	Investment	Operating
2016	14.54		0.8		15.29	
2017	9.52		0.5		10.02	
2027		2.0		0.05		2.05
2037		2.0		0.07		2.07
2047		5.0		0.09		5.09
2057		2.0		0.07		2.07
2067		2.0		0.10		2.10
2077		5.0		0.08		5.08
TOTAL	**24.06**	**18.0**			**25.31**	**18.46**

A.3.2 The next stage is to apply optimism bias. From Table 8, the baseline uplift to apply to investment costs for a local road scheme at Stage 2 of scheme development is 15%. If an extensive quantified risk assessment is undertaken, incorporating project and programme specific risks informed by reference class forecasting and unquantifiable risk through uncertainty, it may be possible to reduce the level of the uplift. However, as this example assumes a standard risk adjustment and that no optimism bias is applied to the operating costs, a 15% optimism uplift should be used. Table A4 shows that the uplift increases the risk-adjusted cost estimate by £3.8m to £47.6m. When using the TUBA appraisal software, costs should be inputted at this stage.

A.3.3 Sensitivity analysis recommends applying a range of uplifts from 0%-30% to investment costs and results in a cost range of £43.8m-£51.4m.

Table A4 Adjustment for Optimism Bias (£m, 2014 prices)

Calendar Year	Risk adjusted cost using QRA P(mean)		Total contribution of optimism bias to costs for the year		Risk and Optimism Bias adjusted cost	
	Investment	Operating	Investment	Operating	Investment	Operating
2016	15.29		2.29	N/A	17.58	
2017	10.02		1.50	N/A	11.52	
2027		2.05	0	N/A		2.05
2037		2.07	0	N/A		2.07
2047		5.09	0	N/A		5.09
2057		2.07	0	N/A		2.07
2067		2.10	0	N/A		2.10
2077		5.08	0	N/A		5.08
TOTAL	25.31	18.46	3.8	0	**29.10**	**18.46**

A.4 Re-basing to the Department's base year

A.4.1 The costs so far have been in real prices but in a 2014 price base year. For appraisal purposes the costs should be presented in the Department's base year. The costs can be deflated to the correct price base by multiplying them by the ratio of the inflation index in the desired base year to the inflation index in the year currently being used. Assuming a Departmental base year of 2010 (and an index value of 100 for that year) and 2% general inflation per year, the costs in each year should be multiplied by 100/108.2 = 0.924 to convert from 2014 to 2010 prices.

A.5 Discounting to the Department's base year

A.5.1 As discussed in TAG Unit A1.1, costs should be discounted and presented in present values. TAG Data Book table A1.1.1 provides the schedule of discount rates that should be applied from the year the appraisal is taking place. Our hypothetical appraisal is taking place in 2014. Therefore, in our example a discount rate of 3.5% per year should be applied until 2044, with a rate of 3% per year applied thereafter.

A.5.2 Therefore, to discount back to a 2010 base year, the discount factor that should be applied to the costs in 2016 is 1/(1.035^6) = 0.814; in 2017 is 1/(1.035^7) = 0.786 ; 2037 is 1/(1.035^27) = 0.3955; and in 2077 is 1/(1.035^34 x 1.03^33) = 0.116.

A.6 Converting to Market prices

A.6.1 The final stage in preparing the costs for appraisal is to convert them from the factor cost to the market price unit of account using the indirect tax correction factor (which can be found in the TAG Data Book).

A.6.2 Table A5 shows the results of applying the price base, discounting and market price adjustments (using an indirect tax correction factor of 1.190). The final scheme cost for use in appraisal is £31.4m and the investment and operating costs of £25.7m and £5.7m, respectively, are those that should be included in the appraisal tables. In this example all of the costs would fall on public sector providers and should be included in the PA table only.

Table A5 Transport Scheme Cost Estimate to be included in the TEE/PA Table								
Calendar Year	**Risk and optimism bias adjusted cost**		**Risk and optimism bias adjusted cost in 2010 prices**		**Discounted Risk and optimism bias adjusted cost in 2010 prices**		**Discounted Risk and optimism bias adjusted cost in 2010 market prices**	
	Invest-ment	Oper-ating	Invest-ment	Oper-ating	Invest-ment	Oper-ating	Invest-ment	Oper-ating
2016	17.6		16.3		13.2		15.8	
2017	11.5		10.6		8.4		9.9	
2027		2.1		1.9		1.2		1.4
2037		2.1		1.9	0.0	0.8		1.0
2047		5.1		4.7	0.0	1.4		1.7
2057		2.1		1.9	0.0	0.4		0.5
2067		2.1		1.9	0.0	0.3		0.4
2077		5.1		4.7	0.0	0.6		0.7
TOTAL	29.1	18.5	26.9	17.1	21.6	4.8	25.7	5.7