ArupScotland

Scottish Parliament

Edinburgh Tram Line 2

Review of Business Case

FINAL

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October 2004

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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CONTENTS

EXECUTIVE SUMMARY

Ove Arup and Partners (Arup) in association with Operis was appointed in October 2004 by the Edinburgh Tram (Line 2) Bill Committee to provide a review of the Edinburgh Tram Network Line 2 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 2) will serve a corridor to the west of Edinburgh, linking Edinburgh Airport and Ingliston to the city centre via major employment sites on the A8 corridor. A shuttle between Ingliston and Newbridge is also proposed. The preferred route for the scheme is 18km in length, with 12 intermediate stops on the Airport route, and four stops on the Newbridge shuttle. Trams will operate at a frequency of 6 trams per hour.

The demand forecasts for the Edinburgh Line 2 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 2 scheme.

On the whole the overall modelling framework appears sound, however there are a few concerns regarding some aspects of the appraisal. Although the underlying growth and the ramp-up growth appear reasonable, we are concerned that 55% of eastbound demand in 2011 originates from just two tram stops

Furthermore, the demand generated by tram stops between the Royal Bank of Scotland and Edinburgh Park appears low, given the extent of the employment proposals. The level of passenger growth using Line 2 originating from Edinburgh Airport also appears low compared with background growth forecasts for the airport.

The passenger forecasts for the scheme were benchmarked against other existing UK Light Rail schemes. The benchmarking exercise demonstrated that Line 2 performed relatively poorly against other UK systems in terms of passenger usage. However, the inclusion of a 33% premium for the tram fares means the revenue per passenger generated by Line 2 is high.

In terms of overall benefits the scheme produces a benefit / cost ratio of 1.38. Although the overall distribution of journey time benefits is reasonable, the level of asymmetry noted requires further explanation. The Scheme Promoter claims a benefit cost ratio of 1.38 represents excellent value for money. Other transportation schemes for Greater Edinburgh including the proposed heavy rail link to Edinburgh Airport and the congestion charging could materially affect the financial and economic case for Line 2. It is therefore recommended that further work be conducted to examine the impact of these proposals.

The overall estimate of the capital and operating costs seems to have been rigorously and thoroughly prepared and are a sound basis for assessing the costs of the project. Some points 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.

Competition for passengers between the proposed Edinburgh Airport Rail Link and Line 2 could significantly adversely affect the Business case for Line 2. A review is needed of whether the full amount of Executive Grant would be available if Line 2 were to be curtailed at the airport with no further station to the west towards Newbridge.

A review has been performed of the financial aspects of the Preliminary Financial Case together with a financial model prepared by Grant Thornton. This review 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 50% 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 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 5% 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

1.1 Arup Scotland was appointed by the Edinburgh Tram (Line 2) Bill Committee in September 2004 to review the Preliminary Financial Case for the proposed Line 2 tram connecting Newbridge and Edinburgh Airport with Edinburgh city centre. This review concentrates on those elements that underpin the financial case, including the patronage and revenue forecasts, the capital and operating costs, the scheme evaluation, risk and the funding mechanisms proposed. Arup has been assisted by Operis with regards to undertaking a review of the financial aspects of the Preliminary Financial Case.

Background

1.2 The Edinburgh LRT Masterplan recommended that Line Two was included in the Integrated Transport Initiative Preliminary Business Case as the West Edinburgh Tram Scheme. The scheme would operate as a segregated alignment from the city centre to Newbridge, broadly following an alignment parallel to A8, with a short spur to Edinburgh Airport. The proposed tram will offer a reliable high quality, high capacity, service that is also accessible to mobility impaired users.

1.3 The alignment would serve major trip generators including South Gyle, Edinburgh Park, Edinburgh Airport and major employment sites located along the A8 corridor. Further growth is planned for Edinburgh Airport (air passengers), and Edinburgh Park (employment), whilst the relocation of the Royal Bank of Scotland to Gogarburn and a major mixed-use development at Newbridge will increase the number of commuting journeys to destinations west of Edinburgh.

1.4 Edinburgh has experienced rapid economic growth in recent years, although this has resulted in worsening levels of traffic congestion, particularly at key intersections on the A8 between the city centre and the Newbridge. Traffic congestion could threaten continued economic growth and prosperity in Greater Edinburgh, unless attractive alternatives are introduced. The A8 corridor has a high population density compared with the rest of Edinburgh, although car ownership levels are lower, and unemployment rates higher. The tram would deliver journey time benefits compared with other modes, and support social inclusion by improving access to jobs, given the population densities and socio-economic characteristics of the area.

1.5 Transport Initiatives Edinburgh (*tie*) has appointed technical advisers with responsibility for providing technical, environmental, financial, transport modelling, operation and legal advice. Although *tie* has cross-checked the robustness of revenue and cost data with other members of the study team and external experts, the preparation of the Preliminary Financial Case indicates this is an opportune moment to independently review the underlying assumptions, methodology and outputs.

Scheme Description

1.6 The preferred alignment for Line 2 begins at Haymarket and runs broadly parallel to the Edinburgh to Glasgow rail line via St. Andrew Square, Edinburgh Park and the Gyle Shopping Centre. The route would serve the Royal Bank of Scotland Headquarters and a park & ride at Ingliston, before turning north and terminating at Edinburgh Airport. In addition, a shuttle service is proposed from Ingliston to Newbridge.

1.7 It is envisaged that 6 trams per hour would operate throughout the day on the airport route, with 6 trams/hour during the peak to Newbridge, and 3 per hour during the off-peak. Estimated journey times are about 28 minutes to the airport from St Andrews Square, covering a distance of about 13.7km. Twelve intermediate stops are proposed. The journey time beween Newbridge and Ingliston is about 9 minutes, covering a distance of 4.2km. Four intermediate stops are proposed.

1.8 There are also potential synergies with the Line 1 route. The proposed Line 1 also serves St Andrew Square, so there are potential benefits in providing a convenient interchange that would improve journey opportunities from West Edinburgh to the Leith Docks / Waterfront areas. We are also reviewing the Preliminary Financial Case for Line 1 on behalf of the Scottish Parliament.

1.9 In compiling this report, we have reviewed the following documents:

- Preliminary Financial Case Update Line Two – September 2004;
- STAG 2 Line 2 Report – September 2004;
- Appendix F – Project Costs Report - Final;
- Appendix H – Modelling methodology;
- Project Risk Register.

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.

Structure of the Report

1.10 Chapter 2 describes the overall model structure. A land use / transport model generates demand, with more detailed assignment models used to evaluate the potential usage of the tram, and the associated impact on buses and the road network. The characteristics and suitability of these models is reviewed in Chapter 2. The suitability of the crowding function, modelling parameters, validation, and time periods modelled are also reviewed.

1.11 Chapter 3 reviews the patronage and revenue forecasts. We comment on the suitability of the underlying growth and have reviewed the patterns of line loadings for 2011 and 2026. Whilst the Scheme Promoter has used Transdev's previous experience as a light rail operator to review the forecasts, we have used a series of key performance indicators to benchmark the out-turn figures from Line 2 with other UK systems.

1.12 Chapter 4 assesses the accuracy of the operating costs and capital costs. We have used statistics from other light rail systems in the UK to review the suitability of these costs. The economic evaluation of the scheme is reviewed in Chapter 5. In addition to the core scenario, the Scheme Promoter has also completed a series of sensitivity tests, and we have reviewed the impact of these scenarios. The spatial distribution of user benefits for public transport and highway users is also examined.

1.13 Chapter 6 considers the financial modelling of the scheme and assesses potential funding mechanisms while Chapter 7 addresses the issues surrounding the assessment of Risk. Chapter 8 presents the conclusions and recommendations.

2. MODEL DEVELOPMENT

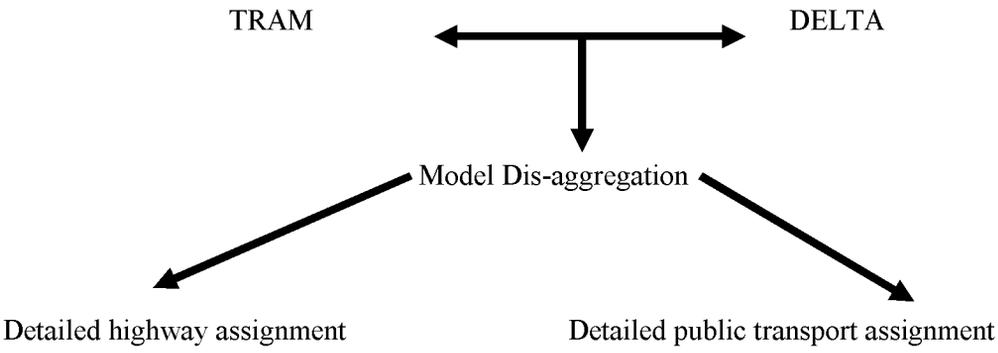
Introduction

2.1 Chapter 2 details the model structure used to develop the forecasts. It describes the land use / transport model, the modelling periods and the parameters used to produce the forecasts.

Overall Model Structure

2.2 Demand forecasts for Line 2 use an integrated land use / transport interaction model (LUTI) to forecast changes in farebox revenue and journey time by road and public transport. The LUTI model adopts the conventional four-stage modelling process, comprising trip generation, re-distribution, assignment and mode choice. Figure 2.1 illustrates the inter-relationships between the models.

Figure 2.1: Overview of the LUTI Model



- TRAM (Traffic Restraint Analysis Model) – operates using 88 zones that cover the Edinburgh, Lothian and South Fife area. TRAM is a strategic transport network to calculate journey times between each pair of zones to determine travel demand and also takes account of changes to trip frequency, destination, mode and time of day that affect demand. It incorporates the results from Scottish Household Travel Diary surveys, cordon surveys and bus-stop interviews.
- DELTA land use and economic model operates using a similar zoning pattern to TRAM. It forecasts the level of travel demand based on associated population and employment levels. The DELTA / TRAM models work interactively to adjust demand levels between each pair of zones based on the journey times;
- The DELTA / TRAM models include a strategic representation of the highway, bus and rail routes but are not sufficiently detailed to identify individual roads, junction or public transport routes. The trip matrices created are dis-aggregated, and then assigned using more detailed highway and public transport models (Detailed Assignment Models, [DAM]);
- The detailed public transport and highway models are used to predict route choice and passenger volumes using rail, bus or tram, and traffic volumes using highway. A park & ride model is also used to assess demand to Ingliston.

2.3 This model structure appears reasonable to assess the likely impacts of Line 2. The coverage enables changes in travel patterns resulting from the introduction of the tram to be clearly identified. Trip data is transferred from the relatively coarse land use zones to the more detailed assignment models.

2.4 However, it is not clear how changes in travel patterns attributable to the tram are not camouflaged by 'model noise'. This relates to changes that are remote from the Line 2 corridor. No information has been provided describing how this issue has been addressed.

Crowding and Capacity

2.5 The highway DAM includes a capacity restraint function at junctions and speed / flow curves on links to ensure the volume of traffic using each route is reasonable. However, it appears there is no crowding function in the public transport assignment model. Crowding could affect the attractiveness of the new tram. If overcrowding does occur, it will affect the viability of achieving the patronage forecasts, and reduce passenger benefits. Crowding will become a particular issue towards the end of the appraisal period when line loadings increase to about 2000 per hour in the westbound direction during the PM peak. This issue is discussed further in Chapter 3.

Model Periods and Years

2.6 Three one-hour time periods are modelled, covering the AM peak, inter-peak and PM peak. Different factors are then applied to convert the hourly trip totals using tram to annual values. Producing demand forecasts for each peak period is sensible, rather than transposing the AM peak demand as a proxy for the PM peak. Travel patterns during the PM peak may be different to the AM peak. Forecasts are produced for 2011 and 2026, with interpolation for intermediate years. There is no passenger growth assumed beyond 2026, and this is a reasonable assumption.

Modelling Parameters

2.7 The following parameters were used in the model:

- Walk time weight – 1.6;
- Wait time weight – 1.8;
- Bus ride time weight – 1.1;
- Rail ride time weight – 1.0;
- Interchange penalty – 10 minutes;
- Annualisation factors – (Public transport) AM peak 557, Off peak 2,425, PM peak 563;
- Annualisation factors – (Highway) AM peak 585, Off peak 2,288, PM peak 656;
- Demand / revenue profile – Year 1: 75%, Year 2: 85%, Year 3: 95%, Year 4: 100%.

2.8 With the exception of the annualisation factors, we were unable to identify references for the modelling parameters. However, the assumed parameters for walk time and wait time are likely to be derived from the Stated Preference coefficients. These values appear reasonable given the recommended range of 1.5-2.0 for walk time and 1.5 to 2.5 for wait time, based on guidelines prepared by the Institute of Highways and Transportation [1] .

[1] Institute for Highways and Transportation *'Guidelines for Developing Urban Transport Studies'*

2.9 The assumed interchange penalty also falls within the IHT guidelines of 5-10 minutes and appears reasonable, given the relatively high frequency bus services on most routes. The suitability of the assumed 'ramp-up' profile is reviewed in Chapter 3.

2.10 Assuming peak travel demand five days a week, 52 weeks of the year, minus an adjustment for public holidays, this implies the modelled peak hour equates to about 2.2 hours per day for either the morning or evening peak. The off-peak factors include an allowance for weekends, and imply the inter-peak hour equates to about 7 hours of off-peak demand. These annualisation factors appear reasonable.

Model Validation

2.11 Validation represents an important step in the modelling process. The replication of base year flows would demonstrate the model is able to replicate current travel patterns, and therefore represents a robust starting point to model future year demand. The developers of LUTI claim the validation of inner and outer cordons reproduce excellent validations for links and screenlines, but there is no evidence for this statement in the document. Furthermore, there is no evidence of a link based validation for the detailed assignment models.

3. OVERVIEW OF PASSENGER AND REVENUE FORECASTS

Underlying Growth

3.1 Patronage growth of 29% is forecast between the opening year and 2026. This equates to an increase of about 1.6% per annum. This growth rate appears reasonable, given the Cambridge Econometrics forecast for Gross Value Added (GVA) for Scotland predicts a 29% increase between 2001 and 2015, an increase of about 2% per annum. Adopting a lower average growth rate than the GVA forecast is reasonable, particularly given the difficulties of producing robust economic forecasts for the longer term. Whilst the growth rate and the ramp-up factors appear reasonable, we select other key performance indicators to benchmark the Edinburgh system against other systems.

Travel Demand

3.2 Table 3.1 illustrates the total number of person trips using public transport, and vehicle trips in 2011 and 2026 by time period. It is interesting to note the number of car trips increases by 25-27% during the peak periods, with a 22% increase during the inter-peak period. It is unclear why the number of bus trips decreases during the inter-peak between 2011 and 2026, given demand at other times of the day increases by 3,000-4,000 trips per hour.

3.3 Regardless of whether the tram is introduced, public transport mode share decreases between 2011 and 2026. Without the tram, public transport mode share decreases from 22-25% in 2011 (depending on time period) to 18-22% by 2026. Worsening traffic congestion would make tram more competitive. No explanation for this is given by the Scheme Promoter. If the tram is introduced, the number of public transport trips increases by just 2-3% during the peak periods and 13% during the inter-peak period between 2011 and 2026. These increases are insufficient to maintain the public transport mode share noted in 2011.

Table 3.1: Hourly Travel Demand

		2011			2026			Difference		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
Without tram	PT (Persons)	41,000	24,000	38,000	44,000	22,000	42,000	3,000	-2,000	4,000
	Cars/LGVs (vehicles)	120,000	81,000	134,000	152,000	99,000	168,000	32,000	18,000	34,000
With Line 2	PT (Persons)	42,000	25,000	39,000	45,000	25,000	43,000	3,000	0	4,000
	Cars/LGVs (vehicles)	119,000	81,000	134,000	151,000	100,000	168,000	32,000	19,000	34,000
Impact of Line 2	PT (Persons)	0.8%	3.9%	0.9%	2.8%	12.7%	2.2%			
	Cars/LGVs (vehicles)	-0.3%	0.2%	-0.2%	-0.6%	0.8%	-0.2%			

Note: Figures assumed to be rounded to the nearest 1000 trips, Source: STAG 2 document

Sources of Tram Patronage

3.4 The LUTI model estimates the changes in land use, trip rates, trip distribution, and mode split. The sources of tram patronage are shown in Table 3.2 for 2011 and 2026. The proportion of trips originating from car is low, when compared with other UK light rail systems. Furthermore, the proportion of generated trips is high, particularly in 2026. The usual allowance for generated trips, namely journeys that would not otherwise be made without the tram is 15%, and this allowance is only applicable to the inter-peak. Further clarification is needed from the Scheme Promoter to understand their definition of 'generated trips', given the relatively high allowance.

Table 3.2: Sources of Patronage

Source of demand	2011	2026
Shift from public transport	80%	67%
Shift from car	2%	4%
Generated trips	17%	29%

Source: Clarification response from Scheme Promoter

3.5 The Scheme Promoter has also provided details of the hourly boarding patterns for bus, rail and trams for 2011 and 2026 by time period. Table 3.3 demonstrates that demand is abstracted from both car and bus. Whilst it is reasonable to abstract some passengers from bus, the proportional change in bus usage noted in 2026 does not appear consistent with the 2011 results. Whereas tram abstracts inter-peak bus passengers in 2011, there is a 10% increase in bus patronage in 2026. This appears counter-intuitive, as worsening traffic congestion by 2026 would lead to slower bus journey times and therefore make trams more competitive.

Table 3.3: Hourly Boardings by Public Transport Mode

		2011			2026		
		AM	IP	PM	AM	IP	PM
Without Tram	Bus	37,000	22,000	33,000	38,000	20,000	36,000
	Rail	10,000	4,000	10,000	15,000	5,000	14,000
	Line 2	No service					
	Total	47,000	26,000	43,000	53,000	25,000	50,000
With Line 2	Bus	35,000	22,000	32,000	36,000	22,000	33,000
	Rail	10,000	4,000	8,000	15,000	5,000	13,000
	Line 2	3,000	1,000	3,000	4,000	1,000	4,000
	Total	48,000	27,000	44,000	55,000	28,000	51,000
Impact of Line 2	Bus	-5.9%	-0.3%	-2.7%	-4.8%	9.8%	-8.2%
	Rail	0.5%	-0.1%	-17.7%	-3.0%	1.4%	-1.2%
	Line 2	New mode					
	Total	1.5%	4.1%	0.6%	3.3%	13.7	2.4%

Source: STAG2 document

3.6 Furthermore, the introduction of Line 2 leads to an 18% reduction in the number of rail trips during the PM peak in 2011. The Scheme Promoter provided no explanation for this reduction. The existing Edinburgh-Glasgow rail corridor is broadly parallel to the proposed Line 2 alignment, indicating some passengers between Haymarket and Edinburgh Park use the tram in preference to the alternative rail service.

Demand Ramp-Up

3.7 The Scheme Promoter forecasts that 5.11m trips per annum will use Line 2 in the opening year (including the adjustment factors), and 6.94m trips in 2026. Patronage forecasts for the first three years are adjusted using factors of 75%, 85% and 95%. Factors are normally applied to the initial forecast years to reflect a delay in some passengers changing their trip patterns. We assessed the suitability of the 75% / 85% / 95% factors, using patronage statistics for Croydon Tramlink that opened in 2000/01. Table 3.4 demonstrates that the ramp-up factors assumed by the Scheme Promoter are reasonable.

Table 3.4: Patronage Statistics for Croydon Tramlink

	2000/01	2001/02	2002/03	2003/04
Patronage (million passengers)	15.0	18.2	18.7	19.8
% of trips compared with 2003/04	76%	92%	94%	100%

Source: DfT website

Line Loadings

3.8 The Scheme Promoter has prepared a summary table and diagrams illustrating the pattern of passengers boarding and alighting by direction, by time of day. Table 3.5 illustrates that the PM peak hour is the busiest, with about 36% growth in peak eastbound trips between 2011 and 2026, and 45% peak growth in the westbound direction. Inter-peak growth between 2011 and 2026 is about 15%.

Table 3.5: Hourly Demand by Direction

	2011			2026		
	AM	IP	PM	AM	IP	PM
Eastbound	1,580	480	850	2,150	550	1,160
Westbound	890	560	1,800	1,290	640	2,630
Total	2,470	1,030	2,650	3,400	1,190	3,790

Source: Table 4, Appendix H Demand Modelling.

3.9 Boarding and alighting graphs by direction, by time period for 2011 and 2016 are provided. We have estimated the loading patterns presented in Table 3.6 using these graphs. We have several concerns about the pattern of loadings shown in Table 3.6:

- The majority of demand in 2011 originates from the Airport and Ingliston. Ingliston is the busiest single tram stop with about 900 passengers per day. It serves both as a park & ride and as an interchange for trips from the Newbridge shuttle. The airport attracts about 700 passengers per day in each direction. It is a concern that 55% of the eastbound demand in 2011 originates from just two tram stops;

- We have not collated the boarding patterns for the Newbridge shuttle. However, the number of passengers using the tram outside the peak travel direction to / from Edinburgh is negligible. The Newbridge shuttle generates about 25% of the demand to Ingliston in 2011. Consequently, over 20% of total eastbound demand originates from the park and ride (75% of 31%). This implies Line 2 would have the highest proportion of demand originating from park & ride for any UK light rail system from a single park & ride;
- The Scheme Promoter has also provided details of the principal trip origins using the Ingliston park & ride. The 'M8 External (West of Whitburn)' and 'Airport' generate almost one third of these trips. They acknowledge that park & ride demand from the Airport to Ingliston may be over-estimated. Further clarification is also needed to understand the geography of the 'M8 External' zone;
- It is also unclear how alternative park & ride sites are modelled that could affect trips using Ingliston, as worsening congestion by 2026 could affect travel patterns. The park & ride trips to / from Ingliston form an important part of the financial appraisal, so further clarification is needed;
- It was noted earlier a number of new employment sites are proposed in West Edinburgh. Despite these major proposals, the number of trips forecast to use the tram in 2011 to / from the Royal Bank of Scotland and Edinburgh Park stops is small. Even in 2026 when the trip patterns to / from these office developments would be established, the level of demand using these tram stops remains very small.

Table 3.6: Estimated Eastbound Demand

Forecast	Time Period	Tram Stop								
		Airport	Ingliston	RBOS	The Gyle	Edinburgh Park	Edinburgh Park Station	South Gyle Access	Stenhouse Drive	Balgreen Road
2011	AM peak	250	825	25	25	-	25	150	200	75
	Inter-peak	200	75	-	25	-	25	100	75	25
	PM Peak	250	0	-	50	75	25	250	150	25
	Total	**700**	**900**	**25**	**100**	**75**	**75**	**500**	**425**	**125**
	% of the total	24	31	1	3	3	3	17	15	4
2026	AM peak	300	950	25	25	-	50	350	350	150
	Inter-peak	200	25	-	25	-	25	150	100	25
	PM Peak	250	25	-	75	100	75	350	175	25
	Total	**750**	**1,000**	**25**	**125**	**100**	**150**	**850**	**625**	**200**
	% of the total	20	26	1	3	3	4	22	16	5

Source: Tram loading diagrams prepared by the Scheme Promoter. Appendix H Modelling STAG 2. Note, the '-' indicate passenger boardings is negligible.

3.10 Furthermore, air travel demand at Edinburgh Airport is expected to increase from about 7 million passengers per annum to about 20 mppa by 2030 (Department for Transport, The Future of Air Transport, December 2003). The Scheme Promoter claims that the forecasts are based on the latest BAA figures, with the LUTI model used to calculate the mode split between car and other modes.

3.11 Whilst we accept that much of the growth in air passengers will not be served by Line 2, it is therefore surprising that only a small increase in passenger numbers using the tram during the AM peak is shown, with the forecasts for the inter-peak and PM peak virtually unchanged in 2026 compared with 2011. We would expect to observe higher growth in trips to the Airport using Line 2, given the importance of Edinburgh city centre supporting this growth as an expanding financial and business centre in Scotland.

3.12 We understand each tram will have a capacity of up to 300 passengers, giving a theoretical hourly capacity of 1,800. The westbound flow PM peak flow in 2026 exceeds 1,800 per hour between Shandwick Place and Balgreen Road, and this is likely to cause crowding problems. As discussed earlier in Chapter 2, it is unclear whether a crowding function was developed for the public transport network. The inclusion of a crowding function would provide reassurance that passengers would still find the tram attractive.

Revenue Forecasts

3.13 The revenue forecast for 2011 is £7.58m (including adjustment), increasing to £9.90m by 2026. Revenue growth has a similar profile to the growth in demand discussed earlier in Chapter 3. The revenue yield per passenger is 33% higher than the equivalent bus fare. An allowance for fare evasion and concessionary travel fares is included in the forecasts, reducing the 2011 revenue to £6.36m and the 2026 forecast to £8.31m. The allowance for concessionary fares is based on data from Lothian Buses and appears plausible. Fare evasion is 4%, this appears to be a reasonable assumption although no justification is given.

Comparative Analysis with other Systems

3.14 We have used key performance indicators to benchmark the forecasts for Line 2 against other UK light rail systems. The statistics for Edinburgh are based on 2011 data, and include the Newbridge shuttle. Line 2 performs relatively poorly compared with schemes in Manchester, Croydon and Tyne & Wear. Table 3.7 illustrates that the Edinburgh scheme has one of the lowest ratios for annual passenger boardings per stop, with only the light rail schemes in Sheffield and West Midlands having lower ratios.

3.15 Line 2 has a relatively high average trip length compared with other UK system. The line loading data highlighted the high proportion of trips from the Airport and Ingliston to the city centre, particularly in 2011, so the average trip length is consistent with these trip patterns. Only Manchester Metrolink and Midland Metro have a higher average trip length. The revenue per passenger journey is £1.24 for Edinburgh Line 2. This is the highest value shown in Table 3.7, and is consistent with a 33% fare premium compared with bus fares. The revenue per passenger is up to 70% higher than other UK examples.

Table 3.7: Comparative Analysis with other UK Systems

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 (£)
Manchester Metrolink	1.1	0.51	0.48	4.33	8.9	1.11	4.57
Tyne & Wear Metro	1.3	0.65	0.49	3.64	7.5	0.76	4.56
Sheffield Supertram	0.6	0.26	0.42	1.45	3.4	0.83	4.08
Midland Metro	0.9	0.22	0.26	2.70	10.6	0.98	3.13
Croydon Tramlink	0.7	0.52	0.71	3.75	5.3	0.76	6.00
Edinburgh Line 2 (2011)	0.9	0.30	0.31	2.52	8.09	1.24	5.70

Source: DfT statistics. Patronage / route statistics based on 2003/04 data, revenue data based on 2002/03 data. Edinburgh statistics taken from the STAG 2 document.

Forecasting Optimism

3.16 Recent experience of other light rail schemes has suggested promoters have a tendency to over-estimate demand, even when an allowance is made for initial build-up and maturity of the system. The National Audit Office, NAO, recently prepared a report (April 2004) demonstrating that several schemes had fallen well short of their expected patronage levels, these shortfalls ranged from 24-45%. Manchester Metrolink Phase 1 was the only system to exceed forecast patronage. Table 3.8 summarises the findings from the NAO report.

Table 3.8: 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 Operation	Patronage in 2002/03	
Sheffield Supertram	22.0	6.6 (1995/6)	12.0	45% shortfall
Midland Metro	8.0	4.8 (1999/00)	5.0	38% shortfall
Croydon Tramlink	25.0	15.0 (2000/01)	19.0	24% shortfall
Manchester M'link Phase 1	12.0	11.0 (1993/94)	19.0	5% excess
Manchester M'link Phase 2	6.0	3.0 (2001/02)		

Source: National Audit Office – Improving Public Transport in England Through Light Rail, April 2004

3.17 We acknowledge the claim by the Scheme Promoter that a conservative approach has been adopted in the forecasting methodology. However, the implication of these findings indicates some caution in accepting the forecasts prepared for Edinburgh Line 2 at face value. It would be prudent to examine the effect of a downward shift in the demand and revenue forecasts on the overall financial and economic case.

4. OPERATING AND CAPITAL COSTS

Total Operating Costs

4.1 Detailed operating costs have been prepared by the Scheme Promoter. The calculations take account of the route length, number of stops, annual service kilometres, fleet size and annual operating hours. There is a discrepancy between the annual operating costs presented in the Preliminary Financial Case (£6.01m) and the STAG 2 documents (£5.71m). No explanation is given for this difference. This analysis assumes the lower value shown in the STAG 2 documents is correct.

4.2 Table 4.1 compares the operating costs per annum for Edinburgh Line 2 with other light rail systems. The operating cost per kilometre for Edinburgh is £4.76 per train kilometre, with the Line 2 costs are higher than the values for Manchester Metrolink, Sheffield Supertram and the Tyne and Wear Metro. However, we acknowledge that the operating cost data used to benchmark other systems is 2-3 years out of date.

Table 4.1: Comparison of Annual Operating Costs

Year	Scheme	Total Operating Costs (£m)	Train Kilometres (m)	Operating Cost per kilometre (£)
2008	Edinburgh Line 2	5.71	1.2	4.76
2000/01	Manchester Metrolink	12.27	4.6	2.66
	Tyne & Wear Metro	25.71	9.4	2.73
	Sheffield Supertram	7.49	2.4	3.12
2001/02	Croydon Tramlink	12.20	2.4	5.08
	Midland Metro	7.80	1.6	4.88

Source: Transport Statistics Great Britain 2002, various company accounts. Edinburgh statistics taken from the STAG 2 documentation

4.3 One of the contributory factors for the high operating cost per train kilometre for Line 2 relative to other schemes is the Newbridge to Ingliston shuttle. The deployment of rolling stock and staff during the inter-peak is relatively inefficient reflecting the duration of the tram layover.

Vehicle Requirements

4.4 We estimate that seven trams would be required to operate a frequency of six services per hour between the Airport and St Andrews Square. Assuming an end-to-end journey time of about 28 minutes, this allows 12 minutes at either end for trams to layover. This layover would provide sufficient slack in the operational timetable in the event of delays. Three of the ten trams allocated to the Airport route would therefore not be required during the peak period, providing cover for maintenance or vehicle break-downs.

4.5 The Scheme Promoter has indicated that three trams are required to operate the Newbridge shuttle. During the peak, a frequency of 6 trams per hour is operated. Assuming a clockface timetable, a layover of about 5 minutes is assumed. Given the relatively short distance between Newbridge and Ingliston, this is sufficient to operate a robust timetable. There are no spare units, although units could be transferred from the Airport route if necessary. The peak vehicle utilisation of 77% appears low compared with other UK systems.

Table 4.2: Peak Vehicle Requirements

Route	Distance (km)	Running Time (minutes)	Peak headway (trams / hour)	Peak trams required	Spare Trams	Layover (minutes)
Airport – City centre	13.64	28.14	6	7	3	12 minutes
Newbridge shuttle	4.18	9.07	6	3	0	5 minutes

Source: STAG 2 documentation

Other Performance Indicators

4.6 The power supply costs quoted are £260,000 per annum, assuming 1.193m train kilometres per annum. This equates to £0.21/km, and is comparable with the electricity costs for other light rail systems in the UK.

4.7 The number of drivers is not shown in the STAG 2 documentation. However, the total of about 40 drivers can be derived using the relevant portion of staff costs, and the quoted unit cost per driver. With 55,400 operating hours per annum, each driver would work about 1,400 hours, or 27 hours / week. These assumptions appear reasonable. The ratio of about three drivers to each tram also appears reasonable when benchmarked against UK light rail systems.

Capital Costs

4.8 In the September 2004 update of the Line 2 Preliminary Business Case the Capital Cost of Line 2, at undiscounted Q2 2003 prices, is given as:-

Base Cost	£256,728,320
Contingency	£ 21,792,000
Optimism bias	£ 42,390,080
Total	£320,910,400

The Capital Cost needs to be considered in three sections:-

- St Andrew Square to Roseburn, which is common to Lines 1 and 2.
- Roseburn to Airport
- Newbridge to Ingliston, which is likely to be omitted initially – but possibly added as a shuttle service later.

4.9 A more detailed breakdown of the Capital Cost is available as Appendix F to the STAG Appraisal, as in the 'Project Cost Report – Final' of November 2003. This does not seem to have been updated, so takes no account of any subsequent changes. 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, comparison to other UK light rail schemes, and reconciliations with earlier project estimates. Thus, it is a sound basis for the build-up of capital cost. However, the following points should be noted:-

- Network Rail has not provided any information in respect of costs relating to their infrastructure, so the final cost for this work could vary very substantially. Any updated information should be sought;

- Utility Diversion estimates have only been available from the Utility Companies for the St Andrew Square to Roseburn section that is common to Lines 1 and 2. Unit rates have been used for the rest of Line 2, so there could be substantial variations in cost when detailed estimates are obtained from the Utility Companies. Whilst no details have been provided, it is likely that such estimates have now been prepared; these should be sought.
- The capital cost allowance for contingency and optimism bias has been reduced from £79,585,779 to £64,185,080, with optimism bias being £42,390,080 of this reduced total. This element is considered further in Chapter 7 of this report.
- Table 4.3 illustrates the composition of capital costs per section.

Table 4.3: Capital Costs

Section	Base Cost	Contingency	Optimism Bias	Total
St Andrew Square to Roseburn	43,444,279	3,687,206*	7,172,401	54,304,186
Roseburn to Airport	172,414,868	14,635,508*	28,469,179	215,519,555
Airport to Newbridge	40,869,173	3,469,286*	6,748,500	51,086,959
Total	256,728,320	21,792,000	42,390,080	320,910,400

Note: * approximate cost, proportioned according to base costs.

4.10 The STAG appraisal and the Preliminary Financial Case calculation of the Capital Expenditure 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. Whilst considerable progress has been made by *tie* in addressing the issue of how much of the revenue risk should be borne by the Contractor, account still needs to be taken of the cost of all this risk, including the part that would be carried by the public sector.

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

	£ M
• Cost of the Proposal £ 51.7M future expenditure on Replacement and renewals. (Revenue is unlikely to be Sufficient to make any significant contribution to this cost)	26
• Notional Allowance for a capital sum to cover risks of future Revenue shortfall. (Borne by contractor or the public sector)	20
Total	46

4.12 Given the major approximations and interpretations involved in the above calculation a wider tolerance needs to be applied, for instance an extra £30-50M, giving overall total costs of £350 to £370 M.

5. ECONOMIC EVALUATION

Transport Economic Table

5.1 The Value of Time assumed by the Scheme Promoter is based on DfT webtag guidance, split into work and non-work time for different users. The parameters used are therefore reasonable. The 'TUBA' program was used to evaluate travel time savings, and highway decongestion benefits, and again this approach is reasonable.

5.2 Costs and benefits are discounted to 2003 prices, and Line 2 generates a Benefit Cost Ratio of 1.38:1. The Scheme Promoter claims this represents "excellent value for money", (STAG 2 Report, paragraph 8.7.6). The comparison of operating costs and revenues demonstrates the scheme will generate an operating surplus throughout the appraisal period. The scheme would generate almost £290m Present Value of economic benefits with £206m Present Value of capital costs. Although the financial operating surplus in 2011 is just £0.01m, it increases to £2.19m by 2026.

The scheme benefits (expressed in terms of Present Value) include:

- £164m – consumer user benefits, predominantly public transport journey time savings;
- £38m – business user benefits, comprising a mixture of benefits to freight, car users and public transport passengers;
- £89m – for private sector providers;

These benefits are offset against a £3m increase in accident costs.

A significant proportion of the scheme benefits are generated by the user time savings for both businesses and consumers. We review the spatial distribution of these benefits.

Spatial Distribution of Public Transport Benefits

5.3 A sectorised matrix illustrating the spatial distribution of journey time benefits has been produced. Thirteen sectors are defined, including three external sectors. Journey time benefits for each time period are collated and then combined to calculate total journey time benefits. Although it is unlikely that the journey time benefits would be symmetrical, the extent of the directionality is surprising, for example, there are larger benefits between a pair of sectors in one direction than the return. This implies there are significant differences in journey time between sector pairs at different times of the day, although no explanation is given by the Scheme Promoter.

5.4 For example, there are £35m Present Value of benefits from the city centre to all sectors, and £16.3m Present Value of benefits from all sectors to the city centre. Despite this asymmetry, the distribution of benefits appears reasonable, with about 45% of benefits to / from the West Edinburgh corridor including Newbridge, and 21% of benefits to / from the city centre.

Spatial Distribution of Highway Benefits

5.5 The distribution of highway benefits is also asymmetrical. Most of the trends shown in Table 8.15 of the STAG 2 documentation appear reasonable, including the highway dis-benefits between Sectors 1 and 10, given the re-allocation of road space to the tram. However, the following results require further explanation:

- highway benefits from Sector 10 are 66% lower compared with benefits to Sector 10 (West of Edinburgh);
- benefits from Sector 9 (East Edinburgh) are 66% higher than benefits from Sector 10 West Edinburgh (including Newbridge). This is counter intuitive, as sector 9 is remote from the proposed Line 2 alignment.

Impact of Sensitivity Tests

5.6 The analysis thus far reviews the 'central case' for Line 2. A number of variants to the 'central case' have also been identified. Although none of these major transport schemes are currently committed the likely impact has been examined.

Congestion Charging

5.7 Two charging cordons proposed for Edinburgh will reduce traffic delays in the city centre. Both car and bus journey times will improve, although the impact on buses is smaller on routes if 'greenways' already operate. The tram extends beyond the congestion charging cordon, so the stops west of Ingliston become more attractive to car drivers. However, the improvements in journey time mean trams are less competitive versus other modes. This outcome appears plausible.

Airport Rail Link

5.8 The proposed Edinburgh Airport Rail Link will introduce direct rail services to a range of destinations across Scotland including Glasgow, Stirling, Perth, Fife, Inverness and Aberdeen. A new station would be served by 8-10 trains per hour in each direction. The introduction of direct rail services to the airport would abstract passengers from the tram. The recent White Paper, 'The Future of Air Transport,' forecasts the number of passengers using Edinburgh Airport would increase from about 7 million currently to 20 million by 2030. Clearly, a significant increase in passenger numbers would strengthen the case for heavy rail link, and abstract passengers from Line 2. This conclusion appears reasonable.

Impact on Buses

5.9 It is advantageous for bus services to be restructured to serve the tram and avoid unnecessary competition. Whilst Lothian Buses have indicated some of their bus services could be revised, First Group are also a major operator in Edinburgh and have made no similar undertaking. A complementary and a competitive response from the bus operators has been tested, and this appears sensible given the deregulated operating environment.

Tram Fare Adjustment

5.10 Other light rail systems in the UK have a premium fare up to 35% compared with bus fares. This demonstrates the premium assumed by the scheme promoters in Edinburgh is at the upper end of the scale. Trams fares were adjusted by 10% to assess the impact on demand.

5.11 A 10% reduction in tram fares led to a 1% increase in patronage, but a 5% drop in revenue in 2011. The 10% increase in fares reduces patronage by 11% and revenue by 5% in 2011.

5.12 The implied elasticities for the patronage and revenue changes are reasonable when benchmarked against other guidance on fare elasticities.

Improved Tram Frequencies

5.13 The impact of increasing tram frequencies to 8 trams per hour has been tested, and revised revenue and operating costs calculated. The forecasting work indicates passenger revenues would increase by 8.2% in 2011 (£0.52m) and 16.0% by 2026 (£1.33m). The estimated cost increase is £0.47m in 2011 and £0.50m in 2026, and would therefore increase the operating surplus. It is unclear why this scenario does not form the central case.

Combined Impact of Sensitivities

5.14 The results of the above sensitivities are not presented separately. Instead, the scheme promoters have combined the sensitivity tests into 'best credible scenario' and 'worst credible scenario'. These scenarios comprise:

- best credible scenario: includes better tram frequencies and co-operative bus networks;
- worst credible scenario: assumes the airport rail link is constructed, the congestion charging is implemented and competitive response by bus operators.

5.15 Although the Scheme Promoter illustrates the revenue adjustment for 2011 and 2026, revised Benefit Cost Ratios are not presented. The worst credible scenario fails to generate an operating surplus during the appraisal period, and would therefore require funding support. The precise impact on the economic appraisal is uncertain, although the benefit cost ratio would reduce, since a lower number of passengers would use the tram.

5.16 Although the congestion charging scheme and the airport rail link proposals are uncommitted, there is on-going feasibility work to review the financial and economic case for each proposal. The poor financial performance of the 'worse credible' scenario is a significant concern. Whilst the 'best credible scenario' generates a stronger financial case compared with the 'central case', the likelihood of this scenario being delivered is questionable.

6. FINANCIAL MODELLING AND FUNDING MECHANISMS

6.1 In partnership with Arup, Operis has been appointed by the Scottish Parliament to review the Preliminary Financial Case prepared on behalf of the promoter of the Edinburgh Tram (Line Two) Bill, *tie*.

6.2 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.

6.3 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

6.4 Operis has based their review on the "Line Two Preliminary Financial Case – Update September 2004" prepared for Line2 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.

6.5 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.

6.6 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).

6.7 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.

6.8 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.

6.9 Section 8 sets out the background to the development of the costs assumptions that are used in the financial analysis.

6.10 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.

6.11 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

6.12 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

6.13 It is noted that the cost and revenue assumptions have been prepared by specialist technical consultants and the suitability of these assumptions is discussed elsewhere in this document. We have 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

6.14 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 £21m. 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 Costs elements.

Funding Options

6.15 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 of 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.

6.16 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.

6.17 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.

6.18 The financial model used to calculate the estimate of 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.

Other Models

6.19 The financial model 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. However, the application of alternative models, including the Shadow Bid Model to estimate the Unitary Charge may be a more robust approach. This explicitly reflects taxation, banking, subordinated debt and equity requirements. We have used a Shadow Bid Model to validate the estimate of the Unitary Charge for the PFI and the PFI Hybrid options.

6.20 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. One possible justification for this cost is reflecting additional costs incurred in the PFI option which would not be present in the Up-Front Grant Option such as taxation and management costs. However, the Unitary Charge is not particularly sensitive to this cost input.

6.21 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. 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, we have 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 0.6% and 1.03%, for the PFI and Hybrid options respectively. Based on this analysis, we consider that the assumption of indexing the Unitary Charge by 1% p.a. is reasonable.

6.22 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. Under the full indexing approach the first year Unitary Charge would be reduced by 28% for both the PFI and Hybrid options.

6.23 Using the methodology prescribed in the Green Book to calculate NPVs based on the full indexing approach produces NPVs which are 30% and 20% lower for the PFI option and Hybrid option respectively, when using the 100% indexation approach. 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).

6.24 The conclusions illustrate 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. A summary of the analysis is set out in the table below:

Table 6.1 Summary of the NPV Analysis

Option	Unitary Charge	NPV
Values from Primary Financial Case.		
PFI – Unitary Charge indexing at 1% p.a	£41.5m	£434.5m
Hybrid – Unitary Charge indexing at 1% p.a	£24.1m	£369.6m
Up-Front Grant	-	£290.5m
Variance		50%
Values from Shadow Bid Model		
PFI – Unitary Charge indexing at 2.5% p.a	£29.5m	£303.62m
Hybrid – Unitary Charge indexing at 2.5% p.a	£17.3m	£295.45m
Up-Front Grant	-	£290.54m
Variance		5%

6.25 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

6.26 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 £65.4m of "Other" income will be available to make the project affordable. 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.

6.27 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 developer contributions etc.

Application of the Green Book Methodology

6.28 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. 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.

6.29 Review of Approach to Risk in the Financial Analysis

- 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.
- 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.
- 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.
- 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

6.30 The Sources and Application of Funding and Affordability section assumes that 28% 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.

6.31 In general the approach described in the Preliminary Outline 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.

6.32 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.

6.33 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.

6.34 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.

6.35 From a financial perspective 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.

7. RISK ANALYSIS

Introduction

7.1 Chapter 7 reviews the Project's approach to risk management. In particular, it judges the reasonableness of the proposed adjustments to both Capital Expenditure and programme spot estimates to account for Optimism Bias (OB).

Risk Identification

7.2 Complementary methods (e.g. workshop, checklists, reviews of registers of comparable projects and continual reviews) have been used to generate a comprehensive list of risks and uncertainties. This is a sound approach and accords with good risk management practice. It increases 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

7.3 The quantification of capital cost and programme contingencies have been estimated by justifying Optimism Bias (OB) adjustment factors. No Quantified Risk Analysis (QRA) using Monte Carlo simulation has 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.

7.4 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

7.5 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 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.

7.6 The predisposition to risk for individual stakeholders 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.

7.7 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 'though when risk response plans are drawn up.

7.8 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

7.9 Detailed Optimism Bias (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[2]. 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

7.10 The Preliminary Financial Case recognises The Department for Transport (DfT) recent OB guidelines[3], 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.

7.11 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 to rail projects' capital expenditure spot estimates is 57 percent. This scheme's P80 value, using DfT guidance, is therefore £400.4 million (i.e. £255 million x1.57). Even the 50th percentile is 40 percent uplift of the spot cost (i.e. £255 million x 1.4 = £357 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 2 is yet to reach outline business case stage, it is considered that current OB uplifts may have been underestimated.

7.12 DfT guidance does allow for OB to be adjusted downward if strong evidence of improved risk mitigation can be demonstrated. This may be the case if advanced risk analysis has been applied. As already mentioned, neither cost nor programme QRAs have been undertaken for this scheme. 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.

7.13 It is uncertain whether the spot-estimates have been adjusted for cost over-runs up to 25%. Inevitably, the cost estimates will be refined if the scheme reaches Outline Business Case, so the greater uncertainty in costs should therefore be reflected in the assumed OB.

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

Mitigation Factors

7.14 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. But 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'.

7.15 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.

7.16 A more representative method would be to average the mitigation factors of those strategies which are intended to mitigate against disputes and claims. There are two related entries in the Risk Register (Risk Refs. 71 & 115) which leads 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. If this method was 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

7.17 The Preliminary Financial Case accounts for the cost of implementing strategies to mitigate against capital expenditure and programme risks by adding a further 1% to the OB applied to capital expenditure. 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% uplift is appropriate. 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 capital expenditure estimate (including the cost of mitigation). It is considered that further justification of the likely cost of mitigation strategies should be provided.

Risk Response Planning, Monitoring and Control

7.18 The project has used information and recommendations from the National Audit Office advice based on comparable light rail schemes. Appropriate risk control strategies, including alternative procurement structures to affect necessary risk transfer are defined. 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.

7.19 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.

8. CONCLUSIONS

8.1 The modelling methodology adopted appears reasonable, and the assumptions underpinning growth and the ramp-up factors applied to the first three years of the forecast are prudent. However, our analysis has highlighted several issues that require further clarification from the scheme promoter, given the boarding patterns at several proposed tram stops. A significant proportion of the demand originates from a limited number of tram stops, particularly in 2011. Furthermore, there is a lack of demand generated by the proposed tram stops serving the major employment sites in the A8 corridor, and this appears counter-intuitive. We have also highlighted the limited growth in tram demand from the airport, whereas air passengers are forecast to almost treble by 2030.

8.2 The calculation of operating costs also appears reasonable when benchmarked against other UK light rail schemes. We have highlighted the relatively low utilisation of peak vehicles, and there may be scope to reduce the fleet size. The review of the capital costs has demonstrated the underlying cost assumptions are generally robust, but we have identified a couple of issues that could increase total capital costs by up to £50m.

8.3 Whilst the scheme generates a Benefit Cost Ratio of 1.38 for the central case, we have concerns about the financial and economic viability of Line 2 if other proposals are introduced in Edinburgh. For example, the completion of the heavy rail link to Edinburgh Airport, together with the implementation of the congestion charging mechanisms and a competitive response from the bus operators would have a significant impact on the financial and economic viability of this proposal. The results presented in the STAG 2 document indicate the worst credible scenario would not generate a financial surplus throughout the appraisal period. Further work is therefore needed to understand the synergies between these major transport proposals for Edinburgh and the Line 2 scheme.

8.4 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.

8.5 Competition for passengers between the proposed Edinburgh Airport Rail Link and Line 2 could significantly adversely effect the Business case for Line 2. A review is needed of whether the full amount of Executive Grant would be available if Line 2 were to be curtailed at the airport with no further station to the west towards Newbridge.

8.6 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.

8.7 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 50% higher than for the Up-Front Grant Option).

8.8 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 5%.

8.9 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.

8.10 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.

8.11 The Project appears to have 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.
- Model Noise - refers to the change in journey time or trips that may occur in locations remote from the Line 2 corridor. For example, if **small scale** changes in journey times and / or trips occurred in East Edinburgh, these changes would not be directly attributable to the introduction of the tram, and therefore are described as 'model noise'.
- 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.