18 WWAY - Quantitative Assessment of Options

18.1 Section Overview

- The capital cost estimates for the construction of the WWAY rapid transit route options between Belfast city centre and West Belfast are based on unit cost rates per length of route taken from the 'Affordable Mass Transit Guidance' revised to reflect local circumstances. Including optimism bias (as guided by WebTAG) and vehicle purchase costs, it is estimated that an LRT scheme could cost in the region of £204million to £460million and a bus-based rapid transit scheme between £36million and £61million depending on the final preferred route.

- Operational cost estimates for the WWAY rapid transit were also developed. It is estimated that the annual operating costs for a bus-based system would be between £399k and £916.5k and for a LRT system they would be between £1.8million and £3.4million per year.

- The operational assessment of the WWAY rapid transit options have been carried out using the Belfast Transportation Model. It is estimated that a BRT scheme could attract between 500 and 1,200 passengers in the morning peak period, depending on the final route. For LRT (mainly because of the extra passenger attraction factor of the vehicle and service), it would attract between 650 and 1,600 passengers in the morning peak period.

- The economic appraisal of the WWAY rapid transit options has demonstrated that the economic performance of the bus-based options which terminated at the Glenmona development on the Monagh Bypass (Route options O3 and O4) were much stronger than bus-based options along Andersonstown Road and Stewartstown Road. However, this conclusion is very much dependent on the level of priority and road space allocation afforded to the scheme. The bus-based options O2a and O2b, suffered (in economic terms) because of the significant highway disbenefits attributed to general road users – due to the reduction in highway capacity.

- The significant investment and operating costs associated with the light rail options outweighs the benefits obtained resulting in a negative NPV and a BCR of less than 1.0.

18.2 Method of Appraisal

The approach used in the appraisal of the rapid transit schemes has followed the Department for Transport's (DfT) Transport Analysis Guidance Website – WebTAG (www.webtag.org.uk). In addition, due cognisance has also been taken of the "*NI Practical Guide to the Green Book*" issued by the Department of Finance and Personnel.

18.3 The WWAY options

The options being evaluated in this appraisal are outlined in Section 17 previously and summarised as follows:

- **Do-Minimum –** Existing bus 'Metro' service continued along relevant corridors in West Belfast with no additional bus priority / bus lane infrastructure other than that proposed by the city centre traffic management proposals;

- **Option O2a (BRT)–** bus-based rapid transit (BRT) system which would run along Route Options I1 and O2 and terminate at the Dairy Farm Shopping Centre (Falls Road / Andersonstown Road). See previous section 17.2 for full description of Route O2 and the level of segregation assumed. Assumed 5 minute peak frequency. This option will utilise specially constructed 'BRT' vehicles which have a higher 'passenger attraction' factor than conventional buses. Other Metro bus services along this route are reduced by 50%.
- **Option O2b (BRT)–** bus-based rapid transit (BRT) system which would run along Route Options I1 and O2 and terminate at a park-and-ride site at McKinstry's Road roundabout (Falls Road / Andersonstown Road). See previous section 17.2 for full description of Route O2 and the level of segregation assumed. Assumed 5 minutes peak frequency. This option will utilise specially constructed 'BRT' vehicles which have a higher 'passenger attraction' factor than conventional buses. Other Metro bus services along this route are reduced by 50%.
- **Option O2a (LRT) –** the same as Option O2a (BRT) above except that the system would operate as a Light Rail Transit (LRT) system along Route Options I1 and O2 and terminate at the Dairy Farm Shopping Centre. The same level of segregation would apply and the services would operate a 5 minute peak frequency. This option would utilise specially constructed 'LRT' vehicles which would have a higher 'passenger attraction' factor than BRT or conventional bus services. Other Metro bus services along this route are reduced by 50%.
- **Option O2b (LRT) –** the same as Option O2b (BRT) above except that the system would operate as a Light Rail Transit (LRT) system along Route Options I1 and O2 and terminate at a park-and-ride site at McKinstry's Road roundabout. The same level of segregation would apply and the services would operate a 5 minute peak frequency. This option would utilise specially constructed 'LRT' vehicles which would have a higher 'passenger attraction' factor than BRT or conventional bus services. Other Metro bus services along this route are reduced by 50%.
- **Option O3 (BRT) -** bus-based rapid transit (BRT) system which would run along Route Options I1 and O3 (Falls Road / Glen Road). See previous section 17.2 for full description of Route O3 and the level of segregation assumed. Assumed 5 minute peak frequency. This option will utilise specially constructed 'BRT' vehicles which have a higher 'passenger attraction' factor than conventional buses. Other Metro bus services along this route are reduced by 50%.
- **Option O3 (LRT) -** the same as Option O3 (BRT) above except that the system would operate as a Light Rail Transit (LRT) system along Route Options I1 and O3. The same level of segregation would apply and the services would operate a 5 minute frequency. This option would utilise specially constructed 'LRT' vehicles which would have a higher 'passenger attraction' factor than BRT or conventional bus services. Other Metro bus services along this route are reduced by 50%.
- **Option O4 (BRT) -** bus-based rapid transit (BRT) system which would run along Route Options I1 and O4 (Springfield Road). See previous section 17.2 for full description of Route O4 and the level of segregation assumed. Assumed 5 minute peak frequency. This option will utilise specially constructed 'BRT' vehicles which have a higher 'passenger attraction' factor than conventional buses. Other Metro bus services along this route are reduced by 50%.
- **Option O4 (LRT) -** the same as Option O4 (BRT) above except that the system would operate as a Light Rail Transit (LRT) system along Route Options I1 and O4. The same level of segregation would apply and the services would operate a 5 minute peak frequency. This option would utilise specially constructed 'LRT' vehicles which would have a higher

'passenger attraction' factor than BRT or conventional bus services. Other Metro bus services along this route are reduced by 50%.

18.3.1 WWAY Capital Costs

The costs for the construction of the WWAY rapid transit options along the three route options between Belfast city centre, the Royal Victoria Hospital and the greater West Belfast community are based on unit cost rates per length of route taken from the 'Affordable Mass Transit Guidance' with some revisions made to take account of local circumstances. The capital costs also include the cost of purchasing new vehicles to operate the service. The detailed capital costs analysis and assumptions are provided in Appendix L of this report. A summary of the cost estimates are outlined in Table 18.1 overleaf.

For the "Do-Minimum" option, a total capital cost estimate of £33,000 has been provided. This includes for the cost of the traffic management elements (signing and lining) associated with the city centre public transport priority along the route of the WWAY in the city centre (i.e. Donegall Square South and Howard Street). Due to the fact that it is assumed that the existing bus service continues as normal, there are no new vehicle purchase costs associated with the Do-Minimum.

It should be noted that the capital cost estimates outlined in Table 18.1 assume that the inner route option utilises the route shown in the BMTP / draft BMAP i.e. inner route option I1 (over Westlink and through RVH site). The impact of using Grosvenor Road (inner route option I2) is described as a sensitivity test in more detail in section 18.6 of this report.

In summary, the light rail transit option (LRT) is based upon a unit rate of £15million per 2-way of track (2002 prices) which has been uplifted to 2007 prices. For the vehicle purchase costs, it is assumed that the average cost of a LRT vehicle is £1.5million each (2007 prices).

The bus-based rapid transit option (BRT) is based upon a unit rate of £0.9million per 2-way of track with some revisions made to account for local circumstances. In addition, a further 25% was added to the unit cost rate to take account of additional land, utility diversions and traffic management requirements during construction – this is due to the fact that a significant amount of on-street widening will be required to accommodate the new rapid transit lanes. For the vehicle purchase costs, it is assumed that the average cost of a BRT vehicle is £350,000 each.

Consideration will also be given to the use of standard low-floor Metro buses instead of the more expensive specialised BRT vehicles. In this instance, the vehicle costs are assumed to be £160,000 each with the infrastructure costs being the same as the BRT scheme.

The unit cost rates outlined above from the Affordable Mass Transit Guidance are in 2002 prices and therefore have been rebased to current prices (2007) using the Building Cost Information Service (BCIS) Tender Price Index (1.283).

Table 18.1: Outturn capital costs for rapid transit options

Technology / Route Option	Out-turn capital costs	Optimism bias	Vehicle purchase costs[19]	Final Capital Cost Estimate
Do-Minimum	£33k	-	-	**£33k**
BRT Options				
BRT Route O2a[1]	£31.32m	£13.78m	£3.50m	£48.60m
BRT Route O2b[2]	£38.58m	£16.96m	£4.90m	£60.44m
BRT Route O3 [3]	£23.91m	£10.51m	£2.45m	£36.87m
BRT Route O4 [4]	£23.22m	£10.21m	£2.45m	£35.88m
LRT Options				
LRT Route O2a	£225.99m	£148.83m	£15.00m	£389.82m
LRT Route O2b	£265.57m	£173.86m	£21.00m	£460.43m
LRT Route O3	£117.19m	£75.93m	£10.50m	£203.62m
LRT Route O4	£125.66m	£81.52m	£10.50m	£217.68m
Standard Bus Options				
Bus Route O2a	£31.32m	£13.78m	£1.60m	£46.70m
Bus Route O2b	£38.58m	£16.96m	£2.24m	£57.78m
Bus Route O3	£23.91m	£10.51m	£1.12m	£35.54m
Bus Route O4	£23.22m	£10.21m	£1.12m	£34.55m

Note 1:Route O2a – Falls Road, Andersonstown, Stewartstown Road terminating at Dairy Farm;
Note 2:Route O2b – Falls Road, Andersonstown, Stewartstown Road terminating at McKinstry Road;
Note 3: Route O3 – Falls Road, Glen Road, Monagh Bypass terminating at Glenmona; and
Note 4:Route O4 – Springfield Road, Monagh Bypass terminating at Glenmona.

The basis for the calculation of the Optimism Bias calculations is based on guidance within WebTAG Unit 3.5.9 which sets out the recommended optimism bias uplift factors for different types of schemes. Further details on the Optimism Bias assumptions are contained within Section 20 of this report.

The unit cost rates taken from the Affordable Mass Transit Guidance include for the following elements of construction:

- Off-vehicle ticketing;
- Land and utilities diversion;
- Civils and trackwork;
- Stops;
- Electrical (including power supply and overhead line equipment) (LRT only);
- Communications and signalling;
- Depot / Control Centre;
- Highway and traffic management works; and
- Design, management and contingency.

[19] 10 vehicles are required to operate Route O2a, 14 vehicles are required to operate Route O2b and 7 vehicles are required to operate Routes O3 and O4.

It should be noted that the unit cost assumptions taken from the Affordable Mass Transit guidance do include for an element of land costs (i.e. for LRT it is approximately 25% of the total unit cost rate and for BRT it is approximately 10% of the total unit cost rate). For the BRT schemes, we have uplifted the unit cost rates by a further 25% as there is a significant level of on-line widening of the existing highways needed to accommodate the new rapid transit lanes. For park-and-ride, it is not possible to say at this stage what the costs are for land as a specific site has not been identified. However, the cost for the park-and-ride site at Millmount (EWAY) has been used as a proxy in the first instance. In addition, should a LRT scheme be taken forward, detailed consideration will also need to be given to the location of a depot / control centre and the implications that this may have for further third party land costs.

As the vehicle purchase costs are included in the upfront capital cost estimate, for the purposes of the economic appraisal, it is assumed that BRT vehicles will be replaced every 10 years and LRT vehicles will be replaced every 30 years.

A construction contract period for a BRT scheme of 3 years is assumed with 30%, 30% and 34% expenditure for each of these years respectively and 6% during the three years prior to this.

A construction contract period for a LRT scheme of 3 years is also assumed with the same spending profile as above. The spend profile for the WWAY options is outlined in Table 18.2. below.

Table 18.2: WWAY S-profile for capital costs

Option	Description	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
1	BRT	2%	2%	2%	30%	30%	34%
2	Light rail	2%	2%	2%	30%	30%	34%

18.3.2 Operating and Maintenance Costs

Conventional Bus / BRT Operating Costs

The following assumptions have been included with regard to Conventional Bus / BRT operating costs:

- A cost of 34 pence per litre has been used for **fuel costs** for conventional buses. This is based on the current cost of 97 pence per litre for Northern Ireland (from Julys AA Fuel Price Report) less VAT (which can be reclaimed) and fuel duty (which is assumed will be reclaimed via the fuel duty rebate). For the articulated BRT vehicles, the fuel costs are assumed to increase by 30% to take account of the additional weight of the vehicle;
- **Fuel consumption** in litres per km has been calculated from estimated operating speeds taken from the Belfast Traffic Model and using the methodology in WebTAG. This is a generic equation only and does not relate to any type of PSV in particular but enables different consumptions for be calculated based on different speeds;
- A **total maintenance cost** of 26 pence per bus km has been used. This is based on the Affordable Mass Transit Guidance figures updated to 2007 prices using the Retail Price Index. For the articulated BRT vehicles, which may be more innovative and highly specified vehicles, the maintenance costs are assumed to increase by 30% to take account of this;

- **Vehicle costs** have been included in the capital cost estimates (see previous section). It has been assumed that average vehicle costs are £160,000 for conventional buses (i.e. Metro bus services), £350,000 for more specialised BRT vehicles and £1,500,000 for LRT vehicles;
- Annual **time-based costs**, such as the cost of a tax licence, MOT and insurance are assumed to be a total of £2,350 per annum per bus;
- The **fleet size** has been based on a calculation of the number of vehicles required to operate the peak frequency plus an additional vehicle for maintenance purposes. This has been calculated based on the assumed frequency and time to complete the route plus an assumed turnaround time (minimum of 5 minutes);
- A **cost of drivers** of £13 per hour has been assumed. This is based on information from the Affordable Mass Transit Guidance increased by Average Earnings to current prices. In order to determine the total driver costs the total number of hours of service operation has been used. This is based on the total hours of operation based on the number of services, journey times and turnaround times;
- A **service frequency** of 5 minutes in the peak (07:00 to 10:00), 5 minutes in the Interpeak (10:00 to 17:00) (10 minutes in the interpeak for the Do-Minimum), 15 minutes in the evening (after 17:00), 10 minutes on a Saturday and 15 minutes on a Sunday has been assumed; and
- **Journey times** are the journey end-to-end times which have been extracted from the Belfast Transportation Model and they take into consideration the swept paths, rapid transit priority measures and delays at junctions which are reflected in the model for each of the tested options. The journey times shown in the tables overleaf are two-way journey times for the forecast year of 2025 and include for an additional 5mins turnaround time at either end.
- Where options include a reduction in frequency of existing Metro services along the relevant routes in West Belfast, an appropriate saving in operational costs has been included in the economics assessment.

The estimated annual operating costs for a bus-based rapid transit scheme are between £399k and £916.5k (2007 prices) depending on the final route chosen. WWAY Route options O2b and O2a are more expensive to operate as they are longer routes with longer journey times and as such more vehicles are required to maintain the required headway. The operating costs per route are summarised in Table 18.3 below and detailed in Appendix M.

Table 18.3: BRT annual operating costs

	Route O2a	Route O2b	Route O3	Route O4
Total journey time (2-way)	44mins	63mins	27mins	29mins
Fleet required	10 vehs	14 vehs	7 vehs	7 vehs
Annual total bus km	617,290km	778,797km	398,708km	422,995km
Element				
Annual Fuel Cost	£81,438	£117,611	£45,707	£50,128
Annual Maintenance Cost	£212,582	£268,202	£137,307	£145,671
Annual Drivers Cost	£340,073	£497,816	£199,560	£196,074
Annual Vehicle Cost	£23,443	£32,820	£16,410	£16,410
Total annual cost	**£657,536**	**£916,449**	**£398,984**	**£408,283**

LRT Annual Operating Costs

LRT costs are currently based upon a simple cost per vehicle km from the Affordable Mass Transit Guidance multiplied by the total vehicle kms runs. A more detailed analysis of route plus information on depot costs would be required to undertake a more robust analysis.

The cost for Midland Metro has been used as a proxy as this reflects the operating cost of the shortest system which information is available for and has a total track length of 20km. It should be noted that the actual cost will be influenced by factors such as:

- Local electricity prices;
- Local staff prices;
- Service frequency;
- Economies of scale through size of network;
- Type of vehicle chosen;
- Level of capital investment on infrastructure; and
- Depot location.

The cost for Midland Metro from the Affordable Mass Transit Guidance is £4.84 per vehicle km in 2002 prices. We have adjusted this to £3.48 to take account of the fact that the vehicle purchase costs have been included separately within the capital costs. Adjusted to 2007 prices this unit cost increases to £4.41 per vehicle km. An estimation of the vehicle km for a light rail system is based upon the route length multiplied by the estimated number of LRT departures in one year. This is based on the service frequency assumptions outlined earlier. As a result, the estimated annual operating costs for a light rail-based rapid transit scheme are approximately between £1.8million and £3.4million (2007 prices). This is summarised in Table 18.4 below and detailed in Appendix M.

Table 18.4: LRT annual operating costs

Route:	Route O2a	Route O2b	Route O3	Route O4
Total journey time (2-way)	44mins	63mins	27mins	29mins
Fleet required	10 vehs	14 vehs	7 vehs	7 vehs
Annual total distance	618,909km	778,797km	398,708km	422,995km
Cost per vehicle km	£4.41	£4.41	£4.41	£4.41
Total annual cost	**£2,720,485**	**£3,432,270**	**£1,757,165**	**£1,864,201**

18.4 Operational Assessment of Options

18.4.1 Belfast Transportation Model

The operational and economic assessment of the rapid transit options has been based on modelling work using the Belfast Transportation Model (BTM). The BTM is a multi-modal model constructed and validated in accordance with the Highways Agency Design Manual for Roads and Bridges (DMRB) with an updated base year of 2007.

In essence, the BTM predicts the proportion of travellers between each possible origin and destination 'zone' which will use each available travel mode, principally car, bus, rapid transit or rail. The structure of the mode-choice model is one with an incremental logit at the upper

level of choice between car and passenger transport and an absolute logit at the lower level of choice between the various modes of passenger transport.

18.4.2 Rapid Transport Patronage Forecasts

The patronage forecasts tabulated in Table 18.5 below are based on unfettered demand as the BTM is unable to take account of overcrowding. The patronage forecasts are expressed in terms of the number of persons using the rapid transit service with a conversion factor of 1,617 applied to convert peak hour usage to annual usage.

Table 18.5: WWAY Core Patronage Forecasts based on morning peak hour usage

Scheme	Route Option	Year	Peak Hour Usage (persons)	% of Peak Hour Usage which are WWAY Park & Ride	Annual Usage (persons)
BRT	O2a	2015	768	-	1,241,856
	O2b	2015	1,288	7% (94)	2,082,696
	O3	2015	500	51% (256)	808,500
	O4	2015	608	47% (286)	983,136
LRT	O2a	2015	998	-	1,613,766
	O2b	2015	1,609	10% (165)	2,601,753
	O3	2015	667	40% (265)	1,078,539
	O4	2015	708	42% (297)	1,144,836

When modelling the options in the Belfast Transportation Model, the light rail mode has been coded in such a way that is it seen by potential passengers as being a higher level public transport service than bus-based options. This results in a higher level of passengers switching from onto the service from other public transport services or the private car.

With regard to route options, it can be seen that Route Option O2b (which runs along Falls Road, Andersonstown Road, Stewartstown Road and terminates at a park-and-ride site at McKinstry's Road) attracts the largest forecast peak hour usage – approximately 1,280 passengers. This is due to the fact that this is the longest route out of the four routes being tested and as such it serves a much larger community in West Belfast. When compared to the passenger forecasts for Route Option O2a (which is the shorter version of the route which terminates at the Dairy Farm Shopping Centre), it can be seen that there is definite merit in extending the route to McKinstry Road (past the Dairy Farm Shopping Centre) as the forecast patronage increases significantly by approximately 67%.

The shorter routes along Glen Road and Springfield Road – Route Options O3 and O4 – do not attract as much patronage as Route Option O2b. This is possibly because these routes do not serve some of the bigger communities in West Belfast, such as Poleglass, Twinbrook, Ladybrook and Andersonstown. However, the proportion of people using park-and-ride on Route Options O3 and O4 is much larger.

Table 18.5 above also shows the percentage of peak hour passengers who are also utilising the park-and-ride scheme at either McKinstry's Road (Option O2b) or Glenmona (Options O3 and O4). There is no park-and-ride option associated with Option O2a as it terminates at the Dairy Farm Shopping Centre. It can be seen that there are higher numbers of park-and-ride users of

WWAY when the park & ride site is located at Glenmona (Route Options O3 and O4) – possibly due to the fact that there could be a market for park and ride from the communities at Hannahstown, Dundrod, Crumlin and Glenavy. The proposed park & ride site at McKinstry's Road (Route Option O2b) does not attract a large number of users, mainly because the market for park & ride from Lisburn could be already served by the existing park & ride at Sprucefield and Blacks Road. Nevertheless, Route Option O2b still provides the highest level of forecast patronage for the WWAY system as a whole.

18.4.3 Source of Patronage of Rapid Transport

A concern with the economic evaluation of rapid transit is the degree to which the new mode may extract passengers from existing public transport services. Analysis of the BTM output shows the following levels of abstraction for the 2015 morning peak hour, expressed in both absolute terms and as a percentage – refer to Table 18.6 below. It should be noted that these figures are approximately only and taken from the Belfast Transportation Model.

Table 18.6: Source of patronage of rapid transit

Scheme	Route	Former Car	Former Public Transport
BRT	O2a	34 (4%)	734 (96%)
	O2b	110 (9%)	1,178 (91%)
	O3	299 (60%)	201 (40%)
	O4	336 (55%)	272 (45%)
LRT	O2a	64 (6%)	934 (94%)
	O2b	186 (12%)	1,423 (88%)
	O3	317 (48%)	350 (52%)
	O4	298 (42%)	410 (58%)

The analysis shows that for Route Option O2b (which attracts the highest level of forecast patronage), approximately 90% of the trips for the WWAY rapid transit service are forecast to be former public transport users (bus and taxi). With Route Options O3 and O4, there are a much higher proportion of former car users who use the WWAY service but this is due largely to the good use of the park & ride site which is associated with the rapid transit scheme.

18.4.4 Service Levels

The proposed service levels for the rapid transit services have been set where possible to meet forecast demand and to ensure a frequent service for users in line with the wider rapid transit network (CITI and EWAY). Although there is scope for significant variation in the carrying capacity of a rapid transit vehicle, it has been assumed that the maximum carrying capacity of a BRT vehicle is approximately 100 passengers (seated and standing).

The largest forecast peak hour patronage for a BRT scheme in 2015 is along Route Option O2b – estimated at 1,288 passengers. The largest demand in the inbound direction (as indicated by the Belfast Transportation Model) is approximately 754 passengers (which is in the vicinity of the Royal Victoria Hospital). Working on this basis, and assuming a service frequency of 5 minutes in the weekday peak hour (12 vehicles per hour) in 2015. On the basis of opening year demand, the average vehicle occupancy would be approximately 63 passengers per vehicle.

This is within the 75% occupational vehicle thresholds considered appropriate for a service of this nature.

However, should the service be operated by a Metro single deck bus (carrying capacity approximately 50 seats) or indeed a Metro double deck bus (carrying capacity approximately 80 seats), it can be seen that the forecast demand for 2015 would result in an occupational vehicle threshold which is close to the 75% threshold (for a double-decker bus) and overcrowding would start to occur. It may be possible to increase frequencies of the service to meet this demand but there is a greater risk for buses to bunch together if peak frequency is greater than 5mins and operating and fleet costs would be higher.

With regard to LRT, it is assumed that the maximum carrying capacity of a LRT vehicle is between 150 and 200 passengers. The largest forecast peak hour patronage for a LRT scheme in 2015 is also along Route Option O2b – estimated at 1,609 passengers. The largest demand in the inbound direction (as indicated by the Belfast Transportation Model) is approximately 935 passengers. Working on this basis, and assuming a service frequency of 5 minutes in the weekday peak hour (12 vehicles per hour) in 2015. On the basis of opening year demand, the average vehicle occupancy would be approximately 78 passengers per vehicle. This is within the 75% occupational vehicle thresholds considered appropriate for a service of this nature.

Outside of the weekday peak hour period, it is assumed that a service frequency of 10 minutes in the Interpeak and 15 minutes in the evening would be required. At the weekend, it is assumed that a service frequency of 10 minutes in the Saturday would be required and 15 minutes on a Sunday. In order to determine the level of patronage outside of the AM peak hour, annualisation factors have been calculated. These have been based on hourly public transport patronage profiles combined with an adjustment to capture the forecast effects of the service level assumed in the operating costs, and a consideration of the capacity of the off-peak service levels.

18.4.5 Revenue Forecasts

The public transport assignment routines in the Belfast Transportation Model use the current Metro fare structure and it is assumed that the fares remain unchanged in real terms for the future year models. The model output files are then interrogated to produce the total amount of revenue collected for each public transport mode – bus, rail, taxi, interchange (trips involving both rail and bus) and park & ride. 'Bus' includes both BRT and LRT services. The total revenues by each mode for the Do-Minimum and Do-Something scenarios are compared to give the net change in revenue for each mode.

The revenue forecasts for the WWAY rapid transit service are based on the annual patronage forecasts outlined in Table 18.5. For passengers on the WWAY rapid transit route, a standard single fare of £1.20 is assumed.

The 'WWAY rapid transit' revenue is then subtracted from the annualised Do-Something 'bus' revenue to find the overall impact on bus revenue. Table 18.7 overleaf outlines the forecast annual revenues. The 'WWAY Revenue' outlines the estimated revenue on WWAY rapid transit services only. The 'Net Revenue' outlines the total impact on the public transport network including extraction from other services and revenue generated on other services as a result of WWAY being introduced.

Table 18.7: WWAY Core Forecast Revenues based on annual usage

Scheme	WWAY Revenues		Net Revenues	
	2015	2025	2015	2025
BRT Schemes				
O2a	£1,378,188	£1,982,940	£840,286	£870,819
O2b	£2,311,336	£3,479,566	£433,792	£826,267
O3	£897,258	£1,421,256	£1,378,746	£1,229,258
O4	£1,089,271	£1,392,544	£1,493,656	£1,144,170
LRT Schemes				
O2a	£1,378,188	£1,982,940	£840,286	£870,819
O2b	£2,311,336	£3,479,566	£433,792	£826,267
O3	£897,258	£1,421,256	£1,378,746	£1,229,258
O4	£1,089,271	£1,392,544	£1,493,656	£1,144,170

18.5 Economic Appraisal results

The overall economic performance of the WWAY rapid transit scheme options are summarised in the Transport Economic Efficiency Table (TEE). The TEE table examines the economic impacts of the proposals by looking at the following issues:

- User benefits related to travel time, vehicle operating costs and user charges (fares, parking fees etc). Impacts are calculated across all appropriate modes;
- Private sector provider impacts relate to the impact on the operating environment. The figures record net effects of operating and capital costs over revenue, and thus define the financial sustainability over the 60 year horizon. For the purpose of the appraisal it is assumed that the additional revenue and operating costs are private sector impacts to enable a consistent comparison between LRT and bus using the TEE framework; and
- Public sector provider impacts consider the particular impacts on public sector revenue (for example, parking charges) alongside capital and operating costs.

The public accounts table reflect the impacts on both local government and central government. For this study this includes the cost of grant towards the capital expenditure, and, loss of indirect taxation through reductions in fuel duty paid and loss of VAT due to consumers switching expenditure to public transport fares which are zero rated for VAT.

The TEE table summarises the benefits in the Analysis of Monetised Costs and Benefits (ACMB) table which also provides value for money indicators for the scheme:

- Present Value of Benefits (PVB) is the scheme benefits including the economy benefits and monetised environmental, safety and interchange benefits of the scheme.
- Present Value of Costs (PVC) is the cost to government and is made up of all government contributions to the building and operating, including tax revenues lost when users switch modes;
- Net Present Value (NPV) represents the net effects of benefits and costs once allowance for discounting has been made; and

- The Benefit / Cost Ratio (BCR) refers to the rate at which benefits exceed (or not) costs to government.

In terms of the calculations used to derive the economic outputs in the TEE table, the assumptions used to calculate these values are as follows:

- The opening year is 2014/2015 for BRT and LRT;
- The assessment period is 60 years from opening year;
- 2002 price and discounting period;
- Discount rate of 3.5% for first 30 years and 3.0% thereafter;
- Monetary valuations for the benefits have been taken from the latest Government guidance;
- Unit of account is market prices and therefore any factor prices are uplifted by 20.9% which is the average rate of indirect taxation in the economy;
- Journey time savings are based upon values of times and value of growth assumptions in WebTAG 3.5.6. The values for both bus and LRT used are £20.22 per hour for business trips, £5.04 per hour for commuting trips and £4.46 for other trips. The same business values of time for bus and LRT have been used due to the approach utilised in the modelling which involving changing the mode constants as opposed to the values of time, and additionally WebTAG does not contain a value of business time specific to an LRT user. Working values of time are assumed to grow in line with income, with an elasticity of 1 whilst non working values of time are assumed to grow income with an elasticity of 0.8. The measure of income used is GDP per capita.
- Journey purpose splits for all modes are based on those contained within WebTAG 3.5.6. The values for both bus and LRT used, based on weekday journey purpose splits, these are 1.5% work, 26.9% commuting and 71.5% other.
- A single fare of £1.20 has been assumed

A summary of the figures in the TEE table is summarised in Tables 18.8 to 18.10 (and outlined in Appendix N) (note that costs are shown as negative and ratios do not have units).

Table 18.8: Summary of TEE Table Valuations for BRT options (specialised BRT vehicles)

Assessment Element	Value in 2002 prices			
	Route O2a	Route O2b	Route O3	Route O4
Table 1: Economic Efficiency of Transport System				
Consumer user benefits				
Travel time saving	£13,045,049	£13,456,379	£32,732,668	£52,290,620
Vehicle operating costs	-£11,829,452	-£11,884,932	£3,383,841	£4,183,411
Business user benefits				
Travel time savings	-£2,960,394	-£2,869,507	£4,002,206	£6,335,834
Vehicle operating costs	-£583,404	-£586,140	£166,884	£206,317
Private sector provider impact				
Revenue	£15,219,382	£13,247,357	£22,116,127	£21,275,839
Operating costs	£7,567,830	£2,475,775	£10,133,301	-£5,031,953
Total present value of transport economic efficiency benefits	**£20,459,011**	**£13,838,932**	**£72,535,027**	**£79,260,068**
Table 2: Public Accounts				
Investment costs	£34,743,715	£45,757,152	£25,289,527	£29,243,587
Indirect tax revenues	£272,576	-£16,022	£4,672,463	£4,641,302
Total present value of costs	**£35,016,292**	**£45,741,130**	**£29,961,990**	**£33,884,889**
Table 3: Analysis of Monetised costs and benefits				
Consumer users (Table 1)	£1,215,597	£1,571,448	£36,116,509	£56,474,031
Business users and providers (Table 1)	£19,243,414	£12,267,485	£36,418,518	£22,786,038
Present Value of Benefits (PVB)	**£20,459,011**	**£13,838,932**	**£72,535,027**	**£79,260,068**
Present Value of Costs (PVC)	**£35,016,292**	**£45,741,130**	**£29,961,990**	**£33,884,889**
Net Present Value (NPV)	**-£14,557,281**	**-£31,902,198**	**£42,573,037**	**£45,375,180**
Benefit Cost Ratio (BCR)	**0.6**	**0.3**	**2.4**	**2.3**

Table 18.9: Summary of TEE Table Valuations for BRT options (using standard buses)

Assessment Element	Value in 2002 prices			
	Route O2a	Route O2b	Route O3	Route O4
Table 1: Economic Efficiency of Transport System				
Consumer user benefits				
Travel time saving	£13,045,049	£13,456,379	£32,732,668	£52,290,620
Vehicle operating costs	-£11,829,452	-£11,884,932	£3,383,841	£4,183,411
Business user benefits				
Travel time savings	-£2,960,394	-£2,869,507	£4,002,206	£6,335,834
Vehicle operating costs	-£583,404	-£586,140	£166,884	£206,317
Private sector provider impact				
Revenue	£15,219,382	£13,247,357	£22,116,127	£21,275,839
Operating costs	£8,761,476	£4,042,075	£10,876,290	-£4,237,061
Total present value of transport economic efficiency benefits	**£21,652,657**	**£15,405,233**	**£73,278,016**	**£80,054,961**
Table 2: Public Accounts				
Investment costs	£30,766,619	£40,189,217	£22,505,559	£26,459,619
Indirect tax revenues	£272,576	-£16,022	£4,672,463	£4,641,302
Total present value of costs	**£31,039,195**	**£40,173,195**	**£27,178,022**	**£31,100,921**
Table 3: Analysis of Monetised costs and benefits				
Consumer users (Table 1)	£1,215,597	£1,571,448	£36,116,509	£56,474,031
Business users and providers (Table 1)	£20,437,060	£13,833,785	£37,161,508	£23,580,930
Present Value of Benefits (PVB)	**£21,652,657**	**£15,405,233**	**£73,278,016**	**£80,054,961**
Present Value of Costs (PVC)	**£31,039,195**	**£40,173,195**	**£27,178,022**	**£31,100,921**
Net Present Value (NPV)	**-£9,386,539**	**-£24,767,962**	**£46,099,994**	**£48,954,039**
Benefit Cost Ratio (BCR)	**0.7**	**0.4**	**2.7**	**2.6**

Table 1 (Economic Efficiency of the Transport System) of the TEE table displays the costs and benefits to users of the transport system and the private sector. The consumer user benefits category covers all trips which are not business trips and include commuting, leisure and education trips. The business category covers all trips during business time which have a higher value of time, but comprise of a lower proportion of the total journeys.

The travel time savings capture time saving benefits of the entire journey and therefore in the case of public transport captures journey time both in and outside of in-vehicle time and thus captures elements such as walk, wait and interchange time. In addition, for simplicity, the outputs also capture the valuation of the mode constant effects assumed which capture the differing perceptions from the BRT and LRT systems. Therefore where the journey times for BRT and LRT are the same, the LRT has higher benefits due to having a greater mode constant which captures the added 'passenger attraction' factor.

The positive benefits under 'bus and coach' (see detailed TEE tables in Appendix N) therefore capture the impacts of improving journey times and improving the quality of the public transport service. Negative benefits or 'disbenefits' for road vehicles (see detailed TEE tables in Appendix N) captures the fact that the rapid transit priority measures and alignment would impact adversely on the existing highway users and they would have journey times increased and vehicle operating costs increased as congestion would result in increased fuel consumption. In instances where the proposed rapid transit measures have no or minimal impact on the highway network, the road vehicle category would have benefits as the mode shift impact of removing vehicles off the network would benefit the remaining road users.

However, as can be seen in Tables 18.8 and 18.9, there are significant highway disbenefits (increased journey times and vehicle operating costs) for Route Options O2a and O2b. This is due to the fact that the high level of on-street priority and road space allocated to public transport has led to excessive congestion for other road users (including cars, lorries, vans etc.). The resultant net travel time savings and vehicle operating costs on these routes are much less when compared to Route Options O3 and O4 where the resultant impacts of highway congestion are much less felt. This has a significant impact on the overall economic analysis as outlined below.

The potential loss of on-street parking (and the resultant impact on local business who rely on passing trade) and the additional congestion caused to other motorists by the reduction in highway capacity is a major issue for the WWAY proposals – particularly for options O2a and O2b. This will need careful consideration at the next stage of design and appraisal.

The private sector impacts capture the net impact of the scheme in terms of revenue, investment costs and operating costs on the private sector operators.

The Public Accounts table (Table 2) shows the impacts on the public sector accounts. The investment costs include the incremental capital costs of the Do-Somethings (Options O2a to O4) over the Do-Minimum and include the infrastructure costs and vehicle purchase costs.

The indirect taxation calculation captures the impacts of the rapid transit scheme on tax revenues. Mode shift to public transport is detrimental to the tax revenues because the government receives less tax revenue from reduced expenditure of fuel, and for newly generated trips experiences a loss in tax revenue as people shift expenditure to public transport fares which are zero rated for VAT from goods which have indirect tax applied.

The Analysis of Monetised Costs and Benefits (Table 3) summarises the costs and benefits and includes indicators such as the NPV and BCR.

The above TEE table demonstrates that the performance of the WWAY Route options O3 and O4, which both terminate at the Glenmona Development, are much better (in economic terms) than the route options that are along the Falls Road (Route Options O2a and O2b). Although Route Options O2a and O2b attract a much higher level of patronage (because they serve a greater area), the journey time savings attributed to public transport users due to the introduction of a high level of priority are more than offset by the significant highway disbenefits which are felt by other road users due to the effective reduction in highway capacity. In this instance, the BCRs are both less than 1.0 and as a result would not be deemed economically viable.

On the other hand, WWAY Route Options O3 and O4 both perform well in economic terms. The journey time savings experienced by public transport users (including a high percentage of park & ride users) outweighs the disbenefits experienced by other road users due to the introduction of priority measures. These two schemes are also less expensive that Route

Options O2b and O2a as they are shorter in length and therefore cheaper to construct and operate. In economic BCR terms, the BRT scheme which has the highest BCR is Route O3 (a BCR of 2.4) which runs from Belfast City Centre to Royal Victoria Hospital and then along Falls Road, Glen Road and Monagh Bypass into the new development at Glenmona. However, the scheme which has the most economic benefits is Route O4 (the highest PVB of £79.3million) is Route O4, which terminates at the same location as O3 but takes a different route via Springfield Road. It should be noted that both of these scheme options assume the implementation of a new park & ride site at the terminus which is currently not included in any development proposals.

If the WWAY system adopts standard low-flow Metro buses instead of the more expensive specialised BRT vehicles, the effect on the overall BCRs can be seen in Table 18.9 previously. It can be seen that the lower vehicle purchase costs and annual operating costs (30% reduction in fuel and maintenance) results in a slightly improved BCR between 0.4 and 2.7.

The TEE tables for the LRT options are shown in Table 18.10 below.

Table 18.10: Summary of TEE Table Valuations for LRT options

Assessment Element	Value in 2002 prices			
	Route O2a	Route O2b	Route O3	Route O4
Table 1: Economic Efficiency of Transport System				
Consumer user benefits				
Travel time saving	£29,831,494	£29,317,475	£42,400,873	£63,718,834
Vehicle operating costs	-£10,425,896	-£11,992,682	£3,213,587	£3,834,997
Business user benefits				
Travel time savings	-£1,865,167	-£2,078,706	£4,490,421	£7,028,796
Vehicle operating costs	-£514,184	-£591,454	£158,487	£189,134
Private sector provider impact				
Revenue	£27,726,171	£21,766,260	£25,038,434	£25,481,254
Operating costs	-£28,723,973	-£41,783,056	-£13,760,094	-£30,644,745
Total present value of transport economic efficiency benefits	**£16,028,445**	**-£5,362,163**	**£61,541,708**	**£69,608,269**
Table 2: Public Accounts				
Investment costs	£301,921,831	£362,491,274	£159,097,031	£174,160,596
Indirect tax revenues	£2,755,167	£1,397,375	£5,116,753	£5,283,392
Total present value of costs	**£304,676,998**	**£363,888,648**	**£164,213,783**	**£179,443,988**
Table 3: Analysis of Monetised costs and benefits				
Consumer users (Table 1)	£19,405,598	£17,324,793	£45,614,460	£67,553,831
Business users and providers (Table 1)	-£3,377,153	-£22,686,956	£15,927,249	£2,054,438
Present Value of Benefits (PVB)	**£16,028,445**	**-£5,362,163**	**£61,541,708**	**£69,608,269**
Present Value of Costs (PVC)	**£304,676,998**	**£363,888,648**	**£164,213,783**	**£179,443,988**
Net Present Value (NPV)	**-£288,648,553**	**-£369,250,812**	**-£102,672,075**	**-£109,835,719**
Benefit Cost Ratio (BCR)	**0.1**	**0.0**	**0.4**	**0.4**

The economic TEE tables demonstrates that the bus-based options are much stronger compared to the light rail options. The Net Present Value (NPV) of the bus-based options for Routes O3 and O4 are positive (between £42.6million and £45.4million) and they return positive BCRs of between 2.4 and 2.3 respectively. The significant investment and operating costs, as well as the highway disbenefits experienced by other road users due to the reduction in highway capacity, associated with the bus-based options for Routes O2a and O2b as well as all of the light rail options (for all routes) outweighs the benefits obtained resulting in negative present values and BCRs less than 1.0.

18.6 Sensitivity Test – Inner Route I2 (Glengall Street / Grosvenor Road)

A sensitivity test was carried out in the Belfast Transportation Model to determine if Inner Route Option I2 (along Grosvenor Road) would offer any additional benefits over and above the alternative inner route option I1.

18.6.1 Concept Designs

Concept designs have been developed for inner route option I2 and are attached at Appendix K. The intent of the concept design is to illustrate, in plan, how the introduction of a dedicated rapid transit lane along the corridor would look like and to identify potential constraints and trade-offs required between high levels of public transport priority and general traffic operations.

From the city centre (City Hall), the WWAY rapid transit services would utilise the new bus lanes / traffic management arrangements proposed as part of the city centre traffic management and public realm project. The scheme would then run along Glengall Street (to provide integration with the existing bus and rail station), Durham Street and Grosvenor Road. The scheme would run on-street in a new 'rapid transit lane' which would also allow shared use by other buses and taxis. This scheme would not penetrate the RVH but instead would run around the periphery of the site (Grosvenor Road / Falls Road). With regard to the inbound section of Grosvenor Road (which would be one-way in the outbound direction with the new city centre traffic management proposals), it is proposed that a contra-flow rapid transit lane is provided so that services would not have to make the longer journey around the proposed College Square gyratory. On-line widening of Grosvenor Road (along its entire length) would be required to accommodate the new rapid transit lane.

It should be noted that the concept designs has not considered in detail the implications for general traffic operations (which could be significant), pedestrians and cyclists – this should be considered at the next stage of design. The concept designs have been developed to sufficient detail at this stage to allow the scheme to be tested within the Belfast Transportation Model.

18.6.2 Capital Cost Estimates

For inner route option I2, we have used the same unit cost rates for a non-guided bus-based solution as used previously in order to provide high level capital costs. This is detailed in Appendix L. Including optimism bias of 44%, it is estimated that the costs of inner route option I2 is approximately £3.36million compared to £15.53million for inner route option I1. This is due to the fact that there is no need to provide additional highway infrastructure over the Westlink. It is assumed that there would be no additional vehicles required over and above

what is needed for the overall route options so any additional vehicle purchase costs are excluded at this stage.

As a result, the use of inner route option I2 is likely to result in a significant reduction in the overall capital costs associated with the wider route options.

18.6.3 Rapid Transport Patronage Forecasts

The same assumptions used to derive the patronage forecasts for wider WWAY route options have been used to test the inner route option I2. A test was undertaken in the Belfast Transportation Model, assuming a bus-based option in 2015 and that the remainder of the route would utilise Option O2a (i.e. Falls Road / Andersonstown Road and terminating at the Dairy Farm Shopping Centre). The results show there is very little impact on the overall forecast patronage levels with a minor increase of 3% (from 768 passengers in the morning peak hour period to 790 passengers in the morning peak hour period).

18.7 WWAY Conclusion

The capital costs for the construction of the BRT and LRT rapid transit options along the WWAY rapid transit routes between Belfast city centre, Royal Victoria Hospital and the wider West Belfast community are based on unit cost rates per length of route taken from the 'Affordable Mass Transit Guidance', amended as appropriate depending on local circumstances. Including optimism bias (as guided by WebTAG) and vehicle purchase costs, it is estimated that an LRT scheme could cost in the region of between £204million and £460million and a bus-based rapid transit scheme between £36million and £61million depending on the final route option.

Operational cost estimates for a bus-based scheme were also developed based on assumptions around service frequency, fleet size, fuel costs & consumption, maintenance costs and driver costs. The annual operating costs for a bus-based rapid transit scheme were estimated to be between approximately £399k and £916.5k per year.

Operational cost estimates for a LRT scheme were developed based on a simple unit cost rate per vehicle km taken from the Affordable Mass Transit Guidance multiplied by the total vehicle kms runs. The cost for Midland Metro was used as a proxy as this reflects the operating cost of the shortest system which information is available for and has a total track length of 20km. The annual operating costs for a LRT system were estimated to be between approximately £1.8million and £3.4million per year.

The operational assessment of the WWAY rapid transit options have been carried out using the Belfast Transportation Model. With regard to route options, it can be seen that Route Option O2b (which runs along Falls Road, Andersonstown Road, Stewartstown Road and terminates at a park-and-ride site at McKinstry's Road) attracts the largest forecast peak hour usage – approximately 1,280 passengers. This is due to the fact that this is the longest route out of the four routes being tested and as such it serves a much larger community in West Belfast. When compared to the passenger forecasts for Route Option O2a (which is the shorter version of the route which terminates at the Dairy Farm Shopping Centre), it can be seen that there is definite merit in extending the route to McKinstry Road (past the Dairy Farm Shopping Centre) as the forecast patronage increases significantly by approximately 67%.

The shorter routes along Glen Road and Springfield Road – Route Options O3 and O4 – do not attract as much patronage as Route Option O2b. This is possibly because these routes do not

serve some of the bigger communities in West Belfast, such as Poleglass, Twinbrook, Ladybrook and Andersonstown. However, the proportion of people using park-and-ride on Route Options O3 and O4 is much larger.

The proposed service levels for the rapid transit service have been set where possible to meet forecast demand and to provide the user with a frequent and high level of service. It is assumed that a service frequency of 5 minutes in the weekday peak hour (12 vehicles an hour) would be required in 2015.

The economic appraisal of the WWAY rapid transit options have been carried out using WebTAG guidance and they are assessed against a do-minimum scenario of the existing Metro bus services along the various routes in West Belfast (Metro services 10). The above economic analyses demonstrates that the performance of the WWAY Route options O3 and O4, which both terminate at the Glenmona Development, are much better (in economic terms) than the route options that are along the Falls Road (Route Options O2a and O2b). Although Route Options O2a and O2b attract a much higher level of patronage (because they serve a greater area), the journey time savings attributed to public transport users due to the introduction of a high level of priority are more than offset by the significant highway disbenefits which are felt by other road users due to the effective reduction in highway capacity. In this instance, the BCRs are both less than 1.0 and as a result would not be deemed economically viable.

On the other hand, WWAY Route Options O3 and O4 both perform well in economic terms, both having a BCR of greater than 2.0. Schemes which have a BCR greater than 2.0 are deemed by DfT to be a "good" scheme in economic terms. In economic BCR terms, the BRT scheme which has the highest BCR is Route O3 (a BCR of 2.4) which runs from Belfast City Centre to Royal Victoria Hospital and then along Falls Road, Glen Road and Monagh Bypass into the new development at Glenmona. However, the scheme which has the most economic benefits is Route O4 (the highest PVB of £79.3million) is Route O4, which terminates at the same location as O3 but takes a different route via Springfield Road. It should be noted that both of these scheme options assume the implementation of a new park & ride site at the terminus which is currently not included in any development proposals.

The significant investment and operating costs associated with the light rail option outweighs the benefits obtained resulting in a negative NPV and a BCR of less than 1.0 for all route options.

A sensitivity test using Glengall Street / Grosvenor Road as the alternative inner route option demonstrated that by using this route, there would be not be any significant impact on the forecast patronage of the system but it would be a much cheaper option. This means that the economic performance of the scheme could be improved. However, the detailed impact on traffic operations along this main arterial route into Belfast would need to be looked at in more detail.