ArupScotland

Scottish Parliament

Edinburgh Line 1

Review of Business Case

FINAL

Scottish Parliament

Review of Edinburgh Line 1

Review of Business Case

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EXECUTIVE SUMMARY

Ove Arup and Partners (Arup) in association with Operis was appointed in October 2004 by the Edinburgh Tram (Line 1) Bill Committee to provide a review of the Edinburgh Tram Network Line 1 Business Case developed on behalf of Transport Initiatives Edinburgh (*tie*) / City of Edinburgh Council (CEC).

This review included the main documents produced by the scheme promoters for the appraisal and business case review, including the STAG (Scottish Transport Appraisal Guidance) appraisal document and appendices.

The scheme will be part of an overall strategy that will provide the city of Edinburgh with infrastructure to promote and support a growing economy and also tackle existing problems of social deprivation and an inadequate transport network.

The proposed scheme (Line 1) will form a loop in north Edinburgh between the city centre, Granton and Leith. The preferred route for the scheme is 22km in length, including 22 stop locations and will provide a service frequency of 8 trams per hour.

The demand forecasts for the Edinburgh Line 1 scheme are based on a series of multi-modal models, including models of land use interaction, which then are linked to detailed public transport and road traffic local assignment models. These local assignment models are used to forecast demand for the Line 1 scheme.

On the whole the overall modelling framework appears sound, however there are a few concerns regarding some aspects. For instance, the age of the data used to produce the demand forecast, which has been taken from the Central Scotland Transport Model (CSTM3) may be too old as most of the underlying data is over 15 years. Some of this data has been updated using global factors. However, we would expect a more robust and up to date data set to have been used as the basis for a scheme of this size. No validation of the local assignment models was presented.

Further, there are also concerns regarding the growth forecasts used. Firstly, growth in travel demand between the base year and the opening year is not presented and secondly, the growth in passenger demand between 2011 and 2026 appears high, at around 50%.

Although a 'limited bus network restructuring' is referred to, the forecasts assume a significant reduction in bus supply with the implementation of Line 1. For example buses per hour in Leith Walk (one of the main corridors of the route) are assumed to reduce from 49 to 27. Our view is that the scale of network restructuring is more than 'limited'. The inference is that the bus network restructuring reflects an assumption that bus operators will act in co-operation. There is no guarantee that such co-operation would occur, in fact it is more likely that the bus service response would be fare reductions and higher frequencies.

The passenger forecasts for the scheme were benchmarked against other existing UK Light Rail schemes. The benchmarking exercise showed that the Line 1 forecasts are near the top, if not above the range of values quoted for the existing Light Rail systems. In particular, passenger boardings per route kilometre are higher than any existing system.

In terms of overall benefits the scheme produces an NPV of £40m and a benefit / cost ratio of 1.21. It may be argued that a benefit / cost ratio of this level does not represent a particularly strong case in terms of economic value of a scheme. The economic case for the scheme could become marginal as a result of relatively small changes in costs or revenues.

In terms of benefits, the largest effects would be expected in those areas that enjoy a significant step change in their public transport accessibility. Of particular interest is Granton, which accounts for 65% of all public transport user benefit (trips both to and from the area). This makes the case for Line 1 very dependant on development in this area. The risk of Granton not delivering the expected patronage or if there is any delay to the expected development in Granton, could be problematic and could more than halve the public transport time benefits. It is of some concern that the scheme appears so dependent on benefits from one area.

Although the overall estimate of both the capital and operating costs would appear to have been correctly prepared and applied we consider that further clarification is required on a number of points. We also conclude that there is a significant shortfall in the available funding. We would also request further details of the measures proposed to reduce the number of buses on Leith Walk.

Operis has reviewed the financial aspects of the Preliminary Financial Case together with a financial model prepared by Grant Thornton. Operis has concluded that:

- In general the approach described in the Preliminary Financial Case is reasonable and robust for a project at this stage of procurement, given that the Outline Business Case has not yet been developed.

- The process leading up to key decisions which have been taken to date, are clearly set out and reasonable alternatives have been considered and assessed. Relevant guidance for assessing projects, including the Green Book, has been considered and applied.

- The risk analysis and risk management appears to be well developed, however it may be appropriate to specifically address the risks posed by the timing and availability of funding sources from property development and "Other" identified sources.

- One of the key outputs of the report in the Preliminary Financial Case is a comparison of the costs in Net Present Values (NPV) terms for the three procurement options identified to develop the infrastructure elements of the project (Full PFI, Hybrid and Up-Front Grant Funding). The NPV calculated show the Full PFI option is 52% higher than for the Up-Front Grant Option.

- The methodology used to calculate the Unitary Charges and NPV's, however, produce results which may cast the PFI options in an unfavourable light compared to the Up-Front Grant Option.

- An alternative approach to the calculation of the Unitary Charges for the same input data suggest the Net Present Value, NPV of the PFI option and the Hybrid Option lie within a range of values and that the NPVs identified in the Preliminary Financial Case sit at the top end of that range. Although the NPV of the Up-Front Grant Option remains lower the full PFI option is only 9% higher.

The Project would seem to place great store by encouraging an effective risk management culture and by drawing on the performance of comparable light rail projects. In the absence of QRA, CAPEX and programme contingencies are based on Optimism Bias (OB) uplifts. These have been estimated using the guidelines in HM Treasury's Green Book. The DfT's recent related guidance is mentioned, but no comparative assessment is made. It is considered that the OB uplifts would increase, if DfT's guidance were to be followed. Similarly, the Project's averaging of mitigation factors is likely to have lead to underestimating OB uplifts. Further justification of the likely cost of mitigation strategies should be provided.

1. INTRODUCTION

Terms of Reference

1.1 Ove Arup and Partners (Arup) was appointed in October 2004 by the Edinburgh Tram (Line 1) Bill Committee to provide a review of the Edinburgh Tram Network Line 1 Business Case developed on behalf of Transport Initiatives Edinburgh (*tie*) / City of Edinburgh Council (CEC). Arup has been assisted by Operis, who have undertaken an assessment into the financial aspects of the Preliminary Financial Case including performing a review of possible funding mechanisms for the scheme.

The Proposal

1.2 CEC is examining ways of providing the city with the transport infrastructure necessary to promote and support a growing economy and create a healthy, safe and sustainable environment. A key component of this objective is a strategy of public transport investment.

1.3 The Line 1 proposal is for a tram (LRT) in north Edinburgh forming a loop between the city centre, Granton and Leith. Other tram lines are proposed for Edinburgh, namely between the city centre and the west (Line 2), and between the city centre and the southeast (Line 3).

1.4 Separate STAG (Scottish Transport Appraisal Guidance) assessments have been undertaken for each line.

Documents Reviewed

1.5 As part of this review, Arup have reviewed the following documents available on the *tie* website:

- Edinburgh Tram Network STAG Appraisal: Line One, Transport Initiatives Edinburgh, 10 September 2004;
- Edinburgh Tram Network STAG2 Appendices: Line One, Transport Initiatives Edinburgh, 28 November 2003;
- Edinburgh Tram Network Preliminary Financial Case: Line One, Transport Initiatives Edinburgh, September 2004.
- CEC Land Use and Transport Interaction Model – Base Year Calibration and Validation Report, David Simmonds Consultancy, June 2002.

1.6 The STAG 2 Appendices document includes a long list of modelling technical papers produced by the consultants involved in the modelling of Edinburgh Tram. These include:

- Steer Davies Gleave (SDG) Table A.5.1 Notes 1-37 on Line 1 Modelling and Appraisal
- Faber Maunsell (FM) Table A.5.2 Notes 1-16 on Line 2 Modelling and Appraisal
- MVA Table A.5.3 Notes 1-16 on Development of TRAM and DAM models
- David Simmonds Consultancy (SDC) Table A.5.4 Notes 1-48 on Development of DELTA land use model

We have also received additional information from the technical advisers supporting *tie*. This has included the financial models used to develop the Preliminary Financial Case.

1.7 There are 117 technical notes in total, which apparently provide a comprehensive record of the work undertaken, but they were not available for this review. However, tables included within the STAG documents do provide a summary of the resolution of the issues discussed.

Scheme Description

1.8 The City of Edinburgh Council is examining ways of providing the city with the transport infrastructure necessary to promote and support a growing local economy and to create a healthy, safe and sustainable environment. This is part of a £1.5 billion New Transport CEC Initiative being undertaken, in co-operation with other local authorities in the vicinity of Edinburgh. As a key component of the strategy of public transport investment in Edinburgh, the council is proposing to develop a network of modern light rapid transit rail systems, or trams. The tram system is being developed in stages and will focus on the major city transport corridors.

1.9 Line 1 of the Edinburgh tram network, the Northern Loop, links the City Centre with Granton, Newhaven and Leith, passing through the Waterfront development area and then along the line of the former Roseburn Railway to Haymarket. This line is expected to provide a number of positive benefits for the area, including economic regeneration and improved accessibility.

1.10 A number of aims are stated in the City of Edinburgh Council's Local Transport Strategy:

- to improve safety for all road and transport users;
- to reduce the environmental impacts of travel;
- to support the local economy;
- to promote better health and fitness;
- to reduce social exclusion; and
- to maximise the role of streets as the focal point of local communities.

1.11 North Edinburgh has demonstrable social deprivation and, in economic terms, performs below average when compared with the rest of the City. Unemployment is higher than the City average while skills and qualifications are below average. There is a high dependency on public transport, yet poor accessibility is highlighted as one of the key obstacles to residents gaining employment opportunities.

1.12 Studies examining the North Edinburgh public transport network have highlighted its apparent inadequacies and the degree to which congestion affects journey times, punctuality and regularity. Previous studies have already highlighted the potential of new and improved bus links. Connections to potential employment opportunities in Leith and the west of Edinburgh are inadequate, creating social exclusion problems. This has been identified in the North Edinburgh Public Transport Strategy and has recurred in several other studies on transport in the north Edinburgh area. Line 1 will not only improve existing connections with the north of the city, but also create much-needed links with the west.

1.13 The Waterfront Masterplan is predicated on the provision of high quality public transport. Studies that have preceded this one have already highlighted that additional public transport capacity will be required and that the development related public transport element will only occur if there is a step-change in the quality of public transport.

1.14 North Edinburgh's road network already experiences peak hour congestion and has a significant problem associated with drivers 'rat-running' through the area. Without a step-change shift to public transport, general economic and local regeneration is forecast to place increasing pressure on the road network.

1.15 The preferred route comprises:

- 15.5 km of double track infrastructure (with 0.520 km of single track at St Andrew Square);
- 58% off street; and
- 22 proposed stop locations.

1.16 Wherever possible, a segregated alignment has been proposed (where the tram operates on dedicated tramway or tramroad) so that the system can maintain speed and frequency and reliability of service without interference with other traffic. The alignment is effectively double track, clockwise and anti-clockwise running, throughout its length, with the exception of the one way loop at St.Andrew Square (approximately 520m long).

Structure of the Report

Section 2 of this report describes the modelling approach while Section 3 provides an overview of the passenger and revenue forecasts. Sections 4 and 5 present a review the economic evaluation of the scheme and the results of a number of sensitivity tests respectively. Section 6 assesses the accuracy of the operating costs and capital costs. Section 7 considers the financial modelling of the scheme and assesses potential funding mechanisms while Section 8 addresses the issues surrounding the assessment of Risk. Finally, Chapter 9 presents our Conclusions.

2. MODEL DEVELOPMENT

Introduction

2.1 Demand forecasts for Edinburgh Line 1 are based on a series of multi-modal models, including models of land use interaction. Such models need to have a sound basis (good validation of model outputs with observed data) and an appropriate forecasting procedure. Such models provide outputs of impacts on both users and non-users of the proposed LRT system.

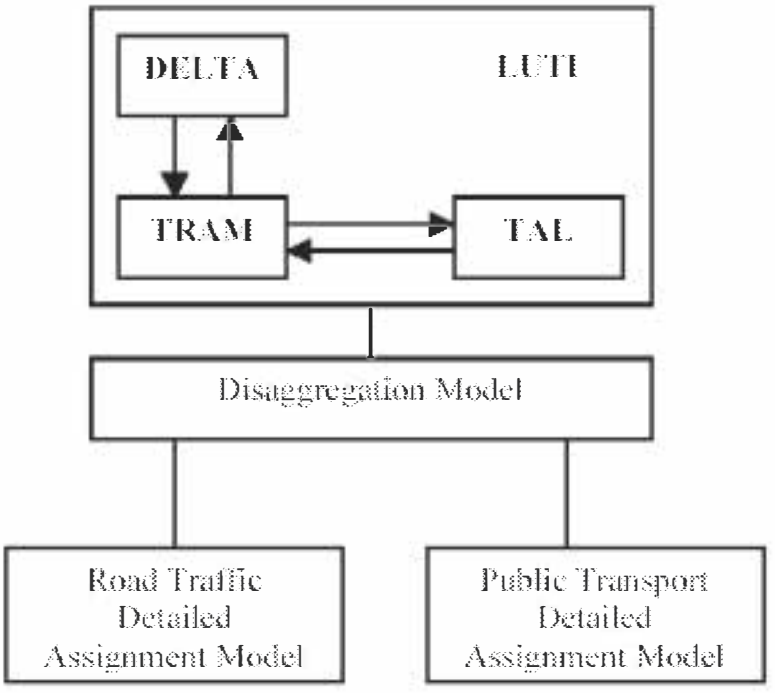
2.2 A second level of modelling provides estimates of tram run times. These are a vital component of the attractiveness and operating costs of the system, particularly when mixed traffic running sections are required.

2.3 It is understood that the model specifications and methodologies were developed to maintain consistency between the Line 1 and Line 2 assessments. However, it is not clear what the significance of impact of any compromise might be on the Line 1 forecasts.

Overall Model Structure

2.4 The overall model structure is illustrated in the following graphic (extracted from the STAG 2 Appendices document):

Figure A.1: Model Hierarchy



2.5 At the top level of the model hierarchy lies a strategic land use – transport interaction model, consisting of the TRAM (Traffic Restraint Analysis Model) transport model and the DELTA land use model covering the Edinburgh, Lothian and South Fife areas. This considers the full range of travel responses to transport and land use changes, including trip frequency, destination, mode and time of day with a baseline scenario at 2001.

2.6 Whilst LUTI is sufficiently detailed to forecast plausible high-level responses to transport interventions, detailed TRIPS assignment models (DAM) were developed covering the same geographic area as the TRAM model. Data was derived from the Central Scotland Transport Model (CSTM3), for which sub-models were extracted using a cordon process but with added detail in the LRT corridors. The DAM models (for highway and for PT) are used to forecast detailed patronage estimates for Edinburgh Tram and the associated impacts on the bus network and the highway network.

2.7 We are somewhat surprised that "skim" data for input into the TUBA model (STAG Report, page 146) comes from the LUTI model, rather than from the DAM models, particularly considering that the LUTI "does not contain sufficient network detail to identify… public transport services." After querying this with SDG it was stated that output from the DAM was used for the TUBA model. Clearly one of these statements is incorrect.

2.8 This model structure seems appropriate as a framework to capture the principal effects. However, important issues are consistency and model equilibrium (convergence and stability issues), and disagregation (passing information from relatively coarse land use zones to fine assignment zones). Care must be taken to ensure that real effects are not masked by model noise, which can be an issue in wide area models.

2.9 The models are based on demand data from CSTM3. There are some queries regarding the "age and lineage" of these data which is of concern. It appears that some data comes from the late 1980s and could, therefore, be 15 years old. We would expect that a model of this type, used to justify major expenditure, would have recent, certainly no more than 5 year old, origin-destination data. Whilst there are some comments in document no 14 (MVA) about the use of 2001 census data, it is not at all clear whether these data were used.

Study Area and Zone Systems

2.10 The extent of the study area modelled embraces all the potential effects, city-wide. The strategic choice/land use interaction model zoning, comprising 88 zones, appears appropriate. The modelled zone systems for the assignment models are more detailed, although the number of zones is not apparent.

2.11 The cordoning down of the CSTM3 model to create study area models is standard practice. These models will provide greater focus on the study area and the opportunity has been taken to incorporate additional local detail.

Market Segments and Modes

2.12 We have been unable to ascertain the segmentation of the demand by purpose, although there is some discussion on the work: non-work split. We are therefore unable to comment further.

Crowding and Capacity

2.13 The highway assignment model is capacity restrained, taking account of delays at junctions and effects of other traffic. This should ensure that realistic volumes of traffic use the available routes.

2.14 For public transport modes (currently bus and rail), the effect of crowding can be significant and the modelling of this is not always straightforward. This can have a significant bearing on the loadings predicted and the economic evaluation of passenger benefits. It is not clear whether the DAM PT model includes the effect of crowding.

2.15 The appraisal report is not clear on how highway capacities have been adjusted when sharing with tram. After requesting further information it was stated by the Promoter's consultants that for segregated running a lane was removed from the model coding and for shared running modelled lane capacities were reduced by 20%. Junction layout coding was modified to reflect the proposals developed during the design process. No detailed coding was made available for review. Also, the modelling of other features such as greenways, Controlled Parking Zones (CPZ), bus speeds, etc are discussed but resolution seems uncertain.

Model Periods and Years

2.16 The modelled time periods (morning and evening peak hour and average inter peak hour) are typical and cover the period of greatest demand for the system. However, expansion of the results to non-modelled periods such as evenings and weekends must be undertaken with care. Important considerations will include the seasonality, for example, of tourist segments.

2.17 The base year for the modelling is 2001 (although original data dates from the late 1980s). Forecast years of 2011 and 2026 have been used. These are typical and sufficient to construct a profile of demand in future years. Initial build-up assumptions are discussed below.

Base Year Demand

2.18 The base year demand is derived from CSTM3 which is based on original OD data from the late 1980s. There are likely to be significant differences between scale and distribution of travel patterns in the intervening years and it is questionable whether such data forms a sufficiently robust basis for producing future year forecasts.

Mode Choice Modelling

2.19 There is some debate in the modelling technical papers summary table over mode choice modelling. Document 6 (SDG) suggests modal constants of 15 minutes and 10 minutes for peak and inter peak respectively. However, document 5 (final specification) states "modal constants are not used". The text of the STAG Appendices concurs with the latter document and we therefore assume that this procedure was adopted. However, document 5 also notes that no interchange penalties were included and that tram fares were to be set at 33% above bus fares. This contradicts para A.3.1 which indicates interchange penalties of 5 to 10 minutes and tram fares equal to bus.

2.20 We have assumed that the text of the STAG Appendices reflects the latest or final position; the inclusion of comments on the technical notes is misleading unless the final position is made absolutely clear.

2.21 A factor of 0.8 is applied to tram in-vehicle time. This is presumably a proxy for a mode constant but we fail to see why this factor is applied, which effectively improves the position of tram compared to both rail and car and would lead to, with all other things being equal, higher tram patronage and revenue. No justification for this factor is apparent.

Model Validation

2.22 Demonstrating the ability of the models to reproduce existing transport demand to within acceptable tolerances is a vital step before using the models to forecast future conditions. Whilst a detailed report was made available detailing calibrating the LUTI model, there is no reporting of an independent validation, particularly of the local assignment model (DAM), which was used to produce the Line demand forecasts.

2.23 After requesting further information about the base year model validation of the local assignment models, we were informed that the validation is set out in the CSTM3 Final Highway / Public Transport Assignment Model, Calibration and Validation Reports, August 2000 produced by MVA. It was noted that these reports present a 1997 model validation and this was considered 'sufficiently robust' for the development of this model. Copies of these reports were not made available for this review. However, given that the DAM model was used to produce the Line 1 forecasts, we would have thought that a base year (2001) model validation would be essential.

2.24 The STAG Appraisal report does note that some validation checks were undertaken of the assignment in the 2001 public transport model. However no detailed results of these checks are presented. It is stated that the results of these checks noted a consistent tendency for the model to underestimate the demand by 10%. This is an average factor with variation noted between locations (no reference was made to variations between time periods). No explanation is given and no investigation or model interventions are described. The subsequent demand and revenue forecasts for Line 1 have simply been scaled by +10%.

2.25 There may be various reasons for this systematic underestimation of base year public transport demand (such as non-modelled trips or very short trips not captured in surveys). However, the solution seems rather broad brush.

3. OVERVIEW OF PASSENGER AND REVENUE FORECASTS

Forecasting Optimism

3.1 In view of the tendency for project costs to be underestimated at the planning and evaluation stage, HM Treasury requires the use of optimism bias factors. However, these are not generally applied to demand and revenue.

3.2 Nonetheless, recent experience does suggest a tendency to be over-optimistic in demand forecasts, even when allowance is made for initial build up and maturity of the system (usually five years). For example, the National Audit Office (NAO) report *Improving public transport in England through light rail* (April, 2004) found that actual passenger numbers fell well short of expected patronage levels in three out of five case studies, with shortfalls in the range 24-45%. In the case of Sheffield, this was despite subsequent additional measures to boost patronage. Manchester Metrolink Phase 1 was the only system to exceed forecast patronage, although there was a shortfall on Phase 2 (with an overall surplus of 5%). The NAO results are reproduced below in Table 3.1. The average of the four systems indicates an overall shortfall in patronage of 25%.

Table 3.1: NAO Case Study Summary

System	Patronage (Millions of Passenger Journeys)			Difference Between 2002-3 Patronage and Expected Annual Patronage
	Expected Annual Patronage	Patronage in First Full Year of Operations	Patronage in 2002-03	
Sheffield Supertram	22.0	6.6 (1995-6)	12.0	45% (shortfall)
Midland Metro	8.0	4.8 (1999-2000)	5.0	38% (shortfall)
Croydon Tramlink	25.0	15.0 (2000-01)	19.0	24% (shortfall)
Manchester Metrolink Phase 1	12.0	11.0 (1993-94)	19.0	5% (excess)
Manchester Metrolink Phase 2	6.0	3.0 (2001-02)		
Average	73.0	40.4	55.0	25% (shortfall)

3.3 The implications of these findings, if representative of methodologies and local circumstances, are that there should be some caution in accepting the forecasts made for Edinburgh Line 1 at face value. On the basis of the precedents illustrated by NAO, and notwithstanding the stated 'conservative' approach to forecasting for this scheme, it would be prudent to examine the effect of a downward shift in the demand and revenue forecasts. This is elaborated further under sensitivity testing.

3.4 The Line 1 appraisal does acknowledge that commercial funders are likely to assume as their base case revenue at or around 50% of the promoter's revenue case (STAG Appraisal Line 1, p 182).

Travel Growth

3.5 Information on the travel growth assumptions is inferred from STAG 2 Report Table 7.5, although SDG provided information for the Base Year (2001). Tables 3.2 and 3.3 set out the growth for the reference case, or do minimum, and for Line 1 (based on Table 7.6) demand respectively as percentage growth over the period 2011-2026.

Table 3.2: Modelled Travel Growth Reference Case (%)

	AM Peak	Inter Peak	PM Peak	Daily
2001 – 2026				
PT Passengers	16%	23%	23%	20%
Cars/LGVs	51%	53%	49%	51%
Total	43%	47%	44%	45%
2011 – 2026				
PT Passengers	6.5%	3.7%	9.9%	7.1%
Cars/LGVs	26.8%	23.2%	25.4%	25.4%
Total	22.6%	19.8%	22.7%	21.9%

Table 3.3: Modelled Travel Growth 2011-2026 Line 1 (%)

	AM Peak	Inter Peak	PM Peak	Daily
PT Passengers	58.1%	22.9%	58.4%	50.3%
Cars/LGVs	58.5%	26.9%	38.7%	44.4%
Total	58.2%	24.8%	49.6%	47.5%

3.6 Predicting short term growth is difficult; however, attempting to forecast growth during the latter years of the evaluation is more so. Most of the business cases for UK LRT schemes assume a levelling-off of growth during the latter part of the evaluation period, reflecting the risks inherent in forecasting so far into the future. This does not appear to be the case for Edinburgh, where growth from 2001 to 2011 is approximately 1.75% per annum and from 2011 to 2026 approximately 1.02% per annum.

3.7 We conclude that the growth between these later scheme years seems high. It is also notable that the growth in public transport usage is much lower than that for cars/LGVs. This is particularly the case for highway trips, for which high levels of congestion are reported in the Reference Case in later years. Also, the growth is lower in the inter peak when the effects of capacity and other restraints will be less. It is, therefore, somewhat surprising that the growth in Line 1 demand is so high when the majority of demand comes from bus abstraction. We conclude that 50% growth, which, over the 15 year period, equates to annual year-on-year growth of 2.6%, appears high.

Sources of Line 1 Patronage

3.8 A useful check of the sense of model forecasts is the source of patronage. This is the shift from other public transport, from car, completely new demand and so on. There is insufficient information to comment on the complete breakdown. In fact, Section 7.2.3 of the STAG appraisal notes that the model does not enable the transfer from car to be established explicitly. We requested further information regarding the breakdown of the source of Line 1 patronage and were informed that the model does not allow this breakdown to be produced. Whilst this appears to be a function of the modelling software used, it means we are unable to comment on the validity of source of the Line 1 patronage. However, our interpretation of Tables 7.5 and 7.6 is that in the AM Peak newly generated demand is some 23% of Line 1 demand, and in the inter-peak, it is some 45%. These figures seem high, but this may be down to our interpretation.

3.9 A comparison of forecast demand with system capacity was undertaken. This showed that in the AM Peak in 2026 the forecast demand was significantly above capacity, with a forecast of approximately 2400 passenger per hour, compared with a capacity of 1800 passengers per hour, approximately 33% above capacity. It is noted that this level of demand could be serviced by providing additional trams by 'fine tuning' the service timetable.

Princes Street

3.10 Princes Street is the core of the network. Effective layout for speed of operation (minimising dwell time avoiding traffic delays) will be important to make the line attractive to passengers.

3.11 The impact on displaced westbound traffic is not apparently accounted for in the evaluation (design freeze at that stage). The impacts on this displaced traffic, and the impact that that traffic may have on others, have not been accounted for.

Bus Networks and Competition/Integration Effects

3.12 The Central Case assumes integrated bus network restructuring in response to the tram, including service reductions on competing corridors. There is a risk that this may not be achieved. The sensitivity of including status quo bus operations was tested; this is referred to as a competitive response.

3.13 However, a more reasonable test which is a standard test for UK Light Rail systems would be a competitive adaptation of the bus network in response to the competitive challenge of the tram and assumed land use changes. For example, more intense competition on the busiest and most profitable corridors, or the opportunity for new services to new generators such as Granton-City Centre.

3.14 Overall, our view is that the downside risk of competitive bus activity has not been adequately explored. This is discussed in more detail later in this review.

Congestion charging

3.15 Edinburgh is proposing a twin cordon road pricing scheme. This is not in the Reference Case because it is not a committed scheme. In general, such a scheme may be expected to have positive impacts on public transport demand in general and help the case for the tram.

3.16 However, there may be some unaccounted for downside of not including the scheme in the Reference Case. The scheme may provide particular benefits to competitive bus operations as a result of traffic reduction, such as scope for more bus priority.

3.17 In addition, the road traffic time and vehicle operating cost savings constitute a large part of the overall case for the tram. This is based on high levels of road congestion in the Reference Case. There is a risk that if the road pricing scheme is introduced, this large apparent benefit will be eroded.

Benchmarking

3.18 In order to verify the realism of the system and revenue characteristics of the proposal, the STAG 2 appraisal includes benchmarking comparisons with current UK systems (p 187). We concur with this approach and have, from our own experience, been able to confirm that the comparisons reported are similar to those available to Arup.

3.19 Variations from the typical observed values must be explained by local conditions or other special circumstances. Table 3.4 summarises some of the key comparisons using data available to Arup. The Edinburgh Line 1 forecasts are taken from STAG 2 Appraisal Tables 8.1 and 8.2.

Table 3.4: Benchmark Comparison of Selected Characteristics

System	Stop Frequency (km)	Annual Passenger Boardings per Stop (m)	Boardings per km (m)	Passenger km per route km	Average trip Length (km)	Revenue per Passenger (£)	Revenue per tram km (£)
Manchester Metrolink	1.1	0.51	0.46	3.52	7.6	1.10	4.37
Sheffield Supertram	0.6	0.25	0.39	1.34	3.4	0.67	3.17
Midland Metro	0.9	0.21	0.24	2.45	10.4	0.81	2.44
Croydon Tramlink	0.7	0.48	0.65	3.51	5.0	0.71	5.38
Average of Tramways [1]	0.8	0.36	0.43	2.70	6.6	0.82	3.84
Edinburgh Line 1 (2011)	0.7	0.41	0.60	2.91	4.8	0.70	5.10 [2]
Edinburgh Line 1 (2026)	0.7	0.60	0.88	4.20	4.8	0.70	7.40 [2]
Edinburgh Line 1 2011 Differences	-0.2	-0.21	-0.15	-0.95	-1.1	-0.08	+0.11
Edinburgh Line 1 2026 Differences	-0.2	-0.20	+0.13	+0.34	-1.1	-0.08	+2.41
Edinburgh Line 1 2011 Differences (%)	-29	-34	-20	-25	-19	-10	+2
Edinburgh Line 1 2026 Differences (%)	-29	-3	+15	+9	-19	-10	+48

[1]Average of systems broadly comparable with Edinburgh Line 1

[2]STAG 2 Report Table 8.2 expresses this as £m

3.20 The results in Table 3.4 show that, on the basis of these criteria, the characteristics of Edinburgh Line1 are generally higher than the expected range of variability given the unique context of each system. The stop frequency is at the lower end of the scale. However, the passenger density, expressed in terms of passengers per stop, passengers per km and pass-km per route km, indicate that the Edinburgh system performs better than the average of existing systems. The projected revenue per passenger is close to the observed average. However, the revenue per tram-km is higher than the average in 2011, exceeded only by Croydon.

4. ECONOMIC EVALUATION

Introduction

4.1 This section covers the parameters used in the economic evaluation, together with our interpretation of some of the benefits set out in the economic appraisal summary tables (Transport Economic Efficiency - TEE tables).

Fares

4.2 The treatment of ticket type allowance / concessions is based on data from Lothian Buses and appears reasonable. Fare evasion is assumed to be 5% which again appears reasonable although no justification for the use of this figure is given.

Patronage Build-up

4.3 The ramp up period to reach a steady state of patronage is 75% of demand in year 1, 85% in year 2 and 95% in year 3. This is a reasonable assumption.

Annualisation

4.4 Annualisation for cars is based on household survey data. For public transport, factors are based on the proportion of frequencies which seems odd. However, the annualisation factors are broadly in the range we would expect.

Generated Demand

4.5 The actual approach used to forecast generated demand is somewhat confused. Some of the modelling technical papers imply the use of 15% of off peak demand, which is a standard approach adopted for business cases for other UK systems. However, document 14 (Faber Maunsell), suggests that this may be double counting as generated demand is also included within LUTI. There are no subsequent technical papers that indicate that this approach was modified. However, section A.3.5 of the STAG Appendices states "no additional allowance is made for generated trips beyond that estimated in TRAM". We therefore assume that this is the final position. However, our interpretation of the figures presented suggests that the level of generated demand appears high.

Economic Benefits Summary

4.6 Table 4.1 summarises the main outputs from the TEE table for the Central Case. This shows a benefit / cost ratio for the Central Case of 1.21. It may be argued that a benefit / cost ratio of this level does not represent a particularly strong case in terms of economic value of a scheme. The economic case for the scheme could become marginal as a result of relatively small changes in costs or revenues.

Table 4.1 – Central Case – TEE Table Summary (£m, 1998 values and prices)

PRESENT VALUE OF BENEFITS	£236
Present Value of Costs	-£195
Net Present Value	£0.04
Benefit Cost to Government Ratio	1.21

Spatial Distribution of Public Transport Benefits

4.7 The STAG 2 Report presents the results of the evaluation in a TEE Table (Table 7.24). Tables 7.25 and 7.26 present the time benefits for public transport users and car users by thirteen sectors. Each sector represents a compression of 352 model zones. This spatial analysis allows the location of 'winners' and 'losers' as a result of the proposals to be identified. The thirteen sectors may be further split into internal and external areas. The 'internal' Line 1 study area comprised the City Centre, Haymarket, Leith, Granton, North LRT, Leith Docks and the Railway corridor. The 'external' area comprised South Edinburgh, East Edinburgh, West Edinburgh, Fife and North Scotland, West Scotland and South and East Scotland.

4.8 Most of the benefits would be expected within the internal-internal quadrant. A second order effect would be expected between external-internal and internal-external quadrants, with little or neutral effect expected between external areas. (Note: no mapping of zones or sectors was available).

4.9 The total public transport user benefits amount to £125m (PV). The internal-internal quadrant of the matrix, comprising the city centre and the north of the city forming the immediate catchment area of Line 1, accounts for over £95m time benefits (75% of the total). Movements in and out of the internal area (E-I and I-E) account for 25% of the total. In general terms these proportions seem reasonable, however, it should be noted that the matrix is rather asymmetrical.

4.10 Of particular interest are the following (the totals do not sum to 100% because of trips between the sectors):

- City centre (Sector 1). This sector accounts for £38m or 30% of the total public transport time benefits.
- Haymarket (Sector 2). This sector accounts for £21m or 17% of the total public transport time benefits.
- Leith (Sector 3). This sector accounts for £6m or 5% of the total public transport time benefits.
- Granton (Sector 4). This Sector alone accounts for nearly £82m or 65% of the total public transport time benefits.
- North LRT (Sector 5). This sector accounts for -£2m disbenefits, or less than -1% of the total public transport time benefits.
- Leith Docks (Sector 6). This sector accounts for £15m or 12% of the total public transport time benefits.
- Railway Corridor (Sector 7). This sector accounts for £62m or 49% of the total public transport time benefits.

4.11 The largest benefits would be expected in those areas that enjoy a significant step change in their public transport accessibility. Areas already served by high frequencies of buses, for example between Leith and the City Centre, may actually be disbenefited by the proposals.

4.12 Of particular interest is Granton with the case for Line 1 very dependant on development, trip making and benefits from this area. The risk of Granton not delivering the predicted number of trips would be a severe problem and could halve the public transport time benefits. Benefits between the city centre and Granton alone accounts for £27m (22%); this could be subject to a competitive threat from new direct bus service much shorter than the tram loop.

4.13 Trips to and from Leith Docks constitute only 12% of public transport time benefits.

Spatial Distribution of Highway Decongestion Benefits

4.14 A similar spatial analysis is presented for car time-savings. External-external car trips (those within Sectors 8-13) amount to £32m (PV) or 38% of the total. This seems a large contribution given that mode shift and decongestion would be expected to be very small and very diluted in these areas remote from the scheme.

4.15 Again, there are some unexplained asymmetries in the matrix of benefits presented (Table 7.32 of the STAG Report – page 151). For example, car trips from Haymarket (Sector 2) contribute £37m, whereas car trips to Haymarket sector suffer £26m dis-benefit. This could be a quirk of expansion from the AM peak models, but should be investigated further before reliance is made on these large predicted effects. A similar effect is noticeable in the results for West of Scotland (Sector 12).

4.16 The spatial presentation of these benefits raises questions that can only be answered by close inspection of the model to confirm (or otherwise) that these are 'real' effects and not the result of model instability or lack of realism, particularly in the Reference Case highway assignment model in 2026.

Non-User Benefits

4.17 Non-public transport users (cars and freight) are forecast to provide roughly equal levels of benefits (£112m or 49%) as public transport users (51%).This includes Vehicle Operating Costs. The scale of this contribution seems very large. The STAG 2 Report (page 146) attributes this to very high delays in the Reference Case in 2026 which is relieved by the modal shift caused by the tram. If this is the case, then the realism of the Reference Case should be interrogated further.

4.18 The STAG appraisal goes on to acknowledge that "model noise" may contribute to the scale of non-user benefits resulting in benefits to travellers in area remote from the tram (Fife and East Lothian). Therefore, a review of the distribution of benefits was undertaken. Following this *"some £109M worth of non-user benefits were deducted from those predicted by the demand model"*. This is misleading as it implies that non-user benefits should equal some £3m (£112m-£109m). However, it is apparent that the central case non-user benefits are £112M. This implies that prior to the adjustment, these benefits were £221M (£112M + £109M).

4.19 One final observation is that no such adjustment was made to user benefits; if a similar adjustment were made, user benefits would be reduced by some 5%

Freight Benefits

4.20 The November 2003 STAG report presented Freight benefits of £75m (Table 7.24 page 145), approximately 25% of the total user benefit, which we found to be rather high, considering the nature of the scheme. The freight benefits presented in the current version of the STAG report have been reduced to £19m (8% of total user benefit). However, the STAG report does not refer to the source of these benefits or why the benefits have reduced between the two versions of the appraisal report. Further information provided stated that these benefits are as a result of the change in demand of Light Goods and Heavy Goods vehicles in response to the implementation of Line 1. This infers that as a result of Line 1 there is a decrease in overall journey time or an increase in demand for Light and Heavy Goods vehicles.

5. SENSITIVITY TESTING

Introduction

5.1 A section of the STAG Appraisal document covers sensitivity testing and risk. In addition, a benchmarking exercise was carried out comparing Line 1 to existing UK LRT systems. Whilst most of the key indicators quoted are comparable, it should be noted that Line 1 is near the top of the range of values quoted. In particular, passenger boardings per route kilometre are higher than any existing system.

Spreadsheet Sensitivity Tests

5.2 Spreadsheet sensitivity tests were undertaken to establish where the NPV would fall to zero if capital costs increased, operating costs increased or benefits decreased. Whilst there appears to be some leeway if each of these individual elements were changed, a combination of these outcomes, e.g. increased capital costs and reduced benefits, would require smaller changes for the NPV to reduce to zero.

Model Sensitivity Tests

5.3 Model sensitivity tests were undertaken relating to changes in bus competition, modal constants, tram frequency, tram run time and work split. Our view on the bus competition test is that the bus network restructuring is by no means guaranteed and the scenario modelled as the sensitivity test could easily be regarded as the central case. The NAO review of UK light rail schemes found that patronage was overestimated by an average of 25% during project development. The bus competition effect reduces Line 1 patronage by around 13%. We consider that this is one of the major risks of not achieving these forecasts.

5.4 Most of the other sensitivity tests give plausible responses. It should be noted that a combination of all down sides gives an operating surplus of -£2.50m in 2011.

6. OPERATING AND CAPITAL COSTS

6.1 In the revised Preliminary Financial Case, PFC, dated September 2004, the Capital Cost of Line 1, at undiscounted second quarter 2003 prices, is given as:-

Base Cost	£ 219,320,000
Contingency	£ 23,730,000
Optimism Bias	£ 31,100,000
Total	£ 274,150,000

The base cost and contingency totals are unchanged from those quoted in the December 2003 PFC, even though some scheme development has taken place in that time. The net change in capital cost of the project due to this is probably quite limited, but it would be worthwhile establishing what changes there have been since December 2003, and what the estimated cost of these changes is. The following elements may need to be allowed for:-

- CETM, especially its effect on the works in Princes Street. It is unclear whether this was included in the initial PFC/STAG costings.
- Adjustments to the alignment on the section from Granton and Leith.
- Any revisions in the vicinity of Haymarket Station.

6.2 Subject to the comments below, the overall estimate of the capital cost seems to have been rigorously and thoroughly prepared using a database of costs and comparison to other UK Light Rail Schemes, and is a sound basis for the build-up of capital cost.

- No specific mention is made of the cost of enhanced paving, stops etc to comply with CEC's aesthetic requirements as detailed in the design manual.
- Utilities Diversions have been estimated to cost £31.8M, unchanged from the earlier December 2003 Estimate. This allowance does not seem unreasonable, corresponding to approximately £4M per kilometre for on-street sections, but some of the estimates have very few details (especially BT – see Appendix E of the STAG appendices), and hence could increase substantially. It is of some concern that no updated figures have been obtained since the earlier December 2003 estimates.

6.3 The capital cost allowance for Optimism bias has been reduced from £44,259,000 in the December 2003 PFC to £31,100,000, giving a reduced Total Capital Cost of £274,150,000. As detailed on Page 68 of the associated revised STAG appraisal, this capital cost estimate relates to the gross capital expenditure prior to commencement of operation of the system, with no offset allowances in respect of revenue, contributions or concession values. In recent years Contractors' willingness to take these risks has greatly reduced, which means that the additional costs for these elements could be significant.

6.4 Whilst considerable progress has been made by *tie* in addressing the revenue risk transfer to the Contractor, account still needs to be taken of the cost of all this risk, including the part of the revenue risk that would be carried by the public sector.

6.5 The following potential additional costs need to be considered in determining the overall capital cost:-

	£M
• Cost of the proposed £44.6M future expenditure on replacement and renewals. (Revenue is unlikely to be sufficient to make any significant contribution to this cost).	22
• Notional allowance for a capital sum to cover risks of future revenue shortfall. (Borne by Contractor or the Public Sector).	20
• Discounted cost of 2 new trams for the year 2026.	1.5
Total	43.5M

Given the major approximations and interpretations involved in the above calculation, a substantial allowance needs to be made for variations in this additional sum, say +£30 – 50M. This provides a total Capital Cost for Line 1 of £304 – £324M.

6.6 The funding of Line 1 from the Executive Grant is quoted in Paragraph 1.5 of the Preliminary Financial Case as being £33M less than the estimated project cost excluding the impact of optimisation bias. Thus, the amount of the Executive Grant that is proposed to be applied to Line 1 is £274-31-33M = £210M.

6.7 On this basis, using the increased Capital Cost of £304-324M, additional funding of £94-114M would be needed from other sources if all of the features in Paragraph 1.7 were to be allowed for. A private developer contribution of £11.6M is quoted on page 5-9 of the revised STAG Appraisal, which leaves a short-fall of approximately £82-102M if account is to be taken of those factors. A strategic decision is needed on which, if any of these factors should be included in the evaluation of the initial available funding.

Scheme Operating Cost and Revenue

6.8 The Annual Operating cost as given in the PFC has been assessed, and, amounting to a cost of £4.80 per vehicle kilometre, compares well with the cost of other tram systems. This cost has been slightly revised from those given in the earlier (December 2003) Preliminary Financial Case, following input from the Operator, Transdev. It is noted that an operating cost of 5.82M per annum is given on page 76 of the updated STAG report, but this excludes, inter-alia operator profit.

6.9 The Annual Revenue is given in the PFC as £6,567,434 in 2011 and £9,564,397 in 2026. These figures are unchanged from those in the earlier PFC. Given that the operating cost is £6.3M per annum, this leaves only a small excess of revenue compared to cost in the early years, with the consequences that:-

- Any significant reduction in revenue would mean that costs exceeded revenue. As a result of this, there is a substantial risk of revenue being insufficient to cover the costs.
- Other funding should be allowed for to finance the life-cycle costs of £44.6M.

6.10 It is also noted that there is quite a high rate of earning per tram kilometre forecast, namely £5.07 in 2011 and £7.40 in 2026. This can be compared to current rates of £1.63 to 4.65 on the other current modern LRT systems in the UK. This figure may therefore be somewhat optimistic.

6.11 A key element in the operating cost/revenue analysis for Line 1 is its ability to carry sufficient passengers along Leith Walk, where there is currently an extensive service provided by buses. With respect to this, the following should be noted:-

- 49 buses per hour currently operate each way in Leith Walk, but a reduction to 27 per hour is proposed. This may be difficult to achieve without creating a "Quality Contact Scheme" as in Part 2 of the Transport (Scotland) Act 2001. No indication is given of whether such a scheme is proposed This should be clarified.
- Even with a reduction in the number of buses to 27 per hour, it seems unlikely that almost half the number of passengers will travel on the tram.

6.12 Further explanations should be sought on the feasibility of achieving this number of passengers on the tram. Dependant upon the responses on this, a re-evaluation of the overall business case may be needed.

7. FINANCIAL MODELLING AND FUNDING MECHANISMS

7.1 In partnership with Arup, Operis has been appointed by the Edinburgh Tram (Line 1) Bill Commitee to review the Preliminary Financial Case prepared on behalf of the promoter of the Edinburgh Tram (Line One) Bill, *tie*.

Approach

7.2 Operis has reviewed the financial aspects of the Preliminary Financial Case together with a financial model prepared by Grant Thornton used to calculate the Net Present Values and estimated Unitary Charges of three alternative procurement options for the provision of design, infrastructure and system integration services for the above project.

7.3 In conducting this review Operis has carried out a review of the information provided, undertaken arithmetical checks on the calculations used in the Preliminary Financial Case; commented on the assumptions used and analysed the approach used in the report. From this review and analysis Operis has drawn a number of conclusions.

Review of Information Provided

7.4 Operis has based their review on the "Line One Preliminary Financial Case – Update September 2004" prepared for Line 1 by Grant Thornton on behalf of the City of Edinburgh Council. Operis has also reviewed a financial model prepared by Grant Thornton to support the calculations and results contained within the Preliminary Financial Case.

Sections 1-4 of the Preliminary Financial Case provide background to the project and progress made to date while Section 5 examines the risks involved in the project.

Section 6 sets out the procurement options which have been considered and describes the steps taken to arrive at the decision to procure the operator and the infrastructure separately. It also sets out the steps that have been taken to date to appoint a preferred bidder for the Operator role. Section 6 also examines the procurement options for the provision of the infrastructure elements. Each has a different split of the tasks required and differing numbers of procurement exercise. Not all of these are noted as being suitable for the Private Finance Initiative (PFI).

This section concludes that it is appropriate to adopt option 2 which recommends two procurement exercises: one for the tram vehicles and the other for design, infrastructure and systems integration. It also concludes that once the tram procurement contract has been agreed it would, in the case of a PFI approach being adopted, be novated to the successful bidder for the other procurement thus making a single infrastructure contract.

Section 7 considers the funding options available for the project and the Value for Money implications. This section looks at the possible sources of funding and highlights area where more work is required. The section also examines Green Book guidance and concludes that it is appropriate to consider using PFI for the project. It also identifies three alternative procurement methods for the infrastructure provision: Full PFI, Hybrid and Up-Front Grant funding options.

Section 8 sets out the background to the development of the costs assumptions that are used in the financial analysis. Sections 9 & 10 set out the Net Present Value (NPV) of each of the three procurement options identified in section 7 and the bases on which they were calculated.

This section also identifies that in NPV terms the PFI option is the most expensive option and the Up-Front Grant Funding option is least expensive. The Full PFI option is reported as being more expensive than the Up-Front Grant Funding option by 52%.
A sensitivity analysis has also been carried out which examines the variances in the NPVs produced by changes to the inflation assumptions. Finally this section examines the sources and applications of funding and affordability by comparing the identified cost with the identified financial resources available.

Analysis and Comment

7.5 The Preliminary Financial Case outlines the background to the project and provides details of key procurement decisions that have been reached and the reasons for doing so. The key procurement decisions identified as being made to date are as follows:

- Provision of infrastructure and operations split into two parts;
- Appointment of Transdev as Preferred Partner for the contract to provide Operator services;
- A preference to procure the infrastructure in two parts; namely, (1) procurement of design, infrastructure works and systems integration and (2) procurement of tram vehicles. This decision was made following consideration of six alternatives. The Preliminary Financial Case also assumes that although the procurement of Trams would be carried out separately, the Tram contract, once agreed, would be novated to the successful bidder for the design of infrastructure works and systems integration services, thus making a single infrastructure contract; and
- Identification of three options to deliver the procurement of design, infrastructure works and systems integration. (1) Full PFI, (2) Hybrid PFI and (3) Up-Front Grant Funding.

One of the key results within the Preliminary Financial Case is the Net Present Value of each of the three options for the provision of the design, infrastructure works and systems integration.

Costs and Income Assumptions

7.6 It is noted that the cost and income assumptions used to calculate the relative cost of each option have been prepared by specialist technical consultants and Operis has assumed these to be reasonable for the purposes of this analysis.

7.7 In particular, Operis has assumed that the capital costs include all costs associated with the provision of the infrastructure including land purchase and where required, any compensation payable to affected land owners under the compulsory purchase code which may be applicable. Operis has also assumed that assumptions relating to the amounts and timings of payments from "other" sources e.g. land and property owners under "Section 75" and other agreements are realistic and achievable.

Review of Financial Information

7.8 One of the key financial results reported in the Preliminary Financial Case is the cost, in NPV terms, of the three procurement options for the provision of infrastructure. The NPV calculations for all three options include the NPV of identical cash flows for annual "Fare Box" revenue and annual Operating Expenditure. The combined effect of this Fare Box revenue and Operating Expenditure is a positive NPV of £30m. As figures and timing of cashflows for these items are identical for all three options the difference in NPVs is due to the difference in the treatment of the Lifecycle and Capital Cost elements.

7.9 The NPV of the Up-front Grant Option includes the NPV for the estimated Capital Expenditure prior to 2009 and the estimated Lifecycle Costs from 2009 to 2039. The NPV for the PFI option includes the NPV of the Unitary Charge which would be payable to a third party Special Purpose Company (SPC) in return for providing the capital and lifecycle expenditure.

7.10 The financial model used to calculate the estimate of the Unitary Charge assumes that the amount and timing of the capital expenditure to be made by the SPC is as per the Up-front Grant Option. For Lifecycle expenditure, however, it has assumed that the SPC will spend a constant annual amount, (the total lifecycle expenditure after indexation is the same as the total amount of lifecycle expenditure after indexation for the Up-front Grant Funding option). The financial model also assumes that for the PFI option an annual cost of £400,000 will be payable. This cost is not included in the Up-front Grant Option.

7.11 The NPV of the Hybrid PFI option includes the NPV of a proportion of the capital costs together with the NPV of a Unitary Charge payable to a SPC. The SPC shall invest in the remainder of the identified Capital costs and all of the lifecycle costs. As with the full PFI option the financial model used to calculate the Unitary Charge assumes that lifecycle is spent at a constant annual amount and there are annual costs of £400,000 which do not appear in the Up-Front Grant Option.

7.12 The financial model used to calculate the estimate of the Unitary Charge is based on a number of assumptions that are stated in the Preliminary Financial Case. These appear to have been applied correctly. During the review of the Financial Model a number of small errors were identified however they are minor in nature and do not materially affect the outcome of the analysis.

7.13 Operis considers that the financial model used has produced a result that would accord with their own view of a Unitary Charge required to fund the Capital and Lifecycle expenditure figures identified. Operis is, however, of the view that a more robust approach would have been to use a Shadow Bid Model to estimate the Unitary Charge. A Shadow Bid Model is one that explicitly reflects taxation, banking, subordinated debt and equity requirements and which would be similar to a model used by a bidder in the current PFI market.

7.14 In addition to reviewing the financial model produced by Grant Thornton, and in order to validate the estimate of the Unitary Charge for the PFI and the PFI Hybrid options, Operis has also estimated a Unitary Charge using a Shadow Bid Model. Operis has used the same input cost assumptions where stated and has used estimates of market rates based on their experience from other projects.

7.15 It is not clear why an additional cost of £400,000 p.a. has been applied to both the PFI and the Hybrid PFI options. It is thought that one possible justification for the inclusion of this cost may be to implicitly reflect additional costs incurred in the PFI option which would not be present in the Up-front Grant Option such as taxation and management costs. Operis has therefore run the Shadow bid model with and without the additional cost and calculated that the Unitary Charge varies by circa 1.5% for the PFI option and by circa 3.5% for the Hybrid Option. Given the degree of accuracy of input costs at this stage this difference is not thought to be material and Operis has, therefore, concluded that the Unitary Charge is not particularly sensitive to this cost input.

7.16 The Preliminary Financial Case assumes that the Unitary Charge for the PFI and Hybrid Options increases by 1% per annum during the 30 year operating period. It is not unusual in the PFI market for a Unitary Charge to have a fixed element and an indexing element.

7.17 The fixed element is usually set at an equivalent level to debt service costs thereby removing inflation risk from the senior debt provider. Typically 70% of a Unitary Charge in a typical PFI project would be indexed. Using the Shadow Bid Model Operis has calculated that 77% of the Unitary Charge would require to be fixed leaving 23% indexed. On this basis the Unitary Charge increases annually by between 0.67% and 1.04%, for the PFI and Hybrid options respectively. Based on this analysis Operis considers that the assumption of indexing the Unitary Charge by 1% p.a. is reasonable.

7.18 It is also possible, however, to set the Unitary Charge so that it is all indexed. Under this full indexing approach 100% of the charge is indexed at 2.5% p.a. Although the senior debt provider is exposed to inflation risk, typical debt service cover ratios ensure that the senior debt repayment is protected from downside RPI risk. Alternatively the PFI contractor can enter into an RPI swap to hedge against adverse RPI movements on the senior debt payments. The "cost" of an RPI swap can be either positive of negative depending on market conditions and at the current time is a negative cost.

7.19 The main advantage of a full indexing approach is that it produces a substantially lower starting level for the Unitary Charge. It does however rise at a faster rate, 2.5% p.a. compared to 1% p.a. Using the Shadow Bid Model Operis has calculated that a 100% indexation approach would enable a first year Unitary Charge which is 27% less for both the PFI and Hybrid options than when using a partial indexation approach.

7.20 The methodology prescribed in the Green Book to calculate NPVs also produces NPVs which are 29% and 20% lower for the PFI option and Hybrid option respectively, when using the 100% indexation approach.

7.21 These results are more of an illustration of the limitations of the NPV methodology as set out by the Green Book rather than a true identification of the cost differences. The prescribed methodology and discount rates tend to produce a higher NPV for projects where costs fall in real terms over a sustained period (i.e. a project with fixed costs or a project with a cost element that increases at a low rate).

7.22 The conclusions drawn from this part of the analysis are that the NPVs of the PFI and the Hybrid options are best considered to fall within a range of values, with the NPVs of these options reported in the Preliminary Financial Case falling at the upper end of this range.

7.23 A summary of the analysis is set out in the following tables:

Option	Unitary Charge	NPV
Values from Primary Financial Case.		
PFI – Unitary Charge indexing at 1% p.a	£35.52m	£360.3m
Hybrid – Unitary Charge indexing at 1% p.a	£20.44m	£304.3m
Up-Front Grant	-	£236.5m
Variance		52%

Values from Shadow Bid Model		
PFI – Unitary Charge indexing at 2.5% p.a	£26.02m	£256.69m
Hybrid – Unitary Charge indexing at 2.5% p.a.	£14.97m	£244.53m
Up-Front Grant		£236.5m
Variance		9%

7.24 Although the ranking of the options does not vary (PFI still has the highest NPV and the Up-Front Grant option the lowest), the variance is significantly reduced and the costs more comparable. It also demonstrates that the NPV analysis and the estimated level of Unitary Charge are very sensitive to the indexation assumptions.

Source and Application of Funding and Affordability

7.25 Section 10 of the Preliminary Financial Case assesses the affordability of the project by comparing the capital costs (including identified contingencies but excluding and element of Optimism Bias) with the level of Grant Funding allocated. The Grant Funding has been allocated between Lines 1 and 2 and the calculation identifies that £33.05m of "Other" income will be available to make the project affordable.

7.26 It should be noted that although paragraph 10.5 implies that the costs relate to the NPV of the Grant Funded Option the costs actually refer to the total amount of Capital Costs. Lifecycle costs are excluded from the affordability analysis as are Operating costs and "Fare Box" revenue.

7.27 It is considered that it would be desirable for the affordability analysis to take account of the lifecycle costs and the risk analysis section explicitly takes account of the availability and timing of the "other" income which is noted as including property development gains, and inter alia developer contributions.

Application of the Green Book Methodology

7.28 It is noted that at the time the Preliminary Financial Case was produced, the Green Book had been recently revised and the methodology contained within it was still subject to development and testing.

7.29 The NPV figures have been calculated by discounting cashflows at 3.5% for the entire period. Annex 6 of the Green book, however, directs that the discount rate should reduce from 3.5% to 3% after 30 years. Operis has recalculated the NPVs on the basis as set out in the Green Book. The difference in NPVs calculated is, however, around 0.1% and therefore not considered material to the results.

Review of Approach to Risk

7.30 At all stages of the approach described in the Preliminary Financial Case it is clear that risk management issues have been considered at length and reflected in the decision making processes described. Costs assumptions have been increased to include specific contingency amounts and an allowance for Optimism Bias as per the Green Book.

7.31 The total amount added for contingency on the capital costs is 25%. Although this is below the maximum level of 44% recommended in the Green Book it is noted that the rate of Optimism Bias selected was agreed following discussion and consultation with technical experts. A specific rate of Optimism Bias has not been identified for the lifecycle costs however it is noted that these costs have been assessed as being conservative.

7.32 The risk section does not specifically discuss the risks associated with the management of interfaces between the following parties:

- Operator and infrastructure provider
- Provider of procurement of design, infrastructure works and systems integration and provider of tram vehicles.

7.33 The Sources and Application of Funding and Affordability section assumes that 15% of the Funding cashflows are derived from "other" sources including property development gains, and developer contributions etc. Given the importance of these receipts to affordability we would suggest it feature more explicitly, than described, in the risk management process.

Conclusions

7.34 Based on the above review, analysis and comment, Operis has made the following conclusions:

7.35 In general the approach described in the Preliminary Financial Case is reasonable and robust for a project at this stage of procurement (the Outline Business Case has not yet been developed). In particular the process described leading up to key decisions are clearly set out and reasonable alternatives have been considered and assessed. Relevant guidance for assessing projects including the Green Book has been considered and applied.

7.36 The calculation of the Net Present Values (NPV) for the three procurement options identified to develop the infrastructure elements of the project (Full PFI, Hybrid and Up-Front Grant Funding) produce results which may cast the PFI options in an unfavourable light compared to the Up-Front Grant Option.

7.37 An alternative approach to the calculation of the Unitary Charges for the same input data suggest the NPV of the PFI option and the Hybrid Option lie within a range of values and that the NPVs identified in the Preliminary Financial Case sit at the top end of that range.

7.38 Clarification should be sought on the reasons for including an additional annual running cost in the PFI and Hybrid options, although the results are not particularly sensitive to the inclusion of that input.

7.39 The risk analysis and risk management appears to be well developed, however it may be appropriate to specifically address the risks posed by the timing and availability of funding sources from property development and "Other" identified sources.

8. RISK ANALYSIS

8.1 This section of our review addresses in more detail the Project's approach to risk management. In particular, it judges the reasonableness of the proposed adjustments to both CAPEX and programme spot estimates to account for Optimism Bias (OB). The review is based primarily on the STAG Appraisal [Ref.[1]], the Preliminary Financial Case [Ref.[2]] and the Project Risk Register[3].

Risk Identification

8.2 Complementary methods (e.g. workshop, checklists, reviews of registers of comparable projects and continual reviews) have been used to generate what appears to be a comprehensive list of risks and uncertainties. This is a sound approach and accords with good risk management practice. Its effect is to increase the likelihood of the quantified cost and programme contingencies being reliable. Importantly, risk impact timeframes are listed in the Preliminary Financial Case. This should enable risk exposure at various project stages (e.g. transaction, construction, operation) to be estimated and also allow the implementation of risk mitigation strategies to be properly planned. However, there is no evidence of risk impact timeframes in the Risk Register.

Risk Assessment

8.3 The quantification of capital cost and programme contingencies have been estimated by justifying Optimism Bias (OB) adjustment factors. No quantified analyses (QRA), using Monte Carlo simulation, have been undertaken at this stage. Yet, in common with HM Treasury's Green Book, STAG states that OB adjustments are 'designed to complement and encourage, rather than replace existing good practice in terms of calculating project-specific risk adjustments and contingency allowances'. However, it goes on to qualify this statement by allowing for 'general uplifts' to offset and adjust for undue optimism in the early stages of an appraisal. Even given this project's early stage in its lifecycle, a QRA of capital expenditure would have been expected to help determine a more accurate estimate of the likely outturn. But as long as there is rigorous justification of OB adjustment factors, the absence of capital cost QRA is not considered to be significant.

Risk Ranking

8.4 A recognised risk classification scheme has been used to assess each risk's exposure in terms of their impact and probability of occurring. Probability, capital cost and programme impact bands seem appropriate to this size of project. Two issues arise with the risk matrix, however. The first concerns whether or not key stakeholders have agreed the risk significance categories (i.e. negligible to very high). Part of the function of risk ranking is to prioritise risk response planning. But each stakeholder's predisposition to risk may be different. Some may be particularly averse to high impact events, irrespective of their probability of occurring. In such cases, impact values should therefore have a greater weight than their equivalent probability values, so that risk prioritisation is biased in favour of impact rather than probability. Without reaching agreement on a risk matrix which reflects stakeholder risk tolerance, there exists the possibility that some risks are not ranked as high as they should be and consequently aren't correctly prioritised for risk response planning.

[1] Tie Edinburgh Tram Network – *STAG Appraisal: Line One*, 10 September 2004
[2] Tie Edinburgh Tram Network – *Preliminary Financial Case – Update: Line One*, September 2004
[3] This review is based on Revision 23 of the Project Risk Register, dated 10 September 2004. The electronic file also includes an explanation of how Optimism Bias uplift percentages have been estimated for both CAPEX and project programme

8.5 The second issue is the number of risk significance categories. The Risk Register has three colours to indicate significance categories, yet the table in Financial Case has five categories. Both issues are, however, considered minor since mitigation strategies have been advanced for all risks regardless of their exposure/significance. It will become an issue when risk response plans are drawn up. Risk exposure has been assessed before and after the effects of mitigation strategies have been accounted for. Again, this accords with good risk management practice.

Optimism Bias

8.6 Detailed OB assessments of capital cost and programme have been undertaken periodically since October 2003. Reductions from upper bound OB values assessments have been justified using HM Treasury's Book guidelines [Ref.[5]]. OB uplifts for capital cost and programme have been reduced from 44 percent to 25 percent and 20 percent to 10 percent respectively.

Recognised Guidance

8.7 The Preliminary Financial Case recognises The Department for Transport, DfT's recent OB guidelines [Ref.[4]], but then doesn't make comparison with the Green Book guidelines or explain the potential effect on the scheme's predicted capital cost. DfT's guidelines provide uplifts at the time of presenting a project's business case. For each project category, there are recommended uplifts for percentile confidence limits. The latter are based on empirical probability distributions of capital cost overruns for comparable projects in the reference project category. The guidelines have additional project categories to those in HM Treasury's Green Book. As well as 'standard civil engineering' it has dedicated 'rail' and 'road' categories. The 80th percentile OB uplift for rail projects is 57 percent. This scheme's P80 value, using DfT guidance, is therefore £345.4 million (i.e. £220 million x1.57). Even the 50th percentile is 40 percent uplift of the spot cost (i.e. £220 million x 1.4 = £308 million). The DfT recommends its OB uplifts be applied at the time of decision to build, which typically equates to business case submission. Given Tram Line 1 is yet to reach Outline Business Case stage, it is therefore considered that current OB uplifts may have been underestimated.

8.8 DfT guidance does guardedly allow for uplifts to be adjusted downward where claims to improved risk mitigation are so strong. This may be the case if advanced risk analysis has been applied. As has already been mentioned, neither cost nor programme QRAs have been undertaken for this scheme and so, on this basis, the justification for reduced DfT OB uplifts would appear to be weak. However, DfT guidance also allows for downward adjustments of OB uplifts when warranted by firm empirical evidence. Scheme benchmarking, included in the STAG appraisal [Ref.1], reports that construction cost overruns for operational tram schemes within the United Kingdom have been up to 25 percent of award construction cost. It is not certain whether or not spot estimates for this scheme have accounted for this optimism by increasing rates and/or quantities. Additionally, the 25 percent applies to contract award whereas this scheme has yet to reach the Outline Business Case. It is unlikely therefore that this scheme's spot estimates are as accurate as they will be at contract award. This greater level of uncertainty at this stage should therefore be accommodated by relatively high OB uplifts (i.e. >25 percent).

Mitigation Factors

8.9 A mitigation factor (between 0 and 1) has been applied to each risk in the Risk Register (1 implies complete mitigation, 0 no mitigation). The average mitigation is then used to calculate the residual OB uplift for each contributory factor in HM Treasury's Green Book [Ref.[5]].

[4] DfT – *Procedures for Dealing with Optimism Bias in Transport Planning*, June 2004
[5] HM Treasury – *The Green Book: Appraisal and Evaluation in Central Government*

However by averaging mitigation factors, the intended accuracy of apportioning OB uplifts to contributory factors and sub-factors may be lost. For example, the Green Book has allocated 21 percent of the overall 44 percent uplift for capital expenditure to 'Dispute and Claims Occurred'. However, the strategies in the risk register aimed at mitigating 'procurement' risks may be dedicated to mitigating procurement-related risks which have nothing to do with disputes or claims. A more representative method would be to average the mitigation factors of those strategies which are intended to mitigate against disputes and claims.

8.10 There are two related entries in the Risk Register (Risk Refs. 71 & 115) which lead to capital expenditure risk or uncertainty. Their associated mitigation factors could be averaged and then used to calculate a reduction in the OB percentage allocated to the 'procurement' contributory factor. Were this method to be applied, the result would be a higher OB uplift because the benefit of some mitigation strategies listed in the Risk Register (i.e. those targeting contributory sub-factors without an allocated percentage) would not be accounted for.

Cost of Mitigation

8.11 The Preliminary Financial Case does account for the cost of implementing strategies to mitigate against capital expenditure and programme risks by adding a further 1 percent to the CAPEX OB uplift. Unfortunately, no justification for this value is provided. There are no costs allocated to mitigation strategies in the Risk Register, nor any apparent method for estimating this value. Without knowing what assumptions have been made, it is difficult to judge whether or not the 1 percent uplift is sufficiently conservative. For example, the allocation of farebox risk has historically had a significant impact on tender prices. This scheme proposes a departure from previous PPP/PFI structures where 100 percent of farebox risk has been transferred to the private sector. But it not clear whether this proposal has been agreed or how it has been accounted for, either as an opportunity or a threat, in the CAPEX estimate (including the cost of mitigation). It is considered that further justification of the likely cost of mitigation strategies should be provided.

Sensitivity Analyses

8.12 Sensitivity analyses of predicted operating and lifecycle costs and revenues have been completed in lieu of a comprehensive review of their related risks. This is considered an acceptable approach at this stage. Detailed comments on these analyses have been made elsewhere in the report

Risk Response Planning

8.13 The project has sensibly acted on information and recommendations from comparable light rail schemes (e.g. from National Audit Office) in order to arrive at appropriate risk control strategies, (including alternative procurement structures to effect necessary risk transfer). Indeed, risk transfer, as a method of risk control, is discussed at length. Given the uncertainties at this stage of the project, it is thought that risk avoidance strategies would also be mentioned, certainly in relation to the more significant risks in the Risk Register.

Risk Monitoring and Control

8.14 The risk reference numbers appear to change from one version of the Risk Register to the next. To help traceability, risk reference numbers should not be changed as the Register evolves. The status of risk is clear; risks only being closed when there remains no likelihood of the risk occurring. Responsibilities for actioning risk mitigation plans have been allocated.

9. CONCLUSIONS

9.1 Our review is based on the main STAG documentation set out in Section 1 of this report. There are a number of working papers that were not available for review, and these may contain some explanation of issues that we have raised. However, there are a number of areas of concern, which are:

- modelling issues;
- assumptions on bus competition;
- scale of non-user, particularly freight, benefits;
- geographical distribution of benefits;
- systematic over-estimation of revenues;.

The main issues relating to these areas are set out below.

Modelling Issues

9.2 There are some potential issues with the demand forecasting which we set out below

Age of underlying model data

9.3 Much of the underlying demand data is derived from the CSTM3 model which is based on data from the late 1980's. The bus data appears to have been updated using a global factor but we do have concerns about the age of these data.

Growth Assumptions

9.4 Growth between 2011 and 2026, but not between now and 2011, is documented. Our view is that average growth in Line 1 data of 50% between 2011 and 2026 is high.

Bus Competition

9.5 The central case assumes a significant reduction in bus supply with a reduction in buses per hour from 49 to 27 on Leith Walk. Overall, 2,200 bus places per hour will be lost across the network. This is replaced by 1,800 tram places per hour. However, we would make the following points:

- Whilst the overall capacity of public transport will be largely retained, there will a reduction in service level of some 30% (49 buses per hour to 35 (27 buses per hour +8train per hour)), with associated increases in waiting time. This is supported by Table 7.31, which shows public transport disbenefits between Leith and the city centre.
- Section 8.6.2 of the STAG appraisal deals with sensitivity tests. The section of bus competition states that *"there is limited bus network restructuring"* in the Line 1 central case.

9.6 Our view is that the scale of network restructuring is more than limited. The inference is that the bus network restructuring reflects an assumption that bus operators will act in co-operation. There is no guarantee that such co-operation would occur. A sensitivity test was undertaken assuming a "competitive" response to Line 1. However, this assumed an unchanged bus network from the Reference Case.

It is our opinion that merely retaining the status quo does not reflect a competitive response, which would more likely be reflected in fare reductions and higher frequencies.

9.7 For various light rail schemes that we have reviewed for the DfT, it is more usual to assume that the central case assumes no change to bus supply with a "downside" forecast undertaken to reflect a competitive response. If that were assumed for Edinburgh, operating costs would exceed revenues, although the improved benefits would improve the BCR.

Non-User Benefits

9.8 Section 7.6 (p149) of the STAG appraisal recognises that the level of non-user benefits *"seems somewhat high"* and suggests that this might be due to *"severe levels of congestion"* predicted by the model by the end of the evaluation period. This means that the modal shift to tram results in a large number of travellers experiencing a small level of benefit. We question the validity of these benefits without further supporting information.

Geographical Distribution of Benefits

9.9 It should be noted that the economic benefits are highly dependent on benefits to and from specific areas. Perhaps the most significant issue surrounds benefits to and from Granton. For example, trips **from** Granton to all areas account for 36% (£46m) of all public transport user (travel time) benefits. It is of some concern that the scheme appears so dependent on benefits from one area.

Optimistic Forecasts

9.10 The recent report from the National Audit Office "Improving public transport in England through light rail", April 2004, indicates that actual passenger numbers fell short of model predictions for three of the four recently implemented UK light rail systems with an average shortfall of around 25%. Irrespective of the care taken in preparing the forecasts for Edinburgh Line 1, it appears that there is a very real risk of the patronage and revenue forecasts being overly optimistic.

9.11 Operating and Capital Costs

The overall estimate of the capital and operating costs seem to have been rigorously and thoroughly prepared and are a sound basis for assessing the costs of the project. Some points as detailed in this report do however, need some clarification or further information supplied by the Promoters of the scheme. There is also a significant shortfall in the funding that is available.

9.12 Further justification and explanation is needed of the measures proposed for reducing the number of buses on Leith Walk and of how the proportion between the predicted number of tram and bus passengers was derived.

Financial Analysis

9.13 In general the approach described in the Preliminary Financial is reasonable and robust for a project at this stage of procurement (the Outline Business Case has not yet been developed). In particular the process described leading up to key decisions are clearly set out and reasonable alternatives have been considered and assessed. Relevant guidance for assessing projects including the Green Book has been considered and applied.

9.14 The calculation of the Net Present Values (NPV) for the three procurement options identified to develop the infrastructure elements of the project (Full PFI, Hybrid and Up-Front Grant Funding) produce results which may cast the PFI options in an unfavourable light compared to the Up-Front Grant Option, (the NPV's calculated show the Full PFI option is 52% higher than for the Up-Front Grant Option).

9.15 An alternative approach to the calculation of the Unitary Charges for the same input data suggests the NPV of the PFI option and the Hybrid Option lie within a range of values and that the NPVs identified in the Preliminary Financial Case sit at the top end of that range. Using an alternative methodology the NPV of the Up-Front Grant Option remains lower than the full PFI option, however the difference in only 9%.

9.16 Clarification should be sought on the reasons for including an additional annual running cost in the PFI and Hybrid options, although the results are not particularly sensitive to the inclusion of that input.

9.17 The risk analysis and risk management appears to be well developed, however it may be appropriate to specifically address the risks posed by the timing and availability of funding sources from property development and "Other" identified sources.

9.18 The Project appears to place great store by encouraging an effective risk management culture and by drawing on the performance of comparable light rail projects. In the absence of QRA, CAPEX and programme contingencies are based on OB uplifts. These have been estimated using the guidelines in HM Treasury's Green Book. The DfT's recent related guidance is mentioned, but no comparative assessment is made. It is considered that the OB uplifts would increase, if DfT's guidance were to be followed. Similarly, the Project's averaging of mitigation factors is likely to have lead to underestimating OB uplifts. Further justification of the likely cost of mitigation strategies should be provided.

GLOSSARY OF TERMINOLOGY USED

- Discounting – a methodology used to calculate the value, in today's terms, of costs and income which are received in the future. Discounting is based on the concept that a pound today is worth more than a pound tomorrow due to the receipt/payment of interest.
- Financial Model – a spreadsheet that describes the financial aspects of a transaction and is typically used to calculate the annual payments required to be charged to the Public Sector by a Private Sector contractor within a project procured under the Private Finance Initiative.
- Green Book – Guidance produced by The Treasury, for Public Sector bodies on how proposals should be appraised, before significant funds are committed and how past and present activities should be evaluated.
- \Forecasts based on a mode choice model - The Promoter has developed forecasts using a mode choice model that takes account of behavioural responses to changes in journey time, wait time and fare. The mode choice model is then applied to calculate demand based on the attractiveness of the rail service.
- Central case - incorporates the most likely scenarios to occur, including underlying economic growth, land use planning assumptions and the completion of other transport schemes.
- Sensitivity tests - alternative scenarios compared with the central case
- Net Present Value (NPV) – the value, in today's terms, taking account of the time value of money (through the application of interest), of a project cash-flow over a long-term period.
- Optimism bias - Historical tendency to overestimate benefits and underestimate costs. An allowance or uplift is included to account for both capital cost and programme optimism.
- Private Finance Initiative (PFI)- The PFI provides a way of funding major capital investments, without immediate recourse to the public purse. Private consortia, usually involving large firms, are contracted to design, build, and in some cases manage new projects. Contracts typically last for 25 - 30 years, during which time the asset is leased to a public authority.
- PFC – Preliminary Financial Case
- RPI swap – a financial instrument that removes the risk of movement in a payment stream which varies by the Retail Price Index by "swapping" the value of RPI for a fixed value.
- STAG – Scottish Transport Appraisal Guidance
- Section 75 Agreements – Section 75 of the Town and Country Planning (Scotland) Act 1997 provides a mechanism where developers make contributions to the public sector.
- CETM – Central Edinburgh Traffic Management
- QRA - Quantified Risk Analysis using computer simulation. Commonly used, together with Optimism Bias uplifts, to quantify, inter alia, cost and schedule contingencies. No QRA has yet been undertaken on this project
- Risk exposure - the product of the likelihood of a risk event and its impact
- P80 value - the value (e.g. capital cost, programme completion date etc.) that has only 20 percent chance of being exceeded
- Mitigation factor - the likely level of risk exposure reduction were a mitigation strategy to be implemented. The range is 0-1, where 1 is complete reduction.

- Contributory factors - refers to those recognised causes of Optimism Bias, which are listed in HM Treasury's Green Book
- Generalised cost - methodology to convert journey times and costs to a single unit
- Zoning pattern - spatial representation underpinning the CSTM
- Unitary Charge – the annual payment by the Public Sector to a Private Sector contractor for the provision of assets and services over a long term period under the PFI.