The Electric Tbus Group
www.tbus.org.uk

Title	**West London Transit Consultation Formal response to Transport for London by the Electric Tbus Group**
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Abstract:

In response to Transport for London consultation documents, it is the view of the Electric Tbus Group that the West London Transit scheme is necessary to relieve future congestion levels and provide improved quality of life and business opportunities to the corridor. The mode required should be by electric traction. To enable financial viability, due to decreased infrastructure necessities, rubber tyred vehicles (tbuses) are preferred to the steel tyred variety (trams). Improved design flexibility, such as options of full, partial or no guidance; flexibility in dealing with other traffic, reduced depot provision and easier route adaptability, are inherent advantages. In all other aspects, other than maximum capacity, rubber tyred electric tbuses provide equal advantages of zero emissions, level boarding, high service performance and route identification. The level of modal shift has been measured as of the order of 17% on plainer installations and is likely to equal that of trams on a like for like basis. Equal or less road segregation with more stops and shorter vehicles are envisaged as a more optimal solution, that benefit customers and are likely to attract car users. A rubber tyred solution would integrate better with other bus services, including the night service that will still operate over the corridor, even if the tramway option goes ahead. The risk premium would be lower than a steel tyred solution.

1. Recommended Actions

It is recommended that -

1) existing planning is adapted to tbus technology to provide an equally segregated route, with provision of stops at 3 per kilometre
2) that provision is continued to obtain a Transport and Public Works act and design to satisfy Her Majesties Railway Inspectorate
3) that the business case is revised to account for reduced capital costs
4) that a BCR of tbuses is carried out using current, realistic costings and benefit analysis
5) that public consultation introduces the concept of ‘rubber tyred trams’ or tbuses

2. Key Points

Financial Implications

2.1 The provision of tbuses on the West London Transit can be provided for less than the provision of trams. Depending on the level of ancillary components, such as the quality of stops, the amount of segregation and possible changes to the route, this can be of the order of one quarter to a one half the capital costs. (see attached appendix 2). With trams schemes showing poor or negative returns, and Audit Office reports advocating stricter financial planning, such schemes have become unattractive to private investors. With less capital costs and comparable running costs, tbus schemes appear to be attractive to private investment (evidence of London First business group in consideration of tbuses for ELT), as having equal potential to reduce congestion and attract business. The risk premium would be lower than a steel tyred solution as lower vehicle capacity enables greater flexibility in coping with demand, thus preserving a more viable revenue stream, and capital risk is reduced by simpler infrastructure installation unrestrained by unquantifiable utility removal.

Legal Implications

2.2 The Mayor's Transport Strategy lists West London Transit as a proposal he supports in principle. Whether tram or tbus, a Transport & Works Act is required.

3. Background

3.1 The Mayor's Transport Strategy lists four intermediate mode schemes across the capital:

- Cross River transit;
- Greenwich waterfront transit;
- East London transit; and
- West London Transit.

The West London Transit scheme uses the entire length of Uxbridge Road, from Shepherds Bush to Uxbridge and passes through the boroughs of Hammersmith & Fulham, Ealing and Hillingdon.

3.2 Transport for London's objectives of the proposed Transit schemes are multiple, the principal objectives being:

- To improve the quality and reliability of public transport
- To encourage motorists to switch to public transport
- To reduce pollution and congestion
- To help bring jobs to the area
- To bring the workforce closer to jobs
- To provide routes through regeneration areas and town / local centres
- To link local communities

3.3 The scheme was first identified in the report 'New Ideas for Public Transport in Outer London' (1996) which was commissioned by London Transport. This study assessed nine potential transit routes across London and identified the Uxbridge Road corridor as having the strongest business case of the routes considered in West London. The assessment of the business case for the transit schemes has been carried out using a Multi-Criteria Assessment Framework (MCAF). This assessment takes into account the following range of factors, and is summarised in appendix 1:

- Environmental impact (including noise & air pollution, energy & fuel consumption & townscape issues)
- Safety & security (including accident levels and personal security)
- Economic (including running costs, travel time savings and capacity)
- Accessibility (including public transport accessibility and accessibility to other modes)

- Integration (including impacts on regeneration & social inclusion)

4. Detail

4.1 The availability of 200 passenger tbuses (European experience), either guided, partially guided or not guided, and realistic costing make the re-assessment of the Benefit Cost Ratio necessary to prove value for money for the West London Transit scheme. Otherwise, there can be legitimate concern that the current tram scheme will be turned down by the minister during the Transport and Public Works process. As tbus benefits are very similar to tram (see attached appendix 1), for less cost, it would be prudent to fully consider this alternative. Much of the work already done would be equally applicable, including segregation, junction priority, accessibility and impact.

4.2 The construction period using tbus technology would be more than halved, as rails or guidance systems would not be necessary. If guidance is considered, this could take the form of kerb guidance at stops to achieve level boarding within 50mm horizontally and vertically. Consideration of optical guidance may be thought necessary at particular points, but would not involve any additional construction other than painted lines. All other aspects of stop design, (apart from length), traffic restraint, pedestrian attractiveness, cycle provision and road surface design could be equally implemented.

4.3 Where public consultation has been undertaken previously and in other parts of Europe, preference is of the order of double that shown for diesel equivalents. No public consultation has been undertaken in London on the basis of high quality, high capacity tbuses running in segregated roadways. The opportunity exists to more easily adapt traffic restrictions with tbuses to answer public objections than is possible with tram technology. Tbus manoeuvrability offers wider design scope, while performance ability (acceleration/deceleration of 1.5metres/sec) offers options that are less likely to compromise service quality.

4.4 Modal shift has not been definitively shown to favour trams as equal modal shift has been demonstrated on high quality bus schemes. As has been shown in WLT polls, the over riding factor is likely to be reliability and frequency rather than mode, in customer's eyes. Tbuses are able to provide equal service performance, as they are, essentially, the same vehicles as trams, differing in wheel, external conductor and suspension design, the necessity of guidance and maximum capacity. Due to legal precedence tbuses are generally narrower than trams (2.5m v. 2.65m).

4.5 Environmental quality provided by the vehicles is equal or better than tram (see appendix 1), due to quieter performance of tbuses, especially on curves. The Environmental impact of the implementation of the transit scheme is likely to be similar to that of the tram. There maybe less tree loss due to the inherent flexibility of the tbus that is not required to follow as rigid a path as the tram.

4.6 Due to the flexibility of the infrastructure of Tbus technology, route adjustments are possible, such as taking the transit scheme into Ealing Hospital, building the scheme in 2 stages, Shepherd's Bush to Hayes and extending to Uxbridge when sufficient patronage is proven and eminent. It might be possible to extend the route to Marble Arch, (as provided currently with night buses), which would be difficult with tram technology, but considerably less invasive with tbuses. (Detailed analysis by local Tbus Group members is to suggest alternative arrangements to the difficult junctions and locations soon).

4.7 Integration with existing and planned diesel bus services is considerably easier with tbuses, as the stops can be made common or extended to accommodate both modes. Tbuses can overtake diesels and vice-a-versa. This is not applicable to trams, which would be impeded by sharing stops, unless made impossibly long. Passenger convenience is thus improved by adopting tbus technology.

4.8 Like trams, tbuses will benefit from future carbon trading as the Kyoto Protocol comes into force and from government incentives to increase use of non-fossil fuelled vehicles. Both modes provide some insurance against fossil fuel scarcity and price volatility.

Tbus design alternatives to TfL tramway proposals by the Electric Tbus Group. October 2004

- Some TfL design problems caused by tram size and tram rail alignment necessities obviated by using tbuses
- No residential streets to be used to divert traffic
- No right turn bans, tbus wiring aligned to allow centre lanes, but with priority signalling
- Major additional utility of route by providing access to Ealing Hospital and to Ealing Broadway Station
- Little loss of segregation
- No additional infrastructure provision needed for depot access
- Greater future integration with railway stations at Iron Bridge and Southall

	tram	tbus	mapref.
Southall - Lady Margaret Road	• Ban right turn into Lady Margaret Road • Divert westbound south via Avenue Road, Cambridge Road, South Road	• No right turn ban, West bound 25m stop allows centre lane, with tbus wiring 3m south of tram line. • No diversion due to heavily congested South Road • Eastbound 25m stop, allows for 2 x 25m tbuses (2 x 40m trams would block Lady Margaret Road) • Future East West bypass in conjunction with Gasworks site redevelopment, to allow additional or diverted tbus route via Southall rail station.	27,28
Hanwell Ironbridge	• New road or tram tunnel • segregation to south carriageway	• New tbus tunnel in longer term with new local railway station • tbus route on existing carriageway in both directions meanwhile. • segregation to south carriageway • wired access to Ealing Hospital	31-34
Hanwell – St George's Road	• Ban right turn except buses into Church Road • Possible property acquisition	• No right turn ban • Westbound stop located after junction, creating centre lane • No property acquisition	34,35
West Ealing – town centre	• Transit/bus/taxi only road • Traffic diverted eastbound via Singapore Road and westbound via Leeland Terrace	• Segregation eastbound after Green Man Lane tbus station, until Coldershaw Road • No traffic diversion via mixed/residential areas	36-37
West Ealing – Lido Junction	• Ban right turn into Drayton Green Road • Diversions via Broomfield Road, Chapel Road and Northfield Avenue	• No right turn ban, eastbound tbus routed to north side, westbound routed to south side to create centre lane • Retention of existing pedestrian crossing • No diversions	38
Ealing Broadway	• Partial road closure • Diverted Eastbound traffic via Springbridge Road, Haven Green and the Broadway • Alternative shared running with south side property take	• No partial road closure • Long term, comprehensive multimodal interchange at Ealing Broadway Station. East and westbound Tbuses to be routed accordingly, via new roads • Short term, Tbus to be routed on A4020 in mixed traffic	41
Acton High Street	• Transit/bus/taxi only road • Eastbound diversion via Steyne Road and locally via Horn Lane and Market Place • Possible additional eastbound diversion via Churchfield Street • Westbound diversion via Acton Lane, Bollo Bridge Road, Bollo Lane and Gunnersbury Lane • Possible additional closure of Acton High Street • Possible shared traffic option • Possible eastbound segregation by acquiring properties on north side and westbound shared traffic	• No road closure • Strict enforcement of existing waiting and loading restrictions, and extension of restrictions if necessary • Westbound stop east of King Street • Eastbound stop at east of Church Road allowing extended segregation • Additional westbound stop at east of Chatsworth Gardens • Additional eastbound stop east of Woodlands Avenue	46,47
Shepherds Bush Green	• Transit and access/bus lanes on north side • Stop beside stations	• Stop at Shepherds Bush Station (Hammersmith Line) (not offset) • Transit and access/bus lanes on north side with turning beside Holland Road gyratory • Stop at Shepherds Bush Station (Central Line/ West London Line)	56-58

Appendix 1

BCR Criteria	*Sub-Criteria*	*Indicators*	**Mode Comparison**
Environmental	Natural Environment	Noise, local air pollution, global emissions, energy and fuel consumption, land-take, townscape, ecology	Tbus and Tram have identical environmental benefits Tbus quieter than tram especially when track is worn
Safety & Security	Accidents & personal security	Public and private transport accidents, personal security	Tbus stated to have half the liability to be involved in accidents than diesel buses on non segregated roads. (Evidence of Salzburg Stadbus, 2004). With equal segregation to tram layout, Tbus is liable to be equal or better, due to better ability to stop and deviate..
Economic	Costs, time savings and revenue	Capital and operating costs, public and private use, public and private journey times, revenue, cost-benefit analysis	Benefit of capital cost of infrastructure and vehicles only (excluding road and station building costs) equal to 1/8th to ¼ cost of tram equivalent. Costs of stations equal to tram cost if built to 40m. Less if built to 25m length. Roadway segregation cost considerably less than tram due to no utility removal or rail installation. Possible disbenefit of increased road maintenance. Journey times by Tbus equal or better than tram, due to higher acceleration ability and equal top speed. Revenue dependant on assessment of capacity, but Tbus is capable of equal capacity. Installation of Tbus system quicker and less disruptive than Tram system Reduced risk premium due to Tbus capacity/demand flexibility (and thus revenue/viablity) and installation simplicity.
	Transport Capacity	Capacity of corridor, crowding, frequency	Tbus equal to tram in passenger/vehicle metre. Tbus disbenefit of 200 passenger vehicles compared to 300 passenger trams. Tbus benefit of needing greater frequency to provide equal capacity.
Accessibility	Public transport	Pedestrian access to public transport, access to local centres	Equal or better than tram. Equal level boarding ability. Additional Tbus benefit of possibility to wire into centre, eg. Ealing Hospital to main entrance.
	Accessibility to other modes	Community severance, pedestrian space, parking and servicing access	Tbus equal to tram. Potentially better integration with parking and servicing access by Tbus, due to better design flexibility
Integration	Integration with other modes	Interface with other modes	Easier Tbus integration with bus mode. Easier Tbus design ability to have increased number of stops than tram.
	Accessibility impacts on regeneration and social inclusion	Access to development sites, access to deprived areas, access to employment	Tbus benefit of easier and quicker installation of extensions than tram.

Appendix 2

COSTS OF A TROLLEYWAY FOR WEST LONDON TRANSIT SCHEME

As the latest TfL proposal (Report to the TfL Boad April 2004) proposes two levels of service with half the frequency between Hayes and Uxbridge as between Shepherd's Bush and Hayes, the spreadsheet separates the service into two.
The costs are given for a service along the whole route from Shepherd's Bush to Uxbridge and then for an additional same frequency service from Shepherd's Bush to Hayes, thus replicating the proposed tramway service. The infrastructure capital costs are allocated to the full route service and thus the short working service Shepherd's Bush to Hayes has only vehicle capital costs allocated to it. Full day to day maintenance and running costs are applied to both routes. The combined costs for the whole service along the route are given at the bottom in the boxes with green background.

LOWER (INITIAL) USAGE

SHEPHERD'S BUSH TO UXBRIDGE

PHYSICAL CHARACTERISTICS RESOURCING IMPLICATIONS	note	TROLLEY WAY	note	TROLLEY WAY
Length of Route (Kilometres)		22		22
Peak Requirement (Number of Passengers Per Hour)		2625		3500
Capacity of each Vehicle	1	200	1	200
Peak Frequency of service (whole minutes)	2	5	2	3
Actual Flow of Passengers Per Hour Provided by Frequency	3	2625	3	3500
Number of stops per kilometre	4	2.25	4	2.25
Mean Distance between stops (metres)	4	444	4	444
Mean Dwell Time at each stop (seconds)	5	18	5	18
Mean (Peak) Time for running between stops (seconds)	6	41	6	41
(Figures assume clear run between transit stops)				
Mean Seconds at a stand for vehicles on Diesel/Trolley/Tramway between stops	6	17.5	6	17.5
Mean (Peak) Time for running between stops (seconds)	6	68	6	68
(Figures assume one stop between transit stops)				
Time for (Peak) end to end journey (minutes)		48		48
(Figures assume clear run between transit stops)				
Time for (Peak) end to end journey (minutes)		71		71
(Figures assume one stop between transit stops)				
Peak Mean Speed Including all time calling at bus stops				
(Figures assume clear run between transit stops)				
(Metres/Second)		8		8
(Kilometres/Hour)		28		28
Peak Mean Speed Including all time calling at bus stops				
(Figures assume one stop between transit stops)				
(Metres/Second)		5		5
(Kilometres/Hour)		19		19
Peak Mean Speed Excluding all time calling at bus stops				
(Figures assume clear run between transit stops)				
(Metres/Second)		11		11
(Kilometres/Hour)		40		40

Peak Mean Speed Excluding all time calling at bus stops				
(Figures assume one stop between transit stops)				
(Metres/Second)		7		7
(Kilometres/Hour)		24		24
Mean Turn Round Time at Each Terminus (Minutes)	7	5	7	5
Minimum Number of Vehicles Required to Maintain Peak Frequency	7	24	7	31
(Figures assume clear run between transit stops)				
Minimum Number of Vehicles Required to Maintain Peak Frequency	7	33	7	44
(Figures assume one stop between transit stops)				
Fleet Allocation for Maintenance/Reliability etc. (percentage)	8	6	8	6
Total Fleet Required for Route				
(Figures assume clear run between transit stops)	8	26	8	33
Total Fleet Required for Route				
(Figures assume one stop between transit stops)	8	35	8	47
Peak Service Operation (Hours per week)	9	30	9	30
Total Hours of Operation (Hours per week)	10	132	10	132
Off Peak Service Operation (Hours per week)		102		102
Off Peak Service (% Reduction in Peak Service Frequency)	11	50	11	50
Off Peak End to End Journey Time	12	48	12	48
(Figures assume clear run between transit stops)				
Fleet Required for Off Peak Route Operation		12		16
Desired Vehicle Crewing	13	1	13	1
Minimum Vehicle Crewing	13	1	13	1
Peak Journeys provided with Desired Vehicle Crewing (%)	13	100	13	100
Off Peak Journeys provided with Desired Vehicle Crewing (%)	13	100	13	100
Crew to provide Peak Service (Hours per week)				
(Figures for vehicles on Diesel/Trolley/Tramway assume clear run between stops)		720		930
Crew to provide Peak Service (Hours per week)				
(Figures for vehicles on Diesel/Trolley/Tramway assume one stop between bus stops)		990		1320
Crew to provide Off Peak Service (Hours per week)				
(Figures for vehicles on Diesel/Trolley/Tramway assume clear run between stops)		1224		1632
Total Crewing required (Hours per Week)				
(Vehicles on Diesel/Trolley/Tramways assume clear run between stops all day)		1944		2562
Total Crewing required (Hours per Week)				
(Vehicles on Diesel/Trolley/Tramways assume one stop between stops in peaks)		2214		2952

COSTS

VEHICLE PURCHASE

Purchase of One New Vehicle (£ UK)	14	500,000	14	500,000
Purchase of Fleet Required to Operate Route				
(Vehicles on Trolleyway assume clear run between stops all day)		13,000,000		16,500,000
Purchase of Fleet Required to Operate Route				
(Vehicles on Trolleyway assume one stop between stops in peaks)		17,500,000		23,500,000
Lifespan of Vehicles (Years)	15	30	15	30
Total Purchase Cost of Vehicles (Including 50% cost for half life refurbishment)				
(Vehicles on Trolleyway assume clear run between stops all day)		19,500,000		24,750,000
Total Purchase Cost of Vehicles				
(Vehicles on Trolleyway assume one stop between stops in peaks)		26,250,000		35,250,000

Equivalent Annual Cost for Vehicle Fleet Purchase				
(Vehicles on Trolleyway assume clear run between stops all day)		650,000		825,000
Equivalent Annual Cost for Vehicle Fleet Purchase				
(Vehicles on Trolleyway assume one stop between stops in peaks)		875,000		1,175,000

PROVISION OF TROLLEYWAY

Cost per Kilometre for two way road trolleyway (£ UK)				
Includes Trolley Poles, Overhead Wiring, Kassel Kerbs (platforms), Road Surface Improvements (or track laying) etc.	17	4,798,700	17	4,798,700
Lifespan of Equipment (Years)	18	30	18	30
Total Purchase Cost of Trolleyway		105,571,000		105,571,000
Equivalent Annual Cost for Trolleyway		3,519,000		3,519,000

MAINTENANCE OF TROLLEYWAY

Maintenance Cost per Route Kilometre (£ UK)	20	10,000	20	10,000
Route Kilometres of System		22		22
Route Kilometres operated per year		1,310,000		1,747,000
Total Cost of System Maintenance (£ UK per annum)		220,000		220,000
Control Centre for Electrical and Operational Purposes				
Assumes apportionment to route of Central Control Resources	21	100,000	21	100,000

MAINTENANCE OF VEHICLES

Maintenance cost (UK pence per kilometre)	22	50	22	50
Total Cost of Fleet Maintenance (£ UK per annum)		655,000		874,000

CREWING COSTS

Inclusive Cost of Crew (£UK per hour)	23	12	23	12
Utilisation of crew (percentage)	24	75	24	75
Total Annual Wage Costs of Crew (£UK)				
Assumes vehicles on Trolleyway stop once between bus stops peak (variation in costs very small)	25	1,842,000	25	2,456,000

ELECTRICITY COSTS

Cost of Electricity (UK pence per Kwh)	28	2.6	28	2.6
Electricity Consumption (Kwh per kilometre)	29	4	29	4
Total Costs for fuel (£ UK per annum)		119,000		159,000

TOTAL COSTS

Operational Running Costs (No Maintenance or Capital Costs)				
(£ UK per annum)	30	1,961,000	30	2,615,000
Costs Including all Maintenance (including Trolleyway) but Excluding Capital Costs				
(£ UK per annum)	31	2,936,000	31	3,809,000
Costs Including all Maintenance (including Trolleyway) and Capital Costs for Vehicles but excluding Trolleyway Capital Costs				
(£ UK per annum)	32	3,811,000	32	4,984,000
Costs Including all Maintenance (including Trolleyway) and Capital Costs for Vehicles (including Trolleyway Capital Costs)				
(£ UK per annum)	33	7,330,000	33	8,503,000

CAPITAL COSTS				
Total Capital Costs	34	131,821,000	34	140,821,000
COST OVERHEADS (No relation to power lines)				
Total cost for vehicle fleet garage space (£1.5 million already included withininfrastructure costs)	36	0	36	0
Staff Overhead cost (admin staff and other miscellaneous costs) (per cent of crew wage cost)	37	10	37	10
Total overhead cost for employment of vehicle crews (£ UK per annum)	37	184,000	37	246,000
Total Costs Overheads	38	184,000	38	246,000
TOTAL COSTS OF OPERATION				
Total Costs (£ UK per annum)	39	7,514,000	39	8,749,000

SHEPHERD'S BUSH TO HAYES

	note	TROLLEY WAY	note	TROLLEY WAY
PHYSICAL CHARACTERISTICS RESOURCING IMPLICATIONS				
Length of Route (Kilometres)		14		14
Peak Requirement (Number of Passengers Per Hour)		2625		3500
Capacity of each Vehicle	1	200	1	200
Peak Frequency of service (whole minutes)	2	5	2	3
Actual Flow of Passengers Per Hour Provided by Frequency	3	2625	3	3500
Number of stops per kilometre	4	2.25	4	2.25
Mean Distance between stops (metres)	4	444	4	444
Mean Dwell Time at each stop (seconds)	5	18	5	18
Mean (Peak) Time for running between stops (seconds)	6	41	6	41
(Figures assume clear run between transit stops)				
Mean Seconds at a stand for vehicles on Diesel/Trolley/Tramway between stops	6	17.5	6	17.5
Mean (Peak) Time for running between stops (seconds)	6	68	6	68
(Figures assume one stop between transit stops)				
Time for (Peak) end to end journey (minutes)		31		31
(Figures assume clear run between transit stops)				
Time for (Peak) end to end journey (minutes)		45		45
(Figures assume one stop between transit stops)				
Peak Mean Speed Including all time calling at bus stops				
(Figures assume clear run between transit stops)				
(Metres/Second)		8		8
(Kilometres/Hour)		27		27
Peak Mean Speed Including all time calling at bus stops				
(Figures assume one stop between transit stops)				
(Metres/Second)		5		5
(Kilometres/Hour)		19		19
Peak Mean Speed Excluding all time calling at bus stops				
(Figures assume clear run between transit stops)				
(Metres/Second)		11		11

(Kilometres/Hour)		40		40
Peak Mean Speed Excluding all time calling at bus stops				
(Figures assume one stop between transit stops)				
(Metres/Second)		7		7
(Kilometres/Hour)		24		24
Mean Turn Round Time at Each Terminus (Minutes)	7	5	7	5
Minimum Number of Vehicles Required to Maintain Peak Frequency	7	16	7	21
(Figures assume clear run between transit stops)				
Minimum Number of Vehicles Required to Maintain Peak Frequency	7	22	7	29
(Figures assume one stop between transit stops)				
Fleet Allocation for Maintenance/Reliability etc. (percentage)	8	6	8	6
Total Fleet Required for Route				
(Figures assume clear run between transit stops)	8	17	8	23
Total Fleet Required for Route				
(Figures assume one stop between transit stops)	8	24	8	31
Peak Service Operation (Hours per week)	9	30	9	30
Total Hours of Operation (Hours per week)	10	132	10	132
Off Peak Service Operation (Hours per week)		102		102
Off Peak Service (% Reduction in Peak Service Frequency)	11	50	11	50
Off Peak End to End Journey Time	12	31	12	31
(Figures assume clear run between transit stops)				
Fleet Required for Off Peak Route Operation		8		11
Desired Vehicle Crewing	13	1	13	1
Minimum Vehicle Crewing	13	1	13	1
Peak Journeys provided with Desired Vehicle Crewing (%)	13	100	13	100
Off Peak Journeys provided with Desired Vehicle Crewing (%)	13	100	13	100
Crew to provide Peak Service (Hours per week)				
(Figures for vehicles on Diesel/Trolley/Tramway assume clear run between stops)		480		630
Crew to provide Peak Service (Hours per week)				
(Figures for vehicles on Diesel/Trolley/Tramway assume one stop between bus stops)		660		870
Crew to provide Off Peak Service (Hours per week)				
(Figures for vehicles on Diesel/Trolley/Tramway assume clear run between stops)		816		1122
Total Crewing required (Hours per Week)				
(Vehicles on Diesel/Trolley/Tramways assume clear run between stops all day)		1296		1752
Total Crewing required (Hours per Week)				
(Vehicles on Diesel/Trolley/Tramways assume one stop between stops in peaks)		1476		1992
COSTS				
VEHICLE PURCHASE				
Purchase of One New Vehicle (£ UK)	14	500,000	14	500,000
Purchase of Fleet Required to Operate Route				
(Vehicles on Trolleyway assume clear run between stops all day)		8,500,000		11,500,000
Purchase of Fleet Required to Operate Route				
(Vehicles on Trolleyway assume one stop between stops in peaks)		12,000,000		15,500,000
Lifespan of Vehicles (Years)	15	30	15	30
Total Purchase Cost of Vehicles (includes +50% for half life refurbishment)				
(Vehicles on Trolleyway assume clear run between stops all day)		12,750,000		17,250,000

Total Purchase Cost of Vehicles (includes +50% for half life refurbishment)				
(Vehicles on Trolleyway assume one stop between stops in peaks)		18,000,000		23,250,000
Equivalent Annual Cost for Vehicle Fleet Purchase				
(Vehicles on Trolleyway assume clear run between stops all day)		425,000		575,000
Equivalent Annual Cost for Vehicle Fleet Purchase				
(Vehicles on Trolleyway assume one stop between stops in peaks)		600,000		775,000

PROVISION OF TROLLEYWAY

Cost per Kilometre for two way road trolleyway (£ UK)				
Includes Trolley Poles, Overhead Wiring, Kassel Kerbs (platforms), Road Surface Improvements (or track laying) etc.	17	0	17	0
Lifespan of Equipment (Years)	18	30	18	30
Total Purchase Cost of Trolleyway		0		0
Equivalent Annual Cost for Trolleyway		0		0

MAINTENANCE OF TROLLEYWAY

Maintenance Cost per Route Kilometre (£ UK)	20	0	20	0
Route Kilometres of System		22		22
Route Kilometres operated per year		1,310,000		1,747,000
Total Cost of System Maintenance (£ UK per annum)		0		0
Control Centre for Electrical and Operational Purposes				
Assumes apportionment to route of Central Control Resources	21	0	21	0

MAINTENANCE OF VEHICLES

Maintenance cost (UK pence per kilometre)	22	50	22	50
Total Cost of Fleet Maintenance (£ UK per annum)		655,000		874,000

CREWING COSTS

Inclusive Cost of Crew (£UK per hour)	23	12	23	12
Utilisation of crew (percentage)	24	75	24	75
Total Annual Wage Costs of Crew (£UK)				
Assumes vehicles on Trolleyway stop once between bus stops peak (variation in costs very small)	25	1,228,000	25	1,657,000

ELECTRICITY COSTS

Cost of Electricity (UK pence per Kwh)	28	2.6	28	2.6
Electricity Consumption (Kwh per kilometre)	29	4	29	4
Total Costs for fuel (£ UK per annum)		119,000		159,000

TOTAL COSTS

Operational Running Costs (No Maintenance or Capital Costs)				
(£ UK per annum)	30	1,347,000	30	1,816,000
Costs Including all Maintenance (including Trolleyway) but Excluding Capital Costs				
(£ UK per annum)	31	2,002,000	31	2,690,000
Costs Including all Maintenance (including Trolleyway) and Capital Costs for Vehicles but excluding Trolleyway Capital Costs				
(£ UK per annum)	32	2,602,000	32	3,465,000
Costs Including all Maintenance (including Trolleyway) and Capital Costs for Vehicles (including Trolleyway Capital Costs)				

(£ UK per annum)	33	2,602,000	33	3,465,000
CAPITAL COSTS				
Total Capital Costs	34	18,000,000	34	23,250,000
COST OVERHEADS (No relation to power lines)				
Total cost for vehicle fleet garage space (£1.5 million already included withininfrastructure costs)	36	0	36	0
Staff Overhead cost (admin staff and other miscellaneous costs) (per cent of crew wage cost)	37	10	37	10
Total overhead cost for employment of vehicle crews (£ UK per annum)	37	123,000	37	166,000
Total Costs Overheads	38	123,000	38	166,000
TOTAL COSTS OF OPERATION				
Total Costs (£ UK per annum)	39	2,725,000	39	3,631,000
WHOLE ROUTE CAPITAL COSTS				
Total Costs (£ UK over full 30 years)	40	149,821,000	40	164,071,000
TOTAL COSTS OF OPERATION				
Total Costs (£ UK per annum)	41	10,239,000	41	12,380,000
TOTAL REVENUE				
Total Revenue (£ UK per annum)	42	28,000,000	42	35,600,000
TOTAL PROFIT				
Total Profit (£ UK per annum)	43	17,761,000	43	23,220,000

NOTES

1. The vehicle considered for trolleybus operation is double articulated and of 25 metre overall length giving a capacity of 200 passengers.

2. This is the frequency required to give the ability to move the passenger flow quoted.

3. As the figures require whole numbers of vehicles, they may not necessarily equal exactly the flow. This figure shows the actual passenger flow possible with the vehicle quantities shown.

4. The spacing of stops is the mean figure calculated from the total number of such stops quoted by TfL in published reports .

5. The dwell time is based on the driver having no involvement with ticketing and the vehicle having multiple entrances and exits. Observation confirms that this dwell time is maintained (and bettered) by single door conductor equipped Routemasters and articulated ('bendy-bus') diesel vehicles. Modern light rail systems can also achieve this level of dwell time.

6. The assumptions are that the trolleycoach accelerates and brakes at 1.5 metres/second ^{2} (possible with an electric trolley vehicle but not with a diesel bus)· If the trolleyway were completely clear of other traffic and trolleycoaches had priority at all junctions, the vehicle could accelerate to top speed (12.5 metres per second - within the normal road limit of 30 m.p.h.) and then travel at this speed until braking for the next stop.

This is the "clear run between stops" figure. In practice there could be deceleration and some stopping. To avoid unnecessary complex mathematical modelling, this has been allowed for, by adding a "seconds at a stand" field. This allows the vehicles to stop and accelerate up to normal speed once between stops and stand still for the time indicated. Extra time has been allocated to allow for those sections of road still available for general traffic.

7. This indicates the number of vehicles required to maintain the frequency with the specified end to end journey times and specified turn round times. Whilst the turn round can theoretically be zero, the smaller the turn round, the greater propensity for delays to spread from earlier to later services (the "domino effect").

8, Theoretically a service can be operated with the minimum number of vehicles required as in (7), but this would imply that if any vehicles were off the road due to damage or major repair, alteration etc., the service would be unable to be maintained.

9. This assumes a two level service with the normal morning and evening peaks Monday to Friday having the higher frequency.

10. The hours shown here give a typical spread for rapid transit and most busy London bus routes - early morning to late night seven days a week.

11. Whilst the combination of frequencies can be very complicated (and often is, on some bus routes), for the purposes of costing, there is no purpose in having complex mathematical models that only marginally affect total cost. As stated in (9) a two level frequency has been applied with a consistent frequency off peak seven days a week. Modern rapid transit systems such as Croydon Tramlink follow this model much more closely than conventional bus routes.

12. It is assumed that the combination of the lighter general off peak traffic combined with the traffic priority measures will enable the vehicles to accelerate to permitted speed from stops and then maintain that speed until braking for the next, "a clear run". It should be noted that all calculations of between stops time are based on 12.5 metres per second maximum speed (less than 30 m.p.h.).

Clearly if some sections of the road had a higher limit, such as 40 m.p.h., this latter higher speed could be achieved by trolleybuses and trams within the 444 metres between stops.

13. In order to minimise dwell time of the vehicles on the Trolleyway, all ticket issuing is done outside the vehicle by use of machines. The minimum staffing is thus one. With the normal penalty fares regime in force, it would not be essential to provide a ticket chcking crew on all journeys, so a percentage with desired staffing to allow for a reasonable level of such cover was input into the origianl calculations. No such allowance has been made in any TfL tram proposal figures for revenue protection so to give comparable figures in this spreadsheet the allowance has been removed..

14. The cost of the trolleybus has been obtained from recent Western European practice.

15. In accordance with the figures used by TfL in their tram option an allowance has been included for a half life refurbishment of the vehicles. Instead of allocating a fixed amount (irrelevant of fleet size) a percentage of fleet cost has been used in this spreadsheet of 50%. This should allow for a very high quality overhaul/refurbihment of the vehicles irrespective of the fleet size.

16. No longer used

17. This figure allows for installation of all electrical supply equipment: poles, wires, substations, feeders etc.for the Trolleyway. It also includes the raised kerbs provided for level access at all stops and necessary maintenance to the road surface to give good ride quality and to avoid the necessity of diverting away from any physical segregated sections, such as stops, because of road repairs on the Trolleyway. Also included is alterations to roadways and especially junctions to give necessary priority to the trolleybuses on the Trolleyway.

18. As with the life of vehicles, this figure is in reality likely to be pessimistic (many previous trolley systems in the UK and elsewhere have used equipment well beyond this timespan). Therefore the apportioned costs per year for Trolleyway provision may be overstated.

19. No longer used

20. The apportionment of the overall maintenance costs for the system infrastructure is very difficult as it would very much depend on the size of the system. Clearly a small route mileage would carry higher overheads (you cannot for instance have less than one tower wagon - although contracting out may be possible for very small systems). The figure here is therefore notional but allows for an amount equal to the entire capital cost to be spent on maintenance within the life span of the system. This is almost certainly pessimistic.

21. A notional figure has been allocated here to cover the apportioned costs of a Control Room. Whilst for quality reasons, conventional motor bus networks would undoubtedly benefit from Control Rooms, they are not universally provided (in practice they are very unusual). Because of the fixed infrastructure and electrical supply, a central Real Time Control Room is required for the operation of a Trolleyway network. The figure selected would mean that ten such routes would support a round the clock fully staffed office. No allowance appears to have been included for a Tramway Control Room within TfL's figures.

22. These figures for normal maintenance have been compiled from historic UK (suitably increased to allow for inflation), current mainland European and current North American experience. There is little variation between the countries concerned.

23. This figure represents the mean total cost to the operator of one hour of crew. It is higher than current levels of bus driver/operator pay. This accords with the desire to improve the quality and image of staff operating public transport (e.g. the well known and forthright views of Ken Livingstone on this subject).

24. To allow for the fact that crew are not always able to be at the wheel of the vehicle, a factor has been incorporated for "non productive" time. Note that the turn round time at each end of the route is already included and considered as "productive".

25. As the difference in costs between the two options of "clear run" or stopping between stops for the Diesel/Trolley/Tramway vehicles is very small compared to the overall total costs, the more expensive figure has been used from here onwards.

26. No longer used

27. No longer used

28. This would be the subject of contractual negotiation between supplier and Trolleyway owner. Discussions with the UK electricity supply industry have indicated that in the current competitive energy market, a long term contract for large power usage could be agreed at the price shown of 2.6 pence per Kwh. Furthermore the same discussions have indicated that long term stability of real pricing could be agreed.

29. Figure derived from previous UK experience (suitably increased for larger vehicle size) and current European and North American experience. Modern Traction systems and possible use of regenerative braking mean that this figure is probably pessimistic.

30. This is the annual direct costs of operation of vehicles and includes crew wage costs and fuel.

31. This figures includes not only direct operational costs of power and crew wages but also maintenance of vehicles and maintenance of the infrastructure.

32. This figure includes all direct operating costs, maintenance of vehicles, maintenance of the Trolleyway and also the apportioned purchase of the vehicle fleet.

33. The final figure includes all direct operating costs, all maintenance costs and also the apportioned costs of both vehicles and Trolleyway installation.

34. The capital costs reflect the cost of the infrastructure (wires, poles track, platfiorms, ticket machines, road layout changes etc.) added to the cost of the vehicle fleet.

35. No longer used

36. As stated in the spreadsheet, £1.5 million allocated for this purpose within the overall infrastructure costs.

37. All staff carry an overhead beyond staff costs. This includes staff who deal with administrative matters, rosters, industrial relations, etc. This is clearly dependent on total number of staff, although it is accepted that this is not a linear relationship. In this case a notional 10% of the vehicle crew payroll budgethas been chosen.

38. Overheads of both vehicles and staff combined.

39. Grand Total of all operating, maintenance, installation and overhead costs.

40. The Whole Route Captal Costs of the Trolleybus option compared to that for the tram version in TfL reports.

41. The total costs of operation (capital and day to day) of the whole route divided by the 30 years of system operation.

42. The revenue for the corridor given by TfL against the same passenger flow provided by a tram option (TfL report to the Board April 2004 Section 5.6). The larger flow rvenue figure has been extrapolated from the smaller.

43. Revenue minus total costs per annum. Note that the trolleybus/Trolleyway option is heavily in profit compared to the ongoing subsidy required for the tramway option.

COMMENTS

Justification has been given for all the figures used in this spreadsheet. It should be noted however that electricity costs make little difference to the end total and that the only figures which would fundamentally change the comparison would be an increase in the cost of infrastructure construction and these costs have been calculated in detail and are available in a separate document.

Appendix 3

Year:	0	1	2	3	4	5	6	7	8	9
Receipts										
Revenue Receipts	0	28,000,000	32,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000
Other										
Total Receipts	0	28,000,000	32,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000
Payments										
Construction of trolleyway	95,200,000									
Purchase of trolleybuses	17,500,000	7,500,000	4,500,000							
Annual Operating & Maintenance		10,799,000	12,000,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000
Tax charge										
Refurbishment of fleet year 16										
Other										
Total Payments	112,700,000	18,299,000	16,500,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000

Year:	10	11	12	13	14	15	16	17	18	19	20	21
Receipts												
Revenue Receipts	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000
Other												
Total Receipts	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000
Payments												
Construction of trolleyway												
Purchase of trolleybuses												
Annual Operating & Maintenance	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000
Tax charge												
Refurbishment of fleet year 16							17,000,000					
Other												
Total Payments	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	30,738,000	13,738,000	13,738,000	13,738,000	20,038,000	20,038,000

Year:	22	23	24	25	26	27	28	29	30
Receipts									
Revenue Receipts	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000
Other									
Total Receipts	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000	35,000,000
Payments									
Construction of trolleyway									
Purchase of trolleybuses									
Annual Operating & Maintenance	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000
Tax charge									
Refurbishment of fleet year 16									
Other									
Total Payments	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000	13,738,000

Lower Discount Rate	4%
Higher Discount Rate	7%
Net Present Value at Lower Discount Rate	0
Net Present Value at Higher Discount Rate	0

Appendix 4

West London Transit Cost Calculations

Uxbridge to Shepherds Bush Trolleybus Route 907

Route summary	span	span #	km	tfl align		
Uxbridge	0.034647059	47	1.628	***		map ref 1.1
Hillingdon	0.034647059	56	1.940	***		map ref 1.2
Hayes	0.034647059	84	2.910	***		map ref 1.2,1.3
Hayes Town	0.034647059	16	0.554	***		map ref 1.3
Southall	0.034647059	89	3.084	***		map ref 1.4
Hanwell	0.034647059	40	1.386	***		map ref 1.4,1.5
Ealing	0.034647059	82	2.841	***		map ref 1.5
Acton	0.034647059	100	3.465	***		map ref 1.5
Shepherds Bush	0.034647059	58.5	2.027	***		
Additional turning circles	0.034647059	30	1.039			
To depot wiring	0.034647059	30	1.039			
Route length	0.034647059	572.5	19.835			
Wired route length						
Number of stations			57			
Av. distance between stops			0.345			
stations per km			3			
total spans		632.5	21.914			

Route description	location	stops	km	road engineering requirement	analysis	
Uxbridge Station	Uxbridge	1	0.208	Pedestrianised with Transit, cycle, pedestrian access; limited local access	6	bracket
High Street		1	0.416	New stopping, parking, loading arrangements	12	spans
Hillingdon Road		1	0.762	Transit Lane across roundabout	22	bracket
Hillingdon Road		4	0.243	New stopping, parking, loading arrangements	7	spans
Hillingdon Hill	Hillingdon	1	0.554	New stopping, parking, loading arrangements	16	bracket
Uxbridge Road			2.806	New stopping, parking, loading arrangements	81	spans
Uxb. Road (County Court)	Hayes		0.312	New stopping, parking, loading arrangements	9	bracket
Uxbridge Road		1	1.178	New stopping, parking, loading arrangements	34	spans
Uxb. Rd (junc. Parkway)	Hayes Town		0.554	New stopping, parking, loading arrangements	16	bracket
The Broadway	Southall	1	2.183	New stopping, parking, loading arrangements	63	spans
Uxbridge Road	Dormer's Wells	1	0.693	New stopping, parking, loading arrangements	20	bracket
Iron Bridge		1	0.208	New stopping, parking, loading arrangements	6	spans
Uxbridge Road		1	0.624	New stopping, parking, loading arrangements	18	bracket
Hanwell Br., Broadway Rd	Hanwell, West Ealing		3.603	New stopping, parking, loading arrangements	104	spans
Ealing Com. Acton Br.	Acton	1	4.573	New stopping, parking, loading arrangements	132	spans
Shepherds Bush Green	Shepherds Bush	1	0.918	New stopping, parking, loading arrangements	26.5	bracket
				additional spans		38
				additional brackets		72
				total straight spans		477
				total braketted spans		205
Total route length			19.835			

Overhead bill of quantites	type	#	unit	price	total
Poles	class B	1159	#	£1,358	£1,574,297
	class C				
	class D				
span wires		477	#	£265	£126,405
bracket arms		205	#	£1,804	£370,312
V-bridles					

Box Bridles					
Pull offs					
Hangers	600mm	1159	#	£149	£172,732
	1200mm	580	#	£149	£86,366
	1800mm	580	#	£149	£86,366
contact wire length		45	km	£4,514	£202,356
span wire length			km		
tension wiring		169375	m	£6	£1,016,250
section insulators		84	#	£765	£64,260
subtotal					£3,699,345
contingency, supervision, contractor's profit +30%					£1,109,803
overhead total					£4,809,148
Substation bill of quantites				each	total, (x3)
Building		10		£61,118	£611,180
500kw transformer rectifier		10		£36,671	£366,710
3 panel dc switchboard		10		£55,006	£550,060
feeder isolator pillar		10		£6,112	£18,340
dc cable		600	312	£20,955	£188,595
11kv public supply		10		£48,894	£488,940
sub total					£2,223,825
contingency, supervision, contractor's profit +30%					£667,148
substation total					£2,890,973
Road engineering estimates		quantity	unit	each	totals
Trolley stations		57		£250,000	£14,250,000
Pedestrianisation			km	£1,000,000	
Road marking		29368.47	m	£125	£3,671,059
New road construction			km	£1,000,000	
Resurfacing		40	km	£1,000,000	£40,000,000
Utility relignment (60%)		0.665	km	£4,000,000	£2,658,353
sub total					£60,579,412
contingency, supervision, contractor's profit +30%					£18,173,824
road engineering total					£78,753,235
Summary infrastructure costs					
overhead installation		19.835	km	£242,452	£4,809,148
power supply		19.835	km	£145,748	£2,890,973
road engineering		19.835	km	£3,970,329	£78,753,235
road construction/pedestrianisation					
Allowance for routeing via Southall station					£7,279,035
maintenance facilities, depot				£1,500,000	£1,500,000
infrastructure estimate					£95,232,391
Vehicle cost estimates					
18m trolleybus		0		£350,000	£0
25m trolleybus		59		£500,000	£29,500,000
Summary					
scheme cost					£117,453,356
contingency 15%					£17,618,003
overall cost					£135,071,360
(electrification costs)					£7,700,121
(electrification % of total)					6
(total cost/km)					£6,809,597
(electrification cost/km)					£351,375
(road engineering cost/km)					£3,970,329