Mersey Gateway
First Stage Public Transit Options Study

Date - May 2007

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Report Status

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<td>J Jordan</td>
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<td>T Young</td>
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Issue Status
Revision: C
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Project Director ............................................
Date ....................................................

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

The overall objective of this study was to assess and identify potential public transport options which are likely to be both commercially viable and practically affordable and will also be complementary to, and be supported by, the M25 Gateway scheme as a whole. This study has shown that a number of high level ME objectives are likely to be realised by improving public transport, including:

- To relieve the congested road, thereby removing the constraint on local and regional development and better provide for local transport needs;
- To improve accessibility in order to maximise social development and regional economic growth opportunities;
- To improve local air quality and enhance the general urban environment;
- To improve public transport links across the river.

Following on from this the detailed objectives for this Public Transport Study were as follows:

- To conduct a high level assessment of public transport options for the main corridors of cross-river movements in Halton;
- To identify those options worthy of further consideration for a range of improvements from minor bus priority to LRT and including also enhancements to heavy rail;
- To include indicative estimates of capital and operating costs and revenue in the assessment;
- To assess public transport improvements in the context of Halton Council's social inclusion, cross-river integration and Access Plan objectives;
- To examine the effects of planned new developments in the evaluation;
- To present the findings in a summary table format showing out the salient features of each option.

This high level first stage study consists of:

1. An Initial Technical Options Assessment;
2. Assessing projects to select preferred option based on a First Stage Demand Study; Socio-economic Assessment;
3. First Stage Demand Study of preferred options;
4. Indicative market assessment and indicative outline business case.

0.1 Alternative Technologies Examined

A top-down approach has been adopted throughout this study in relation to the assessment and evaluation of transport technologies and systems that could be developed for the study area and to this end the following technologies have been examined:

- Personalised Rapid Transit (PART);
- Ultra Light Rail (ULR);
- Guided busway (also including trolley bus);
- Busway;
- Light rail;
- Tram-Train;
- Heavy rail;
- Monorail.

0.2 Structure of the Report

The purpose of this working paper is to summarise the review of public transport options that could be considered for Halton. Following this Introduction, sections are included as follows:

- An initial review of the public transport options listed above;
- A description of these options reflected at the early-stage stage;
- A description of each of the options taken forward, including elements such as operation, cost and example, both in the UK and elsewhere;
- An outline of the indicative costs for light rail extending the M25 bridge;
- A summary analysis of the options suggested for short listing;
- A series of recommendations setting out the outcomes of this study.

The report concludes with a set of reasoned justification for a course of action to improve public transport as an input to the M25 Gateway Scheme.
1.0 INTRODUCTION

1.1 Background

Reid Rail was commissioned in April 2007 by Cheshire West and Chester Council to undertake a preliminary high level study to identify and assess public transport options that could be taken forward as part of the Mersey Gateway project. The study focuses on the existing Silver Jubilee Bridge (SJB) to cater for local traffic only.

This preliminary high level assessment is based on the extent to which the public transport options contribute to, and further enhance, the development of the Mersey Gateway project. The study examines potential implementation strategies linking to the delivery and the potential funding available from the revenue stream generated by the Mersey Gateway Concession arrangements.

The potential for public transport improvements will be assessed by centre and the study includes assessment of bus options as well as light and heavy rail options at the upper end.

The aim of this study is to assess, at a broad level, the potential for public transport improvements, along the main corridor of movement in Halton, and including cross-boundary movement, where relevant.

The new bridge over the Mersey is designed to link with the existing Silver Jubilee Bridge between Widnes and Runcorn. The intention is that local traffic will use the existing and regional traffic will use the new bridge. The structural design could accommodate a rapid transit option and indicative costs for accommodating a rapid transit light rail option into the new bridge are included later in this study.

This first stage study examines the potential transport options that could be considered for serving Widnes and Runcorn.

1.2 Study Objectives

The overall objective of this study is to identify and assess potential public transport options and make recommendations as an integral part of the Mersey Gateway project. A number of MG objectives will be achieved by improving public transport, in particular the following:

• Relieving the congested SJB, thereby removing the constraint on local and regional development and better provide for local transport needs;
• Improve accessibility in order to manage local development and regional economic growth opportunities;
• Improve local air quality and enhance the general urban environment;
• Improve public transport links across the river.

Following on from this, the detailed objectives for this Public Transport Study are as follows:

• To conduct a high level assessment of public transport options for the main corridors of cross-river movement in Halton;
• To identify those options worthy of further consideration for a range of improvements including minor bus priority and rail based solutions and enhancements;
• To investigate indicative estimates of capital and operating costs and revenue in the assessment;
• To assess public transport improvements in the context of Halton Council’s social inclusion, cross-ribbon integration and Access Plan objectives;
• To include the effects of planned new developments in the evaluation;

1.3 Methodology and Tasks

The methodology has included the following:

• Development of a clear assessment framework for potential solutions, with definitions for train and tram-train, through segregated bus Rapid Transit to quality bus corridors. This is to cover vehicles, segregation, road space allocation and complementary infrastructure, suitability of the existing Silver Jubilee Bridge;
• Scoping of acceptable potential solutions with Halton Council and immediate stakeholders addressing potentially contentious issues such as road space reallocation and vehicle types;
• A high-level comparative appraisal of all potentially feasible options, taking into account the schema objectives, demand forecasting, and based on the outcomes the production of cost estimates and the building of the outline business case. These are discussed in detail below.

To present the findings drawing out the salient features of each option.

We understand that in Halton, bus services serve distinct local markets with Halton Transport mainly serving Widnes and Runcorn North West the dominant operator in Runcorn. A north-south public transport corridor has been identified as a key issue for the second LTP to encourage more cross-river integration.

It is clear that given that 80% of pre-lockdown day SJB traffic has one or both ends outside the Borough, a locally centred LRT scheme, unless part of the wider Merseytram network, is likely to be very difficult to justify as opposed to a quality bus system.

We understand that in Halton, bus services serve distinct local markets, with Halton Transport mainly serving Widnes and Runcorn North West, the dominant operator in Runcorn. A north-south public transport corridor has been identified as a key issue for the second LTP to encourage more cross-river integration. It is equally important to include public transport links from both sides of the river to hospitals for example in Warrington.

The effect of new homes and jobs will be evaluated within the study including Widnes Waterside and residential developments in Runcorn.

This study looks at the level of demand and service networks for the existing bus corridors and services and the existing rail route and service in order to quantify existing and forecast future demands, and potentially thereafter validate the business case for a high quality rail transit link.
1.4 Market Analysis

The objective of this analysis was to build a detailed picture of the market environment, the overall market for travel, the market for Travel by public transport and public transport customer profiles. This is based on existing data sets. No additional data has been collected.

Outputs from this analysis provide key inputs to the demand forecast and business case for the project.

The first stage of the market study has been gathering relevant data in order to establish robust trends we sought to gather from 5 years of validated historical data and available validated forecasts or projections. Although this has not been possible for all categories, we have gathered sufficient information to support our analysis. The following data has been examined and collated:

- Population (age and gender profiles) - 2001 census by ward also IMD and ACORN social class (map format)
- Employment/ unemployment levels - employment 2004/05, claimant count 2003/04
- Car ownership - 2001
- GDP per head - GVA/Real 1995/2004
- Policy/ land use development - properties likely to impact on the market environment - location of key services in map format, real development schemes in progress/approved for

Sample data could not be obtained on the following:

- Training / further education
- Inland/ export trade
- Exports / imports

In terms of travel behaviour, the following data has been collated for key study area corridors:

- Travel surveys / travel behaviour statistics - M6 Traffic Survey, mode of travel to work 2001 census by ward, 1981 traffic counts April / May 2006
- Road traffic levels and forecasts - estimated traffic flows (vehicle km) 1995/2005
- Road investment programme - LTP
- Bus service data - published timetables
- Comparative performance e.g. journey times, congestion, reliability - published data
- Comparative journey cost, travel times, public transport fares - published journey time and fare statistics

The following data has been developed for public transport schemes available:

- Passenger volumes - M6 traffic survey
- Passenger revenues - none available
- Service features - e.g. routes, frequencies, journey time, performance, prices (fares), customer facilities - published timetables, fares and transport statistics
- Recent market research - including socio-economic profile, journey purpose, attitudes / satisfaction with existing rail services, attitude / sensitivity to different elements of the marketing mix (e.g. destinations, journey time, frequency, price, customer service, promotion and advertising) - none available

This study has identified the likely need for a limited programme of market research, collecting data for later / subsequent stages of this work.

1.5 Demand Forecasting

We have adopted a simple demand forecasting process for this project based around the guidance and evidence published by the Department for Transport (DfT) and Commission for Integrated Transport (CfIT) using available data sets only. The process we have used is highly transparent and can be further refined as new data becomes available.

We have compared the results from the demand forecasting process with actual patronage achieved by existing UK public transport operators. As part of this validation, we have derived some basic trip rates which can be built upon in future analysis.

Output from the demand forecasting process has been used to evaluate economic benefits in relation to:

- Road congestion and modal split;
- Reductions in vehicle operating costs and other measurable PT operator benefits;
- Safety benefits;
- Local air quality benefits;
- Reductions in traffic growth;
- Noise and vibration reductions;
- Better socio-economic impacts i.e. employment;
- Reduction in costs;
- Saverance;
- Option values;
- Other environmental impacts - landscape, townscape, biodiversity, heritage, land and water pollution.

1.6 Indicative Outline Business Case

The outputs from the demand forecasting work session and the cost estimates have been brought together into an outline business case appraisal framework.

This follows the DfT guidance on transport scheme appraisal and provides an indicative benefit/cost ratio calculation for the selected rapid transit option.

This outline business case from the first stage study will:

- Determine if there is a viable public transport element within the MG project;
- Determine the value of a substantial upgrade of bus services;
- Determine the value of a new rapid transit service or a light rail solution including heavy rail options;
- Determine the value of a rapid community benefits of each option, including employment and accessibility across the river.

1.7 Public Transport Options Examined

A wide range of potential public transport systems have been examined for this study as follows:

- Personalised Rapid Transit (PRT);
- Ultra Light Rail (ULR);
- Guided busway (also including trolley buses);
- Surfway;
- Light rail;
- Tram-Train;
- Heavy rail;
- Monorail.

More detailed descriptions of the characteristics of each of these are included later.
1.9 Structure of the Report

The purpose of this study is to summarize the review of public transport options available for Halton. Following this introduction, sections are included as follows:

- An initial review of the public transport options listed above;
- A description of those options rejected at the long-listing stage;
- A description of each of the options taken forward, including elements such as operation, cost and examples, both in the UK and elsewhere;
- An initial economic assessment for short listed transport options;
- An outline of the indicative costs for light rail access by the M5 bridge;
- A summary analysis of the options suggested for short listing;
- Conclusions and Recommendations

2.0 INITIAL REVIEW OF PUBLIC TRANSPORT OPTIONS

2.1 Overview

An initial review of the alternative technology options listed above was undertaken, based on a detailed examination of the following:

- Spatial considerations, to determine the area with which each system could be integrated into the town centre in Runcorn and Widnes, the suitability for accommodation within the Mersey Gateway Bridge (MG) and potentially the Silver Jubilee Bridge (SJ); a factor that is not necessarily critical initially but one which would allow for future system flexibility and extension;
- The possible energy technologies for each system and determine which transit technologies have been proven commercially and which physical measurable environmental benefits through low emissions and low option risk factor;
- Vehicle capacity and system capacity matched to likely future demand including indicative numbers;
- Indicative system performance for each public transport option;
- Indicative vehicle and infrastructure cost for each public transport option.

2.2 Spatial Characteristics

The table below summarises, at a broad level, and from a physical perspective, the anticipated ease with which each system could be physically integrated into the Halton area. This analysis has taken into consideration the typical dimensions of the vehicles and alignment requirements for operation along segregated and shared rights of way.

The table illustrates that heavy rail services would be the most difficult to integrate into the urban environment, given the requirement to operate on dedicated rights of way with full segregation. The other technologies have a lower requirement for segregation, and are potentially easier to integrate into the urban area and can share traffic lanes where necessary.
2.3 Energy Choices for Public Transport Options

Overview
Investment in any new public transport option will necessarily be accompanied by a desire to utilise those accompanying power supply options which are energy efficient. Appendix XX examines in more detail the different power technology options that can be adopted by illustrating whether individual traction systems would be suitable for each technology.

Recommendation
This study does not exclude the application of traction and dual mode technologies as a traction option for bus based rapid transit solutions for Halton. Electrification can be applied to the bus based rapid transit options described in following chapters for bus only and park and ride buses.

However electrification of bus based rapid transit solutions is not a prerequisite to the deployment of these systems which can all be based initially on diesel or low emission biodiesel.

Electrification using trolley bus and dual mode bogies of a low-emission bus based rapid transit option for Halton remains as an option for the future, worthy of further investigation, subject to detailed technical and investment appraisal.

2.5 Operational Characteristics of Public Transport Options

There are several other factors that determine whether a particular technology would be suitable for Halton, and these are summarised in the Table 2.4 below.

Some of the key conclusions shown in the table are the limited capacity of personalised rapid transit systems and ultra-light rail, whilst the costs for monorails are very high. Although it is difficult to form meaningful comparisons, the unit cost of electrified trains varies from £3 million to £7 million per kilometre, and is therefore significantly more expensive than the bus/rail based alternatives, for which the cost per kilometre ranges from £2 million to £15 million.

Table 2.4
Typical Performance Characteristics of Public Transport Options

<table>
<thead>
<tr>
<th>Performance Characteristics</th>
<th>Personalised Rapid Transit</th>
<th>Ultra Light Rail</th>
<th>Guided Busway</th>
<th>Busway</th>
<th>Light Rail</th>
<th>Tram</th>
<th>Heavy Rail</th>
<th>Monorail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle capacity</td>
<td>4</td>
<td>20-60</td>
<td>70-120 (based on 1.8kN/m wide ambiented vehicles)</td>
<td>75-125</td>
<td>450 (based on two 250kN (60 ktn) cars)</td>
<td>450 (based operating cost)</td>
<td>70-400 (depending on road formation)</td>
<td>100</td>
</tr>
<tr>
<td>Typical system capacity per hour (100kW)</td>
<td>0.5-1</td>
<td>0.9-2</td>
<td>4.5-7.5</td>
<td>5-6</td>
<td>1.2-3</td>
<td>1.2-3</td>
<td>1-2-3</td>
<td>2-6</td>
</tr>
<tr>
<td>Operational speed (km/h)</td>
<td>25</td>
<td>30-60</td>
<td>30-60</td>
<td>Up to 80km/h (speed limit on road)</td>
<td>Over 80km/h</td>
<td>Over 120km/h</td>
<td>Up to 120km/h</td>
<td>30-60</td>
</tr>
<tr>
<td>Vehicle cost (£m)</td>
<td>Not incurred</td>
<td>0.5-1.1</td>
<td>0.15-0.4</td>
<td>0.15-0.4</td>
<td>0.6-2.0</td>
<td>1.2-2.2</td>
<td>1.0-3.5</td>
<td>Very high</td>
</tr>
<tr>
<td>Dedicated Infrastructure Cost (£m)</td>
<td>Very high</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>As for Light rail</td>
<td>Very High</td>
<td>Very High</td>
<td></td>
</tr>
</tbody>
</table>

3.0 LONG LIST OF PUBLIC TRANSPORT OPTIONS

3.1 OVERVIEW

Based on this high level analysis, the following criteria were used to undertake an initial sift of options to eliminate those public transport options that are unlikely to fulfil the requirements of Halton by meeting the overall objective of this preliminary study which is to assess viable public transport options which are likely to be both commercially viable and practically affordable and will also be complementary to, and be supported by, the Mersey Conwy scheme as a whole.

- commercially available, proven technology;
- cost;
- typical system capacity;
- operational speed.

The following section includes a brief description of the rejected public transport options. Following this there is a description of the characteristics of the selected list of public transport options, including reviewing the suitability of these systems for deployment in Halton in more detail.
3.2 Rejected public transport options

3.2.1 Overview

As a result of the initial review of alternative technologies, the following were rejected:

- Personalised rapid transit (in terms of system capacity and operational speed);
- Ultra light rail (in terms of system capacity and operational speed);
- Monorail (in terms of operational speed and cost);
- Trolleybus (in terms of immediate applicability to rejected bus options).

More detail on the reasons for rejection can be found in Appendix B.

3.3 Selected public transport options

3.3.1 Overview

As a result of the initial review of public transport options, the following were selected for further consideration and preliminary evaluation (Appendix B provides a more detailed description and overview of the options):

- Medium level BRT prioritisation;
- High Level Bus Prioritisation;
- Bus rapid transit using guided busways;
- Bus rapid transit using busses only (i.e., BRT);
- Right of way for bus only (rail);
- Opportunities for high-speed rail;
- Heavy rail development.

No detailed description and discussion of regular medium or high level bus priorities is included in this stage of the study owing to the difficulty of prioritising techniques that are familiar and widely practiced.

Appendix B provides a more detailed description and examination of the above public transport options that have been considered as having potential for further consideration and investigation.

4.1 Overview

The Public Transport Objectives of this study have been identified as follows:

- To conduct a high-level assessment of public transport options for the main corridors of cross-river movements in Halton;
- To identify those options worthy of further consideration for a range of improvements from minor bus priority to LRT and including also enhancements to heavy rail;
- To include indicative estimates of capital and operating costs and revenue in the assessment;
- To assess public transport improvements in the context of Halton Council's social initiative, cross-river integration and Access Plan objectives;
- To include the effects of planned new developments in the evaluation;
- To present the findings in a summary table format drawing out the salient features of each option.

4.2 Major Traffic Objectives

The indicative list of options set out below identifies the major traffic objectives that any transport system in Halton should aim to serve. Following the initial options meeting with HBC, the revised list includes all the traffic objectives identified. Those marked "*" are existing or potential modal interchanges.

Halton north of river

- Widnes town centre/Vicarage Road (*Milton Road area/Municipal Buildings/Halton College/Halton Stadium);
- Green Oak*;
- Widnes Rail Station/Farnworth*;
- Widnes West Bank/Riverside;
- Hough Green – Rail station*;
- Widnes Waterfront;
- Ditton strategic rail freight interchange.

Halton south of river

- Runcorn High Street/Bus Station*;
- Runcorn Rail Station*;
- Halton Lea Shopping Centre/Thelwall retail Park/Cinema;
- The Heath Business and Technical Park/High School;
- Halton Hospital;
- Runcorn East Rail Station/Murdeshwar;
- Daresbury Science Park/Daresbury Park;
- Whitehouse;
- Mayor Park;
- Abbey House;
- Widnes Point/Rock Savage/Ashville.

Exterior to Halton

- LAAS*;
- Liverpool*;
- St Helens*;
- Warrington (i.e., Omega Development);
- Warrington Hospital;
- Chester*;
- Manchester*;
- Liverpool South Parkway*.

The extent to which the external traffic objectives could be included in any network will depend on the modes, the network and how it would develop and on the route options selected.

4.3 Indicative Route Options

It is not feasible to devise a transit route that serves all the defined traffic objectives.

The indicative route options are set out in Figure 1 and show the potential for routes aimed at serving the primary objectives and as many others as possible.
Three possible route options were defined at high level to link these traffic objectives, one via the SJB and two via the MG (see Table 4.1).

<table>
<thead>
<tr>
<th>Route Option</th>
<th>Line Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route A</td>
<td>Hough Green/Widnes Station&lt;br&gt;Green Oaks&lt;br&gt;Widnes Town Centre&lt;br&gt;SJBL&lt;br&gt;Runcorn High Street&lt;br&gt;Runcorn&lt;br&gt;Hallin Lea&lt;br&gt;Murdishaw</td>
</tr>
<tr>
<td>Route B</td>
<td>Hough Green/Widnes Station&lt;br&gt;Green Oaks&lt;br&gt;Mersys Gateway&lt;br&gt;Bolton&lt;br&gt;Hallin Lea&lt;br&gt;Murdishaw</td>
</tr>
<tr>
<td>Route C</td>
<td>Hough Green/Widnes Station&lt;br&gt;Green Oaks&lt;br&gt;Mersys Gateway&lt;br&gt;Bolton&lt;br&gt;Runcorn High Street&lt;br&gt;Hallin Lea&lt;br&gt;Murdishaw</td>
</tr>
</tbody>
</table>

There is a need to serve Runcorn old town and Runcorn rail and bus stations, and Hallin Lea. It is possible to serve both objectives via the SJB so only one route is necessary. Route A, but two routes are needed via the Mersys Gateway because of the entry point to the busway at Astmoor.

All three routes were shown continuing from Mersyside to Warrington to satisfy the need for a good transit link, particularly to serve Warrington Hospital. However, a shorter route could be devised from the north end of the transit route which would not need to re-cross the river and Manchester Ship Canal. A Hallin-Warrington extension would be inter-urban in character and probably better served by a different route rather than as an extension to the transit system, with the possible exception of a tram-train solution. A tram-train stop could be located close to Warrington District General Hospital.

### 4.4 Route Lengths

Route lengths have been measured and are shown in Table 4.2.

<table>
<thead>
<tr>
<th>Route section</th>
<th>Length</th>
<th>Alignment type</th>
<th>Transit Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Widnes Station - Green Oaks</td>
<td>1.71</td>
<td>On-street</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Hough Green - Green Oaks</td>
<td>3.79</td>
<td>On-street</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Green Oaks - Widnes Town Centre</td>
<td>1.29</td>
<td>On-street</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Widnes Town Centre - Station via MG</td>
<td>1.77</td>
<td>On-street</td>
<td>A</td>
</tr>
<tr>
<td>Hallin Lea - Multishaw</td>
<td>5.43</td>
<td>Off-street</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Astmoor - Runcorn Bus Station via SJBL</td>
<td>0.00</td>
<td>Off-street</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Widnes Station - Runcorn Rail Station</td>
<td>3.79</td>
<td>On-street</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Runcorn Rail Station - Runcorn Bus Station</td>
<td>5.00</td>
<td>On-street</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Runcorn Bus Station - Astmoor</td>
<td>2.23</td>
<td>Busway</td>
<td>C</td>
</tr>
<tr>
<td>Hallin Lea - Runcorn Exit</td>
<td>3.91</td>
<td>Busway</td>
<td>A, B, C</td>
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</table>
The total route lengths for each Transit Route (excluding the Hough Green spur) are:

Route A: 15.56 km (10.38 on-street, 5.17 busway).
Route B: 16.15 km (4.86 on-street, 6.75 segregated, 5.79 busway).
Route C: 19.07 km (7.43 on-street, 6.88 segregated, 7.26 busway).

The total route lengths for each Transit Route including the Hough Green spur before reaching Widnes Station to Green Oaks are:

Route A: 17.64 km (12.57 on-street, 5.07 busway).
Route B: 18.23 km (5.31 on-street, 6.66 segregated, 6.26 busway).
Route C: 21.05 km (9.51 on-street, 6.66 segregated, 7.28 busway).

4.5 Journey Speeds

Typical journey speeds for the alignment types are likely to be in the region of the following:

- On-street: 10 km/hr
- Busway: 30 km/hr
- Segregated: 50 km/hr

Applying these average speeds to the journey lengths gives the following run times (times in brackets are from Hough Green):

Route A: 44 mins. (59 mins.)
Route B: 37 mins. (43 mins.)
Route C: 47 mins. (53 mins.)

4.6 Peak Vehicle Requirements (PVR)

Applying the journey times to the route options gives the number of peak vehicles required as set out in Tables 4.3 to 4.5 below for service frequencies of 3, 4, and 6 transit vehicles per hour (i.e., 20 minute, 15 minute and 10 minute services).

<table>
<thead>
<tr>
<th>Route</th>
<th>Journey Time (mins.)</th>
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<tbody>
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<td>A</td>
<td>44</td>
<td>2</td>
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<td>B</td>
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<tr>
<td>C</td>
<td>47</td>
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<table>
<thead>
<tr>
<th>Route</th>
<th>Journey Time (mins.)</th>
<th>PVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>44</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>37</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>47</td>
<td>7</td>
</tr>
</tbody>
</table>

5. INITIAL DEMAND STUDY

5.1 Overview

The purpose of this section of the study is to provide an initial costing of potential passenger demand for the short-listed public transport options which could form part of the Mersey Gateway Project.

Passenger demand will be influenced by both route choice(s) which are identified in the preceding section, the existing transport needs of the catchment population, the likelihood of existing commuters switching from their current mode to alternatives. This section of the study considers these influencing factors in order to derive an outline estimate of passenger demand.

5.2 Existing Travel Patterns

In 2006 a series of traffic and travel surveys were conducted specifically for the Mersey Gateway Project. They measured bus and rail passenger trips and traffic flow across the Mersey between Runcorn and Widnes.

The survey results indicate that there are in the region of 2,000 bus passengers in each direction every weekend. These journeys are spread across the entire range of services that use the Silver Jubilee Bridge (SJB) including motor vehicles Liverpool and Wirral Transit.

The rail survey included passenger counts at Runcorn Station and trains crossing Runcorn Rail Bridge. The results of the station counts indicate that trips between Runcorn and stations to the South move the strongest passenger demand. Journeys between Runcorn and stations to the North number about 450 (daily single journeys in both directions). Comparing this with published information about total passenger volumes at the station we can reduce that about 38 to 40 per cent of journeys starting or finishing at Runcorn cross the Mersey.

On-board passenger counts of train services crossing the Mersey suggest an estimated 2,500 passengers per day in each direction. However, the survey found that the majority of these passengers were making long distance trips passing through Halton Borough.

Traffic surveys have been conducted at 300 sites in the region, with the most recent surveys being conducted by the Mersey Gateway Project Ltd.
5.3 Potential Modal Switch

The most significant source of passengers for a new LRT system will be existing travellers switching from other modes, private car, bus and rail.

Waiting in the queue when Professor David Begg, then chair of the Commission for Integrated Transport said "Travellers have in Europe have proved an attractive alternative to the car. They took over, comfortable and exciting. Which any new scheme should make it easy for new services and new the curiosity of the public - which cannot wait to give the scheme a try. Conditions in any new system is demonstrated dramatically by the low prices using the road conditions. In Croydon, where they say prices are high, as people have a more attractive - much higher - cheaper way of getting to work. Those figures are confirmed by considering what will happen to car use and getting people. Croydon is forecast to take 40% of traffic of the road away from the existing road system. In Manchester and Sheffield, over half of the road is taken by the car."

Professor Begg's assertion on modal shift from car to rail is confirmed in guidance published by the Commission for Integrated Transport (CfIT) in 2005. The following table is an extract from the guidance and the LRT figures are derived from evidence from Sheffield, Manchester and Croydon.

5.4 Evidence on patronage transfer from car and public transport

<table>
<thead>
<tr>
<th>Light Rail</th>
<th>Guided Bus</th>
<th>Bus Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>% change fom car</td>
<td>13% - 24%</td>
<td>5% - 15%</td>
</tr>
<tr>
<td>% change from other public transport</td>
<td>40% - 60%</td>
<td>0% - 10%</td>
</tr>
</tbody>
</table>

Source: Affordable Mass Transit; Commission for Integrated Transport Sept 2005

Considering first the road traffic flows we can estimate a range of values for modal shift for cross river travel based on the travel survey information for existing roads over the CfIT guidance. The table below shows the calculation:

<table>
<thead>
<tr>
<th>Flow (L x 10000)</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic at Menzies</td>
<td>60,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Traffic at Menzies</td>
<td>60,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Traffic at Menzies</td>
<td>60,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Traffic at Menzies</td>
<td>60,000</td>
<td>70,000</td>
</tr>
</tbody>
</table>

The traffic surveys identified that more than three-quarters (79%) of vehicles were single occupancy, so for the purposes of the calculation we have assumed that the 79% of vehicles would transfer to LRT from single occupancy vehicles. For trips within Halton we have assumed the bottom end of the CfIT evidence percentage (12.5%) for the low estimate and the top end (20%) for the high estimate.

In the case of trips within Halton we have assumed that only the lower end of the evidence percentage range is likely to switch. Measures such as park and ride facilities at the fringes of the LRT route would probably be required in order to achieve this potential. The CfIT evidence suggests potential for bus passengers to switch to LRT in the range of 49% to 69%.

Applying these percentages to the cross river road survey results of 4,000 trips per day would give a lower estimate of 1,400 transferring to LRT and an upper estimate of 2,700.

Results from the rail survey indicate that most journeys are longer distances and therefore we have assumed that potential for switch to LRT will be negligible.

Based on the above calculations we have a cross river patronage estimate in the range of 7,000 to 9,000 trips per day. However, this does not include any account for someone who live in Whitley or similarly within Widnes for which we have no evidence of existing travel patterns. However, it is assumed that the two towns are seen, reasonable to assume that there will be an impact on the LRT system in each of the towns as those who live in Widnes would be able to travel to Whitley. Using this assumption applied to the cross river patronage estimates in an Whitley and Widnes so that the patronage projections can be refined in future stages of the scheme where more detailed quantitative assessments are required.

1. We understand would be the intention to introduce bridge tolls on vehicles using both Mersey Gateway and Silver Jubilee bridges. These road charges would impact on traffic flow across the bridge and the potential modal shift from road to LRT. In depth modeling, taking account of the generalised cost of all alternative modes, would be required in order to provide a robust prediction of the traffic impact. Correction of such a bridge toll impact would affect cross river traffic which we have assumed will make a third of the total traffic. However, this impact is likely to be small compared to the potential impact of bridge tolls on support for the high end range of the patronage projections included above.

5.5 Generated Passenger Demand

Introduction of a new LRT system for Halton Borough would be expected to support accessibility and journey time requirements. These include: improving the ability of people to access places of work, education, shopping and leisure. Key facilities include the main commercial centres of Halton, Warrington and the town centres: Halton Hospital, key employment sites, Mosely and West Bank.

The route options considered for the LRT system will bring about improvements by providing direct access to a number of key facilities (see separate section on option development). At such the system will be expected to generate new passenger demand.

There is little specific evidence to draw upon for estimation of likely generative effects of a new LRT system. We are able to consider generative growth experience on other LRT systems, as a significant factor in developing a more complete estimate of the generation effects from other factors such as the result of the demand on the early period of introduction and growth due to other factors such as economic prosperity.

Taking all these factors into account we believe a reasonable estimate of generated passenger demand would be in the range of 250 to 300 areas per year for the first three years of operation. Applying this assumption to the base estimate of 21 - 27% would give a daily patronage of 22 - 29 by the end of the third year.
year of operation. This converts to an annual passenger in the range 7.5 million to 9.7 million trips, as summarised below:

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily patronage from model</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>Plus generated growth by end year 3</td>
<td>22</td>
<td>31</td>
</tr>
<tr>
<td>Weekly factor</td>
<td>6.5</td>
<td>8</td>
</tr>
<tr>
<td>Annual patronage</td>
<td>145</td>
<td>188</td>
</tr>
</tbody>
</table>

Assumptions used are: passenger in 79% of weekdays for low estimate and 50% for high estimate (this is because the higher day passenger is likely to rely on higher mode share in the peak which is not likely to be sustained on Saturdays and Sundays).

5.6 Comparison with Existing Light Rail Systems

In order to validate the patronage estimates we have compared them with passenger numbers and other key data for a selection of existing LRT systems in the UK. The comparisons are shown in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Passengers (millions)</th>
<th>Total journeys per year (m)</th>
<th>Population (m)</th>
<th>Journeys per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Manchester</td>
<td>20</td>
<td>16</td>
<td>35</td>
<td>21</td>
</tr>
<tr>
<td>Birmingham LRT</td>
<td>18</td>
<td>16</td>
<td>35</td>
<td>21</td>
</tr>
<tr>
<td>Sheffield Metro</td>
<td>15</td>
<td>20</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Milton Keynes</td>
<td>15</td>
<td>22</td>
<td>24</td>
<td>21</td>
</tr>
</tbody>
</table>

Although it is accepted that these comparisons are somewhat basic they do provide a broad indicator which suggests that the high estimate is likely to be over optimistic whereas the low estimate is within a range being achieved by existing systems. However, it should be noted that none of the existing LRT systems have rate pricing mechanisms as an influencing factor which would be the case with the proposed introduction of bridge tolls both for the M62/63 M42 and Silver Jubilee Bridge.

5.7 Passenger Revenue

In order to establish a passenger revenue estimate for the business case assessment we have applied an incremental fare to the passenger volume estimates. The fare range is derived from figures published in ‘Rapid Transit Monitor’, updated to reflect current rates giving an average fare of £1.15 to £1.15 which in turn provides a passenger revenue estimate of £3.3 million to £1.25 million.

6. INDICATIVE COSTS and OUTLINE BUSINESS CASE

6.1 Capital Costs

We understand from the M62 bridge design team that the form of the bridge deck has been determined on pure structural grounds. The lower decking, which would accommodate a light rail track, or other firm or rigid form of bridge, is in the 500m side of the cross-section, and the alignment is as it is to provide for the required construction depth.

It was recognised early on in the project that the bottom slab would be available for use by light rail, if this was considered feasible and economically viable. The design team estimate that there would be no major structural implications of adding light rail and that an indicative allowance of £0.5 million should cover the additional preparation (track, platform, etc.) current provision, etc.

It is reasonable to assume that this light rail route would enter from the north side of the bridge on the M62/63 side and leave on the south side of the bridge on the M62/63 side. The cost to the expanding additional bridges for crossing the St Helens Canal and the Bridgewater Canal and the Cheshire Terminal would be of the order of £100m to £120m to allow for localised infrastructure works.

Access works should not be too extensive on the Widnes side and indicative costs are £2.5 million. On the Wirral a fairly cost effective solution of constructing a 0.6 million to 1.0 million for the light rail, which would then have to meet the cost is likely to be of the order of £5 million. If an external ramp used then the indicative cost would be of the order of £10 million.

The accommodation costs would be broadly similar for a busway / guided busway if this was selected instead of light rail.

The overall length of the bridge is 2.8km. The infrastructure cost for installing a light rail track works on structure would be in the order of £5 million to £7 million per kilometre or £4.5 million for double track across the bridge.

Total system costs for the remainder of the route would be expected to be in the order of £100 million. £50 million for vehicles and depot and station and surrounding land acquisition. Applying these cost rates to the route length excluding low estimates is shown in Table 6.

Table 6: Capital Costs Summary

<table>
<thead>
<tr>
<th></th>
<th>Low (£m)</th>
<th>High (£m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional costs for light rail</td>
<td>2.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Total</td>
<td>138.65</td>
<td>207.95</td>
</tr>
<tr>
<td>Total costs excluding M62 bridge</td>
<td>252.40</td>
<td>372.25</td>
</tr>
</tbody>
</table>

A comparison of indicative capital costs for the main mode options is given in Table 6. All figures are given over the length of the M62 and M63 routes from the Widnes to M62/63, across the bridge to the Widnes side. The costs of works that are not common to the main mode option, e.g. the bridge, should therefore not be included in the comparison. It may be useful to note that the total system costs include rolling stock costs for light rail but not for the bus transit option as the operators would be expected to fund the vehicles.
Table 6.1A Capital costs of mode options

<table>
<thead>
<tr>
<th>Mode</th>
<th>Typical Range</th>
<th>Capital cost per route km</th>
<th>Capital cost for Route B including VGB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (Km)</td>
<td>High (Km)</td>
<td>Low (Km)</td>
</tr>
<tr>
<td>Bus priority (baseline)</td>
<td>0.1</td>
<td>0.3</td>
<td>14.6</td>
</tr>
<tr>
<td>High Level Bus Priority</td>
<td>1</td>
<td>2</td>
<td>27.1</td>
</tr>
<tr>
<td>Subway</td>
<td>2</td>
<td>4</td>
<td>41.0</td>
</tr>
<tr>
<td>Guided Bus</td>
<td>4</td>
<td>6</td>
<td>88.7</td>
</tr>
<tr>
<td>LRT/Train</td>
<td>10</td>
<td>15</td>
<td>151.9</td>
</tr>
</tbody>
</table>

Recommendation

The design team estimates above indicate that there would be no major structural implications of adding light rail or similar rapid transit systems compared with the railway line’s existing rapid transit options considered in this study. We recommend that consideration is given to making budget provision for the costs of localised approach works and access works with an indicative cost of £10m as indicated in this study.

The indicative costs for the minimum accommodation works would be £10m, i.e., including the estimated indicative cost of £16m for authorised approach works and we recommend that provisions be made within the design scheme for these minimum accommodation works as a possible future potential reduction.

We do not recommend that light rail infrastructure works are provided for, in view of the wider outcomes of this study, given that the rail/white profiles of light rail and tram-bus vehicles are very different and the bus rapid transit option is not discounted in this study. Consequently, such an aspect would be premature.

6.2 Operating Costs

Evidence published by OTR indicates operating costs in 2003/04 of £1.79 per vehicle kilometre. This figure is based on mean 2003/04 costs for Manchester, Tyne and Wear, Sheffield, Leeds and Metroline and is similar to the London figures. The unit cost has been increased to reflect current prices giving a cost of £2.07 per vehicle kilometre.

We have calculated a range of costs based on the unit rate and vehicle-kilometres derived from the model in section 6.4 of the report. The low end of the range is calculated based on a bus option at 3 km per hour, while the high end of the range is based on a route option C at 6 km per hour.

Table 6.2 Operating Costs

<table>
<thead>
<tr>
<th>Annual Vehicle Kilometres (000s)</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>568</td>
<td>1,581</td>
</tr>
<tr>
<td>Annual Operating Costs (£m)</td>
<td>2.9</td>
<td>6.4</td>
</tr>
</tbody>
</table>

6.3 Outline Business Case

For this first stage study of the outline business case analysis, focus on the LRT option which has the greatest potential to achieve the policy objective of minimal switch and the consequent reduction in traffic congestion. It also has high potential investment requirements, therefore, providing a good "return on investment" on the affordability of short-term mass rapid transit options.

The business case assessment has been prepared taking into account Transport Appraisal Guidance (TAG) provided by the Department for Transport. Estimates of costs and benefits are consistent with phase 1 High Level Strategic Assesment in terms of degree of detail and complexity. The assessment includes a financial appraisal of direct costs and revenues (base prices used in the appraisal are 2003/4” over a thirty year appraisal period) the results are summarised in Table 6.3. For other impacts, financial values have not been calculated; all are included in a financial appraisal in Table 6.4. The business case assessment of the impact of a rapid transit scheme over key transport corridors identifying specific transport objectives for Hillsborough Council. The bus rapid transit option has been assessed as having a signification impact on the LRT option. Anticipated passenger demand and the consequent reductions in road traffic levels are major influencing factors for many of the assessment criteria.

Table 6.3 Financial Appraisal: Present Value Summary

<table>
<thead>
<tr>
<th>Financial Appraisal: Present Value Summary</th>
<th>PV Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£m</td>
</tr>
<tr>
<td>Capital costs</td>
<td>£152.5</td>
</tr>
<tr>
<td>Operating costs</td>
<td>£45.9</td>
</tr>
<tr>
<td>Total Costs</td>
<td>£198.4</td>
</tr>
<tr>
<td>Net additional revenue</td>
<td>£152.5</td>
</tr>
<tr>
<td>Net financial effect</td>
<td>£45.9</td>
</tr>
<tr>
<td></td>
<td>£108.6</td>
</tr>
</tbody>
</table>

Table 6.4 Other Impacts

The following table provides a qualitative assessment of the impacts of a rapid transit scheme over key transport corridors identifying specific transport objectives for the business case assessment. The bus rapid transit option has been assessed as having a significant impact on the LRT option. Anticipated passenger demand and the consequent reduction in road traffic levels are major influencing factors for many of the assessment criteria.

<table>
<thead>
<tr>
<th>Assessment Criteria</th>
<th>Specific Benefit Transport Objective</th>
<th>LRT (High range impact)</th>
<th>Bus Rapid Transit (Low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>Minimise impact on historic, natural and human environment</td>
<td>MN</td>
<td>MN</td>
</tr>
<tr>
<td>Noise and Air Pollution</td>
<td>Improve local air quality through reduced traffic levels; support sustainable travel</td>
<td>LP</td>
<td>LP</td>
</tr>
<tr>
<td>Congestion</td>
<td>Reduce S/C congestion</td>
<td>LP</td>
<td>LP</td>
</tr>
<tr>
<td>Safety</td>
<td>Improve road safety through mode switch</td>
<td>LP</td>
<td>LP</td>
</tr>
<tr>
<td>Economy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment (employees)</td>
<td>Route options provide links to employment sites</td>
<td>MP</td>
<td>N</td>
</tr>
<tr>
<td>Employment (employees)</td>
<td>Route options provide links to employment sites</td>
<td>N</td>
<td>MP</td>
</tr>
<tr>
<td>Information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Journey Time</td>
<td>Economic and quality of service improvements through synchronised journey times for a range of trips in particular 2005-06 network</td>
<td>DM</td>
<td>LP</td>
</tr>
</tbody>
</table>

23

24
This preliminary high level appraisal indicates that while a BRT rail scheme over the MG would have a substantial negative diminution effect, there is potential for the area to be considered as a corridor in a positive economic impact. But based on road transit would tend to have a lower level impact than the LRT option. A more comprehensive quantified appraisal would indicate whether a sufficiently high economic return could be achieved to justify the investment required.

Table 6.3 summarises the financial appraisal elements of the outline business case in order to provide an indication of potential funding requirement. A detailed report will be provided later on the context of the appraisal. The economic benefits are considered to be an important value, for example, safety and environment-related issues. Inclusion of these benefits could result in a positive benefit/cost ratio. The following list shows the Department of Transport’s current guidance on value for money.

<table>
<thead>
<tr>
<th>VM category</th>
<th>Generally options which have:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor VM</td>
<td>BCP over 1</td>
</tr>
<tr>
<td>Very Low VM</td>
<td>BCP between 1 and 1.5</td>
</tr>
<tr>
<td>Medium VM</td>
<td>BCP between 1.5 and 2</td>
</tr>
<tr>
<td>High VM</td>
<td>BCP over 2</td>
</tr>
</tbody>
</table>

The outcome of the business case could be influenced by a wide range of factors, for example, the Hallam Borough Council policy on land use and complementary measures such as provision of park and ride facilities or town centre parking controls. However, it is recognised that the Borough Council’s ability to negotiate complementary measures is limited as the majority of town centre planning is privately owned and provided free to the user. Providing links beyond Hallam, for example, to Warragul or Maryborough, could also change the outcome of the business case. The addition of cross-boundary destinations to the LRT route is Warragul and/or Maryborough would increase demand but this would need to be sufficient to cover the higher capital and operating costs of the extended network.

Inception

This study has specifically considered the potential for having a LRT system over the proposed Monash Link and the link to the LRT system in the region of $20m it was anticipated that the link would also have a positive business case.

7.0 PUBLIC TRANSPORT OPTIONS FOR DE-LINKING THE SJ BRIDGE

When the Monash Oaking Bridge (MIB) opens, it is proposed to allow some of the approach roads to the Monash Bridge for use. This would allow for a more effective use of the infrastructure in the area. For all Options, the existing four lane carriageway over the SJ would be reduced to a single lane with carriageway.

with cyclistways and footways. Option 3C is a relatively low cost option which would be more appropriate in the context of major improvements in the area. The changes to public transport services resulting from each option are set out in the following report.

For Option 3C, the proposed rail service would require a new service station.


Inbound from SJ: Greenway Railway Station – Vittoria Slip Road to Swamp Road – Swamp Road – High Street – Bus Station.

These are shown in Fig. 7.1. There is a one-hourly bus service for the services on Greenway Railway Station and are not under the SJ rail network. Additional services are available at the Swamp Railway Station for inbound services. A new service at High Street Swamp Road Station is extended in.

For Option 5 Plus, buses operate in both directions as follows:

- Swamp Station – High Street – Doncaster Place – Doncaster Bridge – new junction with Bridgewater Expressway - Greenway.

The requirements of the objectives for any high-quality tram system are to be reliable and to provide access to major traffic opportunities. In this location it would mean:

- creating a separate public transport alignment between the Swamp Station and the SJ as a reduction in the bus stops.
- creating a rail/road interchange at the Swamp Railway Station.

Options 3C and 4 do not achieve these objectives, although Option 3C would considerably improve interchanges by reducing on-street bus stops at all the stations. Options 3C and 4 are not considered to be a viable option since the rail network.

A further option which can achieve a higher degree of segregation and improved access has 3C incorporating some additional features of Option 3C (Fig. 7.3). This would be a modified version of Option 3C incorporating some of the features of Option 3C.

1. construction of the western carriageway of Greenway Railway Station to be a two-lane dual carriageway between the existing two-lane carriageway and SJ; and
2. construction of a signalised crossroads with the rail lines to the north of the SJ.

This report has been prepared in an effort to retain Greenway Railway Station for some traffic movements or as a further section of tramway for services to higher frequencies. Option 3D would allow buses to operate in both directions, directly from the Swamp Station to Doncaster Bridge and then to Swamp Railway Station.

4. construction of extensions to rail/motorway connections, including busway and rail services.

A further option which can achieve a higher degree of segregation and improved access has 3C incorporating some of the features of Option 3C (Fig. 7.3). This would be a modified version of Option 3C incorporating some of the features of Option 3C.

1. construction of the western carriageway of Greenway Railway Station to be a two-lane dual carriageway between the existing two-lane carriageway and SJ; and
2. construction of a signalised crossroads with the rail lines to the north of the SJ.

This report has been prepared in an effort to retain Greenway Railway Station for some traffic movements or as a further section of tramway for services to higher frequencies.

A further option which can achieve a higher degree of segregation and improved access has 3C incorporating some of the features of Option 3C (Fig. 7.3). This would be a modified version of Option 3C incorporating some of the features of Option 3C.
delays at the junctions with Station Road. The northbound carriageway of Denham Way would become a two-way busway, retaining the southbound carriageway as a two-way all-purpose road. The two carriageways would merge into a single carriageway with bus priority signals at the approach to the SJB. At the Railway Station, the station forecourt and car parking area would be re-modelled to create a bus/park interchange with bus stops at the station in both directions.

The opportunity to construct a major bus/rail inter-change at Rickmans Wool should be developed with all interested stakeholders, particularly the bus and train operators. It would be feasible to provide modest facilities at relatively low cost but there would still be some level differences between bus and rail platforms which would need careful planning. A more extensive scheme could be devised if it was possible to reconstruct the area between the proposed busway and the station entrance to minimise horizontal and vertical distances between bus and railway platforms.

It is suggested that this further Di-Linking Option should be investigated and, if considered feasible, discussed with bus operators, train operating companies and Network Rail.

Recommendation

It is recommended that the further de-linking options for optimising public transport benefits identified in this analysis should provide a much higher level of integration and integration with rail and refined and evaluated in more detail and the Osthams discussed with joint bus operators and Network Rail.
Fig. 7.2 Delinking Option 5 Showing Proposed Bus Stop Intercange Area.

Plan 13 - Delinking Option 5

Fig. 7.3 Sketch plan of suggested Delinking Option 3D showing proposed biway extension.

Plan 14 - Delinking Option 3D

Gifford
8. SHORT LIST OF PUBLIC TRANSPORT OPTIONS

8.1 Overview

This study has reviewed the key characteristics of different alternative technologies that could be implemented for Haltom. The initial shortlist of alternative technologies rejected personal rapid transit, Ultra light rail and monorail systems, using the criteria of proven technology, cost, operational speed and line capacity. The long list of six alternative technologies has then been reviewed in more detail, and the results of this assessment are summarised in Table 8.1 below.

Table 8.1 Suitability of Public Transport Options for Halton

<table>
<thead>
<tr>
<th>Application</th>
<th>Guided Busway</th>
<th>Metro/Busway</th>
<th>Light Rail</th>
<th>Train-Train</th>
<th>Heavy Urban Rail</th>
</tr>
</thead>
<tbody>
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<td></td>
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Comment: Inconsistent between table and recommended options

8.2 Heavy rail options

There are four passenger rail lines passing through Halton and four stations within the Borough, as shown in Figure 8.1:

- in the CLG Liverpool and Manchester line, with local and Transpennine services, running east-west to the north of the Borough with stations at Hough Green and Widnes (formerly Farnworth);
- the West Coast Main Line Liverpool branch, electrified at 25 kV ac Ohm, running from west to south to the west of the Borough with a station at Runcorn;
- the Hetton line, linking North Wales, Chester, Warrington and Manchester to the south of the Borough with a station at East Runcorn;
- the West Coast Main Line (WCML), electrified at 25 kV ac Ohm, running from north to south to the east of the Borough with no stations in the Borough.

Note: CLG is Cheshire Lines Committee, the original railway owner, and is the common identifier for this rail route.

In addition there are freight only lines:

- the double track Ashley Green line between Ditton and Arpley Junction in Warrington, running east-west through the centre of Widnes;
- the single track Runcorn-Denby Branch Forty Lane Single branch line between Runcorn Junction and the former coal chemical plant;
- the Frodsham Branch (closed Chester/Liverpool) between Frodsham Junction on the Helsby line and Helsby Junction to the WCML Liverpool branch, known as the 'Hutton Curve'. This route is only sighted for down (reversing) train movements.

The passenger lines are not connected within Halton and hence they do not provide for any local journeys within Halton, with the exception of Widnes to Hough Green. The freight only lines have limited use but are likely to refit in operation. The 'Hutton Curve' is the subject of proposals for a new Chester - Liverpool service via Runcorn which would include upgrading the line for two way operation.

New stations have been considered at Daresbury on the WCML, Keelick Lane on the Helsby line, Widnes South on the Ashley Green line, Ditton Rocks and Barrow Green on the Liverpool and Manchester lines, Bebington on the Hutton Curve, and Ditton on the WCML Liverpool Branch. There are significant issues to resolve for these proposals, most are dependent on other factors such as new development. Some, e.g. Daresbury, are unlikely to be feasible. Others, e.g. Keelick Lane and Barrow Green could be more feasible if a train-teamed solution was considered, as discussed in Section 8.3.

A number of upgraded or new passenger services are discussed in Halton's LT2. A major upgrade is being considered for the Transpennine route which could open further opportunities for improved services and/or new stations. A passenger service could be considered on the Ashley Green line between Ditton and Warrington Bank Quay but there is currently little potential demand and it is unlikely that a service would be justified unless there was some major development. As already stated, a new service between North Wales, Chester and Liverpool could be operated over the Hutton Curve with a new station at Bebington to serve the south of Runcorn and this proposal is currently being developed. Another option is the Shelt Green route between Ditton and Warrington Central via a re-opened Widnes South station and the re-instatement of a former rail alignment, part of which has been sold. This would create an alternative route for Transpennine or local services between Liverpool and Warrington Central and provide a rail station closer to the centre of Widnes. A number of improvements to existing stations are envisaged to improve access, provide park and ride or other facilities.

It is not clear whether the MG bridge is designed to accommodate heavy rail trains but while it may be feasible to deviate a track connection on the north side, it would be very difficult and expensive to create a
heavy rail alignment at the south end and there is no available route between the southern bridge portal at Ramsay and any of the existing or proposed rail links to the south of Halton. In any event, the potential traffic would not justify the major expenditure required for heavy rail infrastructure and it would dwarf the existing Rocket rail bridge.

There may be opportunities to consider running train-type vehicles on some heavy rail routes and this is discussed in Section 6.2. It is considered that train-train would be a viable option on the existing Rocket rail bridge because it is part of the WCML, and train-train operation is unlikely to be compatible with high-speed inter-city operation. It would not contribute to the intra-metropolitan transport needs of the Borough of Halton.

8.5 Tram-train options

Train-train or light rail vehicles (LRVs), which are technically compatible with operation on heavy rail tracks in a shared track operation with heavy rail trains, (LRVs) which operate on heavy rail alignments, or lines with shared tracks, e.g. Manchester Metrolink, are not train-train. Train-train operation is now used in Germany, Netherlands and France but the only example in the UK is the Sunderland extension to Tyne and Wear Metro. Any new application would have to be developed in close liaison with Network Rail and HMRC.

It is apparent that the expansion of European tram-train systems has significantly increased the number of passengers through a combination of improved service quality, faster journey times and more frequent runs. While social and economic benefits have also been achieved.

There could be potential for tram-train operations near the site, depending on the type and extent of the network to be developed. At the north end it would be possible to dovetail this with the deck on the bridge and the Priory goods line northwestwards to St. Helens, Wigan and Liverpool. At the south end it would be possible to continue southwards on the line for the light rail options, and then join the Liverpool and Manchester line at Wigan, eastwards to Warrington or westwards to Latchford and Widnes. In any case, a study of available capacity would need to be undertaken, and the interchange between heavy and light rail fully evaluated. It would be essential to discuss any connections with Networks Rail and the ORR, HMRC, etc., an early stage to determine whether options may be worth developing.

8.6 Light rail options

Numerous examples of light rail systems throughout the world have a wide range of characteristics. They have generally been successful and stimulated a range of other social, economic and environmental impacts. Light rail networks are often perceived as an attractive, low-frequency service that is highly visible, and which can be further developed as the city centre is the main stations that have encouraged consideration.

It is understood that the provision of the MG would accommodate light rail tracks on the lower deck, within the existing structure supporting the main traffic deck. Track connections would need to be incorporated at each of the existing United Kingdom stations in the existing systems. At the southern end, it would be possible to allow trains to run southwards to Halton Line and Latchford East or westwards to Runcorn and Halton.

For light rail, there is the option of running via the S.J. (Route Option A) which reduces the length of track required to serve the principal traffic objectives.

8.7 Tramway

There is little distinction between a light rail system and a tramway except that a tramway usually has a higher proportion of street running while a light rail system has a higher proportion of segregated, or at-grade, running. In any event, it would be possible to allow trains to run southwards to Halton Line and Latchford East or westwards to Runcorn and Halton.

8.6 Bus rapid transit options

A number of technical options are available for guided busways which could be considered including bus-landmark, bus-guide rail, electronic guidance or rail guidance (ERT). Only one form is likely to be of any interest to the other forms would not be appropriate for UK application. Though the limited service offered by the London service, the U.K. form of these systems are fully rapid transit.

A high frequency service would need to be operated to ensure there is sufficient capacity both for existing alternative guidance systems, the free-guided option prefers the only viable system at present.

On the other hand, the capacity of bus routes is dependent on the traffic flow and is not limited to the traffic flow and is not limited to the traffic flow. It is important that the buses operate on the MG in terms of traffic they would probably need to be guided. The guided option would provide considerable revenue.

Other forms of transit may be applied to busways including hybrid (hydro-electric, fuel cell, trolleybus, or aerial tramways) but it is unlikely that the additional cost of an aerial tramway is the cost that is the future is always open as a transit system.
This study does not evaluate the application of guided bus technologies as a traction option for bus based rapid transit solutions for Halton. Overall, however, it is concluded that all of the alternative technology options to keep guidance are presently unsuitable, or insufficiently developed, for inner urban high performance guided busway applications in the UK, as would be required for Halton.

This certainly does not preclude the use of bus guidance for level boarding and alighting and if buses were to operate on the MS Bridge in place of trains, a form of guidance is likely to be needed for safe operation within the limited structure gauge clearances.

The relatively low unit cost of exploiting local/site specific bus guidance for docking and providing narrow rights of way through physical bottlenecks suggests that the option should be retained for further consideration as part of further detailed study and evaluation of modernising the Runcorn busway as an option for a new north-south public transport link.

8.7 High Level Bus Priorities

If a light rail or tramway alignment is planned, it would normally have a high degree of segregation from road traffic, even when running within a highway. This is to ensure that good levels of operating speed and reliability can be achieved and maintained. The same level of priority can be applied to a bus based system, much like the Runcorn busway, using the usual range of bus priority measures.

Halton’s LTP2 gives reliability as a key quality feature for the bus network. A core bus network is envisaged with ‘turn up and go’ frequencies and a maximum use of bus priority facilities is planned. High Level Bus Priority would build on this approach but extend it to work towards a much higher degree of segregation, as applied on the Runcorn Busway. It would seek to extend the busway over the routes defined as potential priority routes on the Runcorn Busway. It would seek to extend the busway over the routes defined as potential priority routes on the Runcorn Busway. It would seek to extend the busway over the routes defined as potential priority routes on the Runcorn Busway.

The whole range of bus priority measures can be used to create operating conditions which are as close to those of a tramway as possible, with the constraints of bus technology. These measures can include fully segregated busways on separate alignments (as Runcorn Busway), segregated busways within existing highways, segregated bus lanes, with line and contra-flow bus lanes, bus only streets, and traffic signal priority at junctions.

The aim of High Level Bus Priority should be to maximise passenger accessibility to the network, minimise journey times and provide protected stops for buses at intervals due to traffic congestion or other traffic activities such as parking services. It is noted that other measures are being made to parts of the Runcorn Busway, substantial sections of the busway have been abandoned. The High Level Bus Priority option would require this policy to be reversed.

8.8 Medium Level Bus Priorities

In practice it is often difficult to achieve the same level of priority for buses as can be achieved for trains. Buses can operate in normal traffic which reduces the capital costs of priority measures but speeds and reliability will be poorer. The level of bus priority applied can be adjusted at each point of the route to meet specific local needs or opportunities.

This form of priority is similar to that already being applied through LTP2 and would in effect form the basis of this case, and would continue to build upon the currently planned programme of improvements including Halton’s Quality Bus Corridors. The precise form of priorities to be applied for either Medium Level Bus Priority or High Level Bus Priority would depend on a range of factors including routes selected, land availability within the highway or adjacent

8.9 Demand Responsive Transit & Para-transit Options

Where demand levels are low and patterns of demand very dispersed, some form of demand responsive system (DRT), also referred to as ‘para-transit’, may be the most appropriate solution. Several forms of DRT already exist in Halton including Hospital LINK, Halton Dial-a-Ride, minibuses and community car schemes. These may need to be expanded and can feed into interchanges with the primary transit system.

8.10 Innovative Transit Options

Conventional urban public transport systems include bus, guided bus, trolleybus, tram, light rail, metro and suburban rail, as described above. New technology can be applied to improve and develop each of these systems.

New technology systems, or ‘innovative’ transit systems, are those which have been conceived and developed as a whole system with the objective of offering a better or more cost effective solution than conventional systems, or providing for specific ‘gaps’ in the market such as in park and ride links to town centres. A brief description is provided here.

Many different innovative systems have been developed, mainly in Europe, North America and Japan, over the past half century but few have reached prototype stage and even fewer have entered commercial passenger service. Hence the risks in adopting any innovative system are high.

9.0 CONCLUSIONS AND RECOMMENDATIONS

This comprehensive study has taken a top down approach in relation to the identification of potential possible transport technologies and systems, and associated fuel and traction options for consideration in supporting economic growth, accessibility and connectivity in this borough in conjunction with the re-linking of the SBJ and the construction of an additional bridge crossing.

In passing the study has suggested the examination of costs and a preliminary broad brush demand assessment as well as a consideration of water network issues, infrastructure and facilities for passengers.

Opportunities for introducing fixed rail transport systems such as LRT and Tram Train concepts have been examined in the study from both the physical and financial perspective. The general conclusion is that whilst fixed rail systems especially LRT can be highly instrumental in underpinning modal shift particularly in terms of public transport, the business case to support this approach is weak at this moment in time. Furthermore the current political climate in the UK as exhibited by central government, and the intricate and complex funding mechanisms of the DfT associated protocols make LRT difficult to promote compared to bus based systems. Merseytravel and Leeds City Council’s provide an illustration of the difficulties faced by public bodies when trying to promote LRT.

This is not to say that LRT or similar fixed rail technology should be dismissed in Halton. In fact this option could be considered in the long term once the critical mass and levels of demand for public transport in the borough have been developed and expanded in the short to medium term for example through road based transport modes that by comparison with LRT are cheaper and can be implemented within a much shorter timescale.

Halton possesses an extensive and long established public transport network and associated infrastructure, including the unique Runcorn Busway on the south side of the Mersey which one of the UK’s earliest examples of a self contained and highly segregated bus system.
The bus is the main mode of public transport node in Halton for local trips and this is true of neighboring authorities and conurbations including Warrington and Merseytravel. Halton is connected to the regional and national coach network however the travel opportunities that are provided by coach are relatively limited at this moment in time but could be developed and enhanced as part of an integrated transport strategy in the borough for example through the development of coach services linking Halton with Liverpool and Manchester airports.

In terms of heavy rail Halton is connected to both the regional rail network including the Merseyrail services as well as the West Coast Main Line with a key rail hub being at Runcorn. Opportunities to further develop rail based PPR.

Halton is a relatively well defined Borough in the North West Region with good highway connections to the regional and national road network although the borough has two distinct parts on either side of the river.

Increasing congestion is however creating problems for both local trips as well as traffic movement that has trip origins and destinations outside the borough. The creative use of a second Mersey crossing is aimed at providing some relief on the highway network and potentially through the proposed dualling of the S&B there are opportunities to refine the profile of public transport walking and cycling in the borough.

Local bus operations in Halton are dominated by two operators who have developed distinct operating territories. Services on the south side of the Mersey in Runcorn are dominated by Halton Borough Transport services on the north side are and by Arriva in the Widnes area.

The strengthening and development of a clearly defined network of local public transport services has been identified as a key issue for the second LTP to encourage more cross river integration, as part of a wider regeneration strategy and opening up local employment opportunities. A and a stumbling block to this may be the historically situation with the bus operators and its obvious implications of the overall public transport network in Halton.

The public transport report identified a number of major potential traffic generators and attractions on both sides of the river and external to Halton that could form the focus of a strategic network review and a plan of action that can support a strategy that will deliver step change improvements as well as public transport access and penetration improvements in line with the regeneration strategy and the promotion of sustainability.

Existing bus network and associated assets and infrastructure offer significant opportunities for creating step change improvements that offer value for money and can be delivered swiftly compared with for example a fixed rail system such as LRT.

From a network perspective and in relation to improving opportunities for better integration and bringing about the seamless journey travel are clearly a number of further improvements and enhancements that in the short, medium and long term could enable the bus network and associated services to continue to be responsive to meet travel demands in Halton. This could be developed as part of a major partnership initiative involving bus operators and transport providers from both the public and voluntary sectors as well as taxi operators that would work towards the development of a clearly defined, highly visible, attractive and efficient Halton Gateway Travel Network.

Integral to this strategy and approach would be community involvement and an approach that would seek to generate ownership and buy in from the community at large but importantly raise expectations and deliver them. Being a bus based strategy this opportunity is probably more achievable and feasible through public and private sector funding structures and finance initiatives for both capital and revenue support.

An inherent aspect of the recommended approach in terms of physical infrastructure for public transport is that through careful planning and viable engineering opportunities it should be designed and provided for but that a bus based system do not preclude for example a fixed rail systems at some time in the future.

In summary the recommendations are as follows:

- To adopt a bus based approach to the transport system and network in Halton that creates major step change and sustainable improvements for the community.
- To make best use of existing public transport infrastructure and facilities.
- To consider the use of bus priority initiatives to achieve step change improvements in Halton.
- To explore opportunities for improving access, penetration and integration within the Halton area through new initiatives and links that could be segregated and optimised.
- To explore opportunities to introduce new conventional bus priority measures including technology.
- To exploit the development of a high profile Halton Integrated Transport network and in conjunction with bus and rail operators create a strong brand image for services and facilities that attract passengers and enhance awareness from within the community.
- To take forward improvements in the provision of information and of bus safety based on best practice.
- To further improve and develop the bus based public transport infrastructure and associated services and routes in such a way that this would not preclude the introduction of fixed rail systems at some time in the future.
### APPENDIX XXX

Table 2.2 | Energy Supply Options for Public Transport

<table>
<thead>
<tr>
<th>Energy medium</th>
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<th>Trash-Front</th>
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<tr>
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<td>Off-grid operation</td>
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<tr>
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</tr>
<tr>
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<td>Possible traction option for on-board charging</td>
<td>Possible traction option for on-board charging</td>
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**Note:** OMLT, or overhead line equipment, is a combination of overhead line electrification schemes, which include various forms of overhead lines. This table lists examples of high-speed systems, up to 300km, as well as mid-speed systems to 70 km, commonly used for light rail.

<table>
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2.4 Trolley Bus and Dual Mode Bus Options

A trolleybus is a bus powered by high voltage electricity provided by overground electric conductor wires drawing electricity from an overhead line.

A dual mode bus is a trolleybus that can run on power from two different sources, and is a hybrid vehicle typically operating from an overhead line power supply and from an on-board diesel power pack, although storage batteries packs may also be used, as well as fuel cells when these become commercially available.

The diesel power pack can be typically a mechanical transmission providing an independent drive, or it can drive an electric generator which can power the trolleybus electric motor directly when "off wire" at either full performance, or at a reduced performance. The Renault FEH 180 articulated dual mode trolleybus originally used in Nancy, France, is typical of a trolleybus with a full performance diesel mechanical transmission for off wire service.

In the UK until 1984 trolleybuses, unlike motor buses, were not classified as Passenger Service Vehicles (PSV's), now known as Passenger Carrying Vehicles (PCV's) and were subject to separate technical and safety requirements set out by the RM Railway Inspectorate, largely due to the widespread abandonment of UK trolley bus systems.

The production of a dual mode trolleybus experimental installation in South Yorkshire in 1986 prompted a change in UK legislation classifying trolleybuses and dual mode trolleybuses, like motor buses, as Passenger Carrying Vehicles.

Although trolleybuses have higher ongoing operating costs compared to conventional buses, this technology offers cost savings combined with light rail. These cost savings are achieved since there is no requirement to maintain the rail infrastructure.

However, there are several limitations of trolleybuses. The average operating speeds are likely to be slower than either light rail or high performance diesel buses, creating journey time disadvantages.

The analysis shows that the limited current availability of battery or fuel cell technology, so the only practical option to use electricity to transport power via overhead conductors (for both bus and rail). This offers a number of benefits to passengers, the wider public, and the operator:

- Passenger benefits – lower possible noise levels, powerful new technology, higher quality services are likely to be seen through better performance and rail line information.
- Public benefits – lower noise levels, easier line planning, improved air quality, new line planning, improved urban mobility, new line planning, improved urban mobility.
- Operator benefits – higher mechanical reliability, lower maintenance and operating costs, operating lifetimes for vehicles could be extended.

There are several potential guidance systems available for trolley and dual mode buses, where the costs are customary to be above 50% less than the equivalent light rail schemes. Each system has been developed by national and regional governments. The General Electric System is used in the USA, whilst Alternatives like Unibloc/Unix have been built and tested on other systems. Examples of guidance systems include:

- Nolton – used in Sweden in conjunction with diesel generator sets. Also proposed on the NER12 DET bus station.
- Siemens – the West Midlands
to introduce trolleybuses in the UK at the present time.
- Westrail 860 – uses magnetic rails on the overhead line, providing a current flow to the rails which is carried by the vehicles.
- Bombardier SLE – a new trolleybus system developed in France, using a magnetic pick-up to collect power from a flexible conductor above the track.

The benefits of trolleybuses are not limited to cost savings. They also offer environmental benefits, such as reduced noise levels and emissions. In addition, they can be used in areas where light rail is not feasible, such as in urban areas with narrow streets or where land is limited.

However, there are also limitations to the use of trolleybuses. The lack of standardisation and the need for dedicated infrastructure can make them less flexible than other modes of transport. Additionally, the initial costs of installation can be high, and the benefits may only be realised in the long term.

2.4.1 Comparative Costs of Trolley and Dual Mode Buses

Since trolley and dual mode buses are not used to operate on rails, they offer considerable savings compared to light rail systems. Although the infrastructure costs needed for the operation of the more typically trolley buses last about 30 years, whereas conventional buses have a life span of 10-15 years, these costs can be reduced once the overhead wire is installed and the land development is complete.

Although the operation costs for trolley buses are slightly higher than conventional buses, this cost can be offset by the additional revenue generated over the long term. The use of trolley buses for city transport can also reduce the number of road vehicles in use, leading to reduced traffic congestion and improved air quality.

If the public becomes more receptive to this technology, it has the potential to make trolley buses more cost-effective than conventional buses in the long term. This could lead to increased adoption of trolley buses across the country, leading to improved public transport options and reduced environmental impacts.

There are several advantages to the use of rail guidance systems for trolley and dual mode buses, such as improved reliability, lower maintenance costs, and the ability to operate in areas without dedicated rail infrastructure.

In summary, trolley and dual mode buses offer a viable alternative to conventional buses, providing a flexible and cost-effective option for urban transport.

However, there are also limitations to the use of trolleybuses. The lack of standardisation and the need for dedicated infrastructure can make them less flexible than other modes of transport. Additionally, the initial costs of installation can be high, and the benefits may only be realised in the long term.
APPENDIX A

The following are the transport technologies that we consider are not suitable for Hatton and are not considered as part of any further option development and feasibility work.

2.2.2 Personalised Rapid Transport (PRT)

The most appropriate example of a PRT system is UlTra. UlTra is a demand-responsive system of über-luxurious automatic cars travelling on a dedicated guideway. Passengers arrive at the UlTra stations and select their destination via the network. Passengers have the choice of driving alone, or with up to 3 others. Although waiting times are very short, the average speed of UlTra is about 25km/h, and therefore is slow.

There are no commercial examples of UlTra yet, although there is a proposal for a network in Manchester with relatively small-scale coverage, rather than as a city-wide network as envisaged in Hatton.

Furthermore, there are problems in other cities where UlTra would not be suitable for Hatton:
- Insufficient capacity to meet public transport demand into and between town centres.
- Small in area.
- Very high capital costs given the low vehicle and line capacity.

2.3.2 Ultra Light Rail (ULR)

While ULR uses lightweight vehicles with a smaller passenger capacity, these vehicles also have lower procurement costs. Vehicles are generally less powerful, and use hybrid drive technology. ULR may be sufficiently limited as an alternative high-quality public transport system in smaller urban centres, or reducing the public effluent handled to extend local rail lines. ULR allows:
- More frequent stopping points.
- Scope to divert from the existing rail corridor to improve access to land use development.
- The introduction of a more attractive, affordable system than the existing heavy rail.

The Paris People Mover is an example of ULR, and uses innovative ‘flywheel’ technology to power the vehicle, and has the best environmental performance of any form of public transport for short-distance trips. This flywheel can be re-charged from an intermittent electrical supply at the station during boarding, allowing it to slow down. Alternatively, the flywheel could be re-charged using an on-board ULR engine, or diesel or hydrogen-fuelled engines.

However, the People Mover has been tested on the St John’s branch line, but has yet to be introduced as a commercial operation. Passenger usage is low, and the journey times to St John’s Junction are just 3 minutes. Current versions of the People Mover have just 30 seats, with aspirations to develop a higher capacity vehicle. Furthermore, the low cash-worthiness means these vehicles can only be introduced as part of a self-contained route, it is not permitted to inter-work these vehicles with other heavy rail units. Essentially, these systems aim to offer low-cost (affordable) solutions to mass rail systems. Similar to tram-trains, they are able to operate on unshaded track, with a lower noise level for signalling, controlled train crossings, lighting.

ULR could improve service quality on self-contained branch lines, or on routes with high demand between stations. However, there are a number of reasons why this technology is not suitable for Hatton:
- Insufficient capacity for large passenger numbers otherwise.
- Requires recruitment / installation of dedicated right of way using (typically) closed back.
- Limited passenger capacity.
- Generally low line speeds.
- Difficulties with inter-working with mixed traffic lines (on street).
- Difficulties with inter-working with the existing heavy rail network.
- Lack of history / cost not worthiness for predominance.

3.3.4 Monorail

A monorail (or beam guidance system) comprises a single rail that acts as the track for passenger vehicles. Systems are electrically powered, so the level of pollution is low, with vehicles using ULMR 1999.

Monorails have a good safety record, since they operate on a dedicated guidedway separate from pedestrians or other vehicles. However, the costs of constructing monorails are significantly more expensive than other monorails to serve a heavy commuter corridor like Hatton, or indeed the ability of the current flat bridge route to accommodate a monorail technology. The majority of existing systems consist of relatively short stretches and primarily serve tourist attractions.

One of the main exceptions is the new seaside monorail in Wuppertal, Germany, which is fully integrated into the rail of the city’s public transport system. As mentioned earlier, the costs are significantly higher than the option is unsuitable for Hatton.
APPENDIX B

3.1.2 Bus Rapid Transit using Guided Busways

Overview

Guided busways are much closer to trams for bringing, but more easily accommodated within a new or existing layout. 

Guided bus systems may be provided in a number of different ways, usually either mechanically, optically or electrically. 

Guided bus systems technologies have traditionally been developed in two ways:

- As a bus priority system for local, short and urban bus networks,
- As a fully contained rapid transit system

In many of the former, most guided busways have been implemented as a means of avoiding traffic congestion and delays.

They have been developed for bus priority and can be incorporated into the existing road network. 

Guided buses have the priority of traffic, which allows them to avoid traffic congestion. 

Guided bus systems, like trolley buses, use electric power to move the bus along the guideway. 

The guideway is a rail-like structure that provides stability and support for the bus. 

The guideway is usually made of concrete or steel and is placed on the ground. 

The guideway is raised above the road surface, which allows the bus to operate independently of traffic conditions. 

The guideway is typically made of concrete or steel and is placed on the ground or elevated above the road surface. 

The guideway is usually made of concrete or steel and is placed on the ground or elevated above the road surface. 

The guideway is typically made of concrete or steel and is placed on the ground or elevated above the road surface. 

A. Bus Guideway Options

There are four primary groups of guided bus frontier technology options available at present. These are:

- Mechanical guidance
- Magnetic guidance
- Optical guidance
- Variable guidance
<table>
<thead>
<tr>
<th>System</th>
<th>Stategy and Product Description</th>
<th>Applications</th>
<th>Exclusiv for High Performance or Urban Mass Transit Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical 3d guidance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Mode Flex System (DAS)</td>
<td>Similar for low-speed and high-speed systems (e.g., subways and trams)</td>
<td>Lateral Line Mechanical guidance</td>
<td>Proprietary product, exclusive</td>
</tr>
<tr>
<td>Guided Bus System (GBS)</td>
<td>Guided on tracks</td>
<td>Lateral Line Mechanical guidance</td>
<td>Proprietary product, exclusive</td>
</tr>
<tr>
<td>Mechanical guidance on embedded rail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guided Light Rail (GLR)</td>
<td>Lightly guided with a minimal overhead</td>
<td>Proprietary product, exclusive</td>
<td></td>
</tr>
<tr>
<td>TENSILE/100</td>
<td>Developed by Zollinger and Company</td>
<td>Proprietary product, exclusive</td>
<td></td>
</tr>
<tr>
<td>TRAM/CLIO2</td>
<td>Developed by the University of Illinois</td>
<td>Proprietary product, exclusive</td>
<td></td>
</tr>
<tr>
<td>Magnetic Resonance</td>
<td>Based on a high-power magnetic field generator with an external component embedded in the roadway</td>
<td>Proprietary product, exclusive</td>
<td></td>
</tr>
<tr>
<td>Trackless guideway</td>
<td>Guided by an external component embedded in the roadway</td>
<td>Proprietary product, exclusive</td>
<td></td>
</tr>
<tr>
<td>Suspension</td>
<td>Guided by an external component embedded in the roadway</td>
<td>Proprietary product, exclusive</td>
<td></td>
</tr>
<tr>
<td>System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guided Busway guidance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### A.1 Mechanical Kerb Guidance

The first pilot line was the self-balancing, linear, and guided busway system in Essen, Germany, following a public demonstration in Hamburg a year earlier. This system was later marketed commercially by Siemens AG for use in the D-Bahn, now only for Alkewski to Tea Tree Point. The research and development costs were funded as part of a contract from the West German Federal Ministry of Research and Technology (BMFT). A similar concept using "slippery" or "sticky" inductive guidance technology was advanced by MAN, but this project did not proceed to pilot line trials at that time.

The Essen pilot line, constructed in part along the alignment of a recently vacated rail gauge tramway, used prefabricated concrete panels supported by sleepers fixed to bored concrete piles for the foundations. The system consisted of a network of steel guideway rails, which tunnelled the tubes down to the 200 metre wide trackway.

This pilot installation was opportunistic, as it replaced Essen’s street running tramways with a new high performance standard gauge light rail system, including sections of underground trams in congested central areas of the city. The Spurweg was intended to determine whether the spreadout delays and disruptions to the surface bus network in the increasingly congested city centre could be mitigated by constructing segregated bus rapid transit ways along the former tramway formations.

Later trials in Essen included the installation of wooden-attached guided busways in a section of a shared light rail tunnel in the central area to explore the viability of reducing delays to buses by avoiding surface traffic congestion. However, the exhausts from diesel guided buses were discovered to be unacceptable when running in tunnels. Consequently, diesel-electric buses, operating as free-flowing buses, were used, but the project was not pursued further.

In Essen’s guided busways were considered as complementary to the new light rail system, and its a solution to explain tramway alignments to the local bus network. The main reasons for shared kerb guideways from Essen were:

- The reliability of the surface bus network improved using bus priority measures.
- The form of guidance was designed as regular bus routes which were considered as segregated kerbway alignments.
- Shared track operation in light rail tunnel required dedicated guided modes to avoid pollution from diesel fumes.
- Guidance is only used in the congested central area.
- Simple and low tech equipment is needed to allow cheap retrofit to the regular bus network.
- It is not possible to share track operation with light rail.
- The layout causes considerable inconvenience to pedestrians and cyclists.

### Adelaide

This 11.8km long North East Busway is constructed along a linear park along the city centre to the NE suburban shopping centre at Tea Tree Point. There are only two intermediate stops (one is also a bus access point) and it is the largest example of a continuous kerb-guided busway. The first section opened in March 1985 and was completed in August 1986. Plans for a second guided busway have been abandoned. Other Australian cities have not established guided busways, but a number have made limited investments in conventional busways. Operation is done at night through the city centre services can be delayed by buses running in mixed traffic with limited priority. Guided buses use regular routes to serve the outer suburbs. Some local services feed the busway, requiring passengers to interchange.

There are four reasons why the North East Busway represented a major policy shift compared to the Essen model:

1. This technology was chosen instead of light rail for political reasons.
2. It was the world’s first full-sized guided busway application along a major radial corridor.
3. It was the first to use a continuous kerb guidance system (except in the city centre).
A.2 Mechanically Guided Buses Using Embedded Centre Rail

This slot guidance is a mechanism developed for existing tunnels. The 6+1 system developed by Translated Equipment in France and Translink has developed a similar vehicle that comprises twin rails that lock together to form a 'Y' and slot into a central guideway. Vehicles travel in guided modes at speeds of 40 to 50 mph. The capacity of these vehicles ranges from 400 to 2,400 passengers per hour. This principle has been applied in Italy, with a similar example in Clermont-Ferrand.

A.3 Optically Guided Buses (e.g., CIVIS)

CIVIS has developed both a guidance system and several types of vehicles that use the guidance. The optical guidance identifies the contrast between two parallel white lines on the road against the darker road surface to steer the vehicle. Several types of vehicles were developed, and single articulated and double articulated buses can still operate with electric and hydraulic power. In Reno, Nevada, the optical guidance was installed on a belt of 60% articulated buses (second 50% in the fleet), but with a cost of around £250,000, these vehicles are significantly more expensive than conventional buses. It should be noted, however, that the optical guidance is only used to achieve level boarding of passengers. It is not used for general running stability, even though the optical guidance system has been tested with up to 25MPH speeds.

A.4 Suitability of Continuous Bus Guidance as a Rapid Transit Option for Hamilton

As stated previously, the guidance system is by far the most common form of guided busway technology used, and the only one used to date in the UK. However, none of the other options for emerging technologies offer significant benefits, since:

- less have been commercially deployed and operational service experience is therefore limited;
- there are fewer potential vehicles for the application;
- all are proprietary systems subject to one supplier group;
- few are line performance characteristics at present;
- some may encounter regulatory safety-related difficulties in the UK.

Recommendation

This study does not evaluate the potential of guided bus technologies as a significant option for rail-based rapid transit systems for Hamilton. However, it is considered that all of the alternative technologies to vehicle guidance are presently unsuitable, or insufficiently developed, for inter-urban high performance guided busway applications in the UK, as would be required for Hamilton.

It is considered that the value of bus guidance for level boarding and alighting and if buses were operated on the MG Bridge in place of trains, a form of guidance is likely to be needed for safe operation within the limited structure gauge clearances.

A.5 Other Guided Bus Operational Considerations

The UK has increasingly explored the potential of guided bus technology as an alternative to the private car for rapid transit applications. This policy delivers highly visible new investment in public transport systems and can often generate additional patronage. These systems are normally carefully marketed with no mention of it being essentially a bus.

In the market proposition made to potential purchasers by system suppliers and operators is broadly that guided bus based rapid transit technologies offer greater operating flexibility and potentially lower capital and operating costs than rail.

Guided busways are rarely selected on technical and technology grounds alone. So far, all of the recent guided bus rapid transit systems outside the UK have been introduced as either urban services, or along a tram route, or dedicated urban corridors as part of the urban distributor network. Except for those planned in the UK, none are inter-urban in nature.

In the UK, the maximum permitted length of a single bus is 12 metres and 12 metres for a large section articulated motor buses, trolley buses and hybrid buses. The maximum permitted width is 2.55 metres. There may be an allowance for increased length rigid buses of up to 15 metres and some increases in permitted widths. Of the available guidance system options, the hybrid guided systems are most cost-effective for requiring fewer vehicles, particularly requiring flexible elements to be reconfigured and, reconfigured to infrastructure.

Most guided bus systems have been confined to 12 metre rigid or up to 18 metre articulated buses. At 2.5 metre width, optical and electronic guidance technologies would be less effective. Nevertheless, the later systems have all generally restricted operating to an 18 metre maximum length and a 2.5 metre width.

As a guided bus system has adopted longer buses, double articulated buses longer than 18 metres have been produced as conceptual prototypes, and have entered revenue service in Bondouf, Daliana and other cities but not on guidedways.

As detailed previously, there is presently a limited choice of commercially available guided bus technology options. With the exception of vehicle guidance systems each of these mechanical, optical and visual guidance technology choices are proprietary systems supplied by individual manufacturers. Many of these systems' intellectual properties are subject to protection by suppliers' patents or license.

Guided busways therefore remain on emerging technology, where the early simple mechanical systems have the most established. Market trends show that these are being replaced by better or improved mechanical guidance products as well as sophisticated optical as well as new electronic guidance technologies.

The UK has adopted a significantly different policy framework in promoting the bus and tram fast guided busway for high performance rapid transit applications, compared to elsewhere in the world. With the exception of Adelaide, there have generally only been adopted elsewhere to a limited extent as highly specialised solutions for tackling problems within the context of the local urban network and not as a rapid transit technology option.
The only diesel guided busway used for most travel is the 11.4 km system in 4 areas, since no other equivalent kerb guided busway has yet been implemented for high speed inter-urban rapid transit.

A.6 Comparative Cost of Continuous Bus Guideways

Guided busways are generally provided as lower cost alternatives to light rail and trams. Although initial costs of construction are usually similar to those for light rail, the lower capital cost and running costs are dependent on providing only limited amounts of dedicated right of way.

Similarly, the headline direct unit operating cost per vehicle can be less than for light rail and trams. The guided bus tends to have significantly lower passenger capacity, typically 30-50% of modern light rail vehicles, with a vehicle life of 12 - 15 years before renewal compared with 20 - 30 years for light rail vehicles. The need to consider capital costs for guided busways and light rail and trams is a difficult task. For example in France (Lesais - Lorain) the guided busway network is an incursal signal of the earlier rail mode (trains) facilitated intercity bus service.

Consequently in this case, the extent of the primary supply and service/average speed equipment are generally considered as high investment, utilities diversions were minimal and no significant project cost allocations were made for traffic signals. Since much of the existing bus priority measures were largely re-used, capital works were largely for the installation of the central mechanism guidance/trafic systems in existing carriageways.

A.7 UK Examples of Guided Bus

Kesgrave, Ipswich

A 200 metre pilot guided way with a combined foot and cycle path alongside was constructed, but the fullwayway could only accommodate 2.4 Christchurch Buses but has since been re-grouped for 5.2 bus services. Regular vehicles are thereby prohibited, with buses prioritising unassisted use.

The guided way is used by a single bus route, although it seems any other operator could use it if suitable vehicles are used. The route has also been re-routed with new bus shelters, permanent bus lanes and traffic signal detection. Detailed passenger information is available at bus stops, and via the internet.

The guided bus is highly visible and sleek. While this service has increased passenger usage, the comparatively service quality improvements are an important objective to achieving these objectives.

Leeds

The construction of a 2km guided busway covering 2km of the 601 or 412 road and 4/5 of the 604 or 415 road. were completed in the 1980s. The scheme involved five short sections of one-way guideway.

Chasewater, a 1km guided busway was opened in 1990s. The scheme involved five short sections of one-way guideway. The bus service was aimed at public transport to avoid general traffic congestion. The guided busway is constructed from reinforced concrete with separate kerbs for the bus' guide wheels. An unusual island contra-flow busway is also provided.

The guided bus has reduced peak bus journey times by up to 50% and improved journey time reliability. Between 10 - 20% of bus passengers have switched mode from car, equating to about 500 car drivers per week. Bus frequencies have been increased in response to the patronage growth. Research identified the guided busway covers up to 5 minutes per bus in the morning peak, with the trend showing the average 5 minutes in the evening peak.

Bradford

In 2000, 2.4km of guided busway opened, built in five sections as part of a 3.7km quality bus corridor, along the A61 Manchester Road. New pedestrian crossings, 10 stops, seats set into a major landscaping.
B. Bus Rapid Transit Using Buses

B.1. Overview

Reiden possesses the only busway in the UK currently using a 2km network constructed in the 1970s to light rail dimensions, effectively allowing conversion to light rail if necessary at some future time. This is a significant engineering investment.

It was designed to serve residential areas, schools, local centres, employment areas and the main shopping centre. The two (1.5km) land use outlines were described as complementing the Reiden busway concept as a local area distributor though expansion of the busway into Wales would be inter-related in character to the successful busway systems in the UK.

Regular busways aim to reproduce the key features of light rail that are most attractive to customers, particularly service quality and the dedicated physically segregated, operating alignments. They perform the same function as guided busways, and offer the additional benefit of a fully dedicated high-speed alignment where narrow infrastructure is not a physical constraint. Buses using regular busways require no technical changes to dedicated bus lanes or adaptations, and can be up to 18 miles long (in the UK) if they are to be able to operate on street (within the highway).

Physical dimensions in excess of this can only be permitted provided it:

- The bus remains captive to the regular busway;
- The regular busway is not used as a local busway.

Regular busway systems offer a high level of bus priority with dedicated routes of way. They usually include high-speed busway construction, and established traffic management systems to maximise the level of bus priority.

In practice, the maximum operating speed of regular busways will be lower than those of regular busways, with an average speed of up to 100km per hour is possible, which is considerably faster than today's most busways although Adelaide does operate at up to that speed.

Regular busways may therefore offer superior performance compared to standard busways over longer/more urban networks. Physically segregated busways, like all segregated systems where dedicated stops and stations are provided require special attention to design measures aimed at ensuring raising passenger confidence in a more reliable operation, and reducing the operational costs for on-route systems such as regular bus services. The design and operating strategies are widely used at UK heavy rail stations and at UK light rail stations would need to be considered for any segregated bus rapid transit scheme.

B.2. Busway Options

Busways share similar characteristics to light rail, more so than the generally lower performing guided busways, and, like light rail, can include some or all of the following:

- exclusive bus lanes, bus streets, and dedicated light of way busways;
- quieter journeys;
- less traffic delays;
- bus traffic priority or pre-emption;
- better service quality (reliability and punctuality);
- complementary traffic management;
- access to bus stops of varying levels;
- complementary land use policies;
- better passenger facilities and amenities at advanced bus stops.

- track sharing with emergency services;
- operation along wholly dedicated and separate right of way;
- the use of highway median strips;
- the use of directional lane markings with lane dimensions permitted;
- bus only lanes enclosed by physical barriers;
- bus only lanes enclosed by physical barriers with traffic or pedestrian separation.

Any extension of the current Reiden busway might see any or all of these approaches.

B.3. Other Busway Operational Considerations

Most regular busways are segregated highways, especially those designed within the existing highway boundaries, though not necessarily within the general running configuration, for example, busways built within highway median strips and within edge strips.

As such regular busways, regular busways can be constructed to serve at least three distinct roles:

- as a limited express bus priority route for local, corridor and wide urban bus networks or;
- as a community bus service combined with rapid local alternative to light rail and tramways.

In the latter context, it is most relevant to Holland in this study.

Regular busways are often proposed as a means to provide a means of improving the efficiency and effectiveness of existing the head bus services in an affordable way by conversion to rapid transit.

There is renewed interest in busways (ground or rail) as a rapid transit option in the UK. Europe and the United States, with the limited capacity to land the number of light rail and heavy rail schemes being proposed.

Busways may be extended as a pre-carrier to light rail, or a substitute for light rail is simply not affordable, give the recent cost escalation that makes it challenging to achieve the necessary cost benefit ratio needed to obtain Government approval.

B.4. Comparative Costs of Busways

The buses themselves are comparatively inexpensive to buy and provide the core of many new and new public transport networks. Diesel bus operation avoids the capital outlay for electrification costs for a regular light rail line. However, there is a perception that buses offer less comfort, convenience and speed than either light or heavy rail based technologies. The planned physical characteristics of a well-designed busway can be equivalent to, or exceed, that of some light rail conditions.

The construction costs of the busway also fall in line with highway construction costs. Complementary traffic management costs of busways are likely to be similar to that of light rail, or a given level of priority. However, the costs per passenger are likely to be higher, since a higher number of lower capacity buses will be required compared with light rail, for maintaining a good service level and supplying sufficient line head passenger capacity.

B.5. Global Examples of Busways

UK and European applications of regular light rail are used to be seen part of the urban or local bus networks. The UK has recently made the largest investments in busways which exhibit inter-modal rapid transit characteristics. Some of these numerous applications are set out below, followed by some other examples from elsewhere.

- Houston, Texas;
- Washington, DC (Chesapeake Highway).
The characteristics of high performance light rail systems can be broadly summarized as:

- Operation along dedicated, wholly physically segregated alignments;
- Often along former heavy rail alignments;
- Wholly fenced alignments with simplified railway type signalling;
- Use of former heavy rail or metro alignments;
- Permitted line speeds in excess of 100km when signalled;
- Line of sight;
- Limited or no operation on street;
- Not usually interoperable with heavy rail;
- Low or high platforms for level boarding;
- Fewer intermediate stops / stations on line of route;
- Electrification at higher voltages than permitted for on street applications;
- Trench floor or level boarding rail stock generally heavier than typical street running tramways.

C.2. Light Rail Technology Options

Essentially higher performance light rail systems perform the same function as regular heavy passenger railways with the additional benefits of achieving higher rates of acceleration/deceleration and lower dwell times by virtue of their superior performance. Light rail systems have the capacity to utilise more steeply graded routes than is possible with conventional heavy rail passenger services.

The table below summarizes the performance characteristics of the three types of typical light rail operating systems—those systems employed by the major operators, other than the line of technology.

Light rail systems technologies have been exploited in two ways, each distinctively different. These are:
- as an urban light rail system, requiring line of sight street running and level working with other road traffic—this is typical of the newer UK light rail systems;
- as a rapid transit technology alternative to heavy rail and metros.
Table C.2 Light Rail Characteristics

<table>
<thead>
<tr>
<th>System</th>
<th>Performance Characteristics</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street railways</td>
<td>A general term applied to any form of surface-railway operation with direct passenger contact</td>
<td>Belfast Tramway</td>
</tr>
<tr>
<td></td>
<td>Generally with low level or raised platforms, often requiring pedestrian transfer to other forms of public transport.</td>
<td>Gatwick Express Line</td>
</tr>
<tr>
<td></td>
<td>Generally with high level or raised platforms, often requiring pedestrian transfer to other forms of public transport.</td>
<td>Manchester Metrolink</td>
</tr>
<tr>
<td>Urban railways</td>
<td>Medium to high performance light rail serving urban areas or semi-rural areas with high capacity, often requiring pedestrian transfer to other forms of public transport.</td>
<td>South Yorkshire Supertram</td>
</tr>
<tr>
<td></td>
<td>Operating on street and or segregated infrastructure. Line level or grade level platforms (if platform at all), although there are exceptions.</td>
<td>Nottingham Express Transit</td>
</tr>
<tr>
<td></td>
<td>There is no truck clearing or impeding with other modes of transport, and right-of-way can often be shared with transport at night.</td>
<td>Manchester Metrolink</td>
</tr>
</tbody>
</table>

There were substantial investments in light rail and similar "light" railways worldwide in the late part of the 20th century. For the most part, these occurred in North America, where many of these were urban trams or light railways, including many examples in France and Belgium.

Many of the concepts of railways used by the original electrified inter-urban light rail networks in North America have resonance today, and the basic principles are still applied in present-day inter-urban light rail applications. Most, but not all, of these inter-urban light rail lines were electrified.

C.3. Other Light Rail Operational Considerations

There is often strong local political support for new light rail systems, since the promoters of new systems identify the wider social and economic benefits that have occurred elsewhere. The integration of new light rail network is usually accompanied by complementary measures including extensive pedestrianisation of the city centre and parking restrictions. One of the factors contributing to the support for this is the favourable perceptions of service quality. The recent report by the Government Endorses this conclusion by presenting evidence that light rail is more successful in encouraging car drivers to transfer than other alternative modes through:

- Frequent services with intervals, attractive journey times to meet the convenience of car.
- Versatility to operate in high-speed or segregated sections, yet provide convenient access to the city centre.
- Faster economic, environmental and safety benefits.
- High-quality, comfortable, reliable vehicles that has successfully persuaded car drivers to transfer.
- Easy access for mobility impaired, or those travelling with children or luggage. Wheelchair accessible vehicles have been introduced, some cities use relatively new rolling stock that offers limited accessibility.

When considering conversion of heavy rail passenger services to light rail, there are a number of potential benefits including:

- Reduced cost of operation (and the potential for a reduced subsidy requirement), etc.; the modern light rail vehicles offer higher-quality rolling stock than that provided today.
- The potential for improved service frequencies and improved city centre accessibility;
- The restructuring of services to meet local demand and be more responsive to travel patterns;
- The opportunity, through operating lower floor light rail vehicles, to provide more 'stations' to improve access and make better use of the rail corridor;
- Opportunities for local autonomy, involvement and ownership of decision-making;
- Better integration of the rail corridor with other modes, as its frequency improves.

C.4. Comparative Costs of Light Rail

A range of funding mechanisms has been secured for existing UK light rail systems, which are generally more costly than bus-based solutions, but they are generally less costly than a heavy rail alternative.

For example, the first phase of Metrolink was funded through a combination of Section 50 grants from the Department of Transport, and borrowings from Greater Manchester Passenger Transport Authority. The private sector has demonstrated a commitment to delivering high-quality systems. This is evident in the significant support and funding provided by private sector partners, such as Transdev and Network Rail, which have undertaken additional funding for the system.

The private sector has also demonstrated a willingness to invest in light rail systems by contributing 20% of the total costs for the second phase of Metrolink to Euston. Furthermore, the Greater Manchester system was funded by a Private Finance Initiative involving Amey and an onshore company. Significant revenue shortfalls for the concessionaire meant further bank funding or restructuring was needed to continue trading. These difficulties, and the under-performance of several other systems, may have diminished the potential for private-sector investors to secure the other funding sources.

The government has been successful in securing commercial support for the light rail system in England through Light Rail, April 2003.

Section 56 grants were secured for the initial light rail systems, but changes in the funding regime removed this funding mechanism. The Bristol and South Gloucestershire light rail system proposed a hybrid funding revenue from road user charging to cover the gap between operating costs and revenue. There was public support for road user charging, but only if the light rail system was a complete package of the charging regime. At present, this scheme is not being taken forward for implementation.

The concept of combining subsidy offers an innovative funding mechanism if light rail replaces a lost-making heavy rail line. Instead of continuing to provide financial support to cover the difference between revenue and on-going operating costs for lost-making heavy rail routes, capitalising subsidy allows the on-going revenue support to be invested in infrastructure, or the procurement of rolling stock. Both Coventry...
Tramlink and parts of Manchester Metrolink have taken over former heavy rail alignments, and the subsidy previously used to financially support these services has been re-allocated to part-finance the infrastructure. The DfT did not grant approval to these light rail schemes following a significant escalation in the schemes cost caps. Funding announcements for Manchester Metrolink Phase 3, Leeds Supertram and the South Hampshire Rapid Transit System have either been delayed or been withdrawn, with promoters required to reduce the capital costs, or seek alternative funding mechanisms or alternatives to light rail.

Dialogue between the DfT and the scheme promoters in Leeds, with some cost savings of about £200 million achieved through changes in approach to procurement and risk, and re-scoping the definition of the project helped to save the scheme.

C.8: UK Examples of Light Rail

The 11 mile Blackpool Tramway between Starr Gate and Fleetwood, has survived as a coastal tramway. Whilst the segregated alignment to Fleetwood used to exhibit inter-urban characteristics, later inland development means this section is now entirely urban in character and operates as a low speed street railway. The conversion and significant extension of the Blackpool Tramway into a modern urban high performance light rail system is now a key local development theme.

Many of the newer light rail schemes in the UK exhibit intra-urban light rail characteristics along part of the route. However, the systems themselves are still urban in character. The inter-urban sections of these systems are all examples of conversion, reuse or adaptation of former heavy rail alignments. The combination of re-used railways and modern low floor high performance light rail vehicles is an increasing global trend. The utilisation of weaving rading tracks for inter-urban light rail is reducing the number of examples for fully signalled heavy rail track sharing applications. The UK systems exhibiting some inter-urban characteristics along part of their route or alignments are:

- Manchester Metrolink (to Droylsden, Eccles)
- Midland Mainline (Crewe to Wolverhampton)
- Civic Tramlink to Wimbledon
- Tyne & Wear Metro with permitted heavy rail track sharing to Sunderland
- Sheffield Supertram line 2 to Meadowhall
- Nottingham Express Transit (trains on railway alignment)

Tyne & Wear Metro

The opening of the Tyne and Wear Metro in 1980 connected underused suburban railways. This system is fully segregated, with no sections of street-running. The segregated network permits a relatively high operating speed (37.5 km/h), with an average spacing of 1.3 km between stations. A tunnel under the city centre improves access to the main retail and employment areas in Newcastle. The network was subsequently extended to Newcastle Airport and Sunderland. The Metro revitalised local rail services in Tyneside, with the introduction of new rolling stock and more convenient city centre access.

Croydon Tramlink

Croydon Tramlink comprises a 28km network, with routes from Wimbledon to New Addington and Ewell via Croydon. Tramlink attracts significantly higher passenger flows than the former rail service between Wimbledon and Croydon through a combination of higher frequencies (trains operate at least every 10 minutes) and better service quality. Although the majority of passengers using Tramlink were abandoned from bus, about a third of passengers have switched from one to the other.

The service is mainly used by commuters (45%) and shopping (26%). Similar to Manchester Metrolink, the mixture of segregated alignments (Wimbledon to Croydon, and Beckenham to Beckenham Junction) and on-street running in Croydon town centre means the average operating speeds are just 20 km/h, with an average distance between stations of 0.7 km.

Manchester Metrolink

The completion of the first phase of Manchester Metrolink formed part of a wider masterplan to light rail serving the Greater Manchester conurbation. The heavy rail service was operating at a loss, offering a poor quality, unreliable service. Metrolink Phase 1 significantly improved link to Bury and Altrincham, with up to 6 trains operating per hour. The route uses much of the former heavy rail alignment, with on-street running via the city centre.

The conversion to Metrolink has provided a significantly better service. Passengers is over 80% higher, including a doubling of off-peak trips. The average operating speed is 37.5 km/h. This is slightly slower than the Tyne & Wear Metro, reflecting the on-street running via the city centre.

The average gap between stations (1.1 km) is also less than the Tyne & Wear Metro, and this is consistent with the close spacing of stations in the city centre. While 80% of Metrolink passengers were obtained from the former rail service, about 20% of passengers were obtained from car. This has generated significant environmental benefits.

D. Tram-Train as a Rapid Transit Option

D.1. Overview

Tram-train concepts are increasingly popular and provides a means for light rail vehicles to access and use heavy rail alignments where there is the opportunity. The essence of tram-trains is heavy rail interoperability and to deliver greater accessibility within communities.

Tram-train was first introduced in Germany in the late 1970s in response to a need to improve the suburban rail track to allow shared use with light rail. This concept links urban tramways with regional heavy rail networks to deliver significantly better access to the city centre if the main rail station is located remotely from the main employment and retail areas. This is achieved by introducing heavy rail vehicles onto the urban tram alignment, trains are not extended to operate on the heavy rail network.

The first stage in developing a tram-train network was the extension of the Altkothalbahnhof, an electric suburban light rail line from Kunkelsbu to Bad Homburg and Taunusberg. In 1979, the network was extended through central Kranichstein using the tram network, then north to Neuheim serving the track with freight trains on a light-rail branch line. The shared sections were electrified. Dual voltage tracks were developed, using different types of light signalling for each type of section.

High speed services to trains, freight and the local tram-train services are permitted to use the infrastructure. Strong local support for tram-train within the Kranichstein network has led to the tram-train network being extended to 40km.

D.2. Tram-Train Technology Options

There are two approaches that are currently adopted within tram-train technology:

- Metro lines, where all mainline trains are replaced. There is no requirement for inter-operability compatibility with mainline trains. These lines are permitted to use regular modern high-speed trains (of up to 250 km/h or 80 mph maximum speed) on standard railway alignment and potentially 90 - 100 km/h, subject to rail speeds. Line 2 of the Sydney Tramway Supertram (Middlecote to Meadowbank) and the Bury to Altrincham lines of the Manchester Metrolink are typical examples.
- Metro lines, which require the trains to share tracks with mainline trains, passenger and freight, for part or all of the time.

If different types of rolling stock are required to inter-work with each other at the same time, (rather than at different times of the day), metro vehicles must be entirely compatible with the mainline trains, and the signalling and safety systems.
Both Boeber and Siemens have developed rolling stock suitable for tram-train. The “Flexible Line” has been successfully introduced in Rastatt-Rothenburg, to permit travel from the rural hinterland to the city centre with interconnection. The three city tram services also offer a high level of passenger comfort, with air-conditioned interiors. Siemens have developed similar rolling stock, and these units have been successfully introduced in Karlsruhe.

Tram-trains can tackle many of the difficulties associated with high costs for running “mainline” trains along economically and financially fragile passenger routes. Transrail is well equipped to address the problems of:

- poor acceleration and slow braking which restricts the number of stops to maintain line capacity
- the high “mainline” train urban weights are usually double that of similar-capacitated tram-trains, which requires much heavier duty, and more expensive, track design and maintenance, and much higher maintenance costs, particularly for locomotived tram-trains
- slow braking and higher weight prevent drivers stopping within “line of sight” and require expensive signalling and level crossings to be fully protected by signals, gates, or barriers – this reiterates the availability of train paths, and reduces capacity. In contrast, tram-trains can run at any frequency required generally no5-minute intervals or less
- stations typically have underground platforms, and ticket gates to allow passengers to cross the line by a grade-separated route. In contrast, pedestrians must cross the tram-train track at pedestrian level signal crossings.

Tram-train can reduce or eliminate expensive signalling and track circuits. Services can be extended via new alignment, since the rolling stock performance of tram-trains is superior to conventional heavy rail vehicles. It allows trains to climb steeper gradients, and reduce the costs of identifying engineering alignments.

One of the factors contributing to the success of tram-trains is often the distance from the rail station to the main employment areas. A walking distance of about 10 - 15 minutes from the main rail station is usually required to deliver a successful tram-train business case. If the distance is too short, there is no particular reason to walk to the destination. The ability for through running and the time savings achieved are among the main benefits of the tram-train.

Consideration must also be given to the population densities facing service. Tram-trains are not suitable for densely populated corridors in metropolitan areas, where capacities are already sufficient to cater for future demand. Furthermore, a sparsely populated area is unlikely to generate sufficient passenger to develop a robust financial case.

D.3. Other Tram-Train Operational Considerations

While light and heavy rail systems share the same track gauge of 1435mm, they do not share a common operating (infrastructure) gauge. Careful design solutions have to be found to overcome the problems of platforms lengths and widths, bridges and fixed equipment, ramps and safe platform design. Occasionally, one side of the service can operate on a different track gauge with the same track gauge switch to another system when necessary. There are also a need to ensure that platforms are designed to accommodate double-deck stock if required.

Before the introduction of tram-train systems, there is a number of important institutional issues to be addressed before a proposal can be implemented. Ovemheads of rolling stock, impact on existing staff (wages and pension contributions) and operability licensing is a key question. Key delivery milestones include:

- technical acceptance - profile of the wheel-Flange, electromagnetic interference, slewing distance to the pedestrians, compatibility with Network Rail Group Standards
- safety acceptance - meeting all HMI and RIVAR requirements

D.4. Comparative Costs of Tram-Train

The costs of tram-train schemes are broadly comparable to a light rail scheme, although the vehicles themselves may be more expensive. As such, therefore, tram-train is more expensive than a bus-based solution, but less expensive than an equivalent heavy rail scheme.

Many of the comments in the preceding section regarding innovative funding opportunities for light rail schemes should be equally applicable to tram-trains, but these have not yet been tested in the UK.

D.5. UK Examples of Tram-Train

The Sunderland extension of the Tyne & Wear Metro involves track sharing and inter-operability. This example is described in Chapter 7 of this paper.

The Greater Manchester Strategic Rail Study recommended tram-train introduction on the line to Wigan via Ashton and on the Eastern lines to Gorton/Bury/Bolton, Marble and Free Hill as both short and medium term options.

D.6. European Examples of Tram-Train

Karlsruhe

Kaiserslautern is a renowned in the main employment and retail areas of the city, and interchange with the city’s tram network was also poor. The heavy rail network was connected to the local tram routes and rolling stock modified for both types of traffic. A safety case was developed to permit both freight trains and tram-train vehicles to share the track. The project was funded by an existing infrastructure, and offered passengers better access to the city centre without interchanging. Frequencies were improved and journey times reduced, hence the new rolling stock permitted faster acceleration/deceleration.

Increasing the number of stations and thus accessibility, with particular station location in relation to the population and key destinations is also an important determining influencing demand, in Karlsruhe the number of stops was increased from 6 to 36, without any loss in travel times, gives the new through connections to the city centre. The frequencies were increased from about 40 to 70 trains per hour, with services continuing to operate in the late evening and at weekends.

Two routes were initially introduced:

- Karlsruhe – Baden: 60% increase in patronage in 7 years
- Freiburg – Karlsruhe: 100% increase in patronage in 5 years

Several other sections were constructed in the 1990s, including routes to Gottingen, Goettingen, Bremen, Munchen. More recently, funding constraints have prevented the opportunities to expand the network.

The operating costs of the tram-train system are significantly lower than those of heavy rail services. Overall operating costs were reduced by about 50%, although maintenance and fuel costs increased.

Kassel

Kassel has a population of 200,000, with an additional 100,000 people living in the Travails to work area. It is located on the Hanover to Kassel high-speed rail line. In 1995, one of the remaining was extended to

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Batuful (population 25,000, with significant manufacturing employment) using a freight goods line. This increased population required a service and the number of daily passengers more than doubled from about 2,800 to 5,800. Streamlined train trains suitable for heavy rail track sharing were introduced.

Six years later, two tram lines in east Kassel were extended to Holle via a freight-only alignment. Overhead electrification was introduced, and new stations constructed. Bombardier tram-trains were deployed on this route. The increased passenger numbers meant the level of subsidy was reduced by about 10%. There are plans to extend the tram-train network to include towns located about 30km from Kassel, but feasibility assessments are still ongoing.

Saarbrücken

Two tram-train routes have also been developed in Saarbrücken (known as the Saarlinie). The construction of 5.1 km of new track allows passengers to travel directly into the city centre from towns located up to 30 km away. The first phase of the tram-train network was constructed to Brebach, with an extension to Saarbrücken. The original patronage forecasts for the route have been exceeded, with an extra 0.1 million passengers per year using the network.

The tram-train network has helped deliver wider regional economic benefits. About 50% of passengers using tram-train switched from car. The system has been operational for about seven years, and there are proposals to integrate two additional lines to serve the region. One line was completed in about six years, but construction of another alignment took about 14 years, following extensive delays after a public inquiry.

4. PUBLIC TRANSPORT ROUTE OPTION DEVELOPMENT